TEKTRONIX®

To Our Customers On Our Twenty-Fifth Year

Tektronix is now 25 years old. There is no magic in that number to make it significant, any more so than being 24 or 26. Yet the quarter-century mark *does* suggest a time to pause and reflect.

In those 25 years, we have seen great changes in technology. Tektronix has changed too—not in basic ways but certainly in size, in complexity and in its role, moving from unknown challenger to recognized leader.

It would be convenient for me to trace Tektronix' past by citing certain of our products which, over the years, may have taken on particular historical importance. A fairer assessment of our influence on the field of measurement would be gained by scanning that field today. If you do, you will soon realize that a *very* great number of the basic oscilloscope features and functions—things so common to all scopes that we now take them for granted—began as Tektronix innovations. It is for this reason as much as any other that "Tektronix" and "oscilloscope" have become so nearly synonymous.

I should note here that "first"—like "biggest" and "fastest" and so on—are transitory things. A true measurement of a company must also include its quality of workmanship, its adherence to high standards and the lasting value of its contributions. Still, innovation is certainly a key part of leadership; and our history is studded with important "firsts".

Here are a few of many ideas on which today's oscilloscope art depends; each was pioneered by Tektronix:

Triggered sweep. Before the Tektronix 511, commercially available oscilloscopes used synchronized rather than triggered sweeps as their basic time base.

Remember the problems of keeping a stable display? And sweep times shorter than the period of the signal were impossible. The introduction of a *hold-off time* to assure that the sweep circuit recovered completely between sweeps is now routine with oscilloscope designers. But it, too, was a Tektronix invention.

Trigger-level selection, both manual and automatic, was another Tektronix innovation. The more recent "peak-to-peak auto" trigger-point control continues our effort to make the oscilloscope easier to use.

A simple thing that nevertheless added greatly to ease of use was the *1-2-5* scale used for volts/div and time/div. Now universally adopted, it first appeared on the 315.

Regulated power supplies, including the oscillator-type high-voltage supply, were introduced commercially in the 511A and 512.

Non-resonant probes, now used with all high-impedance wideband oscilloscopes, are covered by Tektronix patents. I feel this is one of our more important inventions.

Still another Tektronix "first" was *alternate-sweep* dual or multi-trace amplifier circuitry.

Plug-in units. A sweep that would work as slowly as 12 s/cm and as fast as 20 ns/cm was developed in 1952. It was obvious that, to fully use it, a variety of signal amplifiers would be needed. Thus the plug-in idea was born. Our competitors poked fun at it—but our customers loved it.

Today, our 7000 series uses two sweep and two vertical plug-ins, providing very great flexibility. In addition to numerous preamplifier units, we also offer plug-in sampling systems, counters and DMMs. And there are many more to come.

Direct-viewing bistable storage. Development of a simplified storage CRT that maintained its image without fading out made the storage oscilloscope a widely used instrument. Since our tube required no meshes, as existing ones did, large storage screens became practical, such as those used in our 611 display units and our computer terminals.

In the area of CRTs, *ceramic funnels,* a feature Tektronix alone offers, provide dimensional precision and lighter weight—and they permit good *edge illumination of the internal graticule.*

Portability. Almost unique to Tektronix are truly portable oscilloscopes. These small, lightweight instruments combine laboratory quality with the ruggedness necessary so that, despite being carried about day after day, they will perform reliably.

The 321 was the first battery-operated portable; the 454A is the fastest, the 323, the smallest and lightest.

In our "new-generation" instruments, this innovativeness continues. For instance, *circuit-board switches* have replaced troublesome wafer switches. *Cathode-ray-tube readout,* incorporated in the 7000 series, makes possible the readout of scale factors, counter and DMM output and other information on the screen of the CRT. Thus the oscilloscope is converted into a true integrated test system. The four Tektronix-developed ICs that provide the necessary character generation contain 1200 emitters each. Although these innovations are recent, history suggests that they, too, in time may become so commonplace in the scope field that we may forget, unless reminded, that they started here.

Now, in our 25th year, the instruments in this catalog continue Tektronix' tradition of innovation, performance and value. Let me mention two examples: the 5100 series and the 7400 series. Both move advanced performance down into a new price range.

The 5100 series is by far the most versatile low-frequency system anywhere. Made in two modules, display module and plug-in module, it's an oscilloscope which the user can convert to and from a cabinet or 5¼-inch rackmount at his convenience. Four interchangeable display modules give a choice of single or dual-beam, storage or non-storage CRTs, with a 4 x 5-inch graticule area. The 5100 is the only low-frequency plug-in scope. It accepts up to three of nine plug-in units, with more to come—a combination of features and prices that should prove very attractive to many users.

We are equally enthusiastic about the 7400 series. The DC-to-50 MHz performance range meets more customer needs than any other. Combining three-plug-in capability, smallness and light weight, and offering a 6½-inch CRT, the new 7403 is a most attractive oscilloscope.

Tektronix' pioneering has not been limited to design. Our field organization, the industry's first move to close direct marketing, has become a model for the industry. There are now 220 field engineers operating from 79 offices in 13 countries.

Our manufacturing is highly vertically integrated, producing a large and growing share of the key components and materials on which our technical progress depends. And it makes increasingly creative use of advanced methods, including computers and automation. Factories are located in four key areas of the world.

All of this cannot be otherwise. For, if we are to continue to lead in technical excellence, service and reliability, innovativeness must not only be continuous but also pervade the company. At Tektronix, we intend to continue to live on the edge of the state of the art.

Howard Vollum

Howard Vollum
President

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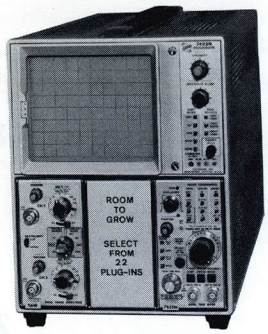
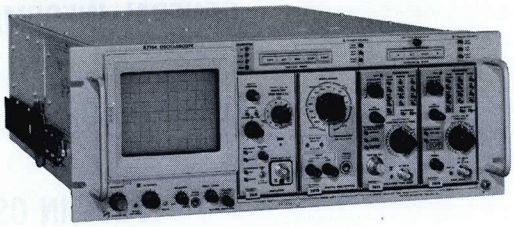
New Product Summary

NEW 7000-SERIES PRODUCTS





7403N Oscilloscope—The 7403N Oscilloscope with a new 7A18 5-mV dual-trace amplifier, 7B53N dual-time base, and a third plug-in compartment, represents today's lowest price ($2200) in a high-performance, 50-MHz plug-in laboratory oscilloscope. The 7403N has a large 6-1/2 inch CRT, weighs only 30 lb and accepts all 7000-Series amplifier and time base plug-ins. See pages 34 and 35 for complete characteristics.

7514 Storage Oscilloscope—The 7514 is a split-screen bistable storage oscilloscope designed to accept all 7000-Series plug-in units. Among its features are a high writing speed CRT, four-plug-in compartments and CRT Readout. The 7514 introduces a unique write-thru mode of operation that allows simultaneous stored and conventional displays in the same area of the CRT. See pages 38 to 40 for complete characteristics.

R7704 Oscilloscope—The R7704 is a rackmount configuration of the 7704 150-MHz Oscilloscope. It is designed to fit a 19-inch by 7-inch rack opening in a standard 24-inch deep rack. See pages 41 to 43 for complete characteristics.

7A15 Amplifier—The 7A15 is a low-cost, 5-mV, single-trace amplifier for use with all 7000-Series oscilloscopes. Its bandwidth is 75 MHz with 7700-Series, 60 MHz with 7500-Series and 50 MHz with 7400-Series mainframes. See page 49 for complete characteristics.

7D13 Digital Multimeter, 7D14 Digital Counter—The 7D13 and 7D14 are the first digital plug-ins for an oscilloscope. Both are compatible with all 7500 and 7700-Series mainframes and will function in any plug-in compartment. Their alphanumeric readout is displayed directly on the CRT. Now, temperature, resistance, voltage, current, and frequency (to 500 MHz without prescaling) can be digitally measured with an oscilloscope, without sacrificing any conventional features. See pages 60 to 63 for complete characteristics.

7S12 TDR Sampling Unit—The 7S12 is a combined vertical-horizontal, double-width plug-in unit, designed to operate in all 7000-Series mainframes. It permits high-resolution TDR or general-purpose sampling measurements. As a TDR, using the new S-6 Sampling Head and the new S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps. Time or distance to a discontinuity of interest is read directly from a tape dial. See pages 66 and 67 for complete characteristics.

NEW S-6, S-52, S-53, S-54 SAMPLING HEADS

These four additional sampling system heads have been added to the seven previously available:

S-6 Sampling Head—A 50-Ω feed-through unit for general-purpose applications in the 3S2, 3S5, 3S6, 286, or 7S11, and TDR applications in the 7S12 Time Domain Reflectometer. Risetime is 30 ps. See page 115 for complete characteristics.

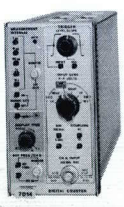
S-52 Pulse Generator Head—A tunnel-diode step generator designed for use with the 7S12 Time Domain Reflectometer. The S-52 is also useful in the 7S11, 3S2, 3S5, 3S6, 285, or 286. Risetime is 25 ps. See page 117 for complete characteristics.

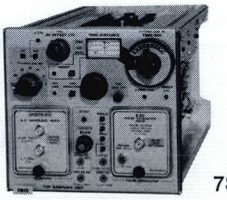
S-53 Trigger Recognizer Head—Intended for use with the 7S12 Time Domain Reflectometer Unit to permit operation as a general-purpose sampling system. The S-53 receives the triggering signal at its input and supplies trigger outputs for the 7S12 or for other triggering applications. The S-53 can also be used in the 7S11, 3S2, 3S5, 3S6, 285, or 286. See page 117 for complete characteristics.

S-54 Pulse Generator Head—A current-source step generator designed for use with the 7S12 Time Domain Reflectometer Unit. The S-54 is also useful in the 7S11, 3S2, 3S5, 3S6, 285, or 286. Risetime is 1 ns, amplitude into 50 Ω is greater than +400 mV. See page 118 for complete characteristics.

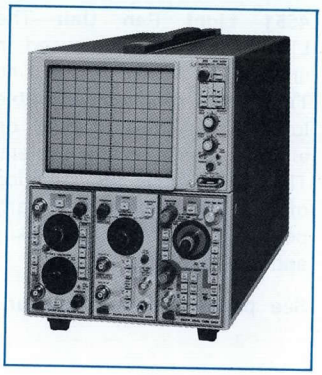
7A15

7D13


7D14


7S12

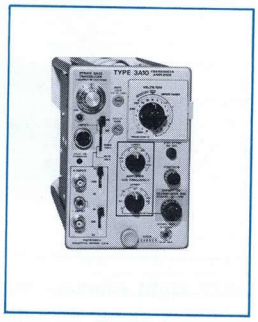
NEW LOW-FREQUENCY PLUG-IN OSCILLOSCOPES



5103N Oscilloscope System—The 5103N Oscilloscope System is a high-performance low-cost system consisting of a mainframe unit, four interchangeable display units, six vertical amplifiers and three time bases. The 5103N mainframe has compartments for three plug-ins and is compatible with each of the four display units. Four display units include single and dual beam units and single and dual beam storage units. Mainframes and display units assemble into cabinet or rackmount models and may be converted to the other configuration as desired. Plug-ins include single and dual-trace units with deflection factors to 1 mV/div and 2-MHz bandwidth. Two differential plug-ins (one has both voltage and current inputs) have 50 μV/div deflection factors and 100,000:1 CMRR. Time bases include a single-sweep and a dual-sweep unit (both with sweep rates to 100 ns/div with the X10 magnifier) and a basic unit with sweep rates to 5 μs/div.

See pages 72 to 82 for complete characteristics.

NEW 560-SERIES PRODUCTS



3A10 Transducer Amplifier—The 3A10 is a DC-coupled differential amplifier specially adapted for transducer inputs. The 3A10 can be used with standard voltage probes or as a transducer amplifier. Its inputs are designed to use piezoelectric and voltage-excited transducers. Pressure, force, acceleration, vibration, displacement, strain, and temperature can be measured with calibrated scale factors appropriate to the transducer used.

See pages 103 and 104 for complete characteristics.

3S7/3T7 TDR System—The 3S7 and 3T7 TDR Units function as a simplified, low-cost time domain reflectometry system designed to operate in a 561B or 564B Oscilloscope.

This is a single channel, loop-through TDR system calibrated in V/div or rho/div. The TDR system has TIME/DIV and TIME-DISTANCE controls, with a direct-reading scale.

See pages 119 and 120 for complete characteristics.

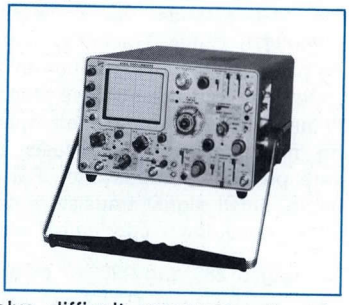
NEW PORTABLE OSCILLOSCOPES

324 Sony/Tektronix Oscilloscope—The 324 has 10-MHz bandwidth, 10 mV/div deflection factors and 1 μs/div to 0.2 s/div sweep rates. It operates from internal rechargeable batteries, AC and external DC sources. Total weight including batteries and accessory pack is less than 9 pounds.

See pages 184 to 186 for complete characteristics.

453A Oscilloscope—The portable 453A is a dual-trace 60-MHz oscilloscope with deflection factors to 5 mV/div, sweep rates to 5 ns/div and delaying sweep. A CRT with 8 x 10 divisions (0.8 cm/div) and 14-kV accelerating potential provides a bright, high-resolution display for field maintenance as well as laboratory applications.

See pages 191 to 194 for complete characteristics.



454A Oscilloscope—The 454A is a solid-state portable oscilloscope with laboratory performance. The 454A has dual channels with deflection factors to 2 mV/div, 150-MHz bandwidth, sweep rates to 2 ns/div, delaying sweep and an 8 x 10 division (0.8 cm/div) CRT. Sweep rates to 2 ns/div, combined with a large CRT, provide the performance to solve difficult measurement problems such as resolving pulses with low-nanosecond periods.

See pages 195 to 198 for complete characteristics.

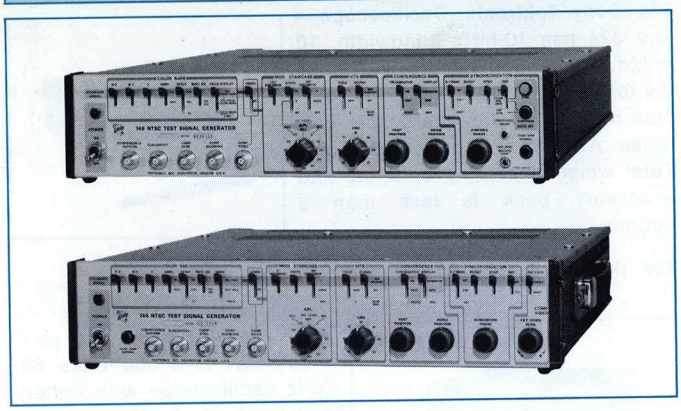
NEW SPECTRUM ANALYZER SYSTEM

1401 Spectrum Analyzer Module—Spectrum analysis in the 1-MHz to 500-MHz frequency range is easily done anywhere with the 1401 when combined with the Sony/Tektronix 323 or 324 to form a 15-pound battery-operated system. The 1401 Spectrum Analyzer Module can also be used with many other oscilloscopes.

See pages 206 and 207 for complete characteristics.

New Product Summary

NEW TELEVISION PRODUCTS



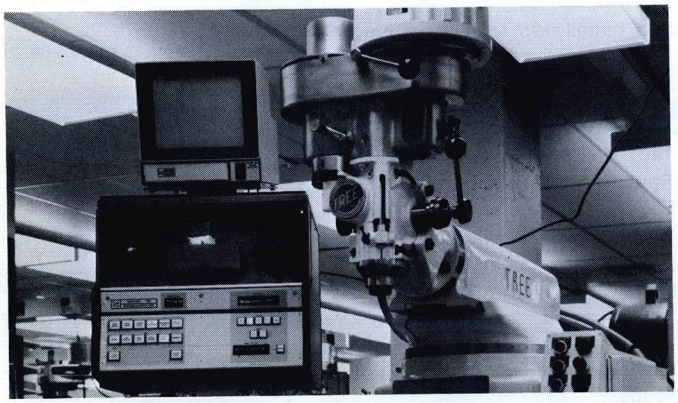
144 and 146 NTSC TV Signal Generators—The 144 and 146 NTSC Signal Generators are sources of high-quality television test, sync, and burst signals for 525-line, 60-Hz field standard NTSC color TV systems. Combined in compact units are the signals needed to operate and test color video equipment.

See pages 266 to 271 for complete characteristics.

NEW SPECIAL PURPOSE PRODUCTS

176 Pulsed High-Current Fixture—The 176 extends the capabilities of the 576 Curve Tracer by providing pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The pulsed operating mode allows many tests that were previously impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over-dissipation.

See pages 289 and 290 for complete characteristics.



1701 and 1702 Machine Control Units—Tektronix Machine Control Units are closed loop, contouring units featuring full floating zero, word address format, and display of sequence number and command and position data. The 1701 is a two-axis control; the 1702 is a three-axis control.

The selection of options includes the unique, fast, tape-check display that verifies part programs at the machine tool in less than two minutes, without cutting.

See pages 294 to 296 for complete characteristics.

NEW INFORMATION DISPLAY PRODUCTS

4551 Light Pen Unit—The Light Pen Unit, when used in any 525/60 line or 625/50 line TV system, produces a visible location indicator (cursor) on all TV dispays in the system. The cursor calls the attention of the TV audience to any point on the TV screen. Applications areas include education and broadcasting.

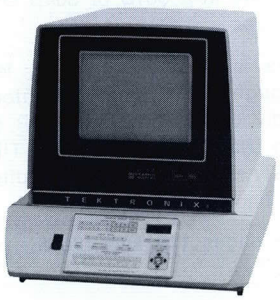
See pages 359 and 360 for complete characteristics.

4601 Hard Copy Unit—The Hard Copy Unit produces permanent, reproducible copies directly from peripherals which display information on Tektronix 11-inch storage CRT's. Copy size is 8-1/2 x 11 inches; copy time is less than 18 seconds.

See pages 361 and 362 for complete characteristics.

4701 Eight Channel Multiplexer—The Eight Channel Multiplexer provides signal conditioning for displaying up to eight different signals on Tektronix instruments including the 601 and 611 Storage Display Units, 602 Display Unit and 4501 Scan Converter.

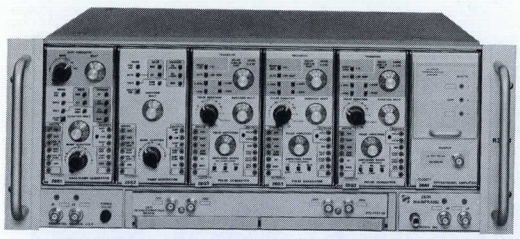
See page 339 for complete characteristics.



T4005 Graphic Display—The Graphic Display is a self-contained computer peripheral designed for high-speed, low-cost displays of drawings, graphs and text. The T4005 is software supported and interfaces to the IBM 1130 computer with an optional interface unit.

See pages 349 to 354 for complete characteristics.

NEW SIGNAL SOURCES



2600 Modular Instrument System—The 2600 Series is a modular instrumentation system of signal generators and conditioners. Plug-in modules permit a building block approach to specialized systems. The system is comprised of the following components:

The 2601 Mainframe provides power for, and interconnection between, up to six plug-in units.

The 26G1 Ramp/Rate Generator provides ramps of variable duration at a variable rate.

The 26G2 Ramp Generator provides voltage ramps of variable duration at a rate determined by an external source.

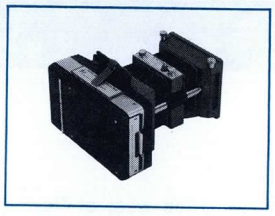
The 26G3 Pulse Generator provides current or voltage pulses of variable duration and amplitude when externally triggered.

The 26A1 Operational Amplifier is easily adapted for many uses.

See pages 319 to 324 for complete characteristics.

NEW CAMERAS

C-32 Camera—The C-32 is a compact, light-weight trace-recording camera designed for use with Tektronix portable oscilloscopes. It is similar to the C-31 camera but with an f/1.4 lens. The C-32 also has selectable magnification settings of 1.2, 1.1, 1.0, 0.9 and 0.85.

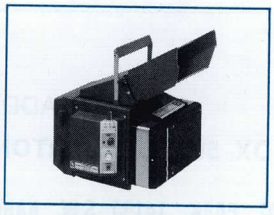


See pages 377 and 378 for complete characteristics.

C-52 Camera—The C-52 camera has all the features of the C-50 and C-51 cameras: trace-brightness photometer, electrically-controlled shutter, range-finder focusing and accurate exposure control. It differs only in the lens. The C-52 lens is f/1.4 and has a magnification ratio of 1:1.

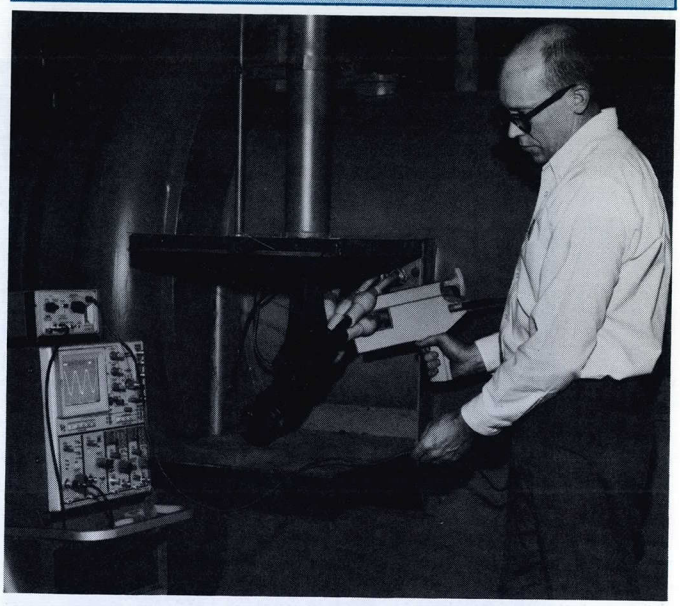
See pages 379 and 380 for complete characteristics.

C-50 Series Camera Battery Pack—The battery pack provides an auxiliary power source for the C-50 Series Cameras when using oscilloscopes that do not have camera power outputs.



See pages 379 and 380 for complete characteristics.

NEW ACCESSORIES



CT-5 High Current Transformer—The CT-5 is a clip-on high-current transformer designed to extend the measurement capability of Tektronix clip-on current probes. Current up to 1000 A Peak can be measured using the CT-5 with a P6021 or P6042 current probe.

See page 407 for complete characteristics.

P6054 10X Voltage Probe—The P6054 is a miniature, fast-rise (0.7 ns) probe designed for use with oscilloscopes having a nominal input capacitance of 15 to 24 pF.

See page 400 for complete characteristics.

P6055 10X Voltage Probe—The P6055 is a miniature, low-capacitance probe designed for use with Tektronix differential amplifiers having nominal input capacitances of 20 to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in the input resistance of the amplifier.

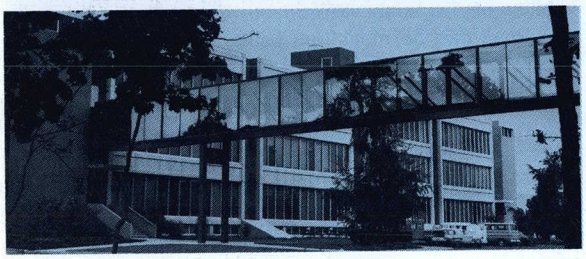
See page 401 for complete characteristics.

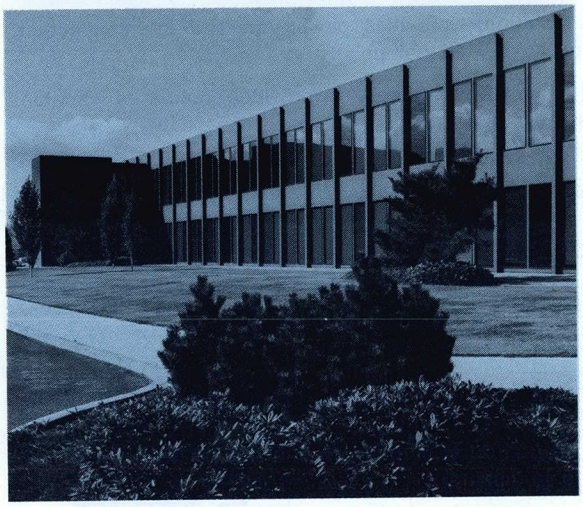
4901 and 4902 Interactive Graphic Units—The 4901 and 4902 interface the Tektronix T4002 Graphic Computer Terminal with graphic input devices which output X and Y analog signals. Both units generate a refreshed, clearly visible, full-screen cursor which always covers the entire X, Y dimensions of the T4002 storage display. Upon command from the computer, the T4002 keyboard, or an external graphic device, the units will digitize the graphic address of the intersection of the crosshair cursor. The digitized graphic address is sent to the computer through the T4002 I/O interface unit.

4951 Joystick—The Joystick inputs signals to the Interactive Graphic Units which provide the X and Y information for positioning the cursor on the screen of the T4002.

See pages 346 to 348 for complete characteristics.

Tektronix—Serving Customers World Wide





The Tektronix home office is located near Beaverton, a few miles west of Portland, Oregon, on the campus-like 300-acre Tektronix Industrial Park. This complex provides over 2 million square feet for design and manufacture of oscilloscopes, information display devices, and other precision electronic measurement products. The four-level Technical Center, shown in the upper left picture, houses engineering, corporate offices, and support functions.

To provide the best value to the user, Tektronix designs and manufactures many of its own electrical and mechanical components including CRT's, integrated circuits, semiconductors, circuit cards, knobs, and chassis. Our Ceramics facility, a portion of which is shown at upper right, manufactures the unique 11-inch CRT funnel, used in several information display products.

Assembly of the many components into finished products takes place here at the Beaverton site, as well as in Heerenveen, The Netherlands; Guernsey, Channel Islands; and Tokyo, Japan.

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Tektronix as a Peripheral Supplier

The T4002 Graphic Computer Terminal shown above with the 4601 Hard Copy Unit.

Selecting a supplier of computer peripherals is no easy task. Consideration must be given not only to the product, its performance, reliability and customer appeal, but to the reputation of the supplier and his long-term ability to provide a continuing line of peripherals.

With nearly 9000 employees and 1970 sales of $165 million, Tektronix is recognized as the world's leader in the manufacture, sales and service of display devices. Tektronix has devoted considerable time and effort to designing and producing display products which effectively fulfill computer peripheral needs, including the capability of producing large, permanent copies directly from the cathode-ray tube.

Some of these display products are:

611 Storage Display Unit—A low-cost high speed unit which retains information on an 11-inch storage CRT without high-cost refresh electronics.

4501 Scan Converter—Links your data or signal source to TV display systems for convenient, large screen viewing. The display size depends only upon your choice of TV monitor or receiver.

4601 Hard Copy Unit—Produces permanent, reproducible 8 1/2 x 11 copies from Tektronix peripherals with 11-inch storage CRTs. Operation is easy and copy time is just seconds.

T4002 Graphic Computer Terminal—An Information Display Unit which contains the components needed for low-cost alphanumeric and graphic interaction between man and computer. Data is stored on a 611 Display Unit.

T4005 Graphic Display—A New self-contained computer peripheral for applications where low-cost, high speed displays of graphics, drawings and alphanumeric data is desired. The T4005 plots data on a storage CRT at speeds up to 100 times faster than mechanical plotters.

Tektronix Field Services

There are many field services available through Tektronix Field Engineering Offices and Overseas Representatives. It is our intent to consistently provide unequalled product service and support which are available through local offices staffed by Tektronix employees. Some of these many services are described below. Take advantage of them. They are a valuable part of your Tektronix product.

FIELD ENGINEERS

Your Field Engineer is fully prepared to respond to your technical and business requirements. He has a strong technical background and has extensive product and business training. Periodic refresher courses fully acquaint him with new products and services. Be sure to take advantage of his services.

COMMUNICATIONS

Your Field Engineer is a valuable communication link between you and the factory. He knows the exact person to contact in each circumstance, and he can reach that person fast and easily. Let him help speed your communication on any problem related to your Tektronix instruments.

ORDERING

There are many types of oscilloscopes, each designed for a specific application area. Your Field Engineer can help you select the one best suited to your present and future needs, and he will be happy to arrange a demonstration of the instrument . . . in your application if you so desire.

If you are a Purchasing Agent or Buyer, your Field Engineer *or his secretary* can provide information on prices, terms, shipping estimates, and best method of transportation on instruments, accessories, and replacement parts.

OPERATION

Your Tektronix Oscilloscope can be most useful to you when you are familiar with all control functions. Your Field Engineer will be glad to demonstrate the use of your instrument in various applications to help you become more familiar with its operation. If your instrument is to be used by several engineers, your Field Engineer will be happy to conduct informal classes on its operation in your laboratory.

APPLICATIONS

Perhaps the answers you need in a specific application can be obtained faster and easier through use of your Tektronix Oscilloscope. Your Field Engineer can help you find out, and if use of your oscilloscope is indicated, help you with procedures. He may also be able to suggest many time-saving uses for your oscilloscope in routine checks and measurements.

FACTORY TRAINING

Often there is a need for in-depth training that cannot be fully accomplished locally. To meet these needs, Tektronix has established a program of factory training which is an extension of Tektronix field engineering services. Customers who participate in this program attend classes at the Tektronix customer training centers located in the Tektronix Industrial Park in Beaverton, Oregon or on the Isle of Guernsey. The cost of accommodations, transportation and board are the only expenses borne by the customer. Ask your Field Engineer for full details, he will make all the arrangements.

MAINTENANCE

Tektronix willingly assumes much of the responsibility for continued efficient operation of the instruments it manufactures. If you should experience a stubborn maintenance problem, your Field Engineer will gladly help you isolate the cause. Often a telephone discussion with him will help you get your instrument back in operation with minimum delay. If yours is a large laboratory, your Field Engineer can be of service to your maintenance engineers by conducting informal classes on test and calibration procedures, trouble-shooting techniques, and general maintenance.

REPAIR PARTS

Tektronix repair and replacement part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office in your area. This procedure will assure you the fastest possible service. Please include instrument Type number and Serial number with all requests for parts or service. PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

INSTRUMENT RECONDITIONING—SERVICING

To help assure adequate instrument maintenance facilities for our customers, Tektronix has established Field Engineering Offices and Service Centers at strategic points in the United States.

An older Tektronix Oscilloscope, properly reconditioned, can give you many additional years of service. Your Field Engineer will gladly explain the advantages of instrument reconditioning, major repair, and recalibration that can be performed at a nearby Field Service Center. Ask your Field Engineer about this service to Tektronix customers.

MAIL LIST

Wish to be on our mail list? Contact the nearest Tektronix Field Office. The addition of your name insures receipt of a new catalog, catalog supplements, Tektronix calendar, and TEKSCOPE.

GENERAL TERMS OF SALE AND WARRANTY

Orders should be placed with your Tektronix Field Engineering Office listed on page 10.

Tektronix offers many different terms of sale in order to meet varied purchasing objectives and to assist in financial planning. Any of the following terms may be arranged with a Tektronix Field Engineer.

NET 30 DAYS

Tektronix standard terms of sale are NET 30 days, which is to agree that payment will be due thirty days following the date of shipment.

EXTENDED TERMS OF SALE

Extended terms of 60 to 120 days are available on the same single payment basis as standard terms. Since the cost of extended terms is not included in catalog prices, a service charge is added to the catalog price. The amount of the service charge depends upon the number of days the terms are extended.

RENTAL AGREEMENT

Tektronix rental products include oscilloscopes, plug-ins, curve tracers and cameras. Each product is equipped with standard catalog accessories.

This plan makes Tektronix oscilloscopes available to customers at a competitive cost and solves the critical maintenance problems frequently faced by users of rented equipment. Under this rental plan Tektronix customers rent directly, confident that competent maintenance support is always available at convenient Tektronix field offices and service centers.

Before a product is rented it is fully checked in a Tektronix service center to insure that it operates at a level consistent with published specifications. Should a product fail during the rental period Tektronix will, at no extra cost to the customer, replace the product with one of equal performance or credit the customer until repairs are made.

Each product is fully insured against loss and theft. Transportation to the customer is prepaid.

The monthly rental rate is $8.50 per $100 of current catalog price for the first three months. The rate reduces to $7.50 per $100 for the fourth, fifth and sixth months. For the seventh month and those thereafter, the rate reduces to $6.50 per $100. There are no additional charges for maintenance and insurance.

LEASE AGREEMENT

All new instruments, digital systems, cameras, Scope-Mobile® Carts and modifications thereof are available under this program. Accessories and parts are not available unless they are associated with the products being leased. Minimum lease is $1000.

A standard lease term of 12, 18, 24, 30 and 36 months is offered. Longer terms are negotiable. Under a Lease Agreement, the customer pays for the use of the product for the term of agreement. It is not a month-to-month rental . . . it is a non-cancellable, fixed-term lease requiring no advance payment. At the expiration of the lease there is the opportunity to update the instruments, to renew the existing lease, or to return the equipment at Tektronix' expense. The customer may exercise an option to purchase the equipment at any time during the term of the lease, provided he gives thirty days written notice. A portion of the paid-in rentals will be credited toward the purchase price.

Certain Information Display Products are available under a separate lease program with a 6-month minimum period.

The standard Tektronix warranty and quantity discount apply to leased products.

CONDITIONAL SALES CONTRACT

This program provides monthly installment payment terms while Tektronix products are in use. All instruments, digital systems, computer terminals, cameras, Scope-Mobile® Carts and modifications thereof are available under this program. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a conditional Sales Contract. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30 or 36 months. Minimum balance amounts may be financed, ranging from $200 for six months to $2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more than $10,000. There are no maximum finance balances.

All products carry the standard Tektronix warranty. The customer is responsible for the equipment and applicable property taxes, licenses, etc. Upon completion of the term of agreement and prescribed payments, the customer owns the equipment.

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Questions regarding warranty should be discussed with your Tektronix Field Engineer.

SHIPMENT

All prices, quotations and shipments are FOB Beaverton, Oregon, unless otherwise specified.

Unless otherwise specified, shipment will be made via most economical method. Surface and air shipments will be insured at full valuation unless your order instructs otherwise.

Information in this publication supersedes all previously published material. Specification and price change privileges reserved.

United States Field Offices And Service Centers

TEKTRONIX, INC.

P. O. Box 500, Beaverton, Oregon 97005

Telephone: (503) 644-0161 Telex: 36-691 Cable: TEKTRONIX

ALABAMA

***Huntsville** 35801
Suite 51, 3322 S. Memorial Parkway
Phone (205)881-2912, Telex 59-4422

ARIZONA

Phoenix
7045 E. Camelback Road
Scottsdale 85251
Phone (602)946-4273, Telex 66-7401
Tucson Area: ENterprise 383

CALIFORNIA

***Alhambra** 91801
Suite D, 1525 S. Garfield Avenue
Phone (213)576-1601, Telex 6-74397
From L.A. call: 283-0501

***Concord** 94520
2339A Stanwell Circle
Phone (415)687-8350, Telex 335-344
From Oakland, Berkeley, Richmond, Albany and San Leandro: 254-5353

***Orange** 92667
1722 E. Rose Avenue
Phone (714)633-3450, Telex 6-78432

***Palo Alto** 94303
3750 Fabian Way
Phone (415)326-8500, Telex 34-8411

***San Diego** 92120
Suite 107, 6150 Mission Gorge Road
Phone (714)283-6225, Telex 69-5025

San Jose
Suite 1B, 1725 De La Cruz Blvd.
Santa Clara 95050
Phone (408)296-3010, Telex 34-6439

Santa Barbara 93104
1310 Santa Barbara Street
Phone (805)963-1848, Telex 658-424

***Van Nuys** 91406
16930 Sherman Way
Phone (213)987-2600, Telex 65-1426
From L.A. call: 873-6868

COLORADO

***Denver** 80222
2120 South Ash Street
Phone (303)757-1249, Telex 45-662

CONNECTICUT

***Hartford**
809 Main Street
East Hartford 06108
Phone (203)289-8695, Telex 9-9338

Stamford 06902
125 Strawberry Hill Avenue
Phone (203)325-3817, Telex 96-5917

FLORIDA

Fort Lauderdale 33311
1871 West Oakland Park Blvd.
Phone (305)731-1220, Telex 51-4474
Also serves Puerto Rico and U.S. Virgin Islands

***Orlando** 32803
Suite 185, 1010 Executive Center Dr.
Phone (305)841-2382, Telex 56-4465
From The Cape Kennedy Area: 636-0343

Pensacola 32501
Suite T1, Fairfield Plaza
Phone (904)434-2785, Telex 70-2430

GEORGIA

***Atlanta** 30329
Suite 106, 1680 Tullie Circle, N.E.
Phone (404)633-0344, Telex 54-2233

ILLINOIS

***Chicago**
Suite 104, 2590 E. Devon
Des Plaines 60018
Phone (312)298-6666, Telex 72-6347

Hinsdale 60521
Suite 111, 119 E. Ogden Avenue
Phone (312)325-3050, Telex 25-3694

INDIANA

***Indianapolis** 46219
6121 East 30th Street
Phone (317)546-2408, Telex 27-348

KANSAS

Kansas City
Suite 101, 6025 Lamar
Mission 66202
Phone (913)432-1003, Telex 4-2321

MARYLAND

***Baltimore**
1526 York Road
Lutherville 21093
Phone (301)825-9000, Telex 87-804
From Harrisburg, Lancaster and York Area call: ENterprise 1-0631

***Rockville** 20852
1500 East Jefferson Street
Phone (301)881-6133, Telex 89-2337

MASSACHUSETTS

***Boston**
244 Second Avenue
Waltham 02154
Phone (617)894-4550, Telex 92-3446

Methuen 01844
240 Pleasant Street
Phone (617)685-1511, Telex 94-7458

Natick 01760
209 West Central Street, Room 6
Phone (617)655-5131, Telex 94-8400
From Boston call: 235-8233

MICHIGAN

***Detroit**
22132 West Nine Mile Road
P.O. Box 363
Southfield 48075
Phone (313)358-3122, Telex 23-400

MINNESOTA

Minneapolis 55426
Suite 115, 7515 Wayzata Blvd.
Phone (612)545-2524, Telex 29-699

***St. Paul** 55112
3775 North Dunlap Street
Phone (612)484-7255, Telex 29-7095

MISSOURI

St. Louis 63135
119 North Harvey Avenue
Phone (314)524-0900, Telex 44-851

NEVADA

Las Vegas 89102
5128 West Charleston Blvd.
Phone (702)870-8201, Telex 68-4419

NEW JERSEY

Cherry Hill 08034
905 Kings Highway, North
Phone (609)667-4333, Telex 84-5338

***Springfield** 07081
964 South Springfield Avenue
Phone (201)379-1670, Telex 13-8259

NEW MEXICO

***Albuquerque** 87108
1258 Ortiz Drive, S.E.
Phone (505)268-3373, Telex 66-0421
Southern N.M. Area: ENterprise 678

NEW YORK

***Albany**
678 Troy Road
Latham 12110
Phone (518)785-3353, Telex 145-402

Buffalo 14225
965 Maryvale Drive
Phone (716)633-7861, Telex 91-385

***Endicott**
3214 Watson Blvd.
Endwell 13763
Phone (607)748-8291, Telex 933-421

***Long Island**
125 Mineola Avenue
Roslyn Heights, L.I. 11577
Phone (516)484-2300, Telex 96-1328

Poughkeepsie 12603
1 Old Mill Road
Phone (914)462-4670, Telex 96-8414

***Syracuse** 13211
112 Pickard Building
5858 E. Molloy Road
Phone (315)455-6666, Telex 937-239

NORTH CAROLINA

***Greensboro** 27405
1011 Homeland Avenue
Phone (919)274-4647, Telex 57-4416

OHIO

Cleveland 44129
5562 Pearl Road
Phone (216)884-6558, Telex 98-5217

Columbus
Suite 5, 12 West Selby Blvd.
Worthington 43085
Phone (614)888-4040, Telex 24-5497

Dayton 45439
3309 Office Park Drive, Suite 103
Phone (513)293-4175, Telex 2-88225

OKLAHOMA

Oklahoma City 73105
901 Office Park Plaza
Phone (405)848-3361, Telex 7-1459

OREGON

Portland
8845 S.W. Center Court
Tigard 97223
Phone (503)639-7691, Telex 36-0205

PENNSYLVANIA

***Philadelphia**
126 Presidential Blvd., North
Bala-Cynwyd 19004
Phone (215)839-3111, Telex 83-4218

Pittsburgh
3834 Northern Pike
Monroeville 15146
Phone (412)351-3345, Telex 86-761

RHODE ISLAND

Providence
2845 Post Road
Warwick 02886
Phone (401)739-4771, Telex 92-7662

TEXAS

***Dallas** 75240
4315 Alpha Road
Phone (214)233-7791, Telex 73-0570

***Houston** 77027
Suite H, 3723 Westheimer
Phone (713)622-8141, Telex 77-494

San Antonio 78209
8031 Broadway
Phone (512)826-0686, Telex 76-7456
From Austin Area: ENterprise 9915

UTAH

***Salt Lake City** 84115
65 West 2950 South
Phone (801)484-8501, Telex 388-365

VIRGINIA

Alexandria 22304
Suite 11, 5249 Duke Street
Phone (703)751-6096, Telex 8-9406

Hampton 23366
1310 Todds Lane
Phone (703)826-4020, Telex 82-3409

WASHINGTON

Seattle 98188
410 Baker Blvd.
Andover Industrial Park
Phone (206)243-2494, Telex 32-488

WISCONSIN

Milwaukee 53226
Mayfair Plaza
2421 North Mayfair Road
Phone (414)476-6850, Telex 2-6604

General Information—Customers Outside The United States

To provide you with personal assistance in ordering as well as servicing Tektronix instruments, we have established Field Engineering Offices and technically qualified Tektronix distributors in many countries throughout the world. The Tektronix office or distributor in your country will be pleased to help you select the instrument that best suits your requirements in performance, and provide you with prompt ordering service.

SERVICE

If you require service, replacement parts, a warranty question resolved, or other help, please notify the Tektronix facility through which you ordered your instrument. They will process all orders for repair parts promptly, and provide emergency parts service when needed to restore an instrument to operating condition. They will also arrange for fast service with necessary recalibration or repair work on your instrument.

WARRANTY

All Tektronix instruments are warranted against defective material and workmanship for one year.

PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

WHO TO CONTACT

COUNTRIES WITH TEKTRONIX FIELD ENGINEERING OFFICES

AUSTRALIA
CANADA
DENMARK
FRANCE
JAPAN
SWITZERLAND
SWEDEN
THE NETHERLANDS
UNITED KINGDOM
Listed on page 12

The Tektronix Field Engineering office in your country will provide you with quotations and accept your orders. Normally, prices quoted are FOB your plant.

COUNTRIES WITH TEKTRONIX DISTRIBUTORS

Listed on pages 12 and 13

Your Tektronix distributor will provide you with quotations FOB your country and accept your orders.

COUNTRIES WITH NO TEKTRONIX DISTRIBUTOR OR TEKTRONIX FIELD ENGINEERING OFFICE

Please address your inquiries and orders to:

Tektronix, Inc
International Marketing Dept.
P. O. Box 500
Beaverton, Oregon 97005 USA

INFORMATION AND QUOTATIONS

Staff Field Engineers will be pleased to provide you with information on Tektronix instruments and answer your technical questions. A pro forma invoice will be issued, if requested, indicating price and sales conditions. When pro forma invoice or purchase order acknowledgement is issued, we will indicate the documents needed to ship your order. We will be glad to prepare necessary export documentation for you and make all shipping arrangements.

METHOD OF PAYMENT

We would like to make our products available to customers on open account terms, whenever conditions permit. Other credit terms are available for a customer's particular requirements. However, due to political, foreign exchange, and regulatory conditions in many areas of the world, credit terms are not always available. In those cases, advance payment or irrevocable letters of credit are required.

SHIPMENTS

Unless otherwise requested, shipments will be made by the most economical method.

Information in this publication supersedes all previously published material. Specification and price change privileges reserved.

International Field Offices And Distributors

TEKTRONIX INTERNATIONAL FIELD OFFICES

AUSTRALIA
Tektronix Australia Pty. Limited

North Ryde, N.S.W. 2113
80 Waterloo Road
Phone 88-7066
Cable: TEKTRONIX Australia

Adelaide, South Australia 5000
128 Gilles Street
Phone 23-2811

St. Kilda, 3182
25-27 Alma Road
Phone 94-0229

CANADA
Tektronix Canada Ltd.

Montreal
900 Selkirk Street
Pointe Claire 730, Quebec
Phone (514)697-5340, Telex 05821-570
Cable: TEKANADA

Calgary 3, Alberta
825 - 12th Avenue S.W.
Phone (403)269-7558, Telex 038-21730

Toronto
1177 Finch Avenue, West
Downsview 463, Ontario
Phone (416)638-6404, Telex 02-2776

Ottawa 5, Ontario
1792 Courtwood Crescent
Phone (613)225-2850, Telex 01-3419

Vancouver 10, British Columbia
10 East 2nd Avenue
Phone (604)879-0986, Telex 04-53465

DENMARK
Tektronix A/S

Krogshojvej 29
DK - 2880 Bagsvaerd
Phone (01)98 77 11, Telex 6482
Cable: TOCOPEN, Copenhagen

FRANCE
Tektronix

91 Orsay
Z. I. Courtaboeuf
B.P. 13
Phone 920 61 73,
Telex TEKFRANS 69332F
Cable: TEKFRANS Orsay

69 Lyon (7°)
Centre Regional de Lyon
166, Avenue Berthelot
Phone (78)72.00.70,
Telex TEKLYON 30 150F

06 - Villeneuve-Loubet-Plage
Centre Regional de Nice
16, avenue de la Mer
Phone (93)31.29.84,
Telex TEKNICE 46 663F

35 - Rennes
Centre Regional de Rennes
6 bis, avenue Louis Barthou
Phone (99)30.05.30,
Telex TEKTREN 70829F

31 - Toulouse
Centre Regional de Toulouse
284, route Saint-Simon
Phone (61)42.04.50,
Telex TEKTOULS 57791F

JAPAN
Sony/Tektronix Corporation

Tokyo 141
9-31, Kitashinagawa - 5, Shinagawa-Ku
(P.O. Box 14, Haneda Airport,
Tokyo 149)
Phone 445-0221 (Area 03/Tokyo)
Telex TK 2262, TK 2436, TK 4666
Cable: SONYTEK Tokyo

Osaka
2-70 Itachibori Minami-dori Nishi-ku
Phone 541-6781/2

THE NETHERLANDS
Tektronix Holland N.V.
Verkoopkantoor Voorschoten

Voorschoten
Leidseweg 16
(P.B. 39)
Phone 01717-6946, Telex 31737

SWEDEN
Tektronix A.B.

Bromma 1
P.O. Box 109, S-161 26
Phone 08/25 2830,
Telex 17831 TEKSWED S
Cable: TEKTROSWED

SWITZERLAND
Tektronix International A.G.

CH-6301 Zug
Lauriedstrasse 3
(P.O. Box 57)
Phone 042 21.91.92, Telex 78808
Cable: TEKINTAG

UNITED KINGDOM
Tektronix U.K. Limited

Harpenden, Herts
Beaverton House, Station Approach
(P.O. Box 69)
Phone Harpenden 61251, Telex 25559
Cable: TEKTRONIX Harpenden

Manchester 19
181A, Mauldeth Road
Phone 061-224-0446, Telex 668409

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix, Inc., P.O. Box 500, Beaverton, Oregon, U.S.A. 97005
Telephone: (503) 644-0161 Telex: 36-691 Cable: TEKTRONIX

ARGENTINA
Coasin S.A.

Buenos Aires
Virrey del Pino 4071
Phone 52-3185, 51-9363 & 52-4368,
Telex 012-2284
Cable: COASIN, Buenos Aires

Cordoba
Lamadrid 188
Phone 2 3707

Rosario
Alberdi 939
Phone 3 1348

BRAZIL
Importacao, Industria
e Comercio Ambriex S.A.

Rio de Janeiro, ZC-00
Av. Graca Aranha 226-6°
Phone 221-4544 & 221-4560
Cable: RAIOCARDIO Rio de Janeiro

Sao Paulo, Estado Sao Paulo
Av. Pacaembu 811
Phone 52-0655 & 51-0912
Cable: RAIOCARDIO Sao Paulo

Ambriex, S.A.
Porto Alegre-Est. Rio Grande do Sul
Rua Coronel Vicente, 421-1° andar
Phone 4-7411

CEYLON
Maurice Roche Limited

Colombo
P.O. Box 61
Cable: LAXAPANA Colombo

CHILE
Equipos Industriales S.A.C.I.

Santiago
Moneda 812 - Of. 912
(Casilla 13550)
Phone 716 882 & 382 942

COLOMBIA
Manuel Trujillo Venegas
e Hijo Ltda.

Bogota 2, D.E.
Carrera 7 #48-71
Apartado Aereo 53747
Phone 32-06-79 & 45-23-04
Cable: TRUVEHIJO Bogota

HONG KONG
Gilman & Co. Ltd.,
Engineering Dept.

P.O. Box 56
(8th Floor, Alexandra House)
(Des Voeux Road, Central)
Phone H-227011, Telex HX 3358
Cable: GILMAN Hong Kong

INDIA
Hinditron Services Private Ltd.

Bombay 6
Manesha
69/A Nepean Sea Road
Phone 365344, Telex 2594
Cable: TEKHIND Bombay

IRAN
Berkeh Company Ltd.

Tehran
20 Salm Road
Roosevelt Avenue
Phone 628294
Cable: BERKEHKAR, Tehran

KOREA
M-C International

Seoul
Room 516, Bando Bldg.
I.P.O. Box 1355
Phone 22-4316, 22-6891, 22-0811,
& 28-1415
Telex 7872428 S
Cable: EMCEEKOREA Seoul

MALAYSIA
Mecomb Malaysia Sendirian
Berhad

Selangor
2, Lorong 13/6A, Section 13
P.O. Box 24
Petaling Jaya
Phone 53570, 53478

MEXICO
Tecnicos Argostal, S.A.

Mexico 18, D.F.
Av. Jalisco 180
Phone 5-15-85-80, Telex 017-74208

Monterey, N.L.
Av Universidad 3335 Norte
Phone 43-70-85, Telex 038865

Guadalajara, Jal.
Calz. J. Gonzales Gallo 383
Phone 5-17-26-46 & 5-17-78-12
Telex 068710

NEW ZEALAND
W. & K. McLean, Ltd.

Auckland
103-105 Felton Mathew Avenue
Glen Innes
P.O. Box 3097
Phone 587-039 & 587-037
Cable: KOSFY Auckland

Wellington
5th Floor, Westbrook House
181 Willis Street
(C.P.O. 496)
Phone 555-869

PAKISTAN
Pak-Land Corporation

Karachi 29
Central Commercial Area
Iqbal Road
P.E.C.H. Society
Phone 417315 & 418094
Cable: PAKLAND Pakistan

Rawalpindi
20, Grand Hotel Bldg.
101, Bank Road
Phone 68348
Cable: NUCLEAR RAWALPINDI

PERU
Importaciones y
Representaciones
Electronicas, S.A.

Lima
Franklin D. Roosevelt 105
Phone 27-2076
Cable: IREING, Lima

PHILIPPINES
Philippine Electronic
Industries, Inc.

Makati, Rizal
Buendia Avenue Corner Dian St.
P.O. Box 498,
Makati Commercial Center
Phone 80-72-41/42/43/44
Cable: PHILECTRON, Makati

SINGAPORE
Mechanical & Combustion
Engineering Co. Pte. Ltd.

Singapore 3
9, Jalan Kilang
Redhill Industrial Estate
(P.O. Box 46, Alexandra Post Office)
Phone 642361-3 & 632611
Cable: MECOMB

TAIWAN
Heighten Trading Co. Ltd.

Taipei
P.O. Box 1408
Republic of China
Phone 518324, 518372, 517517
Cable: HEIGHTEN Taipei

THAILAND
G. Simon Radio Co. Ltd.

Bangkok
30, Patpong Avenue, Suriwong
Phone 30991-3
Cable: SIMONCO Bangkok

URUGUAY
Coasin Uruguaya S.A.

Montevideo
Cerrito 617
Phone 9-79-78
Cable: COAUR Montevideo

VENEZUELA
Coasin C.A.

Caracas
Edificio La Linea-Av. Libertador
entre Las Palmas y Las Acacias
(Apartado 50939-Sabana Grande No. 1)
Phone 72-96-37
Cable: INSTRUVEN, Caracas

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands
Telephone: Guernsey 23411, Telex: 41193

Tektronix Limited maintains a warehouse of United States-made instruments, accessories and parts on the Island of Guernsey to quickly support these distributors in filling customer orders. Technical support of customers and distributors is also available from this facility. In addition, Tektronix has manufacturing facilities within the European Economic Community and European Free Trade Association.

ANGOLA

Equipamentos Tecnicos, Lda.

Luanda
Rua Serpa Pinto 39
(P.O. Box 6319)
Phone 26917, Telex 3147 EQUIPAL LUANDA
Cable: EQUIPAL

AUSTRIA

Inglomark Markowitsch & Co.

A-1151 **Wien**
P.O. Box 73
Phone (0222) 83-05-08, Telex (1) 1393
Cable: INGLOMARK Wien

BELGIUM

Regulation Mesure, SPRL

Brussels 15
73 Av. Vandendriessche
Phone 71.20.20, Telex 02-21520
Cable: MEREG Bruxelles

EAST AFRICA (Kenya and Tanzania)

Engineering & Sales Co., Ltd.

Nairobi, Kenya
Bankhouse, Government Road
P.O. Box 6658
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P.O. Box 10153, 11, Meritullinkatu
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Estrada Lisboa - Sintra Amadora
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Cable: MANLU

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Cable: SERAM Barcelona

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Cable: SERAM Madrid

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Ataturk
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Cable: ROHDESCHWARZ Berlin

Rohde & Schwarz Vertriebs-GmbH

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5 **Koeln** 1
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Cable: ROHDESCHWARZ Koeln

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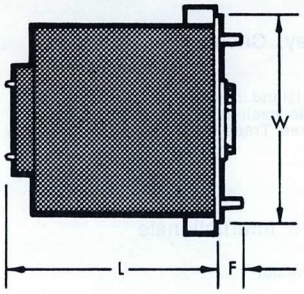
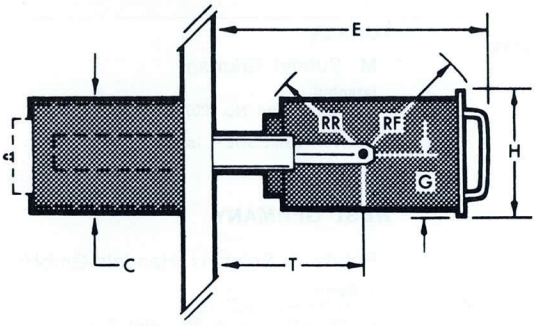
Cable: PIPETTE, Lusaka

Ndola
Brunell Road
P.O. Box 1097
Phone 3522 & 2253/4/6
Cable: PIPETTE, Ndola

Instrument Dimensions





RACK MOUNT INSTRUMENTS

EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Description	Definition
H	Height	Height of front panel.
W*	Width	Width of front panel.
L	Length	Rack front to rearmost permanent fixture, excluding cables.
F	Forward Clearance	Back of front panel to foremost protrusion.
G	Vertical Axis	Bottom of front panel to horizontal plane of rotation.
E	Extended Inst.	Maximum forward clearance with instrument out and horizontal.
RF	Radius — front	Front radius of rotation.
RR	Radius — rear	Rear radius of rotation.
T	Track	Rack front to pivot point.
C	Cabinet	Cabinet height.

** Note: Instruments mount to a standard 19-inch wide rack.*

These instruments mount with sliding tracks in a cabinet that mounts to a standard 19 inch wide rack.

These instruments mount with sliding tracks to a standard 19 inch wide rack. Rear support for sliding tracks is required, such as an enclosed rack.

These instruments bolt directly to a standard 19 inch wide rack. They can be ordered at additional cost, with tilt-lock, sliding tracks. Rear support for tracks is required.

	MOUNTING DIMENSIONS																	
	H		L		F		G		E		RF		RR		T		C	
PRODUCT	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
129	10 1/2	26.6	21 5/8	55.0	2	5.1	1 3/4	4.5	29 1/2	74.9	17 5/8	44.8	11 1/16	28.3	13 1/4	33.7	10 1/2	26.8
RM503, RM504	7	17.8	17	43.2	1 3/4	4.5	3 1/2	8.9	22 11/16	57.6	11 15/16	30.3	7 3/4	19.7	11 1/8	28.3	6 7/8	17.5
RM529	5 1/4	13.3	18 1/4	46.4	1 3/4	4.5	2 3/8	6.1	21 1/4	54.1	12 1/8	30.8	8 7/16	21.5	9 3/8	23.8	5 1/8	13.1
RM545B, RM547	14	35.6	22 11/16	57.7	1 15/16	5.0	6 13/16	17.3	28 3/4	33.0	13 1/2	34.3	12 15/16	32.9	16 1/4	41.3	13 15/16	35.4
RM565	12 1/4	31.1	22 3/16	56.4	1 13/16	4.6	2 3/8	6.1	30 1/2	77.4	15 3/16	39.1	13 1/16	33.2	16 5/8	42.2	12 3/16	31.0
R116	5 1/4	13.3	17 9/16	44.6	1 5/8	4.1	1 3/4	4.5	25 3/4	65.4	11 9/16	29.4	8 1/4	21.0	14 5/8	37.2	5 1/16	12.8
R140, R141A, R142, R144, R146	3 1/2	8.8	18 1/2	47.1	1 5/8	4.1			24 1/8	61.3							3	7.6
R230, R240, R241, R250, R287, R288,	7	17.8	21	53.3	2	5.1	1 3/4	4.4	28 5/8	88.8	14 7/16	36.6	10 3/16	25.8	15 1/8	23.6	7	17.8
R422	7	17.8	12 1/2	31.8	1 13/16	4.6	3 1/2	8.9	16 5/8	42.3							6 3/4	17.2
R453A, R454A	7	17.8	17 3/8	44.2	1 13/16	4.6	3 1/2	8.9	20 11/16	52.6	11 5/8	29.5	7 7/8	20.0	9 5/16	23.7	6 3/4	17.2
R491	7	17.8	17 3/8	44.2	2 1/16	5.2	3 1/2	8.9	21 1/16	53.5	11 15/16	30.4	8 1/2	21.6	9 5/16	23.7	6 13/16	17.3
R520, R521, R522	7	17.8	18	45.8	2	5.1			23	58.4							7	17.8
R556	14	35.6	22 13/16	57.9	1 3/4	4.5	8 1/8	20.7	30 5/16	77.0	13 1/8	33.3	14 1/4	36.2	18 1/2	57.0	13 7/8	35.2
R561B, R564B	7	17.8	18 9/16	47.3	1 3/4	4.5	2 3/8	6.1	24 5/16	60.8	13 3/4	34.9	7 7/8	20.0	11	27.9	6 3/4	17.2
R568	7	17.8	21	53.3	2	5.1	1 3/4	4.4	28 5/8	88.8	14 7/16	36.6	10 3/16	25.8	15 1/8	23.6	7	17.8
R647A	7	17.8	19	48.3	1 11/16	4.3	2 7/16	6.2	27 7/8	70.9	13 5/8	34.5	8 11/16	22.1	16 3/8	41.6	13 7/8	35.2
R1140, R1340	7	17.8	21	53.3	2	5.1	1 3/4	4.4	28 5/8	88.8	14 7/16	36.6	10 3/16	25.8	15 1/8	23.6	7	17.8
R2601	7	17.8	15 1/2	39.4	2 1/16	5.2											7	17.8
R4501	5 1/4	13.3	20 1/4	51.5	1 7/8	4.8			26 1/4	67.1							5 1/4	13.3
R5103N	5 1/4	13.3	19	48.3	1 1/16	2.7	1 3/4	4.5	24 5/8	62.5							5 1/4	13.3
R5030, R5031	5 3/16	13.3	20 11/16	52.8	1 13/16	4.6	2 1/4	5.9	25 1/4	64.5	14	35.7	9 3/16	23.5	11 1/2	29.3	5 3/16	13.3
R7403N	5 1/4	13.3	22 3/16	55.5	2	5.1			25 3/16	63.0							5 1/4	13.3
R7704	7	17.8	22 3/8	56.0	2 1/4	5.8	1 3/4	4.4	33 1/4	84.6	15 1/4	38.9	10 11/16	27.2	18 1/2	47.0	7	17.8
016-0115-02	5 1/4	13.3	16 1/4	41.4	1/4	0.9											5 1/4	13.3
016-0268-00	5 1/4	13.3	19 3/4	50.2	1 13/16	4.6											5 3/16	13.2
040-0551-00	14	35.6	22 7/16	57.1	9/16	1.5			30 7/8	78.6								
040-0554-00	15 3/4	40.0	21 1/2	54.7	1 15/16	4.9			31 1/4	79.5								
040-0555-00	15 3/4	40.0	22 5/8	57.6	1 15/16	4.9			31 1/4	79.5								
437-0031-00	8 3/4	22.2	9 1/2	24.2	1/4	0.7											7 1/16	18.0
437-0071-00	7	17.8	13 3/8	34.0	1 3/8	4.0											6 9/16	16.8

Shipping Volumes

Type	Domestic Pack ft^3	Export Pack ft^3
CA	0.9	1.5
C-10	1.5	3.0
C-12	2.1	4.8
C-27	2.1	4.8
C-30A	1.0	
C-31	1.0	
C-32	2.3	3.0
C-50	2.3	3.0
C-51	2.3	3.0
C-52	2.3	3.0
C-70	2.3	3.0
Engine Analyzer Access	2.2	3.4
O	0.9	1.5
Q	0.9	1.5
S-1	0.3	1.3
S-2	0.3	1.3
S-3A	0.6	
S-4	0.3	1.3
S-5	0.3	1.3
S-6	0.3	1.3
S-50	0.3	1.3
S-51	0.3	1.3
S-52	0.3	1.3
S-53	0.3	1.3
S-54	0.3	1.3
T	0.9	1.5
W	0.9	1.5
1A1	0.9	1.5
1A2	0.9	1.5
1A4	0.9	1.5
1A5	0.9	1.5
1A6	0.9	1.5
1A7A	0.9	1.5
1L5	1.2	2.1
1L20	1.2	2.1
1L40	1.2	2.1
1S1	1.9	3.1
1S2	1.9	3.1
2A60	1.0	1.7
2A63	1.0	1.7
2B67	1.0	1.6
3A2	1.0	1.6
3A3	1.0	1.6
3A6	1.0	1.6
3A7	1.0	1.6
3A8	1.0	1.6
3A9	1.0	1.6
3A10	1.0	1.6
3A72	1.0	1.6
3A74	1.0	1.6
3A75	1.0	1.6
3B2	1.0	1.6
3B3	1.0	1.6
3B4	1.0	1.6
3C66	1.0	1.6
3L5	1.0	1.6
3S1	1.0	1.6
3S2	1.0	1.6

Type	Domestic Pack ft^3	Export Pack ft^3
3S5	1.0	1.6
3S6	1.0	1.6
3S7	1.0	1.6
3T2	1.0	1.6
3T5	1.0	1.6
3T6	1.0	1.6
3T7	1.0	1.6
3T77A	1.0	1.6
7A11	1.1	2.1
7A12	1.1	2.1
7A13	1.1	2.1
7A14	1.1	2.1
7A15	1.1	2.1
7A16	1.1	2.1
7A18	1.1	2.1
7A22	1.1	2.1
7B50	1.1	2.1
7B51	1.1	2.1
7B52	1.1	2.1
7B53N	1.1	2.1
7B70	1.1	2.1
7B71	1.1	2.1
7D13	1.1	2.1
7D14	1.1	2.1
7M11	1.1	2.1
7S11	1.1	2.1
7S12	1.1	2.1
7T11	1.1	2.1
10A1	1.0	1.7
10A2A	1.0	1.7
11B1	1.0	1.7
11B2A	1.0	1.7
106	1.3	3.1
109	1.3	3.1
111	1.2	2.1
113	4.7	6.8
114	1.3	2.5
115	1.3	3.1
R116	5.2	9.9
129	6.7	9.9
130	1.2	2.1
132	1.9	3.1
140	5.2	9.2
R140	5.2	9.2
141A	5.2	9.2
R141A	5.2	9.2
142	5.2	9.2
R142	5.2	9.2
144	5.2	9.2
R144	5.2	9.2
146	5.2	9.2
R146	5.2	9.2
175	4.9	9.9
176	2.0	3.0
184	1.3	3.1
191	1.3	3.1
200-1	9.6	5.0
200-2	9.6	5.0
201-1	13.4	14.5
201-2	13.4	14.5

Type	Domestic Pack ft^3	Export Pack ft^3
201-3	13.4	14.5
202-1	13.4	14.5
202-2	13.4	14.5
204-2	13.4	14.5
204-3	13.4	14.5
205-1	18.4	20.2
205-2	18.4	20.2
205-3	18.4	20.2
230	5.2	9.9
R230	5.2	9.9
240	5.2	9.9
R240	5.2	9.9
241	5.2	9.9
R241	5.2	9.9
R250	5.2	9.9
284	1.3	3.0
285	0.3	1.3
286	0.7	1.6
287	5.2	9.2
R287	5.2	9.2
R288	5.2	9.2
321A wo bat	1.9	3.1
323	1.3	3.0
324	1.3	3.0
410	1.9	3.6
422 w cover	3.7	5.5
422 125B wo bat	3.7	5.5
R422	5.2	9.9
R422 150B	5.2	9.9
453A w cover	3.7	5.5
R453A	5.2	9.9
454A w cover	3.7	5.5
R454A	5.2	9.9
491 w cover	3.7	5.5
R491	5.2	9.9
502A	4.1	7.5
503	3.5	5.6
RM503	5.2	9.9
504	3.5	5.6
RM504	5.2	9.9
519	7.8	10.4
520	5.2	9.3
R520	5.2	9.3
521	5.2	9.3
R521	5.2	9.3
522	5.2	9.3
R522	5.2	9.3
528	1.9	3.6
529	2.4	5.6
RM529	5.2	9.9
544	5.4	7.5
545B	5.4	7.5
RM545B	6.7	9.9
546	5.4	7.5
547	5.4	7.5

Type	Domestic Pack ft^3	Export Pack ft^3
RM547	6.7	9.9
549	5.4	7.5
556	10.3	11.2
R556	10.3	11.2
561B	3.5	5.6
R561B	5.2	9.9
564B	3.5	5.6
R564B	5.2	9.9
565	6.7	9.9
R565	6.7	9.9
568	5.2	9.9
R568	5.2	9.9
575	5.4	7.5
575 122C	5.4	7.5
576	6.8	
601	1.9	3.6
602	1.9	3.6
611	5.5	7.5
647A	3.5	5.6
R647A	5.2	9.9
R1140	5.2	9.9
R1340	5.2	9.9
1401	1.3	3.0
1401/323	2.0	3.0
1401/324	2.0	3.0
1802	32.2	32.2
2601	4.7	9.2
R2601	4.7	9.2
26A1	1.1	2.0
26G1	1.1	2.0
26G2	1.1	2.0
26G3	1.1	2.0
S-3110	36.0	36.0
S-3111	36.0	36.0
S-3120	55.5	55.5
S-3130 2 crates	159.3	159.3
S-3150 3 crates	227.2	227.2
S3150 2 crates	216.9	216.9
T4002	17.2	17.2
T4005	17.2	17.2
4501	5.2	9.9
R4501	5.2	9.9
4601	6.3	9.2
4901	0.8	1.3
4902	0.8	1.3
4951	0.8	1.3
5030	4.4	7.4
R5030	4.7	9.2
5031	4.4	7.4
R5031	4.7	9.2
7403N	4.4	6.6
7503	5.6	8.9
7504	5.6	8.2
7514	5.6	8.2
7704	5.6	8.2

Symbols And Abbreviations

The user of this catalog may find some unfamiliar symbols and abbreviations. In general, Tektronix has adopted the Symbols For Units, IEEE Standard Number 260, dated January 15, 1965. The abbreviations have been adopted by Tektronix following a thorough study of available abbreviations and guidelines published by the National Bureau of Standards, United States Government, American Standards Association, and others.

Many of these symbols and abbreviations are new, and inconsistencies between this list and other sources such as instrument panels and existing instrument manuals will be found. Future instruments and manuals will reflect adherence to these new symbols and abbreviations.

Below are some of the symbols and abbreviations used in this catalog. Those symbols found in IEEE Standard Number 260 are marked with an asterisk.

alternating current	AC
*ampere	A
amplitude modulation	AM
approximate	approx
approximately equal to	$\approx$ or $\simeq$
attenuation	atten
audio frequency	AF
automatic	auto
bandwidth	bw
base	b
*bel	B
beta	β
calibrate	cal
cathode-ray oscilloscope	CRO or scope
cathode-ray tube	CRT
*centimeter	cm
clockwise	cw
common-mode rejection	CMR
common-mode rejection ratio	CMRR
continuous wave	CW
counterclockwise	ccw
current	I
*decibel	dB
*decibel referred to one milliwatt	dBm
deflection factor	DF
*degree	°
*degree Celsius (centigrade)	°C
*degree Fahrenheit	°F
*degree Kelvin	°K
delay	dly
delay line	DL
differential	diff
direct current	DC
division	div
electrocardiogram	ECG
electroencephalogram	EEG
electromagnetic interference	EMI
*farad	F
*foot	ft
*foot lambert	fL
frequency modulation	FM
giga	G
*gigahertz	GHz
graticule	grat
gravity unit	g
greater than	$>$
greater than or equal to	$\geq$
ground	gnd
*henry	H
*hertz	Hz
horsepower	hp
*hour	h
impedance	Z
*inch	in
inductance	L
intermediate frequency	IF
kilo	k
*kilogram	kg
*kilohertz	kHz
kilohm	kΩ
kilometer	km
*kilovolt	kV
less than	$<$
less than or equal to	$\leq$
local oscillator	LO
low frequency	LF
maximum	max
mega	M
*megahertz	MHz
*megohm	MΩ
*meter	m
micro	μ
*microsecond	μs
milli	m
*millimeter	mm
*millisecond	ms
*millivolt	mV
minus	—
nano	n
*nanosecond	ns
National Television System Committee	NTSC
negative	neg
ohm	Ω
operational amplifier	op amp
oscilloscope	scope or CRO
pair	pr
parts per million	P/M
peak to peak	P-P
per	/
phase alternate line	PAL
*pico	p
*picoampere	pA
*picofarad	pF
*picosecond	ps
plus	+
plus and minus	+ and —
plus or minus	$\pm$
positive	pos
pulse per second	p/s
pulse-repetition rate	PRR
pulse width	PW or t_p
radio-frequency interference	RFI
resistance	R
resistance-capacitance	RC
resistance-inductance	RL
*revolution per minute	r/min
risetime	t_r
root mean square	RMS
*second (time)	s
serial number	SN
signal	sig
signal-to-noise ratio	S/N
standing-wave ratio	SWR
storage time	t_s
sweep	swp
synchronize	sync
temperature	T
time domain reflectometry	TDR
tolerance	tol
transconductance	g_m
vertical interval test signal	VITS
*volt	V
*watt	W

*IEEE Standard Number 260

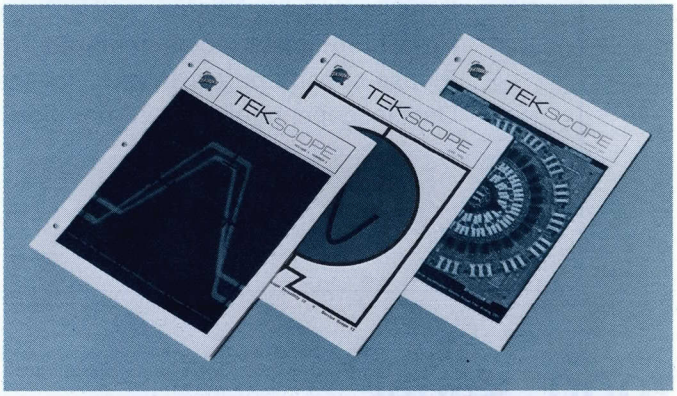
CONCEPT BOOKS

The volumes dealing with circuits give a theoretical description of the selected subject matter. The measurement books describe a variety of measurement techniques. Concept books may be obtained through your nearest Tektronix Field Office for a nominal fee. Twenty two are currently available; more are being written.

Digital Concepts
Horizontal Amplifier Circuits
Oscilloscope Cathode-Ray Tubes
Oscilloscope Probe Circuits
Oscilloscope Trigger Circuits
Power Supply Circuits
Sampling Oscilloscope Circuits
Spectrum Analyzer Circuits
Storage Cathode-Ray Tubes and Circuits
Sweep Generator Circuits
Television Waveform Processing Circuits
Vertical Amplifier Circuits
Automated Testing Systems
Engine Analysis
Information Display Concepts
Probe Measurements
Semiconductor Devices
Spectrum Analyzer Measurements
Television System Measurements
Time-Domain Reflectometry Measurements
Transducer Measurements
Biophysical Measurements

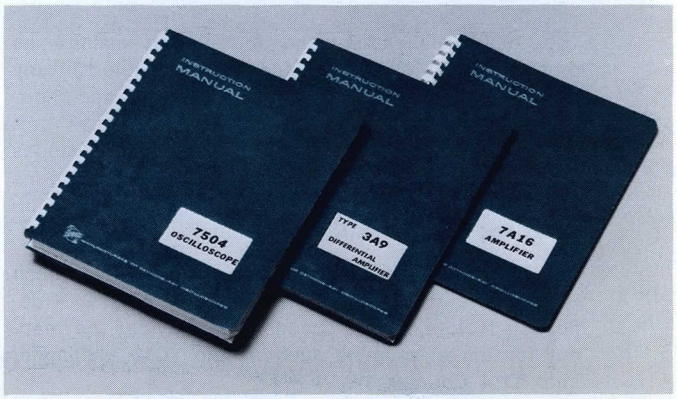
TEKSCOPE

A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques. Service Scope, a feature of TEKSCOPE, provides information for those responsible for the quality of instrument performance.



INSTRUCTION MANUALS

Tektronix instruction manuals are written for both the user and maintenance personnel. Shipped with each instrument, instruction manuals contain instrument specifications, operating instructions, circuit descriptions, maintenance information and calibration instructions as well as complete schematics and electrical and mechanical parts lists. Additional copies are available, at reasonable cost, through your nearby Tektronix Field Office.



Electrical And Mechanical Considerations

POWER

In general, instruments are factory wired for operation at 115 VAC. Most newer instruments provide quick-change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order. Tektronix instruments are designed with electronically-regulated power supplies to compensate for changing line voltages.

Most Tektronix instruments are designed for operation from a power source with its neutral at or near ground (earth) potential. They are not intended for operation from two phases of a multiphase system, or across the legs of a single-phase three-wire system (220 V).

Tektronix instruments are equipped with either a three-conductor attached power cord, or a three-terminal power cord receptacle. The third wire, or terminal, is connected directly to the instrument frame, and is intended to ground the instrument to protect operating personnel, as recommended by national and international safety codes. Color coding of the power cord conductors follows the National Electrical Code (USAS C1 - 1965): the line conductor is black; the neutral is white; the safety earth or ground is green.

This page, and the one opposite, contain a synopsis of all the oscilloscopes in this catalog. The intent of this brief overview is to direct you to the series which best meets your measurement requirements. For a detailed description of that series, go to the indicated page number. If more information is required, or time is not available for you to appraise the specifications to make a choice, call your nearby field engineer or representative. He will quickly recommend the right oscilloscope for your application. Please consult pages 10 to 13 for the location of the field office nearest you. Oscilloscope reference information is located on pages 20 to 27.

7000 Series Page 28

The 7000-Series three and four-plug-in mainframes provide measurement options not available in any other single-beam oscilloscope. Vertical and horizontal switching in the four-plug-in mainframes provides 20 possible combinations of operating modes for unmatched display versatility. Twenty plug-ins are available, including the new 7D13 Digital Multimeter and new 7D14 Digital Counter.

The 7500 and 7700 Series feature CRT Readout which is exclusive to Tektronix. It labels the CRT with deflection factors, sweep speeds, and provides the readout for digital plug-ins such as the 7D13 Multimeter and 7D14 Counter.

Included in this series is the 150-MHz 7704 which is available in both cabinet and rackmount models. Three 90-MHz mainframes are also available. Included are the 7504 oscilloscope, 7514 storage oscilloscope, and the 7503 three-plug-in oscilloscope. Two additional mainframes (7403N and R7403N) feature bandwidths up to 60 MHz, three-plug-in compartments and a big 6 1/2-inch CRT. With a 7A18 dual-trace amplifier, 7B53N dual-time base, and a third plug-in compartment, the 7403N represents today's lowest price ($2200) in a high-performance, 50-MHz plug-in laboratory oscilloscope.

5100 Series Page 72

Many oscilloscope users do not require wide-bandwidth instruments. Frequently, however, they do require plug-in versatility. Until now, this combination has not been available. The 5100 Series meets this need as it offers 2-MHz bandwidth along with three-plug-in versatility.

Four new "firsts" are introduced in the Tektronix 5100-Series Oscilloscopes. The 5103N is the first oscilloscope to feature interchangeable single-beam and dual-beam, conventional and storage display units. The 5103N is the first to feature a cabinet model which may be converted to and from a rackmount model. The 5103N is the first low-frequency oscilloscope to offer plug-in versatility and the 5103N is the first oscilloscope to offer all these features at the price of a low-frequency, non-plug-in oscilloscope.

When you own a 5103N and your measurement requirements change, chances are you will not have to buy a new oscilloscope. Just select a new plug-in or another display unit or convert your cabinet model 5103N to a rackmount model.

560 Series Page 83

The 560 Series offers 28 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical and horizontal deflection systems (Type 565), a bistable storage oscilloscope (Type 564B) with and without auto-erase, and a conventional oscilloscope (Type 561B). The dual plug-in unit features of the Type 564B and 561B allow conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling, spectrum analyzer, operational amplifier, transducer and strain-gage amplifier plug-ins are also available.

With the Type 565 the horizontal amplifiers are built-in and can be driven by either of its two built-in sweep generators. The vertical amplifiers can be of any 2-Series or 3-Series plug-in units except spectrum analyzer and sampling units.

The 560 Series is a family of valued performers that is recommended for measurement applications requiring realtime bandwidths up to 10 MHz, plug-in versatility, dual beam, and storage.

540-550 Series Page 126

This series of plug-in instruments offers the user proven performance in one of the most respected, flexible, versatile oscilloscope systems presently available. Any instrument selected from this highly developed series represents a significant price/performance value which remains difficult to match.

Maximum bandwidth available is 50 MHz. The 50-MHz Type 556 is the widest bandwidth, dual-beam oscilloscope available from Tektronix. Also included in this series is the 549 Storage Oscilloscope. The 549 has a stored writing speed of 5 cm/μs which is the fastest offered by any manufacturer today. Operational amplifier, transducer and strain-gage amplifier plug-ins are also offered (they are also available in the 560 Series).

647A Series Page 158

This series of oscilloscopes operates over a wide temperature range (−30°C to +65°C). This wide operating range allows operation in severe temperature environments with a margin of safety elsewhere unavailable. In addition to exceptional ruggedness, this system also provides the operational and display abilities needed for high accuracy laboratory requirements.

If operating temperature range, vibration, altitude, shock, and humidity are considerations in YOUR selection of an oscilloscope, the 647A Series represents excellent value in a plug-in type package.

Non-Plug-In Oscilloscopes Page 166

The non-plug-in oscilloscopes in this section incorporate a limited number of functions sufficient to do a given measurement job. Economies are realized at the expense of flexibility, since only a limited number of functions can be built into any given oscilloscope.

Maximum bandwidth offered is 1 MHz and it's available in three dual-beam oscilloscopes, two of which (5030 and 5031) have 10-μV sensitivity and auto scale-factor readout. The 5031 also provides dual-beam, bistable storage. Also included in this group is a single-beam, X-Y instrument (503) and an inexpensive 450-kHz oscilloscope (504).

Portable Oscilloscopes Page 177

If you have an application for a portable oscilloscope, then one of the six in this group is certain to be just what you require. Performance ranges from a 4-MHz, 7-lb model (323) to the 150-MHz 454A.

The 453 and 454 set the standard of performance for portable laboratory oscilloscopes. Now, the 453A and 454A offer still more performance. A CRT with 33% more viewing area, wider bandwidth at higher sensitivity, and a mixed sweep mode are just a few examples.

BEHIND THE FRONT PANEL . . .

An oscilloscope is a universal measuring instrument capable of measuring a very wide variety of rapidly changing electrical phenomena, even if the phenomenon occurs once and lasts only a fraction of a millionth of a second.

The oscilloscope graphs the changes with relation to time—measuring the amount of the event in its vertical axis, and how long the event lasts on its horizontal axis. The user can determine whether the voltage is changing positively or negatively, and the amplitude and duration of the event measured and the actual shape of the waveform.

The figure is a block diagram of a typical oscilloscope, omitting power supplies. The waveform *(A)* to be observed is fed into the vertical-amplifier input. The calibrated VOLTS/DIV control sets the gain of this amplifier. The push-pull output *(B and C)* of the vertical amplifier is fed through a delay line to the vertical-deflection plates of the cathode-ray tube. The purpose of the delay line is explained later on this page.

The time-base generator or "sweep generator" develops a sawtooth wave *(E)* that is used as a horizontal-deflection voltage. The rising or positive-going part of this sawtooth, called the "run-up" portion of the wave, is linear. That is, the waveform rises through a given number of volts during each unit of time. This rate of rise is set by the calibrated TIME/DIV control. The sawtooth voltage is fed to the time-base amplifier. This amplifier includes a phase inverter so that the amplifier supplies two output sawtooth waveforms *(G)* and *(J)* simultaneously—one of them positive-going, like the input, and the other negative-going. The positive-going sawtooth is applied to the right-hand horizontal-deflection plate of the cathode-ray tube, and the negative-going sawtooth is applied to the left-hand deflection plate. As a result, the cathode-ray beam is swept horizontally to the right through a given number of graticule divisions during each unit of time—the sweep rate being controlled by the TIME/DIV control.

In order to maintain a stable display on the cathode-ray tube screen, each horizontal sweep must start at the same point on the waveform being displayed. To maintain a stable display, we feed a sample of the displayed waveform to a "trigger" circuit that gives a negative output voltage spike *(D)* at some selected point on the displayed waveform. This triggering spike is used to start the run-up portion of the time-base sawtooth. As far as the display is concerned, then, "triggering" can be taken as synonymous with the starting of the horizontal sweep of the trace at the left-hand side of the graticule.

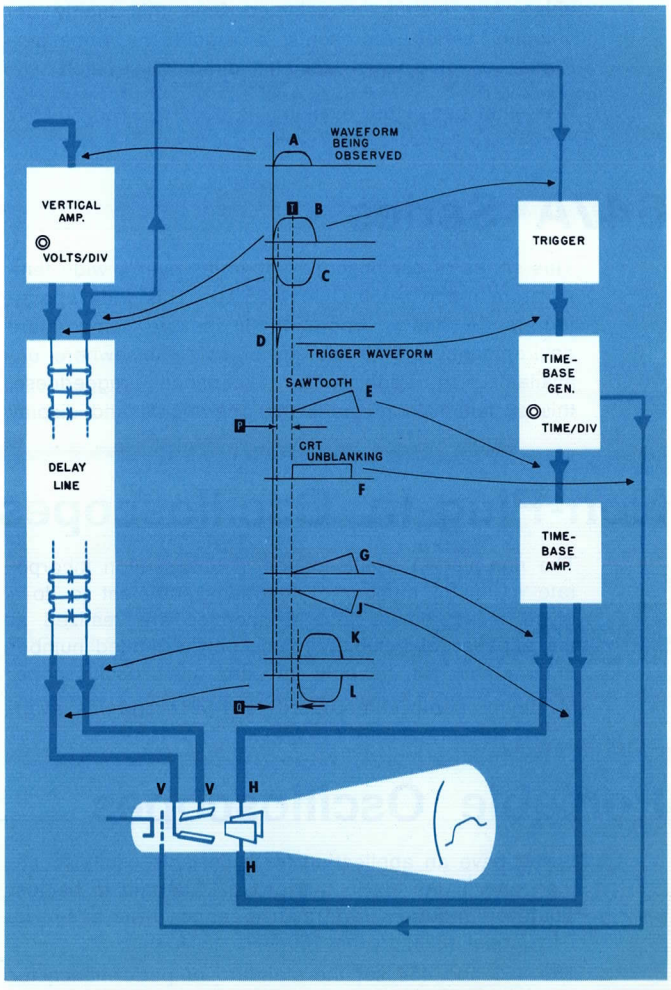
A rectangular "unblanking" wave *(F)* derived from the time-base generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds to the duration of the positive-going or run-up part of the time-base output, so that the beam is switched on during its left-to-right travel and is switched off during its right-to-left retrace.

In the case shown, the leading edge of the waveform being displayed is used to actuate the trigger circuit. Yet we may want to observe this leading edge on the screen—and the triggering and unblanking operations require a measurable time interval *P,* often about 0.15 microsecond. To permit us to see the leading edge, a delay Q of about 0.25 microsecond is introduced by the delay line in the vertical-deflection channel, after the point where the sample of the vertical signal is tapped off and fed to the trigger circuit.

To summarize the purpose of the delay line, it is to retard the application of the observed waveform to the vertical-deflection plates until the trigger and time-base circuits have had an opportunity to get the unblanking and horizontal-sweep operations under way. In this way, we can view the entire desired waveform—even though the leading edge of that waveform was used to trigger the horizontal sweep.

If the delay line were not used, we would be able to see only that portion of the waveform following the instant designated as *(T)* in waveform *(A).*

THE OSCILLOSCOPE BLOCK DIAGRAM



The following discussion is intended to clarify the significance of many of the technical terms used to describe oscilloscopes. The information is intended for those who, being responsible for buying or recommending such instruments, feel a need for a better understanding of the relative importance of different features.

Things like workmanship, component quality and construction layout have important bearings on reliability and serviceability but, unfortunately, cannot be adequately specified. The quality and availability of technical assistance before and after purchase are other matters deserving considerable attention. However, they too can be appraised only **after** *experience.*

SCALES AND SWEEPS

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously and horizontal calibration was based on their repetition *frequency.* In most modern laboratory scopes, sweeps are calibrated in terms of a direct unit of *time* for a given distance of spot travel across the screen; hence the term, "time-base." The present system permits such advantages as:

1. Direct measurement of time between events (waveforms)
2. Viewing and measuring small portions of pulse trains
3. Viewing and measuring random or aperiodic events
4. Viewing and measuring single non-recurrent events

The units of distance are usually inches or centimeters (or fractions thereof) but sometimes are specified simply as "divisions." The choice of how long a division might be is based upon the manufacturer's best opinion of how the full scale should be divided. One major division is the unit of distance in a specification. Some instruments have different distance-units for the vertical and horizontal scales.

A transparent scale with vertical and horizontal lines spaced one division apart usually is fitted against the face of the CRT or in more modern instruments inside the CRT. This scale allows time and amplitude to be read directly. These graduated scales (graticules) often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should *not* be interpreted as the distance-unit in a specification.

Although it is common practice to think and speak of time-bases in terms of relative sweep speeds (horizontal velocity of the spot), we should not specify them in this way. Instead they are specified by a term which is actually the reciprocal of speed: time per division (Time/Div).

FAST AND SLOW SWEEPS

Some investigations require fast sweeps and others slow sweeps. From the standpoint of compatibility with frequency response, the fastest sweeps are usually considered adequate if they are capable of displaying one cycle of the upper passband frequency across the full horizontal scale. High-frequency scopes seldom have sweeps which are that fast.

To measure risetime as accurately as *possible,* a step-signal (squarewave, rectangular pulse, etc.) should occupy almost the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45-deg slope. This requirement can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the risetime of the vertical deflection system. Because of the compounding difficulties and costs of providing extremely fast sweeps which are both linear and accurate, the requirement is seldom met by scopes having very good vertical deflection risetime capabilities.

Fortunately, most risetime measurements are not made to determine *actual* risetime, but are made to determine whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of known risetime can usually be made, using a sweep having a relatively poor figure of merit, if the vertical deflection system risetime is good enough.

SINGLE-SWEEP OPERATION

In applications where the displayed signal is not repetitive or varies in amplitude, shape, or time a conventional repetitive display may produce a jumbled presentation. To avoid this, use of the single-sweep feature, found on most oscilloscopes, is advised. To operate the single-sweep feature, first make certain the trigger circuit will trigger on the event to be displayed. Arming of the sweep is done typically with the push of a switch, a lamp should light and stay lit indicating the trigger circuit is armed and ready for a trigger signal. When the circuit is triggered the sweep will run, the ready light will go out indicating that the circuit has been triggered. The sweep is locked out from that point on until the sweep circuit is again armed. This feature is particularly useful for photographic recording.

SWEEP MAGNIFICATION AND SWEEP DELAY

Sometimes it is desirable to display parts of waveforms which occur considerably later than suitable sweep triggering signals occur. Such waveforms, can always be displayed on sweeps which last long enough, but if the duration of the waveform is short compared to the duration of a full sweep, an accurate examination may not be possible. The need to magnify (expand) the display for the time interval during which a particular event occurs is apparent. Portions of sweeps may be magnified by increasing the gain of the horizontal amplifier (allowing either or both ends of the sweeps to go off-screen) and positioning the display so that the desired portion is on-screen. This is a simple way to meet the need. Another way is to generate suitably delayed sweep triggering signals so that fast sweeps may be triggered just prior to the moment when the signal to be examined occurs. The first method delays the *presentation* of a sweep portion; the second method delays the actual *generation* of the displayed sweep. Calibrated sweep delay can provide some advantages over ordinary sweep magnification, cost and simplicity not being among them. These advantages are:

1. Greater ratios of effective magnification
2. Elimination of "time jitter" or "time drift" of displayed waveforms
3. Greater accuracy of time-interval measurements between waveforms
4. Better long-term accuracy of the displayed time base

DELAYING SWEEP

Delaying-sweep measurements are based on the use of two linear calibrated sweeps. The first sweep, commonly called the delaying sweep, allows the operator to select a specific delay time. When this time is reached, the delayed sweep starts. The delayed sweep typically is a decade or two faster than the delaying sweep and offers additional resolution. The combinations of these two sweeps offer extra resolution and increases accuracy of time-interval measurement.

To understand delaying-sweep operation, it is necessary to understand the time relationship between the delaying sweep and the delayed sweep. To illustrate, an event occurs that starts the delaying sweep at t_0. The delaying-sweep voltage ramp is applied to a voltage comparator that produces a trigger pulse at a later point in time, t_1. This trigger pulse occurring at t_1 starts the delayed sweep. Delay time, then, may be defined as the difference in time between the start of the delaying sweep and the start of the delayed sweep and can be expressed as $t_1 - t_0$.

The accuracy of delay time is basically determined by the delaying sweep and the potentiometer which sets the threshold level of the comparator. The horizontal amplifier and CRT *do not* affect the accuracy of the delay time. An intensifying pulse indicates where the delayed sweep starts with respect to the delaying sweep, and so delay time can be determined independently of horizontal amplifier and CRT considerations. The portion of the delaying sweep that is intensified is a direct function of the duration of the delayed sweep.

Oscilloscope time-interval measurements usually involve finding the period of time between two events. By adjusting the delay-time multiplier (DTM), which controls a potentiometer in the comparator circuitry, the delay time from the start of the delaying sweep to both events is determined. The time between these events is the difference between their corresponding delay times.

The resolution of these delay times can be improved, thus improving the time-interval measurement accuracy, by driving the horizontal amplifier with the delayed sweep. The intensified portion of the delaying-sweep presentation is now displayed over the full CRT display. This appears as a X10 magnified display since 1/10 of the original waveshape time is now displayed over the same graticule area. A delaying-sweep oscilloscope, then, acts as a magnifier whose magnification power is the ratio of the delaying-sweep rate to the delayed-sweep rate.

SWEEP SWITCHING

Sweep-switching oscilloscopes offer dual-beam measurement capabilities with a single-beam CRT for most repetitive signals. Found in the newer instruments sweep switching provides dual-trace, independent time-base displays and simultaneous delaying and delayed-sweep displays. It can also provide four-trace displays using dual-trace vertical systems with sweep-switched horizontal systems.

RISETIME AND HIGH-FREQUENCY RESPONSE

The first qualification generally sought in a scope is adequate risetime or adequate high-frequency sinewave response. Risetime is the more important specification for "faster" scopes, and passband (bandwidth) the more frequently used specification for "slower" scopes. The two will be closely related mathematically, however, when fast step-signals produce little or no overshoot or ringing. The product of risetime and frequency response should produce a factor whose value lies between 0.33 and 0.35, when transient response is optimum. For example, the product of 0.023 microsecond risetime (0.023×10^{-6} second) and 15 MHz (15×10^6 Hz) equals 0.345. Factors larger than 0.35 probably indicate overshoot in excess of 2 percent, while those larger than 0.4 probably indicate overshoot in excess of 5 percent.

Ideally, scopes should have a vertical system capable of rising in about one-fifth the time that the fastest step-signal applied rises. In such a case, the risetime of the signal (as indicated on the scope) will only be in error by about 2 percent, assuming sweep timing and linearity are perfect. Vertical deflection systems which have a risetime no better than *equal* to the fastest rising signal applied are often considered adequate—a conclusion which may or may not be true depending upon the accuracy desired. Such reasoning is based upon the fact that the indicated risetime will be in error by a predictable amount when transient response is optimum. Under such conditions, signal risetime can be calculated to a close approximation by the formula

$$T_s = \sqrt{T_i^2 - T_a^2}$$

where T_s = signal risetime, T_i = indicated risetime and T_a = vertical system (usually amplifier) risetime. The accuracy of such calculations falls off sharply for signals which rise *faster* than the scope amplifier, because of the increased significance of measurement errors. For instance, the following sweep timing or display reading errors will contribute as much as 100 percent difference between calculated and *actual* signal risetimes.

When $T_a/T_s = 2/1$	11 percent	measurement error which can account for 100 percent calculation error
When $T_a/T_s = 3/1$	5 percent	
When $T_a/T_s = 4/1$	3 percent	
When $T_a/T_s = 5/1$	2 percent	

When the fastest sweep is relatively slow compared with vertical deflection system risetime (or the scale is small to start with), measurements become confined to quite small sections of the screen, and the probability of measurement errors becomes even worse.

As mentioned in a previous section, very accurate risetime measurements are usually not as common as risetime comparisons. For *comparing* the risetimes of two signals, scopes having a risetime equal to the risetime of signals applied to them are usually adequate.

SWITCHED INPUTS AND DUAL-BEAM SCOPES

A very useful type of dual-input amplifier is one which can pass either of two input signals one at a time to permit viewing either signal without disturbing connections. Comparison of the two signals is thereby permitted. Manual switching, available on some instruments, is the simplest method but electronic switching permits simultaneous viewing of two signals. Since the two signals trace out separate displays, scopes with built-in electronic switches are commonly called dual-trace scopes. They should not be confused with dual-beam scopes. Dual-trace scopes offer some advantages over dual-beam scopes and vice versa. Two simultaneous, non-recurrent signals of *short duration* may be displayed on a dual-beam scope, but cannot be displayed on a dual-trace scope. Also, some dual-beam scopes can display non-recurrent signals on different time bases. The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities.

Steady displays of two signals which are not synchronous with each other may be displayed on dual-trace scopes. This is possible because the triggering signals may be switched in synchronism with the input signals. A useful application of such a display is one in which one waveform might be some kind of standard. Dual-beam scopes having two sweep generators and two sets of horizontal deflection plates also permit this kind of comparison.

Electronic switches should be capable of switching in two ways: rapidly during sweeps or synchronously during sweep retrace intervals. The first way is usually called "chopped," the second way "alternate." The alternate mode is used more frequently and is preferred for displays employing faster sweeps. The chopped mode usually is reserved for comparing low-frequency recurrent signals or long-duration, non-recurrent signals.

When displaying two very bright traces using the chopped mode, the display may show the chopping waveform transients as faint lines connecting the two traces. Some scopes blank (turn off) the CRT beam during these transition intervals to prevent them from appearing in the display.

The chopping rate (frequency) should be as high as possible so long as the resulting traces are not broadened significantly by distortion of the chopping signal. When the chopped mode is used with relatively fast non-recurrent sweeps, the traces are not continuous but are made up of separate segments, the number of segments depending on the chopping rate and the sweep duration. For instance, if the chopping rate is 100,000 Hz and the sweep duration is 1 millisecond, there will be 100 segments in each trace. How well these separate segments depict all the detail in the two waveforms establishes the limits of usefulness of the chopped mode compared to an alternately switched display or a dual-beam scope.

DIFFERENTIAL, BALANCED OR PUSH-PULL INPUTS

Push-pull signals may be introduced to the vertical deflection system if the input circuits are designed to accommodate such signals. Such amplifiers are commonly called differential or balanced amplifiers. They provide a feature beyond mere accommodation of push-pull signals: they have the ability to cancel or reject, to a high degree, any signal components equal in amplitude and phase that appear at both inputs. This ability explains the term "differential amplifier" since essentially only the difference between two signals is amplified. Such amplifiers provide a simple and accurate means of *measuring* the difference between two signals. They also provide a means of rejecting most of any unwanted signal components common to both inputs, such as power line "hum."

Oscilloscope measurements of voltages can be made with great accuracy using a differential comparator. A differential comparator consists of a differential input amplifier used in conjunction with an accurately calibrated adjustable-voltage source. When operating as a calibrated differential comparator or slide-back voltmeter the calibrated DC comparison voltage is internally applied, to differentially offset any unwanted portion of the applied signal; thereby allowing measurements of relatively small AC or DC signals riding on top of relatively large AC or DC signals. Differential comparator units may be used to make the following measurements: (1) measure DC voltages, (2) measure small AC or DC signals superimposed on DC, (3) measure small AC signal variations on large AC, and (4) measure high-amplitude low-frequency AC signals.

COMMON-MODE REJECTION

The definition of the term "differential amplifier" implies a rejection of equal amplitude, coincident signals. This implication is correct. However, the degree of rejection depends primarily on the symmetry of the amplifier inputs. The amount of difference signal from a particular amplifier is documented with a mathematical relationship that is called the common-mode rejection ratio (CMRR). This ratio and associated terms are defined as follows:

Common-Mode: Refers to signals that are identical with respect to both amplitude and time.

Common-Mode Rejection: The ability of a differential amplifier to reject common-mode signals.

Common-Mode Rejection Ratio: The ratio of the amplitude of the common-mode input signal to the amplitude of the difference signal displayed on the CRT.

Since the differential amplifier is part of an oscilloscope, the output signal used to calculate the CMRR is measured from the CRT screen and volts per centimeter switch setting. Thus, a differential amplifier that produces a .005-volt output when driven by 5.0 volts of common-mode signal has a CMRR of 5/.005 or 1000:1.

FACTORS WHICH AFFECT CMRR

Frequency: Since the common-mode output voltage is a factor of phase difference, as well as gain between channels, the frequency of the input common-mode signal has a direct bearing on the CMRR. Generally as the frequency of the input signal increases the CMRR decreases. (Exception: With AC-coupled input the CMRR can become higher as frequency is increased within the 1 Hz to 100 Hz range.)

Amplitude: The term maximum common-mode input voltage (common-mode signal range) means the maximum voltage that will not overdrive the amplifier. This should not be confused with the maximum non-destructive input voltage which is related to the breakdown limits of the amplifier components. The CMRR decreases as the input voltage increases. If the voltage applied to the input is raised beyond the maximum common-mode input voltage specified for the amplifier, at some point the input circuit will be overdriven and the common-mode rejection ratio becomes meaningless. Once this occurs, further increase of the common-mode voltage will cause a disproportionate increase in the amplitude of the CRT display. This discussion of input voltage also applies to pulses and squarewaves as well as sinewaves. But because these waveforms contain components of many frequencies, it is difficult to predict the shape of the resultant waveform that a differential amplifier may display.

Source Impedance: The specified CMRR assumes the points being measured have identical source impedance. The source impedance and the amplifier input impedance form an RC divider which determines the portion of the signal that appears across the amplifier input, and the apparent effect on CMRR.

Signal Transporting Leads: A principal requirement for maximum CMRR is that the signals arrive at the two amplifier inputs in precisely the same phase and amplitude. Slight differences in attenuation factors, or phase shift between two input attenuators may reduce the CMRR 20% or more.

Ground Connections: Proper grounding reduces signals generated from ground-loop currents. It is best to electrically connect the probe or signal lead shields together at the probe body or instrument, but not to the signal source ground.

In differential measurements each input of the amplifier acts as a reference for the other and ground connections are only used for safety reasons. (The term differential input is synonymous with floating input.)

"SUMMING" INPUTS

A type of dual-input arrangement available on some amplifiers, opposite in character to differential input, is the summing input. Such an amplifier rejects *out-of-phase* signal components which are equal in amplitude but *adds* those components which are of the same phase. Since this amplifier adds or subtracts, depending on phase, a descriptive term is "added algebraically."

"SAMPLING" OSCILLOSCOPES

A very significant advancement in the art of oscilloscope design is a system employing sampling techniques. The technique is very similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers and finally shown, one sample at a time, on the screen of a cathode-ray tube. The graph produced is a replica of the sampled waveforms. The principal difference in appearance, between displays made by sampling techniques and conventional displays, is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than one sample is taken and displayed each time the signal recurs.

The sampling method, however, provides a means for examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 1 nanosecond, on an "equivalent" time-base of less than 1/5 nanosecond per cm and which have less than 10 mV of peak amplitude.

A recent innovation to sampling is the random sampler. The random sampler constructs a display of a repetitive waveform in a manner much like a conventional sampling oscilloscope but with a very significant difference for the user—no delay line or *pretrigger* is required for *lead time* in the display. The benefits thus afforded are numerous:

1. The inherent distortions and risetime limitation of bulky signal delay lines are eliminated.
2. It is no longer necessary to work into the 50-Ω characteristic impedance of a delay line.
3. Direct sampling probes may be used for convenient high-impedance, in-circuit signal pickup.
4. Triggers may occur prior to, coincident with, or AFTER the displayed signal without sacrificing lead time in the display.
5. Display jitter caused by pretrigger-to-signal jitter or by signal period uncertainty is eliminated.
6. Signals with no convenient source of pretrigger can be observed.

TIME-DOMAIN REFLECTOMETRY

Maintaining the fidelity of electronic signals that of necessity have to be transmitted from point-to-point is of primary concern to those that design, build, and maintain electronic equipment. The simple, inexpensive coaxial transmission line is perhaps the most common method used to connect two points. The techniques for determining transmission line performance vary from simple visual inspection to elaborate instrumentation set-ups that require a great deal of skill and time. The availability of instruments such as the Tektronix 7S12/S-6/S-52, 3S7/3T7, and 1S2 TDR Plug-In Units simplify the testing of transmission line performance.

A time domain reflectometer is basically an oscilloscope that incorporates a pulse generator. The pulse generator output is coupled to the oscilloscope's vertical input and to one end of the coaxial cable under test. The pulse travels down the cable and any discontinuities it encounters are displayed on the CRT. TDR not only identifies a discontinuity . . . it locates it in time and distance also. Frequency domain reflectometers, the slotted line and bridges, do not offer this convenience. Time resolution and TDR system risetime are directly proportional.

STORAGE OSCILLOSCOPES

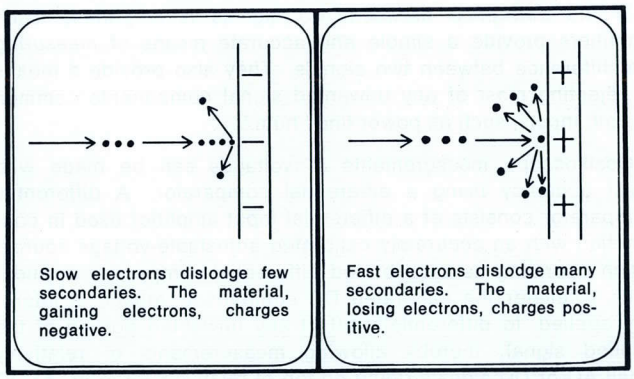
The freezing of a waveform in time by recording it on the storage oscilloscope screen until observed, or until a second event can be stored for direct comparison, has added unparalleled capability to oscilloscope instrumentation.

A storage oscilloscope has an ability to store a CRT display in order that it may be observed for any required time. This stored display may be instantly erased to make way for storage of a later event. By the flick of a switch, the instrument is converted to a normal display oscilloscope.

Storage oscilloscopes enable an engineer to make meaningful evaluations of slowly changing phenomena, that would appear not as a line but as a slow-moving dot on a conventional oscilloscope; and very rapidly changing "one-shot" events whose image would flash across the conventional oscilloscope screen too fast to be seen without elaborate camera equipment.

Historically, a limiting factor in adapting storage CRT's to oscilloscopes was the slowness of the storing mechanism in relation to the sweep velocities of general purpose scopes. New, faster responding storage CRT's are now available and, coupled with circuit methods which increase their speed of response, these obstacles have been overcome.

The Tektronix direct-view bistable storage tube (DVBST) is based on a secondary emission principle. When a stream of primary electrons strikes the phosphor target, secondary electrons are dislodged from the phosphor surface. As the potential increases, each primary electron displaces more than one secondary electron, resulting in the material charging positive.

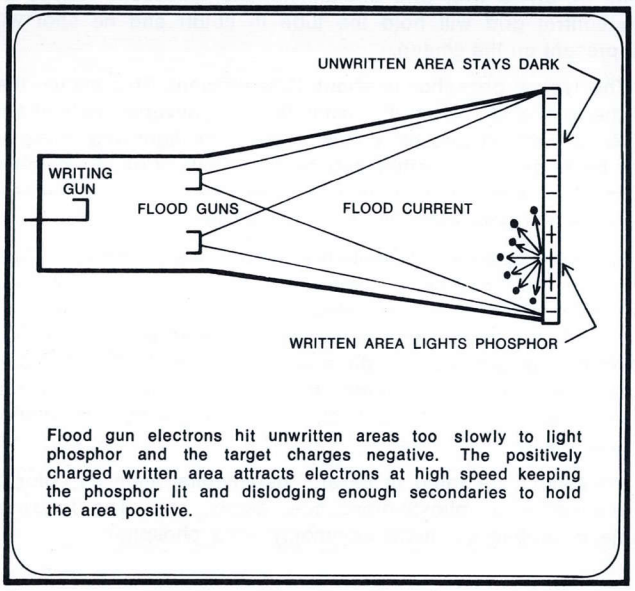


In addition to the normal CRT writing guns, flood guns are used to cover the complete phosphor screen uniformly with low-velocity electrons. A conductive transparent face plate under the phosphor completes the circuit and allows storage to take place.

The normal writing gun bombards the phosphor screen with a beam of high-speed focused electrons. The beam writes and also dislodges great numbers of secondary electrons. The written surface where the waveform is traced out loses electrons and charges positive.

By using the flood-electron guns, the display may be stored. The flood guns emit low-velocity electrons over the whole CRT-screen area. The electrons strike the unwritten area too slowly to jar loose many secondaries. As a result, these areas merely collect electrons until they are driven negative and can attract no more current.

The latent image where the beam has written attracts flood electrons at such a velocity so each entering primary dislodges



Flood gun electrons hit unwritten areas too slowly to light phosphor and the target charges negative. The positively charged written area attracts electrons at high speed keeping the phosphor lit and dislodging enough secondaries to hold the area positive.

sufficient secondaries to hold the phosphor target positive. Thus, the written area neither gains nor loses electrons but remains positively charged and continues to attract flood current. As a result of this equilibrium, the trace is stored.

This is the basis for all Tektronix direct-view bistable storage tubes. The same flood current that holds the background dark also holds the written trace bright.

All Tektronix storage oscilloscopes feature split-screen CRT's. This means that either half of the 8 x 10 division display can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. A stored display can be compared simultaneously with a conventional display. Or, a test or standard signal can be stored on one half of the screen, and compared in detail with successive signals displayed on the other half.

SPECTRUM ANALYZERS

Tektronix Spectrum Analyzers, built as plug-in accessories for existing oscilloscopes and as complete portable instruments, cover frequencies from 50 Hz to 40 GHz (Gigahertz).

For additional information please see the section dedicated to Spectrum Analyzers.

PLUG-IN OR NON-PLUG-IN

Tektronix has oscilloscopes available in two forms: plug-in types and a self-contained, non-plug-in type.

The plug-in type consists of a mainframe containing, at the least, the low-voltage and high-voltage power supplies and the CRT and its associated circuitry. With this type of mainframe, the entire vertical amplifier is a plug-in unit, and the time base and horizontal-sweep amplifier comprise another plug-in unit. The 561B and 564B utilize this type of design.

Other types of mainframes may also contain the vertical deflection amplifier and the entire horizontal sweep circuit. With this type, only a vertical preamplifier is contained in a plug-in unit (540 and 550 Series). Still another type of mainframe may contain the horizontal sweep amplifier and the vertical deflection amplifier in which case the vertical preamplifier is contained in one plug-in unit, and the time base or sweep generator is contained in another plug-in unit. This is the design of the 7000, 5100, and 647A Series. The 5100 Series accepts two vertical preamplifiers and one time base; the 7000 Series, two vertical preamplifiers and two time bases.

With a wide range of plug-in units, particularly in the vertical preamplifier line, one can convert an instrument from a "conventional" voltage/time display to any one of a number of other types of displays (dual trace, four trace, differential, operational amplifiers, sampling, spectrum analysis, etc.) simply by changing vertical preamplifier plug-in units. In fact, the 7000 Series also offers digital multimeter and digital counter plug-in units.

The non-plug-in oscilloscope has all circuits included in the single instrument and usually is designed for voltage/time measurements only. The advantage of the non-plug-in oscilloscope is that equal or better performance in any one measurement area usually can be obtained for less cost, compared to the plug-in type. Also, the non-plug-in type is usually smaller and sometimes provides the option of battery operation. Its chief disadvantage of course is that it does not offer the versatility of plug-ins.

Turn to pages 18 and 19 for a brief description of the outstanding features offered by each oscilloscope series.

ENVIRONMENTAL CHARACTERISTICS

The environmental characteristics listed include some or all of the following:

Temperature, Altitude, Humidity, Vibration, Shock and Electromagnetic interference (EMI, previously RFI).

Sample production instruments are tested periodically as part of a continual quality control process. Complete tests on every production instrument are undesirable as well as uneconomical.

The specifications for humidity, vibration, shock and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical deterioration. Such operation, however, should not cause electrical performance deterioration outside specifications. The specifications for temperature and altitude are such that continual use at the limits will not cause significant short term deterioration. Naturally, higher temperature operation can be expected to reduce long-term reliability and should be avoided if possible. The EMI test is completely non-destructive.

For more specific information on the environmental characteristics and how they apply to given instruments, please refer to the page covering that instrument.

CATHODE-RAY TUBE PHOSPHOR DATA

The catalog description of each oscilloscope indicates the phosphor normally supplied. However, for specific applications, you may want to specify another phosphor.

Human Eye Response

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wave length from deep red to violet. The human eye is peaked in its response in the yellow-green region and falls off on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

If the quantity of light falling on the eye is doubled, the brightness "seen" by the eye does *not* double. The brightness of a color tone as seen is approximately proportional to the log of energy of the stimulus.

The term *luminance* is the photometric equivalent of brightness and is based upon measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The unit commonly used for luminance measurements is the foot lambert. The term *luminance* implies that data has been measured in a manner, or has been so corrected, to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de l'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful *only* when the phosphor is being *viewed visually*.

Phosphor Burning

When a phosphor is excited by an electron beam having an excessively high current density, a permanent loss of phosphor efficiency may occur. The light output of the damaged phosphor will be reduced and in extreme cases complete destruction of the phosphor may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

The two most important and controllable factors affecting the occurrence of burning are *beam-current density* (controllable with the Intensity, Focus and Astigmatism controls) and the length of *time* the beam excites a given section of the phosphor (controllable with the Time/Div control). Under normal conditions in CRT's with grid unblanking, the quiescent voltage on the control grid will hold the tube in cutoff and no spot will be present on the screen.

The typical phosphor is about 10% efficient. This means that of the total energy from the beam, 90% is converted to heat and 10% to light. A phosphor must radiate the light and dissipate the heat; or as any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping intensity down or the time short will save the screen.

For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Field Engineer, Representative or Distributor. He will know the factors that must be considered in selection of a phosphor for any given application. For example, P11 is excellent for waveform photography but due to its short persistence, it is not well suited for applications requiring visual observation of low speed phenomena.

Phosphors are rated in several parameters, such as color of fluorescence or phosphorescence, decay, etc. The following table describes the more commonly used phosphors.

PHOSPHOR DATA CHART

Phosphor	*Fluorescence*	*Phosphorescence Where Different Than Fluorescence*	*Relative Luminance*Ⓐ	*Relative Photographic Writing Speed*Ⓑ	*Decay to 0.1% (in ms)*	*Relative Burn Resistance*	*Comments*
P1	Yellowish-green	—	50%	20%	95	Medium	Replaced by P31 in most applications.
P2	Bluish-green	Yellowish-green	55%	40%	120*	Medium high	Good compromise for high and low speed applications.
P4	White	—	50%	40%	20	Medium high	Television displays
P7	Blue	Yellowish-green	35%	75%	1500*	Medium	Long decay, double layer screen.
P11	Purplish-blue	—	15%	100%	20	Medium	For photographic applications
P15	Bluish-green	—	15%	15%	0.05	Very high	Very short decay for flying spot scanner use.
P31	Yellowish-green	—	100%	50%	32	High	General purpose, brightest available phosphor.

Ⓐ Taken with a Spectra Brightness Spot Meter which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

Ⓑ P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

* Low level lasts over one minute under conditions of low ambient illumination.

Glossary of Terms

accelerating voltage—The cathode-to-viewing-area voltage applied to a cathode-ray tube for the purpose of accelerating the electron beam.

alternate display—A means of displaying output signals of two or more channels by switching the channels in sequence.

astigmatism—In the viewing plane of the cathode-ray tube, any deviation of the indicating spot from a circular shape.

attenuator—A device for reducing the amplitude of a signal without deliberately introducing distortion.

automatic triggering—A mode of triggering in which one or more of the triggering circuit controls are preset to conditions suitable for automatically displaying repetitive waveforms. The automatic mode may also provide a recurrent trigger or recurrent sweep in the absence of triggering signals.

bandwidth—Of an oscilloscope, the difference between the upper and lower frequency at which the voltage or current response is .707 (—3 dB) of the response at the reference frequency. Usually both upper and lower limit frequencies are specified rather than the difference between them. When only one number appears, it is taken as the upper limit.

Note 1: The reference frequency shall be (1) for the lower bandwidth limit, 20 times the limit frequency, and (2) for the upper bandwidth limit, 1/20 the limit frequency. The upper and lower reference frequencies are not required to be the same.

Note 2: This definition assumes the amplitude response to be essentially free of departures from a smooth roll-off characteristic.

Note 3: If the lower bandwith limit extends to DC, the response at DC shall be equal to the reference frequency, not —3 dB from it.

beam finder—A provision for locating the spot when it is not visible.

bezel—The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube in an oscilloscope. May also be used for mounting a trace recording camera or other accessory item.

blanking—Extinguishing of the spot. Retrace blanking is the extinction of the spot during the retrace portion of the sweep waveform. The term does not necessarily imply blanking during the holdoff interval or while waiting for a trigger in a triggered sweep system.

brightness—The attribute of visual perception in accordance with which an area appears to emit more or less light.

chopped display—A time-sharing method of displaying output signals of two or more channels with a single cathode-ray tube gun, at a rate which is higher than, and not referenced to, the sweep rate.

chopping transient blanking—The process of blanking the indicating spot during the switching periods in chopped display operation.

common-mode signal—The instantaneous algebraic average of two signals applied to a balanced circuit, both signals referred to a common reference.

conventional mode—That mode of operating a storage tube where the display does not store but performs with the usual phosphor luminance and decay.

deflection blanking—Blanking by means of a deflection structure in the cathode-ray tube electron gun which traps the electron beam inside the gun to extinguish the spot, permitting blanking during retrace and between sweeps regardless of intensity setting.

deflection factor—The ratio of the input signal amplitude to the resultant displacement of the indicating spot (for example, volts/division).

delay pickoff—A means of providing an output signal when a ramp has reached an amplitude corresponding to a certain length of time (delay interval) since the start of the ramp. The output signal may be in the form of a pulse, a gate, or simply amplification of that part of the ramp following the pickoff time.

delayed sweep—A sweep that has been delayed either by a predetermined period or by a period determined by an additional independent variable.

dual trace—A multi-trace operation in which a single beam in a cathode-ray tube is shared by two signal channels. See alternate display, chopped display and multi-trace.

focus—Maximum convergence of the electron beam manifested by minimum spot size on the phosphor screen.

Gaussian response—A particular frequency response characteristic following the curve $y(f) = e^{-af^2}$. Typically, the frequency response approached by an amplifier having good transient response characteristics.

geometry—The degree to which a cathode-ray tube can accurately display a rectilinear pattern. Generally associated with properties of a cathode-ray tube; the name may be given to a cathode-ray tube electrode or its associated control.

graticule—A scale for measurement of quantities displayed on the cathode-ray tube of an oscilloscope.

input RC characteristics—The DC resistance and parallel capacitance to ground present at the input of an oscilloscope.

intensity modulation—The process and (or) effect of varying the electron beam current in a cathode-ray tube resulting in varying brightness or luminance of the trace.

internal graticule—A graticule whose rulings are a permanent part of the inner surface of the cathode-ray tube faceplate.

jitter—An aberration of a repetitive display indicating instability of the signal or of the oscilloscope. May be random or periodic, and is usually associated with the time axis.

magnified sweep—A sweep whose time per division has been decreased by amplification of the sweep waveform rather than by changing the time constants used to generate it.

mixed sweep—In a system having both a delaying sweep and a delayed sweep, a means of displaying the delaying sweep to the point of delay pickoff and displaying the delayed sweep beyond that point.

multi-trace—A mode of operation in which a single beam in a cathode-ray tube is shared by two or more signal channels. See dual trace, alternate display and chopped display.

resolution—A measure of the total number of trace lines discernible along the coordinate axes, bounded by the extremities of the graticule or other specific limits.

risetime—In the display of a step function, the interval between the time at which the amplitude first reaches specified lower and upper limits. These limits shall be 10% and 90% of the nominal or final amplitude of the step, unless otherwise stated.

roll-off—A gradually increasing loss or attenuation with increase or decrease of frequency beyond the substantially flat portion of the amplitude-frequency response characteristic of a system or transducer.

signal delay—In an oscilloscope, the time required for a signal to be transmitted through a channel or portion of a channel. The time is always finite, may be undesired, or may be purposely introduced as in a delay line.

tangential noise measurement—A procedure to determine displayed noise wherein a flat-top pulse or squarewave input signal is adjusted in amplitude until the two traces (or portions of two traces), thus produced, appear to be immediately adjacent or contiguous. Measurement of the resulting signal amplitude determines a noise value which correlates closely with the value interpreted by the eye from a sampling display and is called the "tangential noise value".

trigger—A pulse used to initiate some function (for example, a triggered sweep or delay ramp).

unblanking—Turning on of the cathode-ray-tube beam.

MAINFRAMES

MAINFRAME	PAGE	BANDWIDTH
7403N, R7403N	34	DC to 60 MHz
7503	36	DC to 90 MHz
7504	38	DC to 90 MHz
7514	41	DC to 90 MHz (Storage)
7704, R7704	38	DC to 150 MHz
MORE TO COME		

VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER		7A11	7A12	7A13	7A14	7A15	7A16	7A18	7A22
PAGE		44	45	46	48	49	50	51	52
PERFORMANCE FEATURE		Low-Capacitance FET Probe Amplifier	Dual-Channel Amplifier	Differential DC Offset, High-Freq CMRR Amplifier	AC Current Probe Amplifier (2 current probes)	Low-Cost Conventional Input Amplifier	Wide-Bandwidth Conventional Input Amplifier	Dual-Channel Amplifier	DC-Coupled, High-Gain Differential Amplifier
TRACES		1	2	1	1	1	1	2	1
MIN DEFL FACTOR		5 mV/div	5 mV/div	1 mV/div	1 mA/div	5 mV/div	5 mV/div	5 mV/div	10 μV/div
7400 SERIES	BW	60 MHz	55 MHz	55 MHz	40 MHz (P6021) 55 MHz (P6022)	50 MHz	60 MHz	50 MHz	1 MHz ±10%
	Tr	5.9 ns	6.4 ns	6.4 ns	8.8 ns (P6021) 6.4 ns (P6022)	7.0 ns	5.9 ns	7.0 ns	350 ns ±9%
7500 SERIES	BW	90 MHz	75 MHz	75 MHz	45 MHz (P6021) 75 MHz (P6022)	60 MHz	90 MHz	60 MHz	1 MHz ±10%
	Tr	3.9 ns	4.7 ns	4.7 ns	7.8 ns (P6021) 4.7 ns (P6022)	5.9 ns	3.9 ns	5.9 ns	350 ns ±9%
	SIG OUT BW	60 MHz	50 MHz	55 MHz	40 MHz (P6021) 50 MHz (P6022)	50 MHz	60 MHz	50 MHz	1 MHz ±10%
7700 SERIES	BW	150 MHz	105 MHz	100 MHz	50 MHz (P6021) 105 MHz (P6022)	75 MHz	150 MHz	75 MHz	1 MHz ±10%
	Tr	2.4 ns	3.4 ns	3.5 ns	7.0 ns (P6021) 3.4 ns (P6022)	4.7 ns	2.4 ns	4.7 ns	350 ns ±9%
	SIG OUT BW	60 MHz	50 MHz	55 MHz	40 MHz (P6021) 50 MHz (P6022)	50 MHz	60 MHz	50 MHz	1 MHz ±10%
ACCURACY*	WITHOUT PROBE	2% (Integral)	2%	1.5%	———	2%	2%	2%	2%
	WITH PROBE		3% (P6053)	1.5% (P6053)	2% (P6021) 2% (P6022)	3% (P6053)	3% (P6053)	3% (P6053) 3% (P6054)	2% (ANY)

*System Environmental Specification—Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%. Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Non-operating to 50,000 feet.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	MAINFRAME	TRIGGERING FREQ RANGE
7B50	54	Delayed Sweep & Ext Amplifier	5 ns/div	7500 Series	DC to 100 MHz
7B51	54	Delaying Sweep	5 ns/div	7500 Series	DC to 100 MHz
7B52	56	Delayed & Mixed Sweeps	5 ns/div	7500 Series	DC to 100 MHz
7B53N	56	Delayed & Mixed Sweeps	5 ns/div	7400 Series	DC to 100 MHz
7B70	58	Delayed Sweep & Ext Amplifier	2 ns/div	7700 Series	DC to 200 MHz
7B71	58	Delaying Sweep	2 ns/div	7700 Series	DC to 200 MHz

DIGITAL and SAMPLING

PLUG-IN	PAGE	PERFORMANCE FEATURE
7D13	60	Measures: Temperature, Voltage, Current, and Resistance
7D14	62	Directly Gated Counter to 500 MHz
7M11	64	High Quality Dual Delay Line
7S11	65	Accepts Plug-In Sampling Heads
7S12	66	TDR and Sampling Applications
7T11	70	Random or Sequential, Equivalent or Real-Time Sampling

- A NEW CONCEPT IN PLUG-IN AND MAINFRAME VERSATILITY
- NEW MEASUREMENT CAPABILITY ACROSS A BROADER PERFORMANCE SPECTRUM
- CRT READOUT
- ADVANCED PHOTOGRAPHIC TRACE-RECORDING CAPABILITIES
- VERTICAL AND HORIZONTAL MODE SWITCHING
- EXPANDED TRIGGER SOURCE SELECTION
- PEAK-TO-PEAK AUTO TRIGGERING
- SINGLE-ACTION LIGHTED PUSH-BUTTON CONTROLS
- COLOR-KEYED CONTROL PANELS
- LOW-TORQUE CAM SWITCHES
- THICK-FILM DRUM ATTENUATORS

Throughout its history of product development, Tektronix has sought to safeguard the customer's investment. The Tektronix 7000-Series Oscilloscope System illustrates the major effort which has been devoted to achieving this goal. Currently, the 7000 Series consists of seven mainframes and twenty plug-ins. Included in the mainframes are: 7704 (150-MHz), R7704 (150-MHz, 7-inch rackmount), 7504 (90-MHz), 7514 (90-MHz storage), 7503 (90-MHz), 7403N (60-MHz), and R7403N (60-MHz, 5 1/4-inch rackmount). All have four plug-in compartments, with the exception of the 7503, 7403N, and R7403N which have three plug-in compartments.

The 7403N and R7403N, the newest additions to the 7000 Series, feature a 6 1/2-inch CRT. With the new 7A18 Dual-Trace Amplifier and the new 7B53N Dual Time Base Plug-Ins, the customer has 50 MHz, dual-trace, 5 mV deflection factor, and delaying sweep, for only $2200. The 7403N weighs only 30 pounds.

The 7000-Series plug-ins are comprised of: eight amplifiers, six time base units, three sampling units (includes a TDR unit), a digital multimeter, a digital counter, and a high-quality delay line. The significance of the four-plug-in mainframe was made even more apparent with the introduction of the 7D13 Digital Multimeter and the 7D14 Digital Counter as the 7000 Series became an Integrated Test System (ITS). In addition to having all conventional oscilloscope capabilities, now, frequency, temperature, resistance, voltage, and current can be digitally measured. ITS another exciting measurement development from Tektronix and there's more to come!

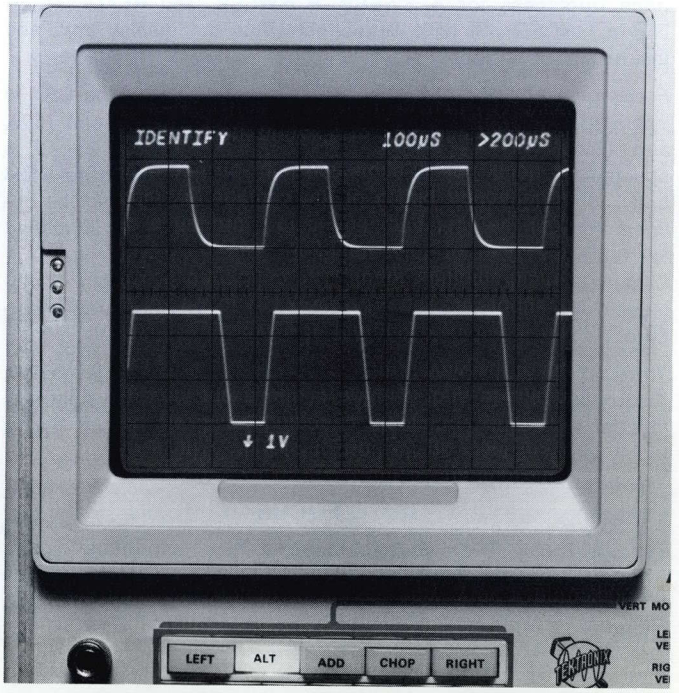
Both new digital plug-ins are compatible with all 7500 and 7700-Series Oscilloscope mainframes and will function in any plug-in compartment. The alphanumeric readout for both units is displayed on the CRT, a unique feature which is standard with all Tektronix 7500 and 7700-Series Oscilloscopes. A photograph of the CRT gives the operator a permanent record of both analog and digital data.

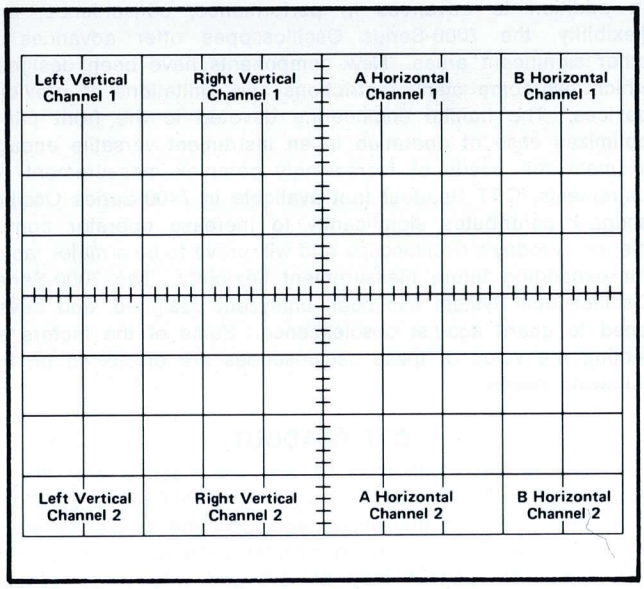
In addition to advances in performance, convenience, and flexibility, the 7000-Series Oscilloscopes offer advances in other significant areas. New components have been designed which overcome many restrictions and limitations of previous devices. The human engineering devoted to the front panel optimizes ease of operation in an instrument versatile enough to meet the needs of increasingly complex measurement requirements. CRT Readout (not available in 7400-Series Oscilloscopes) contributes significantly to increase operator convenience in today's oscilloscope and will prove to be a major factor for expanding future measurement flexibility. The 7000-Series Oscilloscope System has been analyzed, designed, and developed to guard against obsolescence. Some of the factors affecting the value of these oscilloscopes are discussed on the following pages.

CRT READOUT

The CRT is the focal point of any oscilloscope and this is particularly true of these instruments. The CRT of the 7500 and 7700 Series displays the analog waveform and an alphanumeric readout of the vertical and horizontal deflection factors. The advantages of readout may be grouped into three general categories: (1) By displaying measurement information on the CRT, it relieves the user of many of the simple, but time consuming motions and interruptions normally associated with waveform measurement, (2) It eliminates many of the errors frequently made in waveform measurements, (3) In anticipation of the requirements of expanding technologies, it provides the user with the future capability of displaying, on the CRT, measurement information in areas not now fully defined or developed.

The following examples are typical of the questions which must be answered during a measurement procedure. What is the vertical deflection factor? What is the horizontal deflection factor? Is a horizontal magnifier in use? Is a 10X probe in use? Is either trace inverted? Are any vertical or horizontal controls in an uncalibrated mode? What is a feasible way of recording pertinent information on photographs? With Readout, these questions and others are answered on the CRT. Thus, time and effort are saved, and errors are reduced.





The readout sequence is from left to right in the same order as the plug-in channels: LEFT, RIGHT, A and B. If a single channel plug-in is used the readout appears at the top of the CRT; the second channel of a dual-channel unit would appear in a corresponding position at the bottom of the CRT. A trace IDENTIFY push button on each amplifier unit deflects the appropriate trace and identifies the correct readout.

Single-shot readout is also selectable. It allows a single event to be photographed, complete with readout, during one camera shutter opening.

CONVENTIONAL AND STORAGE CRT'S

The cathode-ray tube in the 7500 and 7700 Series is a single-beam, 5-inch rectangular display device. The internal, parallax-free graticule is 8 div x 10 div (each division is 1.0 cm) with variable illumination. The 7400 Series has a 6-1/2-inch CRT. The internal parallax-free graticule is 8 div x 10 div (each division is 1.22 cm). Three independent intensity controls adjust trace brightness for A SWEEP, B SWEEP, and READOUT. A BEAM FINDER will limit deflection within the display area and insure a visible trace.

For improved visual and photographic writing speed the CRT is operated at 24 kV in the 7704, 18 kV in the 7504, 7514 and 7503, and 15 kV in the 7403N. The photographic writing speed is specified at 3300 cm/μs in the 7704 and 2250 cm/μs in the 7504 and 7503, with the standard P31 phosphor. By selecting the optional P11 phosphor, the 7704 writing speed can be increased to 7000 cm/μs. The writing speeds are measured with the C-51 Camera, 10,000 ASA Polaroid* film without film fogging techniques. The lens in the C-51 is an f/1.2, 1:0.5 object-to-image ratio.

The CRT in the 7514 is a split-screen, bistable, storage device. Tektronix rugged bistable storage offers stored trace brightness independent of viewing time or writing speed, it also has a highly burn resistant phosphor.

AUTO-FOCUS

The 7500 and 7700 Series feature a new auto-focus circuit. After the focus control has been initially set, the auto-focus circuit eliminates the need for additional manual focusing with changes in intensity.

*Registered Trademark Polaroid Corporation

PLUG-IN FLEXIBILITY

Plug-in capability, a theory in instrumentation when first introduced by Tektronix, was validated by immediate customer acceptance. The beginning was a single-plug-in oscilloscope; several years ago the dual-plug-in oscilloscope was introduced. Both concepts represented a mark of achievement in instrumentation. But, in anticipation of future user needs and expected technological breakthroughs, a new concept was formulated—the four-plug-in oscilloscope. The four-plug-in oscilloscope will prove to be a valuable contribution to your measurement flexibility.

There are twenty plug-in units available for the 7000-Series mainframes: eight amplifiers, six time-base units, three sampling units, a high quality plug-in delay line, a digital multimeter, and a digital counter. The versatility of the system lies in these building block combinations which allow a more concise matching of instrument to application.

Combinations

Single Trace—Any single-channel amplifier operating as the only vertical plug-in. The counter and/or DMM may be operated in the unused compartments. A blank plug-in panel is available to cover any unfilled plug-in compartment.

Dual Trace—A single 7A12 or 7A18, or any two single-channel amplifiers utilizing the internal amplifier switching (ALT or CHOP). The two units can be the same or mixed to offer different input configurations.

Three Trace—A dual-channel 7A12 or 7A18 using its own switching capability matched with a single-channel amplifier.

Four-Trace—Two dual-channel 7A12's or 7A18's using both plug-in and internal amplifier switching.

X-Y Operation—The amplifiers will operate in vertical or horizontal channels, providing for X-Y operation. The internal amplifier switching presents dual X-Y display with four amplifier units, or X-Y, Y-T display with three amplifiers and a time-base unit.

TIME-BASE PLUG-INS

There are two time-base units available for each four-plug-in 7000-Series mainframe, the 7B50 and 7B51 for the 7504 and 7514, the 7B70 and 7B71 for the 7704. The difference between the plug-ins are the maximum sweep speeds available and the triggering frequency range they are designed to cover. The units for each mainframe are essentially identical, and can be used separately or in combination which provides for DELAYING SWEEP operation. The 7B52 and 7B53N, with intensified, Mixed and Delayed Sweep Modes, are compatible with all 7000-Series Oscilloscopes. The 7B52 is designed especially for the Type 7503 which has one horizontal plug-in compartment. The 7B53N is designed especially for the 7403N. The 7B53N and 7403N do not have CRT Readout capability.

SAMPLING UNITS

The 7S11 SAMPLING UNIT, 7M11 DELAY LINE, and 7T11 SAMPLING TIME BASE are the building blocks for utilizing the sampling technique with the 7000-Series mainframes. In conjunction with the six plug-in sampling heads and the mainframe switching capability, they offer an extremely versatile combination of operational modes.

The 7S11 accepts a PLUG-IN HEAD which determines the frequency response (to 14 GHz) and input configuration. The 7S11 also controls DEFLECTION FACTOR, DOT RESPONSE, and DC OFFSET functions.

The 7T11 features 10 ps/div to 5 ms/div calibrated sweep rates and random or sequential operations. To cover that wide

range of TIME/DIV settings, the 7T11 automatically crosses from EQUIVALENT time to REAL time displays at an appropriate sweep range. The triggering range of the unit is from ≃ 10 Hz to above 12.4 GHz which precludes the requirement for an internal trigger countdown unit.

The 7S12 is a double-width plug-in which uses a plug-in sampling head and a plug-in pulse generator to accomplish high-resolution TDR measurements. It also includes a time base.

The 7M11 is a dual 75-ns delay line and pretrigger source necessary for viewing the triggering event in the sequential sampling mode of operation. For most applications above 1-kHz repetition rate, the random mode can be used which requires no pretrigger or delay line.

Combinations

Single Trace—One 7S11, one 7T11 with the 7M11 optional depending on the application. There are direct interconnections between the 7S11 and 7T11 requiring the units to be adjacent in the mainframe. In the four-plug-in oscilloscopes the 7S11 would occupy the RIGHT vertical channel and the 7T11 the A horizontal channel; for convenience the 7M11 can occupy an unused plug-in compartment. The 7S12 must be located in the two middle compartments.

Dual Trace—Two 7S11's can be used with a single time base for time-related displays utilizing the internal vertical switching. The direct interconnections necessary between the LEFT vertical and the time base passes through the RIGHT channel 7S11. The 7S12 can be used in the two middle compartments with a 7S11 in the LEFT vertical channel, this provides dual-trace sampling.

X-Y Sampling—Two 7S11's mounted in RIGHT vertical and the adjacent horizontal compartment automatically adopt a common 50-kHz free-running strobe condition for X-Y displays.

Single-Trace Sampling and Single-Trace Real Time—A pair of sampling plug-ins (vertical and horizontal), or a 7S12, and a pair of real-time plug-ins can be used simultaneously for convenience in applications which require frequent use of both types of displays. This is a capability of the four-plug-in oscilloscopes.

DIGITAL PLUG-INS

The NEW 7D13 DIGITAL MULTIMETER measures DC voltage, current, resistance and temperature. The NEW 7D14 DIGITAL COUNTER measures frequency directly to 500 MHz, without prescaling. Both the 7D13 and 7D14 will function in any compartment of a 7500 and 7700-Series mainframe. Alphanumeric readout for both units is displayed on the oscilloscope CRT, provided that a standard mainframe is used (Option 1 is *not* specified).

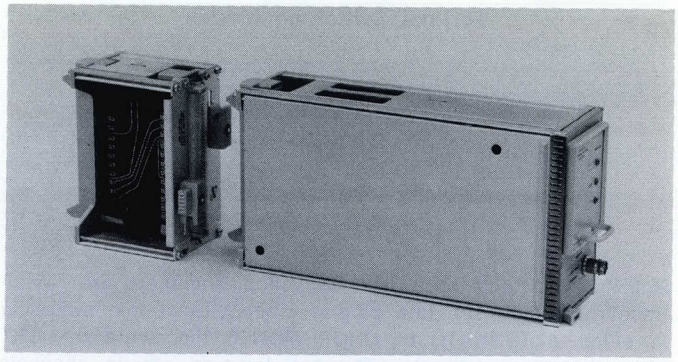
Using an amplifier, digital counter and time-base unit, a signal can be displayed on the oscilloscope screen while simultaneously measuring its frequency to 0.00005% accuracy.

2600 SERIES

The 2600-Series plug-in modules can be operated in all 7000-Series Oscilloscope mainframes. This series consists of the following plug-ins which are fully described in the Signal Sources section of this catalog:

26G1 Ramp/Rate Generator provides ramps of variable duration at a variable rate.

26G2 Ramp Generator provides voltage ramps of variable duration at a rate determined by an external source.



2600-Series Module with 7000-Series Adapter

26G3 Pulse Generator provides current or voltage pulses of variable duration and amplitude when externally triggered.

26A1 Operational Amplifier is easily adapted for many uses, including processing signals generated by other 2600-Series plug-ins.

An adapter is required to provide power to the plug-in and to extend the plug-in length for mechanical compatibility.

2600/7000-SERIES ADAPTER, order 013-0115-00 ..... $50

X-Y COMPENSATION OPTION

(Included in 7503)

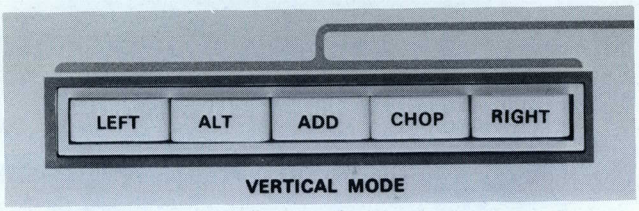
For X-Y applications which require precise phase measurement, the horizontal mainframe amplifiers can be equipped with a network which compensates for the difference between vertical and horizontal signal delay. With correction, the phase shift between vertical and horizontal can be adjusted to be less than 2° from DC to 2 MHz. Without the compensation network, phase shift is 2° or less from DC to 35 kHz.

VERTICAL AND HORIZONTAL MODE SWITCHING

By electronically switching between vertical and horizontal plug-ins, the 7000-Series four-plug-in mainframe provides measurement options which are not available in any other single beam oscilloscope. In the past, a second or third vertical plug-in was not always usable in combination with another plug-in in a single-beam oscilloscope. Now, different kinds of plug-ins may be used simultaneously in a single mainframe. To realize the maximum benefits from this new option, the user needs electronic plug-in switching at his disposal; the mainframe is the logical place for this switching to be done. Vertical and horizontal switching in the 7000-Series mainframes provide 20 possible combinations of operating modes in the four plug-in oscilloscopes. A wide selection of multi-trace options is provided even in applications where performance parameters vary considerably. Thus, the user can select the two vertical plug-ins most appropriate for his measurement, and still have multi-trace performance.

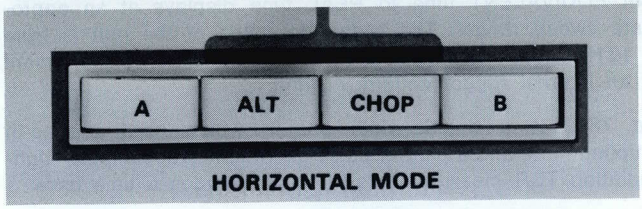
A second important benefit of vertical and horizontal mode switching in the mainframe is the simulation of dual-beam capabilities. Many users have found themselves faced with having to purchase a dual-beam oscilloscope for applications where horizontal chopping or alternating between two time bases would have solved the measurement problem. The 7000-Series horizontal mode switching (7403N and 7503 excluded) provides this capability. It is another of the many new features which have been included in the mainframe to make the system as nearly complete as possible to reduce the customer's total instrument cost.

Vertical Switching Modes



Both vertical and horizontal deflection amplifiers are "dual-trace" with two separate plug-in inputs. Electronic switching in either ALTERNATE or CHOP MODES time-share the CRT beam between channels. The two left-side plug-in channels are labeled LEFT vertical and RIGHT vertical. The MODE is push-button selected as LEFT only, ALT, ADD, CHOP, RIGHT only. Any pair of 7000-Series plug-ins can operate as a vertical combination. Bandwidth, sensitivity, and signal input characteristics are plug-in dependent, as outlined in the Vertical System Specification chart.

Horizontal Switching Modes (7503 and 7403N excluded)



The two right-side plug-in channels are labeled A (left) and B (right). The horizontal MODE is push-button selected as A only, ALT, CHOP, B only. Any pair of 7000-Series plug-ins will operate as a horizontal combination.

Horizontal Switching Logic

The ALT vertical and ALT or CHOP horizontal MODE combination is a "slaved" operation. RIGHT vertical information will be displayed only by A sweep; LEFT vertical information by B sweep. The result, effectively, is a "dual-beam" type of display as it relates to independent control of deflection factors, position and intensity.

The chart briefly shows 20 possible combinations of vertical and horizontal operating MODES.

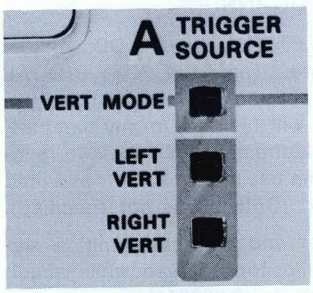
VERT MODE	HORIZ MODE	DISPLAY
LEFT	A, B	Single-trace
	ALT, CHOP	(A) independent dual time base (B) simultaneous DELAYING and DELAYED-sweep display
ALT	A, B	Dual-trace
	ALT, CHOP	(A) independent "dual-beam" display (B) X-Y, X-Y display (CHOP ONLY) (C) X-Y, Y-T display (D) "dual-trace" delaying-sweep display
ADD	A, ALT, CHOP, B	Algebraic addition of vertical channels with: (A) single-trace (B) dual time base (C) "dual-trace" delaying-sweep display
CHOP	A, B	Dual-trace
	ALT, CHOP	"dual-trace" delaying-sweep display
RIGHT	A, B	Same display capability as with LEFT above
	ALT, CHOP	

TRIGGERING

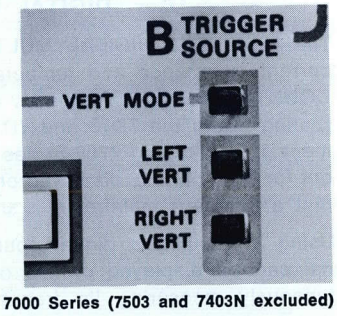
Triggering in the 7000-Series Oscilloscopes is improved by the Peak-to-Peak Auto triggering mode (7B52 and 7B53N excluded) and expanded internal trigger selection from vertical plug-ins and the mainframe. The Peak-to-Peak Auto Mode provides stable, hands-off triggering for many applications. Even an inexperienced oscilloscope user will find triggering to be as simple as pressing three push-button controls: INT, AC and P-P AUTO. With P-P Auto triggering, a bright baseline is provided at all sweep speeds in the absence of a signal. When a signal of 0.5 div or greater is present, a triggered sweep is obtained throughout the 360° range of the Level/Slope control.

There will be times, of course, when the measurement will require different triggering modes. In anticipation of these requirements, the 7000 Series is designed with a wide range of mainframe and plug-in trigger selection options. Mainframe trigger selection options include the VERT MODE, LEFT VERT, and RIGHT VERT modes. Both the A and B time-base trigger signal can be selected individually from either of these sources. To complete the selection options, the trigger signal may be selected from Channel 1 or 2, or a composite of Channels 1 and 2, in multi-trace plug-ins. All trigger source controls are color-keyed for ease of operational understanding.

INTERNAL TRIGGER SELECTION



7000 Series



7000 Series (7503 and 7403N excluded)

The trigger signal to the time base is selected by lighted push-button switches for LEFT, RIGHT, or VERT MODE. The vertical signal from both LEFT and RIGHT plug-ins is coupled through the trigger logic circuitry and made available to the time-base units for triggering purposes, and to a SIGNAL OUT jack for external use. The VERT MODE eliminates the need to continually select the trigger source. Activating the VERT MODE trigger switch slaves the trigger signal source to the displayed signal in the LEFT VERT, RIGHT VERT and ALT position of the VERTICAL MODE display switch. In the ADD or CHOP positions of the VERTICAL MODE display switch, the internal trigger signal is the algebraic sum of the signals

applied to the vertical plug-ins. This prevents the time base from triggering on the chopped signal. When a 7D14 Digital Counter is used in a horizontal plug-in compartment, signals can be internally routed to it from the vertical plug-ins by the trigger source switches.

LIGHTED PUSH BUTTONS

Versatility in a waveform measurement system imposes stringent demands upon human engineering. For example, if an instrument is to have advanced versatility and remain functional, it must have switches, controls and panels designed to optimize the user-instrument interface. It is evident that the 7000-Series Oscilloscopes are designed such that they are easily operated even with more controls at the user's disposal.

Single-action push-button switches have been used extensively to conserve front panel space. The most obvious advantage of this is the reduction of operator inconvenience which close proximity of controls normally causes. All push-button switches are lighted when depressed (7400 Series excluded) for identification ease and protrude approximately 5 mm from the front panel to eliminate any interference between push-button switches and other controls.

VARIABLE CONTROLS

The vertical deflection factor and sweep speed variable controls are recessed flush with their associated calibrated controls until placed into use. When pressed, the variable control unlatches from its recessed position, protrudes for easy access, and is used for varying between the calibrated settings. The sides of the variable controls are colored red to indicate that the instrument is in an uncalibrated mode. When the variable mode is no longer needed, the knob is pressed into the latched position, the red disappears and the instrument is calibrated again.

COLOR-KEYED PANELS

The potential usefulness of a general purpose instrument would be destroyed if its versatility becomes such that the user does not understand its operation. Tektronix recognized the challenge of building a versatile instrument whose operation would be straight forward enough so that the user, with a minimum amount of effort, could benefit from the complete advantages of its measurement capabilities. The human engineering devoted to the color-keyed front panel clearly illustrates that the response to this challenge is successful.

The functions of the front panel controls have been identified by background color codes. There are four primary colors: red, blue, green, and gray.

Red—used for the nomenclature and controls that will uncalibrate the instrument.

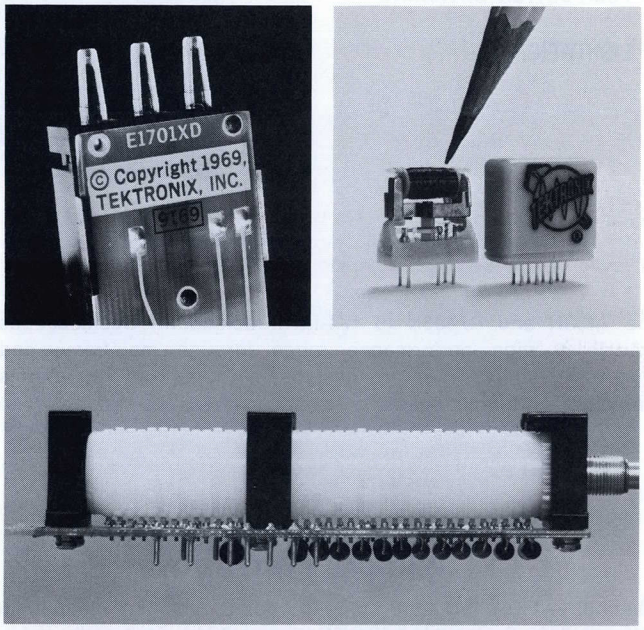
Blue—identifies controls affecting the CRT display mode.

Green—identifies all trigger controls.

Gray—has no functional meaning, used to group or combine certain controls such as CRT beam controls.

ELECTRO-MECHANICAL CONSIDERATIONS

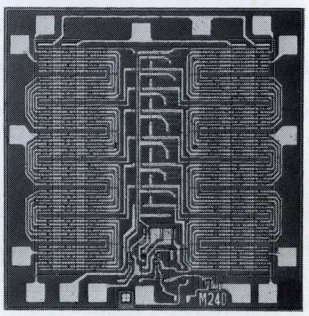
The increased measurement capabilities of the 7000-Series instruments have placed previously unencountered demands upon electro-mechanical design. Many of the capabilities of this new series of oscilloscopes would not have been possible without advances in mechanical designs. Wafer type switches and conventional attenuators impose definite limitations upon instrument design. To overcome these limitations, Tektronix has designed and incorporated into these instruments new low-torque cam switches to reduce wiring problems, increase switch life, reduce congestion, and to improve maintenance and ease of operation. Conventional attenuators are replaced in many of the vertical amplifiers by cam actuated attenuators which have the RC network mounted upon a ceramic chip. The new Tektronix instruments make extensive use of relays and relay switching. These low-capacitance miniature sensitive relays have less leakage than semiconductor switches and are much more tolerant of transient voltage considerations.



Some of the Tektronix components used in new generation instruments. Clockwise from upper left: lighted push button switch, miniature relays, rotary cam switch.

INTEGRATED CIRCUITS

The ability to custom-design integrated circuits permits instrument features that would otherwise be prohibitively expensive. A character-generator IC with 1440 emitters made it possible to provide the 7000 Series Oscilloscopes with CRT Readout.

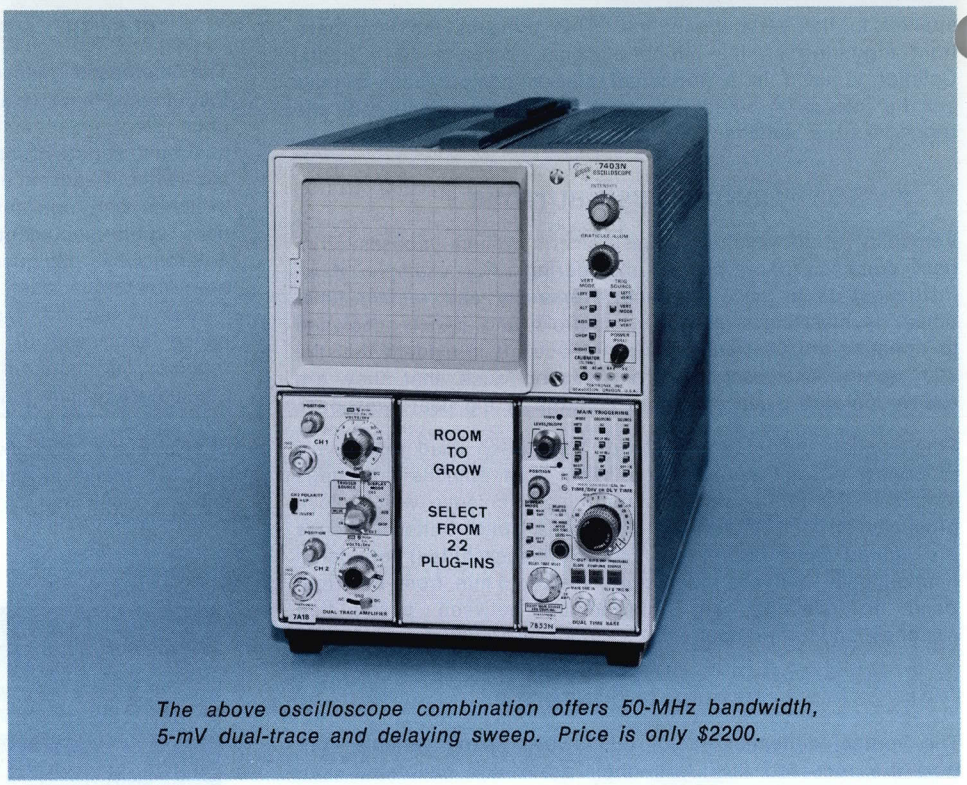


NEW

7403N

60-MHz Oscilloscope

- THREE-PLUG-IN FLEXIBILITY
- 6½-INCH CRT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL MODE SWITCHING
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING
- LIGHTWEIGHT



The above oscilloscope combination offers 50-MHz bandwidth, 5-mV dual-trace and delaying sweep. Price is only $2200.

The 7403N and R7403N (5 1/4-inch rackmount) Oscilloscopes provide a wide performance range through mainframe and plug-in versatility. They are designed to accept all 7000-Series amplifiers and time bases.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins (7D13 and 7D14 excluded).

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit. See System Specification Chart in the preceding reference section (page 28).

Modes of Operation—LEFT, ALT, ADD, CHOP, RIGHT.

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

7A18 DUAL-TRACE AMPLIFIER

The 7A18 is a dual-trace plug-in amplifier designed for use with all 7000-Series Oscilloscope Mainframes. It features 50-MHz bandwidth, 5 mV/div to 5 V/div deflection factors and five operating modes. The operating modes are alternate, chop, add, channel 1, and channel 2. See page 51 for a complete description. Price of the 7A18 is $500.

HORIZONTAL SYSTEM

Channels—One right-hand plug-in compartment; compatible with all 7000-Series plug-ins (7D13 and 7D14 excluded).

Internal Trigger Modes—LEFT VERT, VERT MODE, RIGHT VERT.

Fastest Calibrated Sweep Rate— 5 ns/div with the 7B53N.

X-Y Mode—The phase shift between vertical and horizontal channels is 2° up to 35 kHz. Bandwidth at least 2 MHz.

7B53N DUAL TIME BASE

The 7B53N is a dual time-base plug-in designed specifically for use with the 7403N and R7403N Oscilloscope Mainframes. The 7B53N features calibrated sweeps from 5 s/div to 50 ns/div (5 ns/div with X10 magnification), triggering to 100 MHz and four display modes. The display modes are main sweep, intensified sweep, delayed sweep, and mixed sweep.

The 7B53N does not have readout capability. See page 56 for a complete description. Price of the 7B53N is $750.

CALIBRATOR

Output Wave Shape—Rectangular, positive-going from ground.

Voltage Ranges—40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 2 V into 50 Ω. DC voltage available when BEAMFINDER is pressed.

Current Output— 40 mA DC or 40 mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and GND pin jacks.

Voltage Amplitude Accuracy—Within 1% (+15°C to +35°C); within 2% (0°C to +50°C).

Repetition Rate—Approximately 1 kHz.

7403N
60-MHz Oscilloscope

NEW

EXTERNAL Z-AXIS INPUT

2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (DC + Peak AC) and P-P AC.

CAMERA POWER OUTPUT

Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for the C-50, C-51, and C-52 Cameras.

CRT

Accelerating Potential— 15 kV.

Graticule—Internal 8 x 10 div (1.22 cm/div) with variable illumination.

Phosphor—P31 standard; P1, P2, P7, P11 optional at no additional cost.

Photographic Writing Speed—Measured using Polaroid* Type 410 film without film fogging.

WRITING SPEED		CAMERA	LENS
P31	P11		
700 div/μs (850 cm/μs)	1500 div/μs (1830 cm/μs)	C-51-R	f/1.2 1:0.5
475 div/μs (580 cm/μs)	1150 div/μs (1400 cm/μs)	C-27-R	f/1.3 1:0.5

Beam Finder—Limits display within graticule area.

POWER REQUIREMENTS

Line Voltage Ranges— 110 VAC ±10%, 120 VAC ±10%; internally selectable with quick-change jumpers. Operates over a line frequency of 57 Hz to 63 Hz. **7403N Option 4** line voltage ranges are 100, 110, 120, 200, 220 and 240 VAC ±10%; internally selectable with quick-change jumpers. Operates over a line frequency of 50 to 440 Hz.

Max Power Consumption—160 Watts, 2.0 Amps at 115 V line, 60 Hz.

DIMENSIONS AND WEIGHTS

	7403N		R7403N	
	in	cm	in	cm
Height	11.4	28.9	5.25	13.3
Width	9.2	23.3	19.0	48.2
Length	24.0	60.9	21.5	54.6
	lb	kg	lb	kg
Net weight	30.0	13.6	30.0	13.6

INCLUDED STANDARD ACCESSORIES

Instruction manual 7403N (070-1124-00); instruction manual R7403N (070-1129-00); two pin-to-BNC cables (175-1178-00). The R7403N also includes rackmounting hardware.

For 110 or 120 VAC (selectable), 57 to 63 Hz operation, order
7403N OSCILLOSCOPE, without plug-in units **$950**

For 100, 110, 120, 200, 220 or 240 VAC (selectable), 50 to 440 Hz operation, order
7403N OSCILLOSCOPE, Option 4 ..... **$950**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. The C-50 and C-51 cameras are recommended for use with the 7400 series. A lower-cost camera (C-59) will be available mid 1971. A C-27 with a 1:0.7 or 1:0.5 lens can also be used, but a portion of each corner cm will be cut off. Cameras, Probes, Scope-Mobile® Carts, and other major accessories are completely described in the catalog accessory pages.

Blank Plug-In Panel
When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel may be used to cover unused channels.

7000-SERIES BLANK PLUG-IN PANEL (016-0155-00) $6

Current Loop
40 mA is available when loop is connected between the 4 V output from the calibrator and GND pin jack.

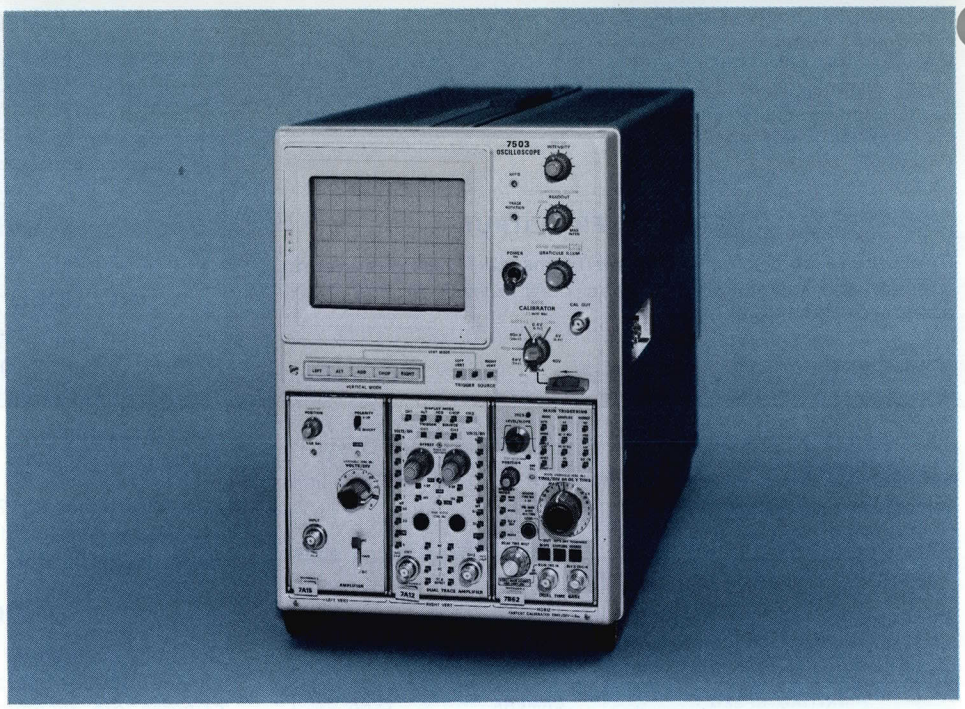
CURRENT-LOOP (012-0259-00) $10

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7503
90-MHz Oscilloscope

- THREE-PLUG-IN FLEXIBILITY
- 8 x 10 cm DISPLAY AREA
- CRT READOUT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL MODE SWITCHING
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING
- HIGH WRITING SPEED CRT



The 7503 Oscilloscope provides a wide performance range through mainframe and plug-in versatility and is designed to accept all 7000-Series plug-ins.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit. See System Specification Chart in the preceding reference section.

Chopped Mode—Approx 1-MHz repetition rate.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—One right-hand plug-in compartment; compatible with all 7000-Series plug-ins.

Fastest Calibrated Sweep Rate— 5 ns/div with the 7B52.

X-Y Mode—The phase shift between vertical and horizontal channels is adjustable to less than 2° from DC to 2 MHz. Bandwidth at least 2 MHz (3 div reference).

CALIBRATOR

Output Wave Shape—Rectangular, positive-going from ground.

Voltage Ranges— 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V, 0.4 V into 50 Ω.

Current Output (Loop)— 40 mA DC or 40 mA signal, waveshape determined by RATE SWITCH.

Amplitude Accuracy—Within 1% (+15°C to +35°C); within 2% (0°C to +50°C) for both voltage and current.

Sources—DC; 1 kHz accurate within 0.25% (+15°C to +35°C); within 0.5% (0°C to +50°C); duty cycle is 50% accurate within 0.1%; GATE ÷ 2 frequency determined by every other GATE pulse.

Risetime and Falltime— 0.25 μs or less for all ranges except +40 V which is 2 μs or less with 10-pF load.

EXTERNAL Z-AXIS INPUTS

High Sensitivity Input—Minimum pulse width to blank trace is 40 ns at 2 V; 2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace, input R is 500 Ω within 10%. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC.

High Speed Input—Minimum pulse width to blank trace is 5 ns at 60 V; 60 V P-P for full intensity range from DC to 75 MHz. A positive signal blanks the trace, input R is 18 kΩ within 15%. Maximum input voltage is 60 V (DC + Peak AC) and P-P AC.

OUTPUTS

+Sawtooth—Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate—Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω within 2%.

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in. See Systems Specification Chart in the preceding reference section. Output R is 950 Ω within 2%.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for the C-50 and C-51 Cameras.

Probe Power—Two rear-panel connectors provide correct operating voltages for two P6051 FET Probes.

7503
90-MHz Oscilloscope

CRT

Accelerating Potential— 18 kV.

Graticule—Internal 8 x 10 cm with variable illumination.

Phosphor—P31 standard; P1, P2, P7, P11 optional at no additional cost.

Photographic Writing Speed—Measured using Polaroid* Type 410 film without film fogging.

WRITING SPEED		CAMERA	LENS
P31	P11		
2250 cm/μs	3500 cm/μs	C-51-R, C-31-R	f/1.2 1:0.5
1500 cm/μs	2800 cm/μs	C-27-R	f/1.3 1:0.5

Beam Finder—Limits display within graticule area.

POWER REQUIREMENTS

Line Voltage Ranges

115 V	Low — 90 VAC to 110 VAC Med — 104 VAC to 126 VAC High — 112 VAC to 136 VAC
230 V	Low — 180 VAC to 220 VAC Med — 208 VAC to 252 VAC High — 224 VAC to 272 VAC

Line Frequency— 48 Hz to 440 Hz.

Max Power Consumption— 258 Watts, 3.0 Amps at 115 V line, 60 Hz.

DIMENSIONS AND WEIGHTS

Height	13.5 in	34.2 cm
Width	9.3 in	23.6 cm
Length	24.5 in	62.3 cm
Net weight	47 lb	21.3 kg
Domestic shipping weight	≈67 lb	≈30.4 kg
Export-packed weight	≈80 lb	≈36.3 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-1039-00); BNC-post jack (012-0092-00); two 18-inch patch cords BNC-BNC (012-0087-00); 9-pin connector, male insert (134-0049-00); blue light filter installed (378-0625-00).

7503 OSCILLOSCOPE, without plug-in units **$1775**

*Registered Trademark Polaroid Corporation.

INSTRUMENT OPTIONS

OPTION 1

Readout Modification
The 7503 may be ordered without CRT READOUT by specifying "Option 1". This deletes the character generator circuitry contained on a single plug-on printed circuit card. The feature may be easily added at any time by ordering the Readout conversion kit (040-0533-01).

7503 OSCILLOSCOPE without readout, Option 1 ..... **$1375**
CRT READOUT CONVERSION KIT (040-0533-01) **$400**

OPTION 3

Electromagnetic Interference (EMI) Modification
The 7503 may be ordered to meet the interference specifications of MIL-1-6181D over the following frequency ranges: Radiated from the instrument under test - 150 kHz to 1 GHz; conducted through the power cord - 150 kHz to 25 MHz. A field EMI conversion kit (040-0547-00) is available to convert an instrument whenever necessary.

EMI MODIFICATION, Option 3 ..... **Add $75**
EMI modified instruments include the standard accessories plus the following: mask (426-0514-00); mesh filter (378-0603-00).

EMI CONVERSION KIT (040-0547-00) **$100**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

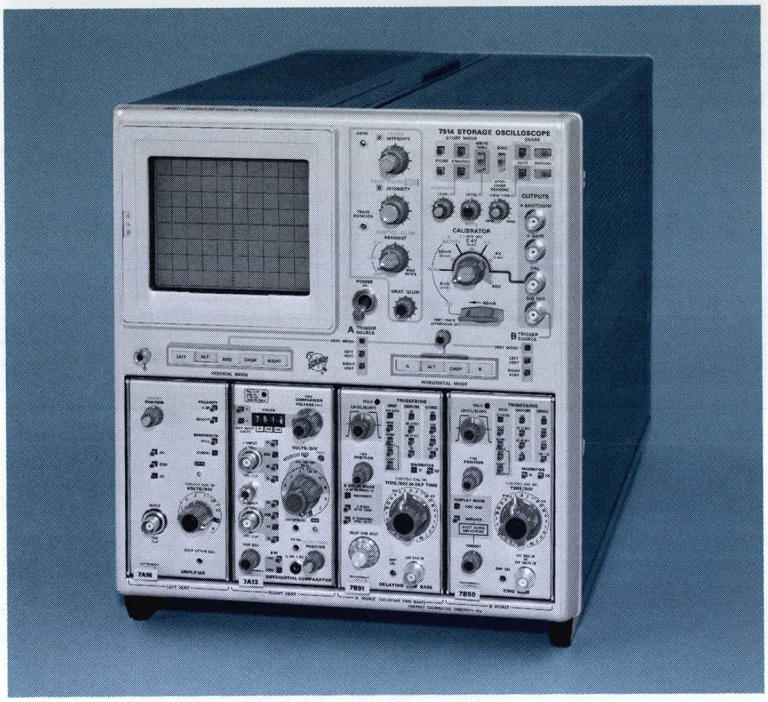
Blank Plug-In Panel
When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel (016-0155-00) may be used to cover unused channels.

7000-SERIES BLANK PLUG-IN PANEL (016-0155-00) **$6**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

7514
Storage Oscilloscope



- DC-to-90 MHz BANDWIDTH
- BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS
- ERASES AFTER A SELECTABLE VIEW TIME AND STORES NEW INFORMATION, AUTOMATICALLY
- WRITE-THRU MODE ALLOWS CONVENTIONAL DISPLAYS TO BE SUPERIMPOSED OVER STORED DISPLAYS
- HIGH CONTRAST RATIO
- HIGH WRITING SPEED CRT
- CRT READOUT
- FOUR-PLUG-IN FLEXIBILITY
- VERTICAL AND HORIZONTAL MODE SWITCHING

The 7514 is a split-screen storage oscilloscope designed to accept all 7000-Series plug-in units. The 7514 features a large 8 x 10 cm CRT, compact solid-state circuitry, excellent conventional performance together with bistable storage capabilities. High writing speeds are achieved, both in the store and non-store modes, by operating the CRT at 18-kV accelerating potential. A unique write-thru feature allows non-store displays in the presence of stored information. An auto-focus circuit maintains correct focusing with changes in intensity. The ability to use four plug-ins at one time provides a measurement capability previously not available in storage oscilloscopes. Now it is possible to make sampling and real-time, wideband and high-gain or X-Y and Y-T measurements simultaneously.

With the split-screen storage feature, either half of the 8 x 10 cm display can be independently controlled, allowing stored or conventional displays on either the upper or lower half. Through front panel controls this system can be directed to automatically erase either or both halves after a predetermined viewing time. Viewing time can be varied from 0.5 s to 5 s in the auto-erase mode. The write-thru mode allows conventional displays over the entire CRT while retaining displays stored on the upper, lower, or full CRT.

CRT Readout labels the CRT with deflection factors and sweep speeds, invert and uncalibrated symbols, and identifies the trace and its data. The readout is automatically corrected when magnified sweeps and 10X probes are used.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit. See System Specifications Chart in the preceding reference section.

Chopped Mode—Approx 1-MHz repetition rate.

Trace Separation Range (dual-sweep modes)—The B trace can be positioned at least 4 div to 6 div from the A trace.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—Two right-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Fastest Calibrated Sweep Rate— 5 ns/div with the 7B51 and/or 7B50.

Chopped Mode—Chopping rate is approx 200 kHz between two horizontal plug-in compartments.

X-Y Mode—PHASE SHIFT is within 2° from DC to 35 kHz between vertical and horizontal channels. Bandwidth is DC to at least 5 MHz.

7514
Storage Oscilloscope

NEW

STORAGE CRT AND DISPLAY FEATURES

CRT READOUT

Reads out scale-factors associated with horizontal and vertical plug-ins. The readout sequence is from left to right in the same order as the plug-in channels: LEFT, RIGHT, A, and B. If a single channel plug-in is used, the readout appears at the top of the CRT; the second channel of a dual-channel unit would appear in a corresponding position at the bottom of the CRT. A trace IDENTIFY push button on each amplifier unit deflects the appropriate trace and identifies the correct readout. Scale-factors of inverted and uncalibrated displays are prefixed by invert (⏚) and uncalibrate (>) symbols.

STORAGE CRT

The CRT is a split-screen, bistable, storage device operated at 18-kV accelerating potential. Phosphor type is P1. Tektronix bistable storage offers stored trace brightness independent of viewing time or writing speed.

DISPLAY AREA

8 x 10 cm split-screen storage area with independent or common control. The graticule is internal with variable illumination. A beam finder compresses the display within the graticule area when depressed.

SPLIT-SCREEN STORAGE

Store on either upper or lower half of screen with conventional display on other half. Store on entire screen or non-store on entire screen. Independent operation of both halves.

Writing Speed—Normal writing speed is at least 60 cm/ms. Adjustable to at least 1 cm/μs in Enhanced Mode.

Storage View Time—1 hour or less.

View Time Range— 0.5 s or less to at least 5 s.

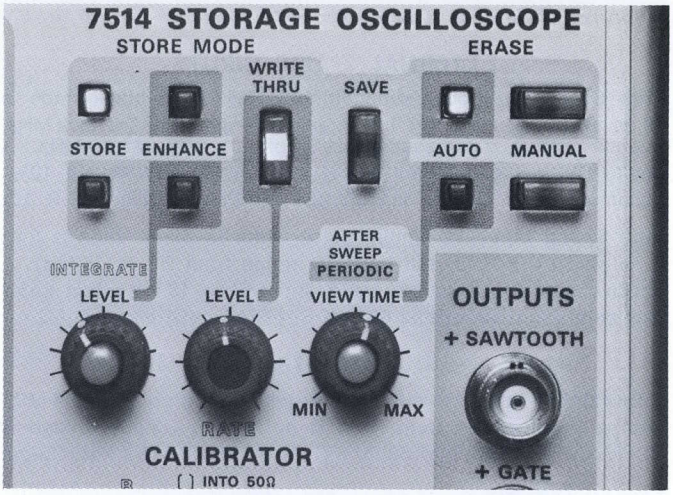
Erase Time— 1 s or less.

Enhance Mode—Controls single sweep writing capabilities of the storage CRT. Through adjustment of ENHANCE LEVEL control, single-trace spot velocities up to 1 cm/μs or better can be stored with minimal loss of resolution and contrast.

Write-Thru Mode—Allows conventional displays while still holding a previously stored display. One control for both halves of the CRT.

Integrate Mode—Provides additional writing speed for repetitive signals by allowing the storage target to integrate the written information over several signal repetitions.

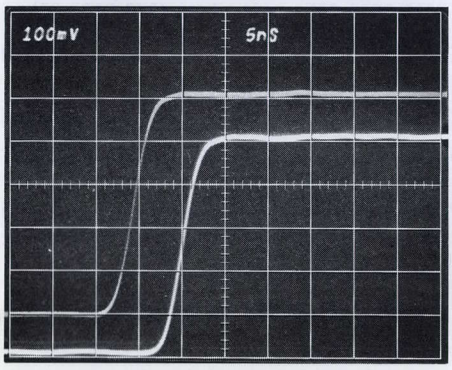
Auto Erase Mode—Viewing time continuously variable up to 5 s. In the PERIODIC Mode, there is a continuous sequence of storing, viewing time, and erasure. This sequence occurs regardless of whether or not a signal is present and is independent of the sweep. In the AFTER SWEEP Mode—the sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep (or at the end of both sweeps in dual sweep modes), the stored display is retained and further sweeps are locked out (both time-base units inhibited) for the viewing interval selected by the VIEW TIME control. Then, the display is erased and the time-base units are enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. A SAVE mode disables automatic erasure. The stored display may be erased by the MANUAL control.



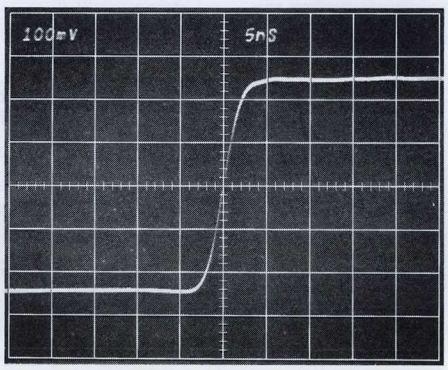
REMOTE CONTROL OPERATION

The 7514 has remote-control operation capabilities using contact closure. A 9-pin connector, located on the rear panel, supplies one ground, two outputs and six inputs that allow the following functions:

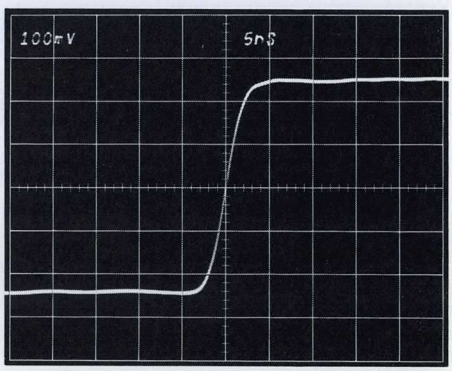
1. Remote resetting of the A and B sweeps for single-sweep operation.
2. Remote erase of upper screen.
3. Remote erase of lower screen.
4. Remote switching from store mode to write-thru mode.
5. Remote readout lockout.
6. Remote single-shot readout.
7. Output voltage to light bulb indicating A sweep is reset.
8. Output voltage to light bulb indicating B sweep is reset.



Upper trace is stored, lower trace is a brighter write-thru display.



10-kHz pulses having 1-ns risetime stored after being integrated.



Conventional display of 10-kHz, 1-ns risetime pulses. Bright trace is made possible by operating the CRT at 18 kV.

7514
Storage Oscilloscope

OTHER CHARACTERISTICS
CALIBRATOR

Output Waveshape—Rectangular, positive-going from ground.

Voltage Ranges— 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V, 0.4 V into 50 Ω.

Current Output (Loop)— 40 mA DC or 40 mA signal, waveshape determined by RATE SWITCH.

Amplitude Accuracy—Within 1% (+15°C to +35°C); within 2% (0°C to +50°C) for both voltage and current.

Sources—DC; 1 kHz accurate within 0.5%, duty cycle is 50%, accurate within 0.1%; GATE ÷ 2 frequency determined by every other GATE pulse.

Risetime and Falltime— 0.25 μs or less for all ranges except +40 V which is 2 μs or less with 10-pF load.

EXTERNAL Z-AXIS INPUTS

High Sensitivity Input—Minimum pulse width to blank trace is 40 ns at 2 V; 2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace, input R is 500 Ω within 10%. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC.

High Speed Input—Minimum pulse width to blank trace is 5 ns at 60 V; 60 V P-P for full intensity range from DC to 75 MHz. A positive signal blanks the trace, input R is 18 kΩ within 15%. Maximum input voltage is 60 V (DC + Peak AC) and P-P AC.

OUTPUTS

+Sawtooth—Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate—Positive-going rectangular waveform derived from A, B, or DELAYED gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω within 2%.

Sig Out—Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in. See Systems Specifications Chart. Output R is 950 Ω within 2%.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for the C-50 and C-51 Cameras.

Probe Power—Two rear-panel connectors provide correct operating voltages for two P6051 FET Probes.

PHOTOGRAPHIC WRITING SPEED

Measured in the non-store mode, without film fogging.

WRITING SPEED	CAMERA	LENS	FILM
450 cm/μs	C-51-R, C-31-R	f/1.2 1:0.5	10,000 ASA
300 cm/μs	C-27-R	f/1.3 1:0.5	

POWER REQUIREMENTS

Line Voltage Ranges— 90 VAC to 136 VAC, 180 VAC to 272 VAC.

Line Frequency— 48 Hz to 440 Hz.

Max Power Consumption— 225 Watts, 3.3 A at 115 V line, 60 Hz.

DIMENSIONS AND WEIGHTS

Height	13.5 in	34.2 cm
Width	12.0 in	30.5 cm
Length	23.4 in	59.4 cm
Net weight	43 lb	19.5 kg
Domestic shipping weight	≈64 lb	≈28.1 kg
Export-packed weight	≈76 lb	≈34.4 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-1030-00); BNC-post jack (012-0092-00); two 18-inch patch cords BNC-BNC (012-0087-00); 9-pin connector, male insert (134-0049-00); blue light filter, installed (378-0625-00).

7514 OSCILLOSCOPE, without plug-in units **$3200**

INSTRUMENT OPTIONS

OPTION 1

Readout Modification

The 7514 may be ordered without CRT READOUT by specifying "Option 1". This deletes the character generator circuitry contained on a single plug-on printed circuit card. The feature may be easily added at any time by ordering the Readout conversion kit (040-0533-01).

7514 OSCILLOSCOPE, without readout, Option 1 ..... **$2800**
CRT READOUT CONVERSION KIT (040-0533-01) **$400**

OPTION 2

X-Y Horizontal Compensation

A compensation network may be added to equalize the signal delay between the vertical and horizontal amplifiers. When included, the phase shift between vertical and horizontal channels is adjustable to less than 2° from DC to 2 MHz. The option may be included at the time of purchase, or added later with the field X-Y conversion kit (040-0528-00).

X-Y HORIZONTAL COMPENSATION, Option 2 ..... **Add $75**
X-Y CONVERSION KIT (040-0528-00) **$75**

OPTION 3

Electromagnetic Interference (EMI) Modification

The 7514 may be ordered to meet the interference specifications of MIL-1-6181D over the following frequency ranges: Radiated from the instrument under test — 150 kHz to 1 GHz; conducted through the power cord — 150 kHz to 25 MHz. A field EMI conversion kit (040-0571-00) is available to convert an instrument whenever necessary.

EMI MODIFICATION, Option 3 ..... **Add $75**

EMI modified instruments include the standard accessories plus the following: mask (426-0514-00); mesh filter (378-0603-00).

EMI CONVERSION KIT (040-0571-00) **$110**

Blank Plug-In Panel

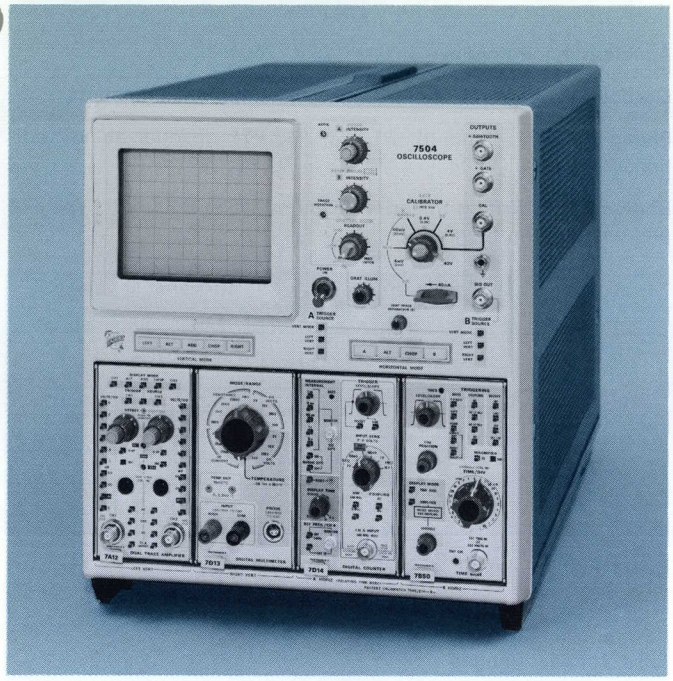
When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel (016-0155-00) may be used to cover unused channels.

7000-SERIES BLANK PLUG-IN PANEL (016-0155-00) **$6**

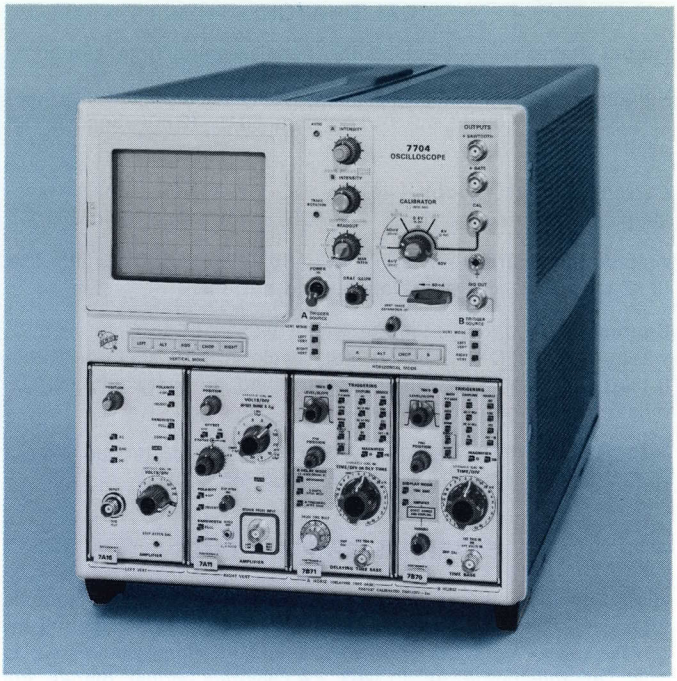
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7504 and 7704

90 and 150-MHz Oscilloscopes



7504
DC to 90 MHz



7704
DC to 150 MHz

FEATURES OF BOTH OSCILLOSCOPES

- FOUR-PLUG-IN FLEXIBILITY
- 8 x 10 cm DISPLAY AREA
- CRT READOUT
- VERSATILE TRIGGER SOURCE SELECTION
- VERTICAL AND HORIZONTAL MODE SWITCHING
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING
- HIGH WRITING SPEED CRT

The 7704 and 7504 are four-plug-in oscilloscopes which accept all 7000-Series plug-ins. The 7704 is also available in a 7-inch rackmount (R7704) configuration.

CHARACTERISTICS

Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit. See System Specifications Chart in the preceding reference section.

Chopped Mode—Approx 1-MHz repetition rate.

Trace Separation Range (dual-sweep modes)—The B trace can be positioned at least 4 div to 6 div from the A trace.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—Two right-hand plug-in compartments; compatible with all 7000-Series plug-ins.

Fastest Calibrated Sweep Rate

7704 - 2 ns/div with the 7B71 and/or 7B70.
7504 - 5 ns/div with the 7B51 and/or 7B50.

Chopped Mode—Chopping rate is approx 200 kHz between two horizontal plug-in compartments.

X-Y Mode—PHASE SHIFT is within 2° from DC to 35 kHz between vertical and horizontal channels. Frequency Response at 10% down is DC to at least 3 MHz in 7704. Bandwidth is DC to at least 5 MHz in 7504.

7504 and 7704
90 and 150-MHz Oscilloscopes

CALIBRATOR

Output Waveshape—Rectangular, positive-going from ground.

Voltage Ranges— 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V, 0.4 V into 50 Ω. (2 mV range is not available in R7704).

Current Output (Loop)— 40 mA DC or 40 mA signal, waveshape determined by RATE SWITCH. (Not available in R7704).

Amplitude Accuracy—Within 1% (+15°C to +35°C); within 2% (0°C to +50°C) for both voltage and current.

Sources—DC; 1 kHz accurate within 0.25% (+15°C to +35°C) within 0.5% (0°C to +50°C); duty cycle is 50% accurate within 0.1%; GATE ÷ 2, frequency determined by every other GATE pulse. (1 kHz only in R7704).

Risetime and Falltime— 0.25 μs or less for all ranges except +40 V which is 2 μs or less with 10-pF load.

EXTERNAL Z-AXIS INPUTS

High Sensitivity Input—Minimum pulse width to blank trace is 30 ns at 2 V for 7704, 40 ns at 2 V for 7504; 2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace, input R is 500 Ω within 10%. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC.

High Speed Input—Minimum pulse width to blank trace is 3.5 ns at 60 V for 7704, 5 ns at 60 V for 7504; 60 V P-P for full intensity range from DC to 100 MHz for 7704, DC to 75 MHz for 7504. A positive signal blanks the trace; input R is 18 kΩ within 20% for 7704, within 15% for 7504. Maximum input voltage is 60 V (DC + Peak AC) and P-P AC.

OUTPUTS

+Sawtooth—Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+Gate—Positive-going rectangular waveform derived from A, B, or DELAYED gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω within 2%.

Sig Out—Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in. See System Specification Chart in the preceding reference section. Output R is 950 Ω within 2%.

Camera Power—Three-prong connector to the left of the CRT provides power, ground, and remote single sweep reset access for the C-50 and C-51 Cameras.

Probe Power—Two rear-panel connectors provide correct operating voltages for two P6051 FET Probes. R7704 connectors are located on both the front and rear panels.

CRT

Accelerating Potential— 7704 - 24 kV, 7504 - 18 kV.

Graticule—Internal 8 cm x 10 cm with variable illumination.

Phosphor—P31 standard; P1, P2, P7, P11 optional at no additional cost.

Photographic Writing Speed—Measured using Polaroid[1] Type 410 film without film fogging.

MAINFRAME	WRITING SPEED		CAMERA	LENS
	P31	P11		
7704	3300 cm/μs	7000 cm/μs	C-51-R, C-31-R	f/1.2 1:0.5
	2200 cm/μs	5500 cm/μs	C-27-R	f/1.3 1:0.5
7504	2250 cm/μs	3500 cm/μs	C-51-R, C-31-R	f/1.2 1:0.5
	1500 cm/μs	2800 cm/μs	C-27-R	f/1.3 1:0.5

Beam Finder—Limits display within graticule area.

POWER REQUIREMENTS

Line Voltage Ranges

	7704	7504
115 V	90 VAC to 136 VAC	Low - 90 VAC to 110 VAC Med - 104 VAC to 126 VAC High - 112 VAC to 136 VAC
230 V	180 VAC to 272 VAC	Low - 180 VAC to 220 VAC Med - 208 VAC to 252 VAC High - 224 VAC to 272 VAC

Line Frequency— 48 Hz to 440 Hz (7704 and 7504), 48 Hz to 66 Hz (R7704). The R7704 may be ordered for 360-440 Hz, 48-66 Hz operation by ordering R7704 MOD 101K.

Max Power Consumption

7704, 210 Watts, 2.6 Amps at 115 V line, 60 Hz.
7504, 280 Watts, 3.2 Amps at 115 V line, 60 Hz.
R7704, 225 Watts, 2.8 Amps at 115 V line, 60 Hz.

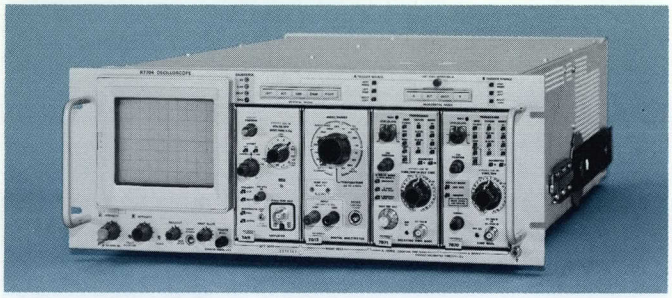
DIMENSIONS AND WEIGHTS

	7704		R7704		7504	
	in	cm	in	cm	in	cm
HEIGHT	13.5	34.2	7.0	17.8	13.5	34.2
WIDTH	12.0	30.5	19.0	48.2	12.0	30.5
LENGTH	23.4	59.4	22.4	56.9	24.6	62.2
	lb	kg	lb	kg	lb	kg
NET WEIGHT	42.0	19.0	44.0	20.0	54.0	24.4
DOMESTIC SHIPPING WEIGHT	62.0	28.1	59.0	27.0	75.0	34.0
EXPORT-PACKED WEIGHT	75.0	34.0	79.0	36.0	87.0	39.5

[1]Registered Trademark Polaroid Corporation.

7504 and 7704

90 and 150-MHz Oscilloscopes



INCLUDED STANDARD ACCESSORIES

BNC-post jack (012-0092-00); two 18-inch patch cords BNC-BNC (012-0087-00); 9-pin connector, male insert (134-0049-00); blue light filter, installed (378-0625-00); instruction manual, 7704 (070-0981-00); instruction manual, 7504 (070-0932-00). The R7704 same as above except: delete two 18-inch patch cords BNC-BNC (012-0087-00); instruction manuals, 7704 and 7504; add 42-inch patch cord BNC-BNC (012-0057-01); pin to BNC patch cord (175-1178-00); current loop adapter (012-0259-00); instruction manual, R7704 (070-1088-00). R7704 also includes rackmounting hardware.

7704 OSCILLOSCOPE, without plug-in units **$2500**
R7704 OSCILLOSCOPE, without plug-in units **$2600**
R7704 MOD 101K (For 360-440-Hz, 48-66 Hz line) **$2650**
7504 OSCILLOSCOPE, without plug-in units **$2000**

INSTRUMENT OPTIONS

OPTION 1

Readout Modification
The instrument may be ordered without CRT READOUT by specifying "Option 1". This deletes the character generator circuitry contained on a single plug-on printed circuit card. The feature may be easily added at any time by ordering the Readout conversion kit (040-0533-01).

7704 OSCILLOSCOPE, without readout, Option 1 ..... **$2100**
R7704 OSCILLOSCOPE, without readout, Option 1 ..... **$2200**
R7704 MOD 101K, without readout, Option 1 ..... **$2250**
7504 OSCILLOSCOPE, without readout, Option 1 ..... **$1600**
CRT READOUT CONVERSION KIT (040-0533-01) **$400**

OPTION 2

X-Y Horizontal Compensation
A compensation network may be added to equalize the signal delay between the vertical and horizontal amplifiers. When included, the phase shift between vertical and horizontal channels is adjustable to less than 2° from DC to 2 MHz. The option may be included at the time of purchase, or added later with the field X-Y conversion kit (7704/R7704, 040-0529-00; 7504, 040-0528-00).

X-Y HORIZONTAL COMPENSATION, Option 2 ..... **Add $75**
7704/R7704 X-Y CONVERSION KIT (040-0529-00) **$75**
7504 X-Y CONVERSION KIT (040-0528-00) **$75**

OPTION 3

Electromagnetic Interference (EMI) Modification
The instruments may be ordered to meet the interference specifications of MIL-I-6181D over the following frequency ranges: Radiated from the instrument under test - 150 kHz to 1 GHz; conducted through the power cord - 150 kHz to 25 MHz. A field EMI conversion kit (7504, 040-0571-00; 7704, 040-0570-00; R7704, 040-0562-00) is available to convert an instrument whenever necessary.

EMI MODIFICATION, Option 3 ..... **Add $75**
EMI modified instruments include the standard accessories plus the following: mask (426-0514-00); mesh filter (378-0603-00).

7704 EMI CONVERSION KIT (040-0570-00) **$95**
R7704 EMI CONVERSION KIT (040-0562-00) **$100**
7504 EMI CONVERSION KIT (040-0571-00) **$110**

Blank Plug-In Panel
When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel (016-0155-00)) may be used to cover unused channels.

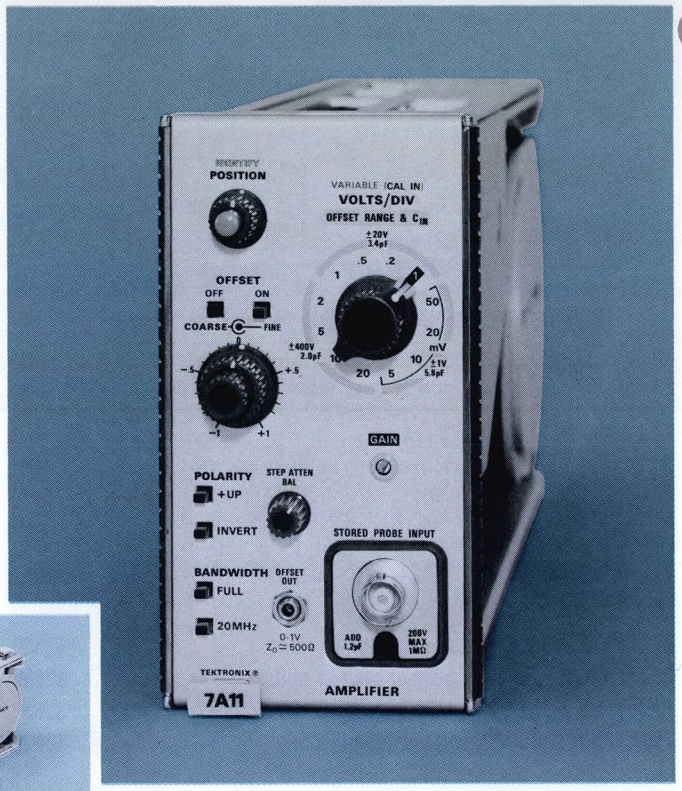
7000-SERIES BLANK PLUG-IN PANEL (016-0155-00) **$6**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

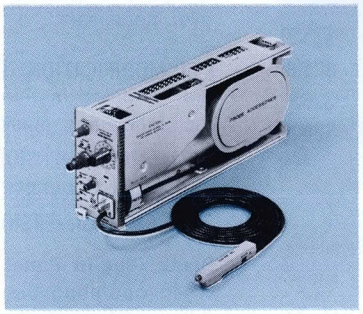
7A11

Single-Trace Amplifier

- **BUILT-IN FET PROBE**
- **DC-to-150 MHz BANDWIDTH**
- **5 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS**
- **DC OFFSET**



The 7A11 is a wideband plug-in amplifier for all 7000-Series mainframes. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF max at 5 mV/div) without loss of signal amplitude by probe attenuation. With large amplitude signals it is necessary in any amplifier to insert attenuation before the input stage to keep the signal extremes on-screen. The 7A11 probe has two 20X attenuators, physically mounted in the probe tip, that are relay-switched into the input signal path at the appropriate deflection factor. This frees the operator from concern with manual plug-on attenuators and dynamic signal range. If signal can be positioned or offset to fall within the viewing area, the amplifier is operating linearly.



Other operational features include: trace IDENTIFY, which moves the trace up slightly and identifies the appropriate CRT Readout area; DC OFFSET with an accurate monitor output; and internal probe storage with BNC input for convenience in less demanding applications.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	150 MHz	2.4 ns
7500 Series	90 MHz	3.9 ns
7400 Series	60 MHz	5.9 ns

20-MHz Bandwidth Mode; DC to 20 MHz within 2 MHz. AC Coupled; 15 Hz or less (lower —3 dB point).

Deflection Factor— 5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2% of GAIN adjustment at 0.1 V/div. Uncalibrated VARIABLE is continuous between steps and to at least 50 V/div.

Input R and C— 1 MΩ within 1%; 5.8 pF within 0.6 pF (5 mV/div to 50 mV/div), 3.4 pF within 0.4 pF (0.1 V/div to 1 V/div), 2 pF within 0.2 pF (2 V/div to 20 V/div).

Signal and Offset Range

DEFLECTION FACTOR SETTINGS	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
OFFSET RANGE	+1 V to —1 V	+20 V to —20 V	+400 V to —400 V
OFFSET RANGE TO OFFSET OUT	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
MAX DC COUPLED INPUT	200 V (DC + Peak AC) (AC Component to 50 kHz)	200 V (DC + Peak AC) (AC Component to 20 MHz)	200 V (DC + Peak AC) (AC Component to 40 MHz)
MAX AC COUPLED INPUT (DC VOLTAGE)	±200 V		

DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 0.1 div or less per minute after 20 minute warm-up. Long Term; 0.3 div or less per hour after 20 minute warm-up. Drift with Ambient Temperature (constant line voltage) 200 μV/°C or less.

Displayed Noise— 0.5 mV or 0.1 div, whichever is greater, in FULL BANDWIDTH mode, measured tangentially.

Offset Function—An internal DC SOURCE, continuously variable between +1 V and —1 V which may be used to offset the trace. (See chart for OFFSET RANGE.) An OFFSET OUT Jack allows monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within 3%.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.8 lb	1.3 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0984-00); AC coupler (011-0110-00); retractable hook tip (013-0106-00); bayonet ground (013-0085-00); ground lead (nose), 3-inch (175-0849-00); ground lead (screw-in), 3-inch (175-0848-00); ground lead (screw-in), 12-inch (175-0848-02); three minigator clips (344-0046-00); two insulating tubes (166-0404-01); hook tip (206-0114-00); GR/PROBE adapter termination (50 Ω) (017-0088-00); 18-inch Offset Out cable (175-1092-00).

7A11 AMPLIFIER **$850**

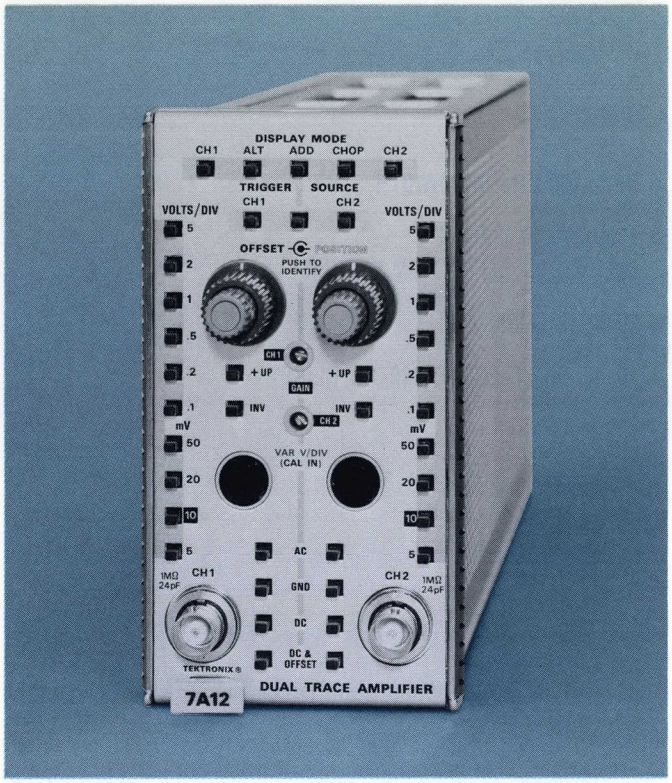
U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A12
Dual-Trace Amplifier

- DC-to-105 MHz BANDWIDTH
- 5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS
- DC OFFSET

The 7A12 is a dual-trace plug-in amplifier for use with all 7000-Series mainframes. It is the basic building block for 3 or 4 trace operation. It features constant bandwidth for all deflection factors, 5 operating modes, trigger source selectivity, trace OFFSET with ±1000 div range, color-keyed control grouping, and a trace IDENTIFY function.

The high density of controls on a 2 5/8 inch by 5 inch front panel was made possible, and very usable, by the development and use of lighted push buttons for all except continuously variable functions. The switches conserve space both in front and behind the panel, provide faster operation (direct steps to any position) and easy readability by backlighting.



CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	105 MHz	3.4 ns
7500 Series	75 MHz	4.7 ns
7400 Series	55 MHz	6.4 ns

AC Coupled; 10 Hz or less (lower —3 dB point).

Deflection Factor—5 mV/div to 5 V/div in 10 calibrated push button steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 12.5 V/div.

DC Offset Range—At least +1000 div to —1000 div (5 mV/div), at least +500 div to —500 div (10 mV/div to 5 V div).

Max Input Voltage

DEFLECTION FACTOR SETTING	DC COUPLED	AC COUPLED
5 mV/div to 10 mV/div	350 V, DC or DC + Peak AC at 1 kHz or less for 10 s. 250 V continuous	350 V, DC or DC + Peak AC at 1 kHz or less
20 mV/div to 5 V/div	500 V, DC or DC + Peak AC at 1 kHz or less	500 V, DC or DC + Peak AC at 1 kHz or less

Display Modes—Either single channel, + up or inverted; algebraic addition; chopped or alternate electronic switching between channels. Chopped: successive 1 μs segments (±0.2 μs) of each channel displayed at an approx 500 kHz rate. Alternate: channels switched at the end of each sweep.

Input R and C— 1 MΩ within 2%; 24 pF within 1 pF.

Common-Mode Rejection Ratio—At least 10:1 at 40 MHz or less.

DC Stability—Drift with ambient temperature (constant line voltage) 100 μV/°C or 0.01 div/°C or less, whichever is greater.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.8 lb	1.3 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

7A12 DUAL-TRACE AMPLIFIER **$850**
Includes instruction manual (070-0977-00).

PROBES

Probes are not supplied with the 7A12 and are ordered separately to fit the application.

The P6053 (10X) probe is recommended for use with the 7A12 for frequency response and CRT Readout compatibility. Other Tektronix probes may be used, but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A13

Differential Comparator Amplifier

- DC-to-100 MHz BANDWIDTH
- 1 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS
- 20,000:1 CMRR
- 10,000 cm EFFECTIVE SCREEN HEIGHT

The 7A13 is a differential comparator plug-in amplifier for all 7000-Series mainframes. It incorporates a number of performance features which make it particularly versatile, especially in multi-trace combination with other 7000-Series vertical plug-ins. Following is a treatment of the three operational areas which describe the functions of the 7A13.

As a conventional amplifier the 7A13 has excellent and constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at FULL (100 MHz in the 7704, 75 MHz in the 7500-Series), or 5 MHz for best displayed noise conditions during low-frequency applications. The + or — INPUTS allow normal or inverted displays.

As a differential amplifier the 7A13 maintains its conventional features and provides a balanced (+ and —) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from DC to 100 kHz, derating to 250:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 utilizes its differential capabilities, but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or —) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	100 MHz	3.5 ns
7500 Series	75 MHz	4.7 ns
7400 Series	55 MHz	6.4 ns

5 MHz Bandwidth Mode; DC to 5 MHz within 500 kHz. AC Coupled; 10 Hz or less (lower —3 dB point).

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with GAIN adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ within 0.15%; 20 pF within 0.4 pF. R in ≃ ∞, is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Signal Range

DEFLECTION FACTOR SETTINGS	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
DIFFERENTIAL SIGNAL RANGE	±0.8 V	±8 V	±80 V
COMMON-MODE SIGNAL RANGE	±10 V	±100 V	±500 V
MAX DC COUPLED INPUT (DC +PEAK AC at 1 kHz or less)	±40 V	±400 V	±500 V
MAX AC COUPLED INPUT (DC VOLTAGE)	±500 V		

7A13
Differential Comparator Amplifier

Max Input Gate Current— 0.2 nA or less from 0°C to +35°C; 2 nA or less at +35°C to +50°C.

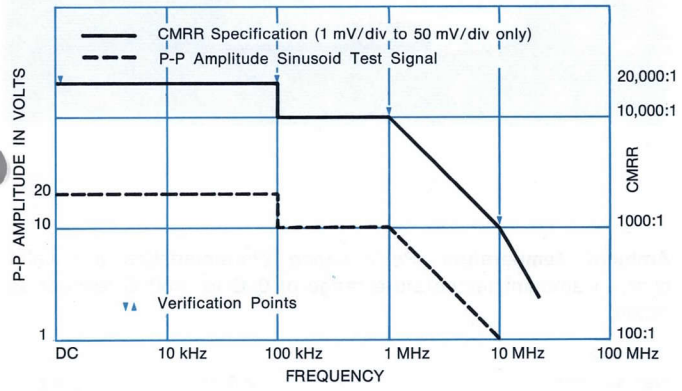
DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 1 mV P-P or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minutes warm-up. Long-Term; 1 mV P-P or 0.1 div, or less (whichever is greater) during any 1-hour interval after 20 minutes warm-up. Drift with Ambient Temperature (constant line voltage) 2 mV/10°C or 0.2 div/10°C, or less, whichever is greater.

Displayed Noise (Tangentially Measured)—With X10 Vc in, 400 μV (200 μV RMS) or less at 1 mV/div; 0.2 div or less at 2 mV/div to 5 mV/div; 0.05 div or less at 10 mV/div to 5 V/div. With X10 Vc out, 0.4 div or less at 10 mV/div to 0.5 V/div.

Overdrive Recovery— 1 μs to recover to within 1.5 mV and 0.1 ms to recover to within 0.5 mV after the removal of an overdrive signal between +10 V and −10 V, regardless of overdrive signal duration.

Internal Comparison Voltage—Range, 0 V to ±10 V; accuracy, ± (0.1% of setting, +5 mV); electrical zero, 0.5 mV or less; Vc output R, approx 15 kΩ.

Common-Mode Rejection Ratio



At least 2000:1, 10 mV/div to 50 mV/div (X10 Vc out) and 0.1 V/div to 5 V/div. AC Coupled input at least 500:1 at 60 Hz.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	3.1 lb	1.4 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

7A13 DIFFERENTIAL COMPARATOR AMPLIFIER **$1100**
Includes instruction manual (070-1113-00).

PROBES

Probes are not supplied with the 7A13 and are ordered separately to fit the application.

The P6053 (10X) probe is recommended for use with 7A13 for bandwidth and CRT Readout compatibility.

The P6055 (10X) low-capacitance probe is recommended for the 7A13's differential capabilities. It also has CRT Readout compatibility.

The P6055 probe can be adjusted to match preamplifier nominal input capacitance ranging from 20 pF to 47 pF. The attenuation ratio can be adjusted to 10X to compensate for differences in the input resistance of the preamplifier. When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other helps to maintain the common-mode rejection ratio of the system. The bandwidth and risetime of the 7A13/P6055 combination with the 7000-Series mainframes is as follows.

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	65 MHz	5.4 ns
7500 Series	55 MHz	6.4 ns
7400 Series	45 MHz	7.8 ns

Other Tektronix probes may be used, but may not be directly compatible (Consult your Tektronix Field Engineer or Representative).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A14
Current Probe Amplifier

- **25 Hz-to-105 MHz BANDWIDTH**
- **1 mA/DIV to 1 A/DIV CALIBRATED DEFLECTION FACTORS**

The 7A14 is an AC current probe amplifier for all 7000-Series mainframes. It provides constant bandwidth, dependent on the current probe and mainframe over the 1 mA/div to 1 A/div calibrated deflection factors (see bandwidth specifications). POLARITY is selectable, +UP or INVERT, as is BANDWIDTH, FULL or 20 MHz.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH W/PROBE		RISETIME W/PROBE	
	P6021	P6022	P6021	P6022
7700 Series	50 MHz	105 MHz	7.0 ns	3.4 ns
7500 Series	45 MHz	75 MHz	7.8 ns	4.7 ns
7400 Series	40 MHz	55 MHz	8.8 ns	6.4 ns

20 MHz Bandwidth mode; 20 MHz within 3 MHz. Lower —3 dB Point; with P6021, 25 Hz or less (+20°C to +75°C), 30 Hz or less (0°C to +20°C); with P6022, 250 Hz or less.

Deflection Factor—1 mA/div to 1 A/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mA/div. The VARIABLE is continuous between steps and to at least 2.5 A/div.

Displayed Noise— 0.2 div or less throughout the calibrated deflection factor range, measured tangentially.

Input Characteristics

	WITH P6021	WITH P6022
MAX CW CURRENT	15 A P-P to 5 MHz, decreasing to 1 A P-P at 100 MHz.	6 A P-P to 10 MHz, decreasing to 2 A P-P at 150 MHz.
MAX PULSE CURRENT	25 A peak, limited to an Amp-second product of 2.0 A-ms or 5.3 A RMS.	25 A peak, limited to an Amp-second product of 30 A-μs or 2.1 A RMS.
MAX VOLTAGE	600 V (DC + peak AC)	600 V (DC + peak AC)
DC SATURATION	0.5 A	0.2 A
INSERTION IMPEDANCE	0.03 Ω at 1 MHz, increasing to 1.0 Ω at 60 MHz.	0.03 Ω at 1 MHz, increasing to 0.7 Ω at 175 MHz.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.1 lb	1 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈11 lb	≈5 kg

7A14 CURRENT PROBE AMPLIFIER **$575**
Includes instruction manual (070-0979-00).

PROBES

Probes are not supplied with the 7A14 and are ordered separately to fit the application.

The P6021 and P6022 AC current probes are designed for use with the 7A14. The probes can be interchanged without gain adjustment due to the special BNC input connector which senses the type of probe and switches internal compensation circuits. Both probes are the quick-connect, locking-jaw type.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A15
Single-Trace Amplifier

NEW

- **DC-to-75 MHz BANDWIDTH**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**

The 7A15 is a wideband plug-in amplifier for all 7000-Series mainframes. It features constant bandwidth over all the deflection factor settings. The two vertical mainframe channels allow the 7A15 to be used alone, or with another vertical unit for dual-trace operation. Polarity of the display is selectable. The 7A15 can also be used in the horizontal channels for X-Y operation.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	75 MHz	4.7 ns
7500 Series	60 MHz	5.9 ns
7400 Series	50 MHz	7.0 ns

AC Coupled, 2 Hz or less (lower —3 dB point).

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ within 2%; 20 pF within 1.5 pF.

Max Input Voltage— 500 V (DC + Peak AC). AC component 500 V P-P maximum, 1 kHz or less.

DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 250 μV/min P-P or 0.05 div, whichever is greater, 1 hour after turn-on. Long Term; 250 μV/hr P-P or 0.05 div, whichever is greater, 1 hour after turn-on. Drift with Ambient Temperature (constant line voltage) is 100 μV/°C or less.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.1 lb	1 kg
Domestic shipping weight	≈5 lb	≈10 kg
Export-packed weight	≈10 lb	≈4.5 kg

7A15 AMPLIFIER **$250**
Includes instruction manual (070-1044-00).

PROBES

Probes are not supplied with the 7A15 and are ordered separately to fit the application.

The P6053 (10X) probe is recommended for use with the 7A15 for frequency response and CRT Readout compatibility. Other Tektronix probes may be used, but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A16

Single-Trace Amplifier

- **DC-to-150 MHz BANDWIDTH**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**

The 7A16 is a wideband plug-in amplifier for all 7000-Series mainframes. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable, as is bandwidth, which can be either FULL or limited to 20 MHz for low frequency applications. The 7A16 should be considered as half the vertical capability. The two vertical mainframe channels allow the 7A16 to be used alone, or with another single-trace vertical unit for dual-trace operation. The 7A16 can also be used in the horizontal channel for X-Y operation.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	150 MHz	2.4 ns
7500 Series	90 MHz	3.9 ns
7400 Series	60 MHz	5.9 ns

20 MHz Bandwidth Mode; DC to 20 MHz within 3 MHz. AC Coupled; 10 Hz or less (lower —3 dB point).

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ within 2%; 15 pF within 0.5 pF.

Max Input Voltage— 500 V, 500 V P-P AC, 1 kHz or less (100 mV/div to 5 V/div); 100 V, 100 V P-P AC, 1 kHz or less (5 mV/div to 50 mV/div). AC Coupled, 500 V DC.

DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 250 μV/min P-P or 0.05 div whichever is greater, 1 hour after turn-on. Long Term; 250 μV/hr P-P or 0.05 div whichever is greater, 1 hour after turn-on. Drift with Ambient Temperature (constant line voltage) is 100 μV/°C or less.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	1.8 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

7A16 AMPLIFIER **$600**
Includes instruction manual (070-0980-00).

PROBES

Probes are not supplied with the 7A16 and are ordered separately to fit the application.

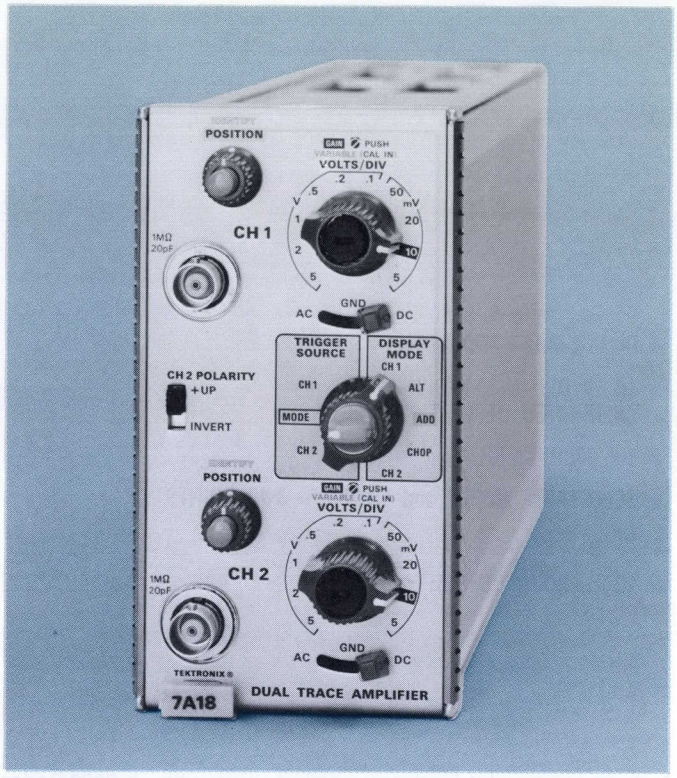
The P6053 (10X) probe is recommended for use with the 7A16 for frequency response and CRT Readout compatibility. Other Tektronix probes may be used but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7A18
Dual-Trace Amplifier

NEW

- **DC-to-75 MHz BANDWIDTH**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**



The 7A18 is a dual-trace plug-in amplifier for use with the 7000-Series mainframes. It is the basic building block for 3 or 4 trace operation. It features constant bandwidth for all deflection factors, 5 operating modes, trigger source selectivity, color-keyed control grouping, and a trace IDENTIFY function.

CHARACTERISTICS

Bandwidth

MAINFRAME	BANDWIDTH —3 dB	RISETIME
7700 Series	75 MHz	4.7 ns
7500 Series	60 MHz	5.9 ns
7400 Series	50 MHz	7.0 ns

AC Coupled; 10 Hz or less (lower —3 dB point).

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ within 2%; 20 pF within 0.5 pF.

Max Input Voltage—DC Coupled: 250 V (DC + Peak AC); AC component 500 V P-P maximum, 1 kHz or less. AC Coupled: 500 V (DC + Peak AC); AC component 500 V P-P maximum, 1 kHz or less.

DC Stability—Drift with ambient temperature (constant line voltage) is 0.01 div/°C. Drift with time (ambient temperature and line voltage constant) 0.02 div in any one minute after 1 hour warm-up.

Common-Mode Rejection Ratio—At least 20:1, DC to bandwidth limit.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.5 lb	1.1 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

7A18 DUAL-TRACE AMPLIFIER **$535**
Includes instruction manual (070-1126-00).

7A18, without readout compatibility, Option 1 ..... **$500**
Includes instruction manual (070-1126-00).

READOUT CONVERSION KIT (040-0585-00) **$35**

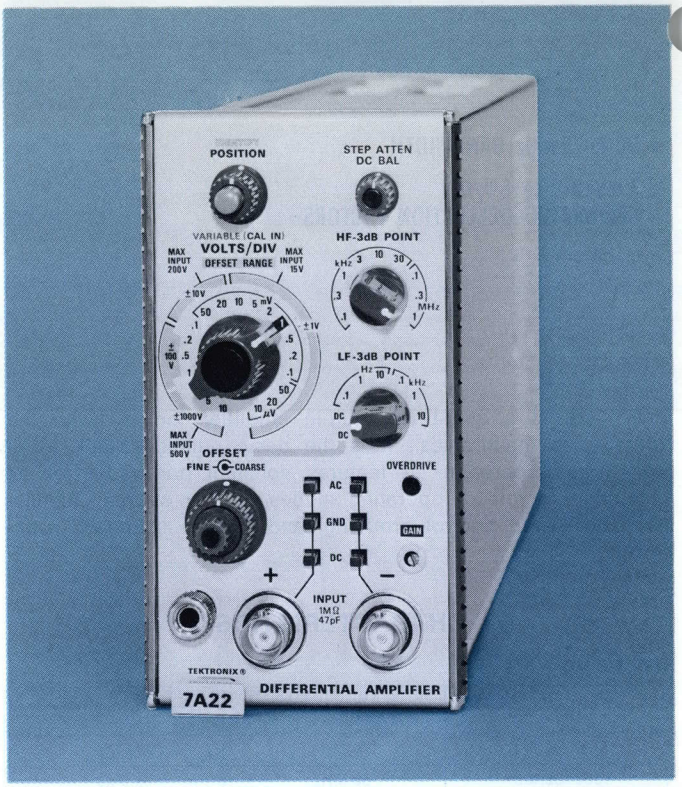
PROBES

Probes are not supplied with the 7A18 and are ordered separately to fit the application.

The P6053 (10X) Probe is recommended for use with the 7A18 for frequency response and CRT Readout compatibility. The P6054 (10X) Probe is recommended when readout compatibility is not required. Other Tektronix probes may be used, but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7A22
Differential Amplifier



- **DC-to-1 MHz BANDWIDTH**
- **10 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS**
- **100,000:1 CMRR**
- **SELECTABLE UPPER and LOWER −3 dB POINTS**
- **DC OFFSET**
- **10 μV/HOUR DC DRIFT***

The 7A22 is a differential amplifier for use with all 7000-Series mainframes. Basic performance features are 10 μV/div to 10 V/div deflection factors, DC to 1 MHz bandwidth with selectable HF and LF −3 dB POINTS, common mode rejection ratio of 100,000:1 at 10 μV/div, DC coupled, differential signal range ±1 V at 10 μV/div, and a DC OFFSET feature with ±1 V range ±100,000 div at 10 μV/div.

There are many factors which affect the usability of high-gain, wideband differential amplifiers. Noise (if excessive) can make the high-gain positions unusable. Displayed noise (grounded inputs) is held to 16 μV at 10 μV/div, tangentially measured at full bandwidth. Since noise is related to bandwidth, the displayed noise can be greatly reduced with the HF −3 dB POINT selector when the application allows. DC drift can also hinder measurements if the trace moves offscreen rapidly. Drift with time in the 7A22 is specified at 5 μV per minute and 10 μV per hour at 10 μV/div. Drift with temperature is 50 μV/°C or less. Low amplitude signals often ride a small DC component, perhaps a few millivolts, which would place a DC-coupled display offscreen at 10 μV/div. There are three ways to reject this DC voltage in the 7A22: (1) AC coupled input if the signal frequency is high enough to be unaffected (2 Hz, LOWER −3 dB POINT). (2) AC coupling with the LF −3 dB POINT selector which allows lower bandwidth selection down to 0.1 Hz. (3) DC OFFSET which utilizes the differential feature and supplies an internal DC voltage to offset, or reject, the DC signal component. These factors, and more, make the 7A22 well suited for measurements in the difficult low-amplitude low-frequency area.

*With constant temperature. See DC STABILITY specifications.

CHARACTERISTICS

Bandwidth—HF −3 dB point; selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency, risetime in 1 MHz position is 350 ns ±9%. LF −3 dB point; selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency, the switch also contains DC and DC with OFFSET positions. AC Coupled at input, 2 Hz or less.

Deflection Factor— 10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps and to at least 25 V/div.

Input R and C— 1 MΩ within 1%; 47 pF within 2.5 pF.

Max Input Gate Current—Differentially measured, 40 pA (+25°C) and 200 pA (+50°C) at 10 μV/div to 10 mV/div; 10 pA (+25°C) and 20 pA (+50°C) at 20 mV/div to 10 V/div. Single ended, one half the differential measurement. Display shift is ±4 div (+25°C) and ±20 div (+50°C) at 10 μV/div (AC coupled).

7A22
Differential Amplifier

Signal and Offset Range

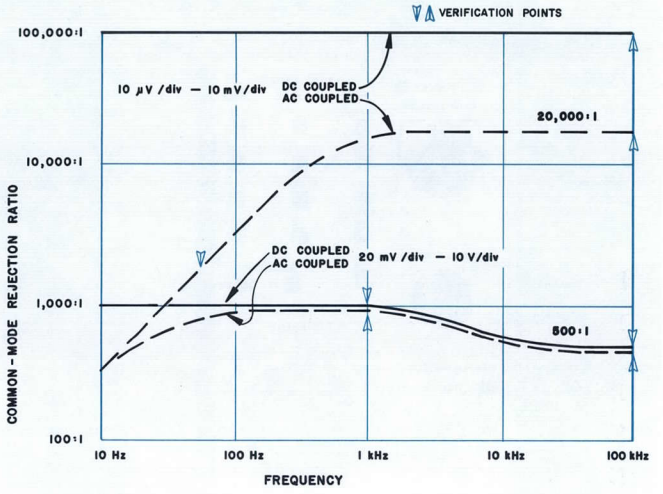
DEFLECTION FACTOR SETTINGS	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
DIFFERENTIAL SIGNAL RANGE	±1 V	±10 V	±100 V	±1000 V
COMMON-MODE SIGNAL RANGE	±10 V	±100 V	±500 V	
MAX DC COUPLED INPUT (DC + PEAK AC AT 1 kHz OR LESS)	±15 V	±200 V	±500 V	
MAX AC COUPLED INPUT (DC VOLTAGE)	±500 V DC rejection, at least 4 x 10^5:1			
DC OFFSET RANGE	+1 V to −1 V	+10 V to −10 V	+100 V to −100 V	+1000 V to −1000 V

DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 5 μV (P-P) or 0.1 div whichever is greater in any minute after 1 hour warm-up. Long Term; 10 μV (P-P) or 0.1 div whichever is greater in any hour after 1 hour warm-up. Drift with Ambient Temperature (constant line voltage) is 50 μV/°C or less.

Displayed Noise— 16 μV or 0.1 div (whichever is greater) at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Overdrive Recovery— 10 μs or less to recover within 0.5% of zero level after removal of a test signal applied for 1 s (signal amplitude not to exceed differential dynamic range). A front panel OVERDRIVE light indicates an overdrive condition is being approached.

Common-Mode Rejection Ratio (for signals not exceeding common-mode signal range)



Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.6 lb	1.2 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

7A22 DIFFERENTIAL AMPLIFIER **$500**
Includes instruction manual (070-0931-00).

PROBES

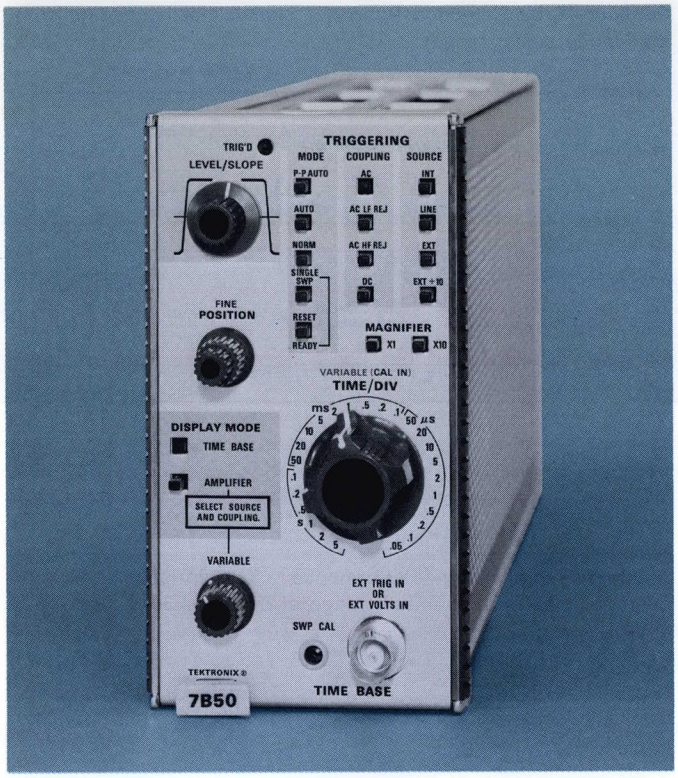
Probes are not supplied with the 7A22 and are ordered separately to fit the application.

The P6052 (10X) probe is recommended for use with the 7A22 for bandwidth and CRT Readout compatibility. The P6055 (10X) low-capacitance probe is recommended for the 7A22's differential capabilities. It also has CRT Readout compatibility. Other Tektronix probes may be used but may not be directly compatible (consult your Tektronix Field Engineer or Representative).

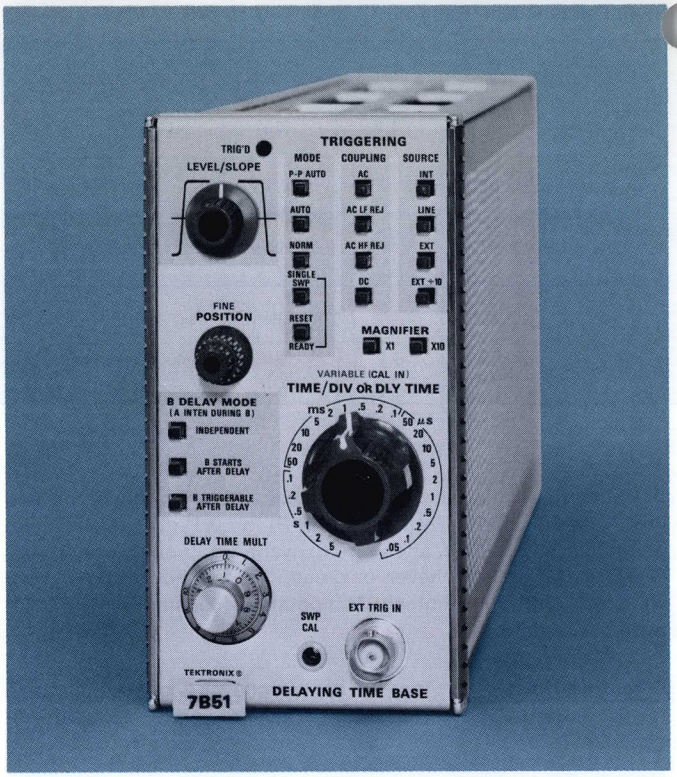
U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7B50 and 7B51

Time Bases



TIME BASE



DELAYING TIME BASE

FEATURES OF BOTH TIME BASES

- 5 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- PEAK-TO-PEAK AUTO TRIGGERING
- TRIGGERING TO 100 MHz
- SINGLE-SWEEP OPERATION

The 7B50 and 7B51 are horizontal TIME-BASE units designed primarily for use with the 7500-Series mainframes to provide bandwidth/sweep speed compatibility. However, the 7B50 and 7B51 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B51 being the DELAYING SWEEP and the 7B50 the DELAYED SWEEP. The 7B50 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

The calibrated TIME/DIV range is from 5 ns/div to 5 s/div. The 5 ns/div rate, obtained with the X10 MAGNIFIER, complements the 3.9-ns risetime capability of the 7500-Series vertical systems.

Triggering control is very flexible with 12 push-button positions to program MODE, method of COUPLING, and SOURCE. For routine applications, hands-off triggering is accomplished by actuating the three upper-most push-button switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE—the most commonly used combination. The P-P AUTO MODE provides a baseline trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or — SLOPE this mode is completely automatic. The other triggering positions are useful for specific applications.

The triggering frequency range is from DC to 100 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B51 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B50 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

Both units can be used singly in all 7000-Series mainframes or in combination to add the delaying-sweep function. Independent dual-sweep operation is possible only in mainframes with two horizontal amplifiers using CHOP or ALT modes.

7B50 and 7B51
Time Bases

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

Sweep Rate— 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div, with the 7500-Series mainframe calibrator.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP CHARACTERISTICS (7B51 ONLY)

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting.

Delay Time Accuracy— 5 s/div to 1 s/div within 2%; 0.5 s/div to 1 μs/div within 1%.

Multiplier Incremental Linearity—Within 0.2% of full scale.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial div for 1 μs to 0.5 s delay time; within 2% and 2 minor dial div for 1 s to 5 s delay time.

Jitter— 1 part or less in 50,000 of X10 the TIME/DIV setting.

TRIGGERING

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 150 mV 750 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	150 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P Auto Operation— 0.5 div INT, 250 mV EXT from 200 Hz to 10 MHz; 1.5 div INT, 750 mV EXT from 10 MHz to 100 MHz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter— 1 ns or less at 75 MHz.

Ext Trigger Input—Max input voltage is 500 V (DC + peak AC), 500 V (P-P AC) at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. The level range (excluding P-P AUTO) is at least +3.5 V to −3.5 V in EXT, at least +35 V to −35 V in EXT ÷ 10.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

EXT HORIZONTAL INPUT (7B50 ONLY)

Deflection Factor—Minimum deflection factor is 90 mV/div within 10 mV/div when in EXT source with variable fully CW; minimum deflection factor is 900 mV/div within 110 mV/div when in Ext ÷ 10 source position with variable fully CW. The VARIABLE is continuous between steps and to at least 9 V.

Frequency Response (measured in 7500-Series mainframes)

COUPLING	LOWER −3 dB	UPPER −3 dB
AC	16 Hz	500 kHz
AC LF REJ	70 kHz	500 kHz
AC HF REJ	16 Hz	100 kHz
DC	DC	500 kHz

Weights (Apply to both plug-ins)

Net weight	2.9 lb	1.3 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

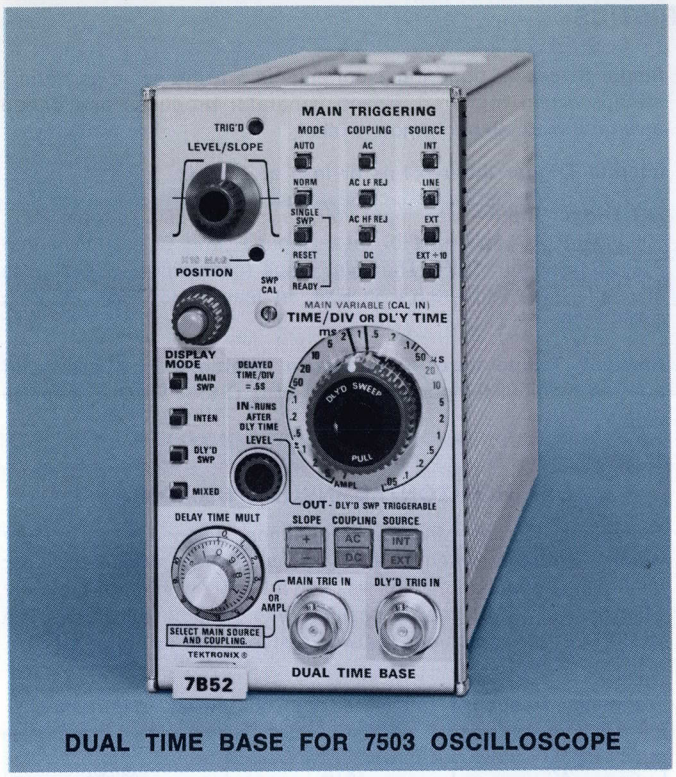
7B50 TIME-BASE **$450**
Includes instruction manual (070-0975-00).

7B51 DELAYING TIME-BASE **$510**
Includes instruction manual (070-0976-00).

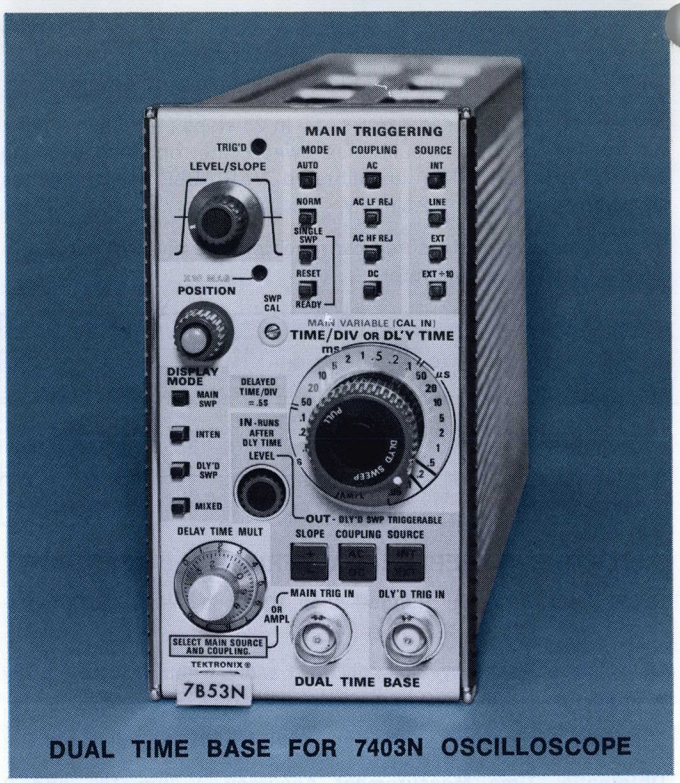
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7B52 and 7B53N

Dual Time Bases



DUAL TIME BASE FOR 7503 OSCILLOSCOPE



DUAL TIME BASE FOR 7403N OSCILLOSCOPE

FEATURES OF BOTH TIME BASES

- **5 ns/DIV to 5 s/DIV CALIBRATED TIME BASE**
- **CALIBRATED MIXED SWEEP**
- **TRIGGERING to 100 MHz**
- **SINGLE-SWEEP OPERATION**

The 7B52 Dual Time-Base is designed specifically for use with the 7503 Mainframe; however it is compatible with all 7000-Series Oscilloscopes. The 7B53N Dual Time Base is designed specifically for use with Tektronix 7000-Series Oscilloscopes without CRT Readout (7403N and R7403N); however, it also is compatible with all 7000-Series Oscilloscopes. The 7B52 and 7B53N feature calibrated sweeps from 5 s/div to 50 ns/div (5 ns/div with X10 MAGNIFICATION), triggering to 100 MHz and four different display modes.

The display modes are main sweep (MAIN SWP), intensified sweep (INTEN), delayed sweep (DLY'D), and mixed sweep (MIXED). Each mode is easily selected by four separate, lighted push-button switches (not lighted in the 7B53N) and two concentric TIME/DIV or DLY TIME controls. The TIME/DIV or DLY TIME controls are used to select two sweep speeds, one faster than the other, when the time base is operated in the INTEN, DLY'D or MIXED MODE.

When the MAIN SWP push button is pressed, the display is at the slower sweep speed; when the INTEN push button is pressed, the main sweep is intensified for a period of time determined by the faster sweep speed. Pressing the DLY'D push button displays only the intensified segment of the main sweep at the faster of the two sweep speeds. Pressing the MIXED push button combines the slower and faster sweep speeds into one display. The main sweep is displayed at the slower speed from the beginning of sweep to a selectable point on the main sweep. Past this point, the sweep is displayed at the faster of the two sweep speeds. The intensified zone, delayed sweep and mixed sweep may be initiated at any point on the main sweep determined by the DLY TIME MULT.

The delayed sweep may be operated in either a triggered or untriggered (free run) mode. The mode is selected by a dual-purpose (push-push) control which is flush with the front panel in its latched position. In the latched position, the delayed sweep free runs after the delay time. When pressed, the control unlatches (out position) and switches the delayed sweep to a triggerable mode. In the unlatched position, the control is also the delayed sweep trigger LEVEL control.

The 7B52 and 7B53N are designed so that the user may easily operate the time base in the many applications where delayed sweep and increased measurement accuracy are mandatory.

The main sweep triggering controls include 12 lighted, push-button switches (not lighted in the 7B53N) and a LEVEL/SLOPE control which provides wide trigger flexibility. With this wide range of triggering options, the operator may quickly select the proper trigger mode even for specific applications. Triggering for routine applications can usually be solved by actuating the three upper-most push-button switches.

The DC to 100 MHz triggering frequency range is selectable by the COUPLING CONTROLS. AC LF REJ attenuates undesirable frequencies below 30 kHz which can cause triggering problems during high-frequency applications. AC HF REJ attenuates high-frequency components above 50 kHz which can cause triggering problems during low-frequency applications. In the INT (internal) mode, the trigger signal is coupled from the plug-in to the time base. This provides triggering from a single source for time-related, multiple-trace displays.

The DLY'D TRIG IN connector serves a dual purpose. It is the external input connector for the delayed trigger circuit when the delayed SOURCE switch is set to EXT (out). When the delayed SOURCE switch is set to INT (in), this connector provides a delayed gate output.

7B52 and 7B53N
Dual Time Bases

NEW

CHARACTERISTICS

MAIN (DELAYING) SWEEP

Sweep Rate— 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div. The variable control is switchable between main and delayed sweep (7B53N only).

Sweep Accuracy—Measured over the center 8 div.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

Delay Time Accuracy— 5 s/div to 1 s/div, within 2%; 0.5 s/div to 1 μs/div, within 1%.

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting.

Delay Time Multiplier Incremental Linearity—Within 0.2% of full scale.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5 s delay times.

Jitter— 1 part or less in 20,000 of X10 the TIME/DIV setting.

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 100 mV 500 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	100 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter—1 ns or less at 75 MHz.

External Trigger Input—Max input voltage is 500 V (DC + peak AC), 500 V P-P AC at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT, at least +15 V to −15 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate— 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps to at least 1.25 s/div and is switchable between the main and delayed sweep (7B53N only).

Sweep Accuracy—Measured over the center 8 div.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

Delayed Sweep Gate—Output voltage is approximately +3.5 V into at least 10 kΩ shunted by 100 pF or less. Risetime is 50 ns or less, output R is 1 kΩ within 10%. Gate is available at the DLY'D TRIG IN connector when the delayed sweep source switch is set to INT.

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

Internal Trigger Jitter— 1 ns or less at 75 MHz.

External Trigger Input—Max input voltage is 500 V (DC + peak AC), 500 V P-P AC at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +3.5 V to −3.5 V in EXT.

MIXED SWEEP

Sweep Accuracy—Within 2% plus measured MAIN sweep error. Exclude the following portions of MIXED Sweep: First 0.5 div after start of MAIN sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of MAIN to DELAYED sweep.

EXT HORIZONTAL INPUT

Deflection Factor— 10 mV/div within 10% when in EXT, MAG X10; 100 mV/div within 10% when in EXT; 1 V/div within 10% when in EXT ÷ 10.

Frequency Response

COUPLING	LOWER −3 dB	UPPER −3 dB
AC	40 Hz	2 MHz
AC LF REJ	16 kHz	2 MHz
AC HF REJ	40 Hz	100 kHz
DC	DC	2 MHz

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights (Either plug-in)

Net weight	3.3 lb	1.5 kg
Domestic shipping weight	≈7 lb	≈3.2 kg
Export-packed weight	≈12 lb	≈5.4 kg

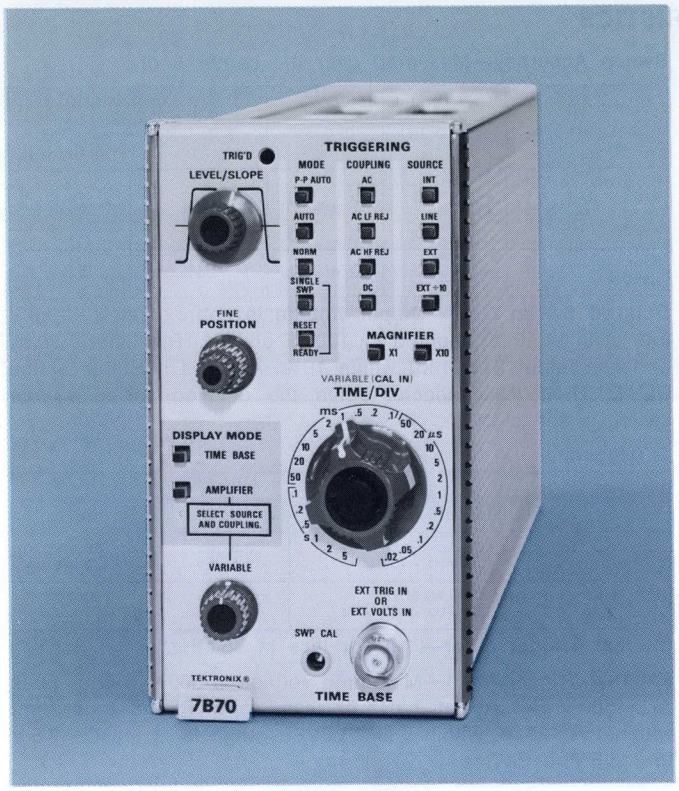
7B52 DUAL TIME BASE **$900**
Includes instruction manual (070-1043-00).

7B53N DUAL TIME BASE (without readout) **$750**
Includes instruction manual (070-1125-00).

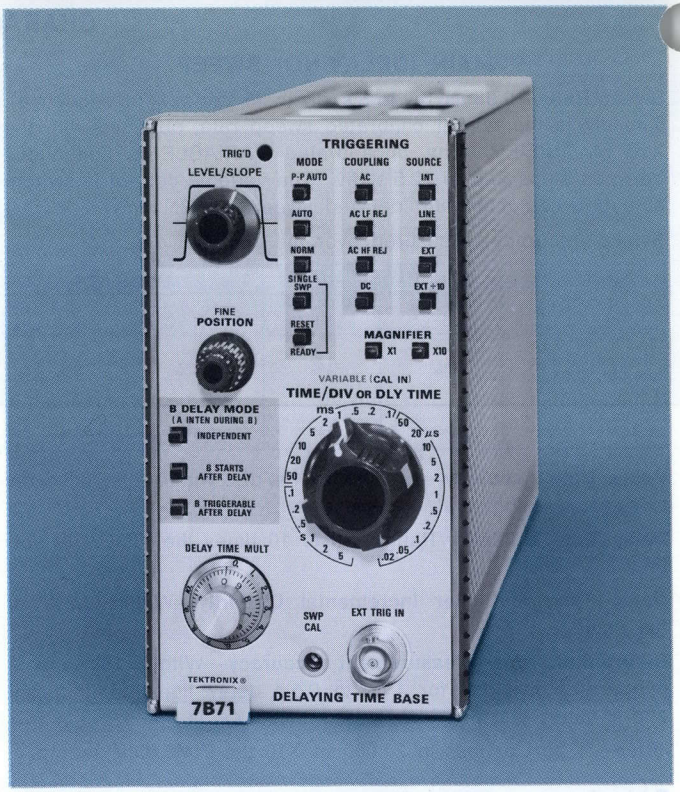
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7B70 and 7B71

Time Bases



TIME BASE



DELAYING TIME BASE

FEATURES OF BOTH TIME BASES

- 2 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- PEAK-TO-PEAK AUTO TRIGGERING
- TRIGGERING TO 200 MHz
- SINGLE-SWEEP OPERATION

The 7B70 and 7B71 are horizontal TIME-BASE units intended primarily for use with the 7700-Series mainframes to provide bandwidth/sweep speed compatibility. However, the 7B70 and 7B71 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B71 being the DELAYING SWEEP and the 7B70 the DELAYED SWEEP. The 7B70 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

The calibrated TIME/DIV range is from 2 ns/div to 5 s/div. The 2 ns/div rate, obtained with the X10 MAGNIFIER, complements the 2.4 ns risetime capability of the 7700-Series vertical systems.

Triggering control is very flexible with 12 push-button positions to program MODE, method of COUPLING, and SOURCE. For routine applications, hands-off triggering is accomplished by actuating the three upper-most push-button switches: INT source, AC COUPLING, and P-P AUTO MODE which is the most generally used combination. The P-P AUTO MODE provides a baseline trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of + or — SLOPE this mode is completely automatic. The other triggering positions are useful for specific applications.

The triggering frequency range is from DC to 200 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B71 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B70 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

Both units can be used singly in all 7000-Series mainframes or in combination to add the delaying-sweep function. Independent dual-sweep operation is possible only in mainframes with two horizontal amplifiers using CHOP or ALT modes.

7B70 and 7B71
Time Bases

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

Sweep Rate— 0.02 μs/div to 5 s/div in 26 steps (1-2-5 sequence). 2 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div, with the 7704 mainframe calibrator.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.02 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP CHARACTERISTICS (7B71 ONLY)

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting.

Delay Time Accuracy— 5 s/div to 1 s/div within 2%; 0.5 s/div to 1 μs/div within 1%.

Multiplier Incremental Linearity—Within 0.2% of full scale.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial div (1 μs to 0.5 s); within 2% and 2 minor dial div (1 s to 5 s).

Jitter— 1 part or less in 50,000 of X10 the TIME/DIV setting.

TRIGGERING

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC LF REJ*	30 kHz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	75 mV
DC	DC - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P Auto Operation— 0.5 div INT, 125 mV EXT from 200 Hz to 20 MHz; 1.5 div INT, 375 mV EXT from 20 MHz to 200 MHz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter— 1 ns or less at 150 MHz.

Ext Trigger Input—Max input voltage is 500 V (DC + Peak AC), 500 V (P-P AC) at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. The level range (excluding P-P AUTO) is at least +1.5 V to −1.5 V in EXT, at least +15 V to −15 V in EXT ÷ 10.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

EXT HORIZONTAL INPUT (7B70 ONLY)

Deflection Factor—Minimum deflection factor is 25 mV/div within 5 mV/div when in EXT source with variable fully CW; minimum deflection factor is 250 mV/div within 50 mV/div when in EXT ÷ 10 source with variable fully CW. The VARIABLE is continuous between steps and to at least 2.5 V.

Frequency Response (measured in 7700-Series mainframes)

COUPLING	LOWER −3 dB	UPPER −3 dB
AC, AC LF REJ, AC HF REJ	16 Hz	100 kHz
DC	DC	100 kHz

Weights (Apply to both plug-ins)

Net weight	2.9 lb	1.3 kg
Domestic shipping weight	≈6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5 kg

7B70 TIME-BASE **$600**
Includes instruction manual (070-0982-00).

7B71 DELAYING TIME-BASE **$685**
Includes instruction manual (070-0983-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

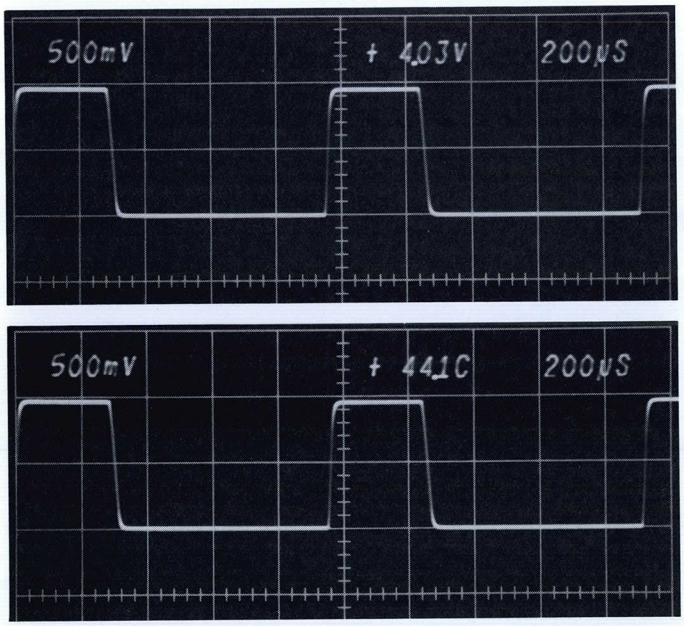
7D13
Digital Multimeter

- **TEMPERATURE MODE**
- **INPUT CAN BE FLOATED UP TO 1500 V ABOVE CHASSIS**
- **3½-DIGIT READOUT**

The 7D13 is a digital multimeter plug-in designed for use with all 7500 or 7700-Series oscilloscope mainframes. The 7D13 will function in any plug-in compartment.

In addition to measuring DC volts, DC current and resistance, temperature measuring capability is also featured in the 7D13, provided by a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 volts). Temperature analog output is independent of mode, thus, temperature may be measured simultaneously with any other function. Most any NPN transistor can be used as a separate sensor to make small space, "free air", measurements.

Each 7500 and 7700-Series oscilloscope mainframe includes a character generator that is normally used for CRT Readout (V, mV, ms, μs, etc.). When the 7D13 is used, the character generator traces out a 3 1/2-digit display on the face of the CRT, along with a legend for units like kΩ, mA, C (temperature).



A signal source's pulse amplitude and period are measured while a bias voltage is adjusted. Lower photo shows the generator's case temperature being monitored simply by switching to temperature position.

CHARACTERISTICS

DC Voltage Range— 0 to 1000 V in four ranges. 3 1/2-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +40°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 megohms on all ranges. Maximum safe input is 1.5 kV Peak between either contact and ground, 1.0 kV Peak between voltage contacts.

DC Current Range— 0 to 2 A in four ranges. 3 1/2-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +40°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum safe input is 3A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range— 0 to 2 megohms in five ranges. 3 1/2-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +40°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range— −55°C to +150°C in one range. 3 1/2-digit presentation to +150°C. Accuracy (+15°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Accuracy (0°C to +50°C ambient) is ±2°C from −55°C to +125°C, ±3°C above +125°C.

7D13
Digital Multimeter

NEW

Settling Time— 1.5 s or less (voltage, current, and resistance modes).

Polarity—Automatic indication.

Maximum Common-Mode Voltage— 1.5 kV Peak between two terminals and ground.

Normal-Mode Rejection Ratio—At least 30 dB at 60 Hz increasing at 20 dB/decade.

Common-Mode Rejection Ratio—With a 1-kΩ imbalance it is at least 100 dB at DC; 80 dB at 60 Hz.

Overrange Indication—When overrange occurs, the readout goes into a "blinking" mode with the most significant digit displaying a 2.

Recycle Time— 5 measurements per second.

Temperature Out— 10 mV/°C into a load of at least 2 kΩ.

Weights

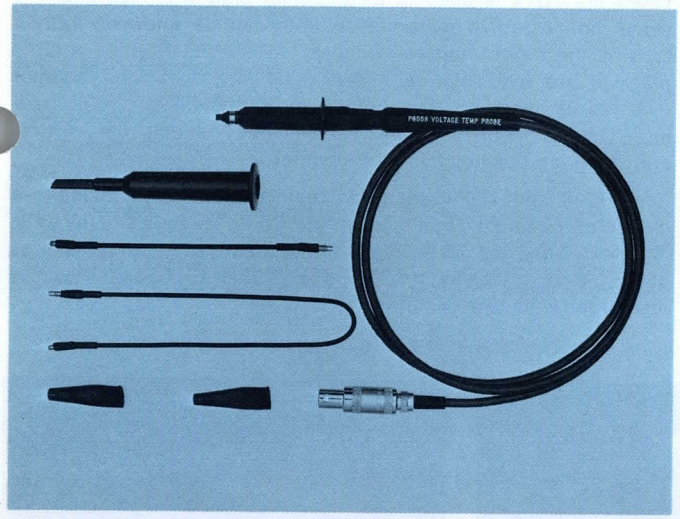
Net weight	1.8 lb	0.8 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

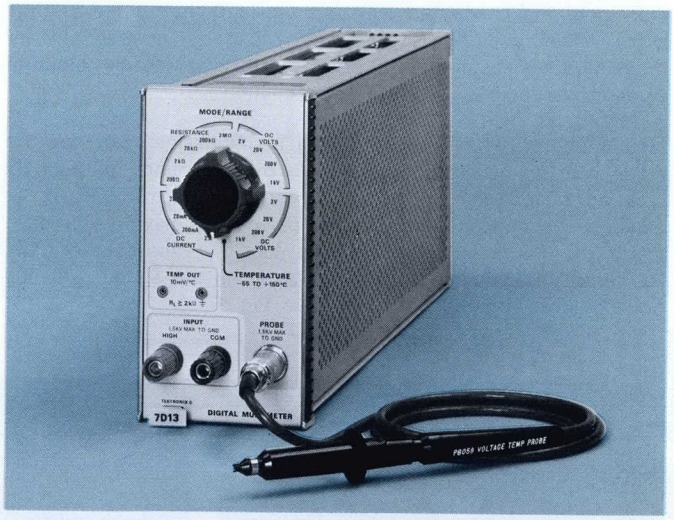
INCLUDED STANDARD ACCESSORIES

Instruction manual (070-1096-00); P6058 Voltage/Temperature Probe (010-0260-00).

7D13 DIGITAL MULTIMETER **$560**
7D13 DIGITAL MULTIMETER, without P6058 Probe, Option 1 .. **$495**

P6058 PROBE





The P6058 Probe is a combination 1X DC voltage and temperature measuring device. The temperature sensing element consists of a transistor installed in the nose tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and a five inch "common" (low) strap is provided, and is attached by threading into a hole in the side of the probe body. There is no external ground on the P6058 body, "ground" or the low potential point of the circuit under test is obtained via the common strap or connector, which is a floating common that has no tie to chassis ground. This lead may be floated at up to 1500 VDC away from chassis ground. The retractable hook-tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

CHARACTERISTICS

DC Voltage Range— 0 to 1000 V. Accuracy is ±0.1% of reading ±1 count.

Maximum Safe Input— 1500 V peak between either voltage contact and chassis ground. 1000 V peak between voltage contacts.

Temperature Range—See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable— 46 inches including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight—Approximately 5 ounces.

P6058 VOLTAGE/TEMPERATURE PROBE, order 010-0260-00 .... **$65**
Includes: P6058 Probe (010-0259-00); retractable hook tip (013-0121-00); 5-inch common strap (175-0848-01); 12-inch common strap (175-0848-02); two minigator clips (344-0046-00); instruction manual (070-1112-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7D14
Digital Counter

The 7D14 is the first counter plug-in for an oscilloscope and it counts directly to 500 MHz. Many other counters reach 500 MHz or above, but they use prescalers, transfer oscillators, heterodyne converters, or other special techniques. The gated approach makes possible "single-event" counting which is frequently very desirable in rapid burst measurements. Also, whenever a prescaler is used, resolution and accuracy are lost by the factor of the prescaler division ratio. For example, if the prescaler divides the input signal by 10, the resolution of the signal that's counted will only be 1/10 that of the original signal. The resolution and accuracy can be improved by increasing the measurement interval, but this may not be tolerable when measurement time is at a premium.

Measurements which were previously impossible can now be made with an oscilloscope having a digital counter plug-in. By locating the counter in one of the vertical compartments of the oscilloscope and operating the scope in the delaying time-base mode, the B sweep (delayed sweep) can drive the counter gate. By doing this, signals can be displayed on the screen with the ones being counted intensified (see Fig 1).

Using a vertical amplifier, time-base unit, and a 7D14, a signal can be displayed on the oscilloscope screen while simultaneously measuring its frequency to 0.00005% accuracy.

With the 7D14 in a vertical compartment, the output of its trigger circuit can be displayed directly on the CRT. This provides an indication of the actual triggering point, thus, many signals that were difficult to trigger on in the past can now be measured with much greater reliability. Not only is general-purpose triggering made easier, selective triggering is now possible. An interesting setup is to place the oscilloscope's vertical mode switch in the ADD mode. Adding the signal applied to the vertical amplifier plug-in and the output of the counter's trigger circuit causes a glitch to occur in the waveform displayed on the CRT, located at the point where the counter is triggering (see Fig 2).

When the 7D14 is used in a horizontal plug-in compartment, a signal connected to a vertical plug-in can be internally routed to it by the trigger source switches. All the 7000-Series vertical plug-ins are available as signal conditioners for the counter (see Fig 3). Another advantage is the reduction of circuit loading. One connection to the oscilloscope deflects the vertica and provides the input for the counter.

Each 7500 and 7700-Series oscilloscope mainframe includes a character generator that's used for CRT Readout (V, mV, ms, μs, etc.). When the 7D14 is used, the character generator traces out an 8-digit display on the face of the CRT, along with a legend for units like kHz or MHz.

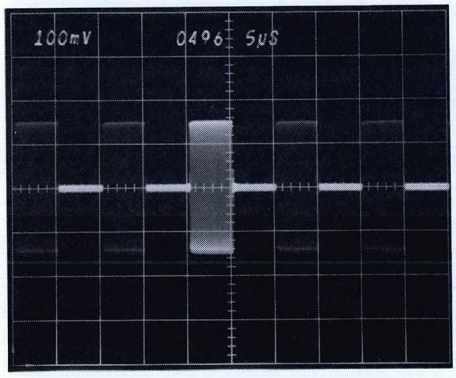


Fig 1: The quantity of pulses within a burst is counted and their amplitude measured. All in one display!

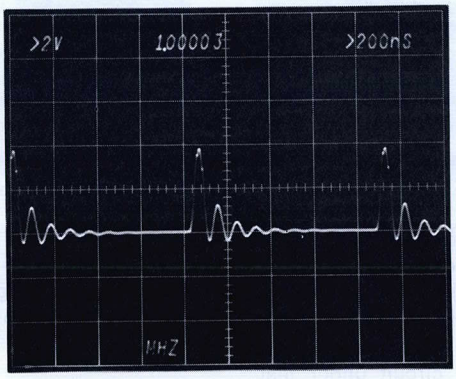


Fig 2: Output of 7D14 trigger circuit is added to the displayed signal. This allows the user to determine which signal is being counted.

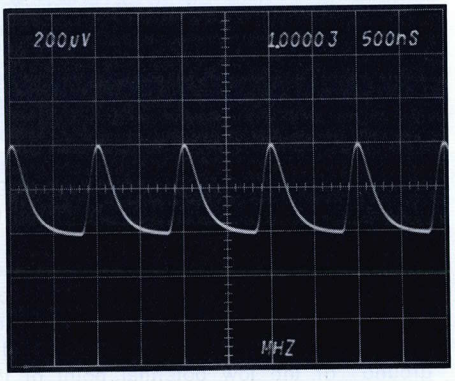


Fig 3: The frequency of a 400 μV signal is measured by connecting it to a 7A22 Amplifier and routing it to the counter through the scope's trigger source switch.

7D14
Digital Counter

NEW

- FREQUENCY MEASUREMENTS DIRECTLY TO 500 MHz
- TRIGGER INDICATOR DISPLAY
- 50-Ω and 1-MΩ INPUTS

The 7D14 is a digital counter plug-in designed for use with all 7500 or 7700-Series oscilloscope mainframes. It will function in any plug-in compartment. The 7D14 has three modes of operation: Frequency—0 to 500 MHz, Frequency Ratio (A/B)—0 to 10^5:1, and Totalize—0 to 10^8.

CHARACTERISTICS

Input Characteristics

	CHANNEL A		CHANNEL B	INTERNAL
	50 Ω	1 MΩ		
DC COUPLED	DC to 500 MHz	DC to 500 MHz	AC coupling only	AC coupling only
AC COUPLED	200 kHz to 500 MHz	5 Hz to 500 MHz	10 Hz to 2 MHz	5 Hz to 150 MHz*
SENSITIVITY	100 mV P-P (35 mV RMS)	100 mV P-P (35 mV RMS)	800 mV P-P	1.5 graticule div
INPUT R & C	50 Ω	1 MΩ ≈20 pF	10 kΩ ≈30 pF	50 Ω
MAX VOLTAGE	10 V RMS	200 V (DC + Peak AC) to 5 MHz 50 V (DC + Peak AC) 5 MHz to 500 MHz	15 V (DC + Peak AC) to 2 MHz	Depends on amplifier plug-in used

*When 7D14 is used in a 7704 mainframe.

FREQUENCY MEASUREMENTS

Input—Channel A, 0 to 500 MHz. Upper bandwidth can be restricted to 5 MHz to filter incoming high frequency noise.

Measurement Interval (Time Base)— 1 ms to 10 s in five decade steps. Up to 0.1 Hz resolution can be obtained.

Accuracy—Within $\pm \frac{1}{\text{total count}} \pm$ time base.

Stability—Within 0.5 P/M, 0°C to +50°C ambient temperature.

Long Term Drift— 1 part or less in 10^7/month.

FREQUENCY RATIO

Range—Channel A 0 to 500 MHz
Channel B 10 Hz to 2 MHz

TOTALIZE

Range— 0 to 10^8.

Gating—Manual or with an electrical reset. Also an external gate input which is compatible with the Sweep Gate from the oscilloscope mainframe. Reset and external gate must be a positive pulse of at least 2 V (compatible with TTL logic).

MONITORS

Monitor/Ext Gate—Provides crystal-based time markers of +5 V, the width is determined by the measurement interval.

REF FREQ/CH B Monitor—Provides a crystal-based, 1-MHz, +5 V output pulse. This connector functions as CH B input in the EXT IN mode.

READOUT

Display— 8 digits with leading zero suppression, positioned decimal, MHz or kHz.

Display Time— 0.1 to 5 s, also a preset position for infinite display time.

TRIGGERING

Level/Slope Range— + and —0.5 V with INPUT at 100 mV.

Displayed Trigger Indicator—Displayed amplitude of Schmitt trigger output is approximately 0.2 div. Upper frequency limit is at least 100 MHz (7704 mainframes).

Weights

Net weight	2.4 lb	1.1 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5.0 kg

INCLUDED STANDARD ACCESSORIES

BSM male to BNC female adapter (103-0036-00); instruction manual (070-1097-00).

7D14 DIGITAL COUNTER **$1400**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

7M11

Dual Delay Line

- 75 ns TIME DELAY
- SELECTABLE TRIGGER OUT
- 175 ps RISETIME

The 7M11 is a passive dual DELAY LINE unit for use with the 7000-Series sampling system. In low-repetition rate applications, requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50-Ω, 75-ns delay lines. The closely matched (30 ps) lines have GR874* INPUT-OUTPUT connectors, 175-ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay— 75 ns within 1 ns.

Delay Difference— 30 ps or less between channels.

Risetime— 175 ps or less.

Attenuation— 2X within 2% into 50 Ω.

Input Impedance— 50 Ω within 2%.

Maximum Input Voltage— ±5 V (DC + Peak AC).

TRIGGER OUTPUT

Risetime—600 ps or less.

Attenuation— 5X within 10% into 50 Ω (referred to INPUT).

Output Impedance— 50 Ω within 10%.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	5.8 lb	2.6 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.3 kg

*Registered Trademark General Radio Company

INCLUDED STANDARD ACCESSORIES

18 inch BNC cable (012-0076-00).
Instruction manual (070-0987-00).
Two 2 ns GR cables (017-0505-00).

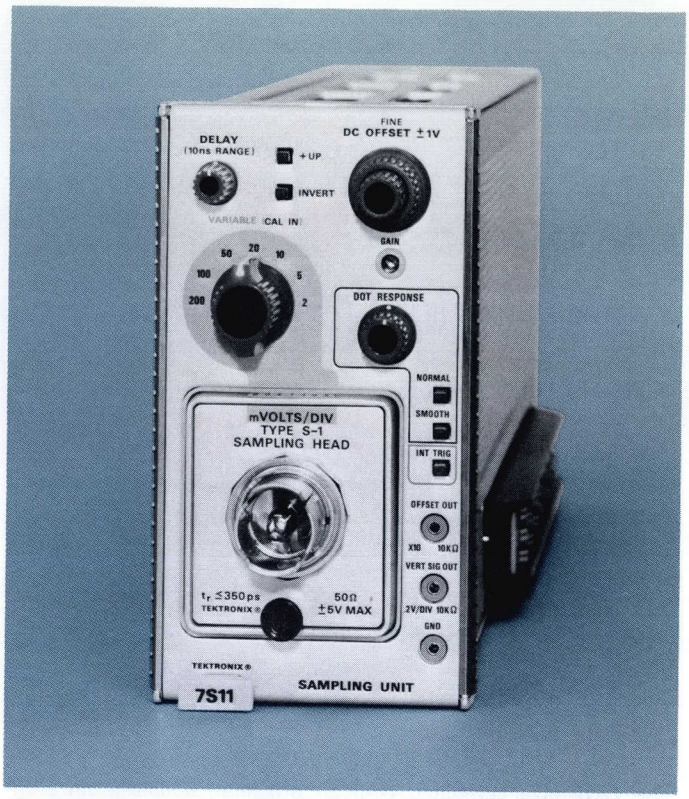
7M11 DELAY LINE UNIT **$250**

7M11 CARRYING CASE (437-0106-00) $30

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7S11
Sampling Unit

- **2 mV/DIV to 200 mV/DIV CALIBRATED DEFLECTION FACTORS**
- **PLUG-IN SAMPLING HEADS**



The 7S11 is a single-channel sampling unit for use in all 7000-Series mainframes. It contains the basic deflection amplifier and control circuitry common to all sampling systems. The input configuration employs the sampling "Plug-In Head" concept for maximum application range. The heads, which mount in the 7S11, cover the impedance/bandwidth spectrum from 1 MΩ/350 MHz to 50 Ω/14 GHz. (See sampling head descriptions.)

The 7S11 can be used in a variety of combinations. Single channel sampling would use one 7S11, together with a 7T11 Time-Base. Two 7S11's and one 7T11 would provide dual-trace sampling utilizing the electronic switching in the mainframe vertical amplifier. Two 7S11's can be used for X-Y operations.

An INTERNAL TRIGGER path is provided from the Plug-In Head (except for the S-3A) to the 7T11 Time-Base when the INT TRIG mode is selected. When operating in dual-trace mode, either vertical channel may be used as the trigger source.

The 7S11 deflection factor is in UNIT/DIV (i.e., mV/DIV is determined by the plug-in head) from 2 UNITS/DIV to 200 UNITS/DIV with a continuous VARIABLE control. The DOT RESPONSE control optimizes dot transient response in the NORMAL mode. The SMOOTH position reduces display noise at the more sensitive deflection factor settings.

The ±1 V DC OFFSET can be used as a vertical magnifier/position control to view small segments of a large signal within its range, or to effectively cancel the same range of DC level on the signal. The DC OFFSET voltage is available at the OFFSET OUT jack, amplified X10, for external monitoring.

CHARACTERISTICS

Deflection Factor— 2 units/div to 200 units/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/DIV or less to at least 400 units/DIV). Deflection factor (i.e., mV/DIV) is determined by the plug-in sampling head.

Bandwidth—Determined by the sampling head.

Input R and C—Determined by the sampling head.

DC Offset—Range, +1 V to −1 V or more. Offset Out is X10 the offset voltage within 2%. Source R 10 kΩ within 1%.

Delay Range—At least 10 ns.

Memory Slash— 0.1 div or less at 20 Hz.

Vertical Signal Out— 200 mV per displayed div within 3%.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

Weights

Net weight	2 lb	0.9 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

7S11 SAMPLING UNIT without sampling head **$550**
Includes instruction manual (070-0985-00).

OPTIONAL ACCESSORIES

Patch cords are available for the OFFSET OUT, VERT SIG OUT and GND jacks of the 7S11. Pin-jack to pin-jack, 0.08 inch dia pin.

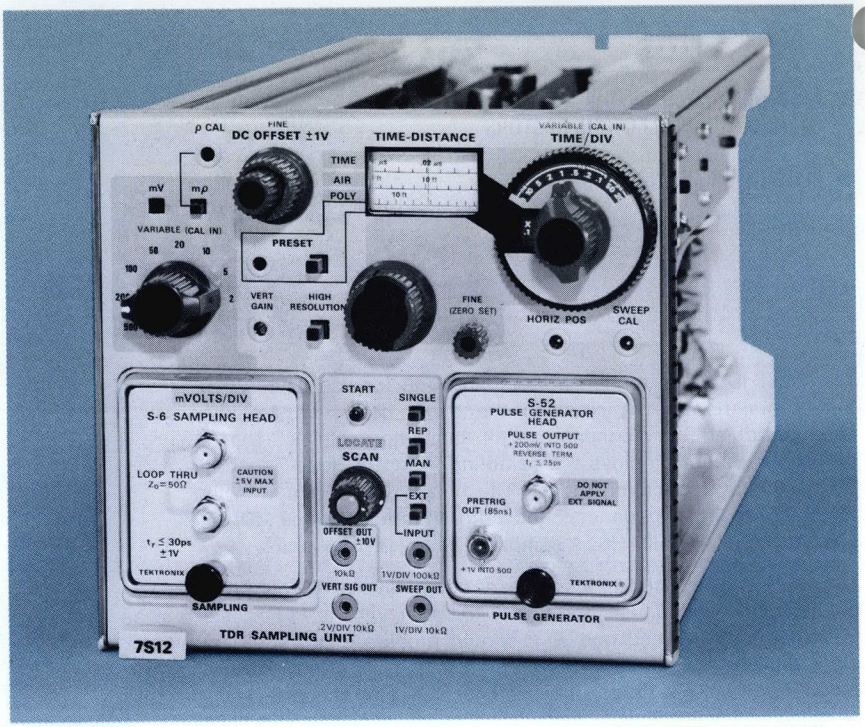
Order	Part Number	Price
Red, 8 inch	012-0179-00	$1.95
Red, 18 inch	012-0180-00	1.95
Black, 8 inch	012-0181-00	1.95
Black, 18 inch	012-0182-00	1.95

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

7S12

Time-Domain Reflectometer Unit

- 45-ps TDR SYSTEM RISETIME
- PLUG-IN SAMPLING HEADS
- PLUG-IN PULSE SOURCES
- GENERAL-PURPOSE SAMPLER



The 7S12 is a combined vertical-horizontal, double-width plug-in unit, designed to operate in all 7000-Series mainframes. It permits high-resolution TDR or general-purpose sampling measurements. As a TDR, using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination). Its vertical scale is calibrated in reflection coefficient (ρ) from .002 ρ/div to 0.5 ρ/div and in voltage from 2 mV/div to 500 mV/div. Time or distance to a discontinuity of interest is read directly from a tape dial calibrated for air or polyethylene dielectrics. As a TDR, using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 ft (airline) and discontinuities to twice this distance may be viewed. System risetime with this combination of low-noise, high-pulse amplitude heads is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head (DC-to-14 GHz with an S-4) with an S-51 Trigger Countdown Head or S-53 Trigger Recognizer Head. Dual-trace sampling displays are possible by using the 7S12 with a 7S11 Sampling Unit. The addition of a 7M11 Dual Delay Line provides signal delay necessary to view the triggering event.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Risetime— 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 750-ps test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distances to at least 490 ft (airline). Time range is at least 2 μs, round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude—At least +200 mV into 50 Ω.

Input Characteristics—Nominal, 50-Ω, feed-through signal channel (termination supplied). SMA (3-mm) connectors.

Jitter—Less than 10 ps (without signal averaging).

Aberrations— +5%, −5% total of 10% P-P within first 5 ns of step; +2%, −2% total of 4% P-P thereafter.

7S12
Time-Domain Reflectometer Unit

NEW

SYSTEM PERFORMANCE WITH S-5 AND S-54

System Risetime— 1.5 ns or less, for the displayed reflection from a short-circuited test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distances to 4900 ft (airline). Time range is 20 μs, round trip.

Pulse Amplitude—At least +400 mV into 50 Ω.

Input Characteristics—Nominal, 50-Ω test-line connection (cable and T supplied). BNC connectors.

Jitter—Less than 20 ps (without signal averaging).

Aberrations— +4%, −6%, total of 10% P-P within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.

OTHER 7S12 CHARACTERISTICS

Vertical Scale—Calibrated in mρ (reflection coefficient X10^{-3}) and mV from 2 to 500 units/div in 8 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

Resolution—Reflection coefficients as low as 0.001 can be observed. Signal averaging reduces test-line noise in display.

DC Offset Range— +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 actual DC offset through 10 kΩ.

Time/Distance—Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectrics having propagation factors from 0.6 to 1.0.

Time/Div— 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button—Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes—Repetitive or single sweep, manual or external scan.

Signal Outputs—Pin jacks provide both vertical signal and sweep outputs. Amplitude is 1 V for each division of displayed signal through 10 kΩ.

Weights

Net weight	4.5 lb	2.1 kg
Domestic shipping weight	≈8 lb	≈3.6 kg
Export-packed weight	≈13 lb	≈5.9 kg

INCLUDED STANDARD ACCESSORIES

750 ps rigid "U" cable with SMA (3-mm) connectors (015-1017-01); SMA (3-mm) short-circuit termination (015-1021-00); TDR Measurement Concepts Book (062-1244-00); instruction manual (070-1127-00).

7S12 TDR SAMPLING UNIT without sampling heads $1200

PLUG-IN HEADS

Ordering information on the various plug-in heads that can be used with the 7S12 is located on the next two pages. Complete specifications commence on page 112.

OPTIONAL ACCESSORIES

Patch cords are available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT and SWEEP OUT jacks of the 7S12. Pin-jack to pin-jack, 0.08 inch dia pin.

Order	Part Number	Price
Red, 8 inch	012-0179-00	$1.95
Red, 18 inch	012-0180-00	1.95
Black, 8 inch	012-0181-00	1.95
Black, 18 inch	012-0182-00	1.95

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Sampling Heads

350-ps, 50-Ω INPUT

The S-1 is a 350-ps risetime, 1-GHz bandwidth unit with low random noise. Complete specifications on page 112.

S-1 SAMPLING HEAD **$350**

75-ps, 50-Ω INPUT

The S-2 is a 75-ps risetime, 4.5-GHz bandwidth unit. Complete specifications on page 112.

S-2 SAMPLING HEAD **$400**

350-ps, 100-kΩ INPUT

The S-3A is a 350-ps risetime, 1-GHz bandwidth unit with a sampling probe input for higher INPUT IMPEDANCE (100 kΩ, 2.3 pF). Complete specifications on page 113.

S-3A SAMPLING HEAD **$550**

25-ps, 50-Ω INPUT

The S-4 is a 25-ps risetime, 14-GHz bandwidth unit. The 50-Ω input uses a 3-mm connector. Complete specifications on page 113.

S-4 SAMPLING HEAD **$875**

1-ns, 1-MΩ INPUT

The S-5 is a 1-ns risetime, 350-MHz bandwidth unit. The input impedance is 1 MΩ, 15 pF and can be used with conventional passive probes. Complete specifications on page 114.

S-5 SAMPLING HEAD **$375**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Sampling Heads

30-ps, 50-Ω LOOP-THRU INPUT

The S-6 is a 30-ps, 11.5 GHz bandwidth unit designed primarily for use with the 7S12 TDR Sampling Unit. Complete specifications on page 115.

S-6 SAMPLING HEAD **$875**

TRIGGER COUNTDOWN

The S-51 is a free-running, tunnel diode oscillator designed to provide stable sampling displays of signals from 1 GHz to 18 GHz. Complete specifications on page 116.

S-51 TRIGGER COUNTDOWN HEAD **$500**

25-ps PULSE GENERATOR

The S-52 is a 25-ps, 50-Ω reverse terminated unit designed for use with the 7S12 TDR Sampling Unit. Complete specifications on page 117.

S-52 PULSE GENERATOR HEAD **$550**

TRIGGER RECOGNIZER

The S-53 permits using the 7S12 TDR Sampling Unit as a general-purpose sampler from DC-to-1 GHz. It generates a trigger signal that can be synchronized with the signal input to permit internal triggering. Complete specifications on page 117.

S-53 TRIGGER RECOGNIZER HEAD **$375**

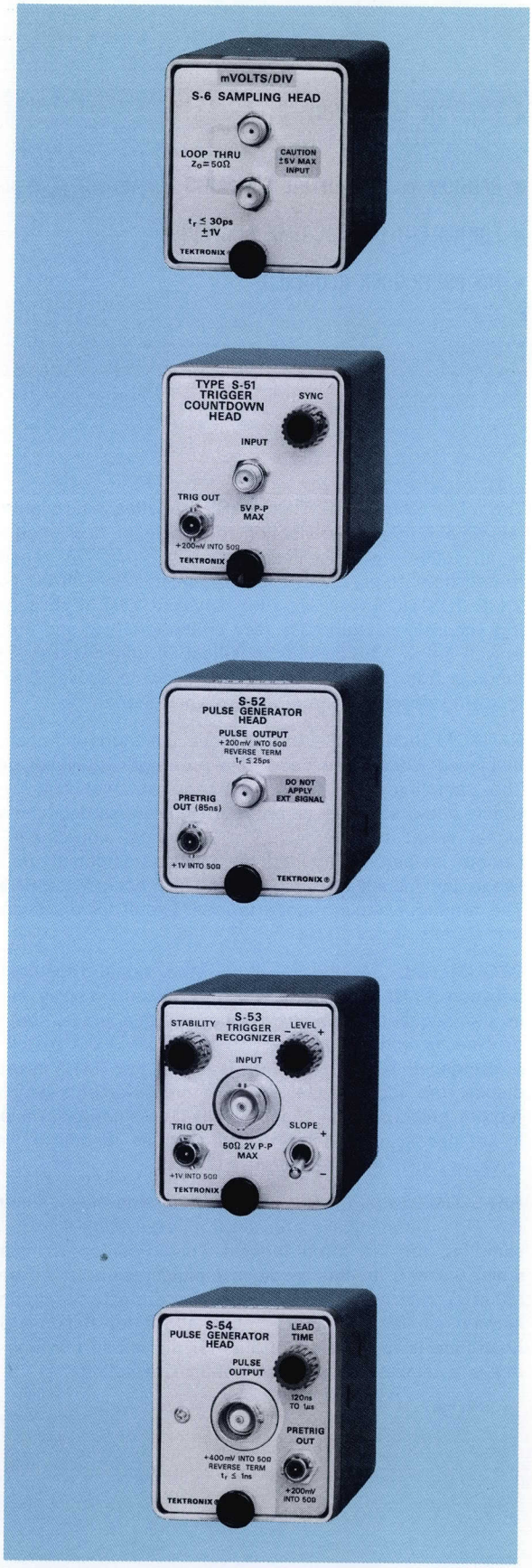
1-ns, 400-mV PULSES

The S-54 is a 1-ns, 50-Ω reverse terminated unit designed for use with the 7S12 TDR Sampling Unit. Complete specifications on page 118.

S-54 PULSE GENERATOR HEAD **$275**

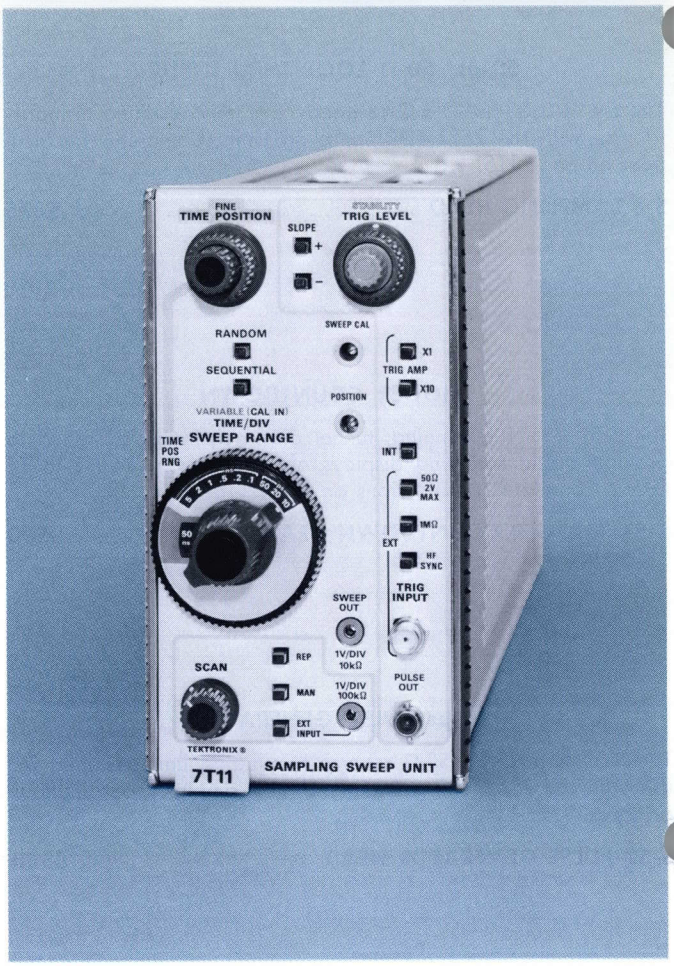
For applications requiring up to 64 Sampling Heads, see Type 286, 287 and R288 Multiplexers. Complete specifications on pages 232-234.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page



7T11
Sampling Sweep Unit

- 10 ps/DIV to 5 ms/DIV CALIBRATED TIME BASE
- RANDOM or SEQUENTIAL SAMPLING
- EQUIVALENT or REAL-TIME SAMPLING
- NO PRETRIGGER REQUIRED



The 7T11 SAMPLING TIME-BASE provides equivalent-time and real-time horizontal deflection for single or dual-trace sampling in all 7000-Series Oscilloscopes. The TIME/DIV range is calibrated from 10 ps/div to 5 ms/div, selectable with the concentric TIME POSITION RANGE, TIME/DIV and VARIABLE control. Timing accuracy is within 3% (see characteristics) and non-linearity is well below 1%, making specification unnecessary. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz. The following describes the modes of operation.

RANDOM SAMPLING—In this mode the triggering event may be displayed without the need of a pretrigger or signal delay line. The sampling process is controlled automatically by circuits which allow samples to be taken before, during and after the signal event of interest. The horizontal coordinate of each sample is then determined by a measurement of the time between the instant of sampling and the occurrence of a trigger. The random-sampling mode is most useful for displaying repetitive signals above 1 kHz.

SEQUENTIAL SAMPLING—When the signal repetition rate is between 10 Hz and 1 kHz, the most useful display is obtained in the sequential-sampling mode. In this mode, the sampling process is initiated by the trigger signal. As a result, either a pretrigger or signal delay line (such as the 7M11) is required to display the triggering event. For measurements which do not require display of the trigger-event (i.e., sinewaves) a pretrigger is not necessary and the decision to use random or sequential mode is based on repetition rate.

REAL TIME SAMPLING—To provide a wide measurement range, the 7T11 automatically crosses from equivalent-time to real-time sampling for the three longest Time Position Ranges (50 ms, 5 ms, 0.5 ms). In this mode, sampling occurs at a free-running (50 kHz) rate with the horizontal coordinate determined in a manner similar to that described above for Random Sampling. Lead-time is fixed at about 3 μs for this mode but time-positioning is available as in equivalent-time sampling.

TIME-POSITION RANGE—Control selects the time window from 50 ms to 50 ns in 7 steps. The TIME/DIV controls can then select all or a portion of the time window for display. Each RANGE has 9 TIME/DIV steps (1-2-5 sequence) associated with it. The displayed portion of the time window is selectable with the TIME POSITION control.

TRIGGERING CONSIDERATIONS—The unit is capable of triggering on signals in the useful sampling range from 10 Hz to above 12.4 GHz. The EXT mode has 50 Ω, 1 MΩ, and HF SYNC positions, each with its special application advantage. The 50 Ω input complements sources requiring termination and provides an optimized signal path to the DC coupled trigger recognition circuit; operation extends to 1 GHz. The 1 MΩ input inserts a X1 FET amplifier in the 50 Ω path for minimum loading of the signal source at frequencies under 100 MHz. The HF SYNC position operates from 1 GHz to above 12.4 GHz as a trigger countdown device. An INT trigger source from the 7S11 is provided (except with the S-3A plug-in head) for frequencies up to 500 MHz.

7T11
Sampling Sweep Unit

CHARACTERISTICS

Time/Div Range— 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to TIME POSITION RANGES. Uncalibrated VARIABLE is continuous between steps and to at least 4 ps/div.

Time Position Range—Equivalent time is 50 ns to 50 μs in 4 steps, real time is 0.5 ms to 50 ms in 3 steps.

Time/Div Accuracy—Within 3% for all TIME/DIV settings over center 8 cm.

TRIGGERING

Ext 50 Ω Input—Frequency range is DC to 1 GHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V P-P (DC to 1 GHz) in X1 TRIG AMP, 0.5 mV to 2 V P-P (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Max input voltage is 2 V (DC + peak AC).

Ext 1 MΩ Input—Frequency range is DC to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V P-P (DC to 100 MHz) in X1 TRIG AMP, 0.5 mV to 2 V P-P (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 MΩ within 5%. Max input voltage is 100 V P-P to 1 kHz, derating 6 dB/octave to a minimum 5 V P-P.

Ext HF Sync—Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV P-P. Input R is 1 MΩ. Max input voltage is 2 V P-P.

Int Trigger Source (Sinewave Triggering)*—Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP, 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 50 mV to 1 V P-P (referred to the vertical input) in X1 TRIG AMP, 5 mV to 1 V P-P (referred to the vertical input) in the X10 TRIG AMP.

*NOTE: Trigger circuits will operate to DC with pulse triggering, except for HF Sync.

Random Mode Trigger Rate— 100 Hz minimum.

Display Jitter—Measured under optimum trigger conditions TIME/DIV switch cw.

TIME POS RNG	SEQUENTIAL MODE	RANDOM MODE
50 μs to 500 ns	0.4 div at 10 ps/div	1 div at 10 ps/div
50 ns	10 ps	30 ps

Pulse Out—Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5-ns risetime or less.

Trigger Kickout— 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate—Continuously selectable from at least 40 sweeps/s to less than 2 sweeps/s.

External Scan—Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ within 10%. Max input voltage is 100 V (DC + Peak AC).

Sweep Out— 1 V/div within 2%, source R is 10 kΩ within 1%.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Weights

Net weight	2.8 lb	1.3 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5.0 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0986-00).
Cable, 42 inch, 50 Ω, BNC/BNC (012-0057-01).
Attenuator, 10X, 50 Ω, BNC (011-0059-01).
SMA (3 mm) male to BNC adapter (015-1018-00).
SMA (3 mm) male to GR874* adapter (015-1007-00).

7T11 SAMPLING SWEEP UNIT **$1450**

OPTIONAL ACCESSORIES

Patch cords are available for the SWEEP OUT and EXT SWEEP INPUT jacks of the 7T11. Pin-jack to pin-jack, 0.08 inch dia pin.

Order	Part Number	Price
Red, 8 inch	012-0179-00	$1.95
Red, 18 inch	012-0180-00	1.95
Black, 8 inch	012-0181-00	1.95
Black, 18 inch	012-0182-00	1.95

*Registered Trademark General Radio Company

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

IMPORTANT FEATURES OF THE NEW 5103N OSCILLOSCOPE SYSTEM

- LOW COST MODULAR OSCILLOSCOPE SYSTEM
- UNEQUALED VERSATILITY USING INTERCHANGEABLE PLUG-INS PLUS INTERCHANGEABLE DISPLAY MODULES PLUS BENCH-TO-RACK CONVERTIBILITY
- LARGE 6½-INCH CRT
- MAINFRAME ACCEPTS UP TO THREE PLUG-INS
- BANDWIDTH UP TO 2 MHz
- 50 μV/DIV HIGH GAIN DIFFERENTIAL
- ONE TO FOUR TRACE CAPABILITY
- SIMULTANEOUS DISPLAY OF TWO INDEPENDENT TIME BASES OR DELAYED SWEEP
- Y-T OR X-Y OPERATION
- NEW IMPROVED STORAGE CAPABILITY
- SIMPLIFIED CONSTRUCTION, EASY TO MAINTAIN, RELIABLE
- COLOR CODED FRONT PANELS FOR EASY OPERATION
- LIGHT WEIGHT, EASY TO CARRY
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- SOLID STATE STABILITY

When Tektronix introduced the first plug-in oscilloscope, customer acceptance quickly established this concept as one of the outstanding contributions to instrumentation. The ability to interchange display units in an oscilloscope, and the ability to convert between cabinet and rackmount configurations is expected to represent the same significance to oscilloscopes as did the plug-in.

The new 5103N Oscilloscope System supports the Tektronix commitment to progress in waveform measurement. This oscilloscope system will provide present and future measurement capabilities at a sound price/performance ratio, and the customer will realize continuing benefits from this new concept as it is applied to tomorrow's oscilloscopes.

Users of low frequency oscilloscopes have always been confronted with choosing a non-plug-in oscilloscope designed to meet specific measurement criteria, or a more costly wide bandwidth plug-in oscilloscope.

If a plug-in oscilloscope were selected for greater flexibility it usually covers a broader performance spectrum than the user needs for DC to 2 MHz measurements. To date, plug-in oscilloscopes have been designed for mid or high frequency use and as such were often too expensive for lower frequency requirements. Therefore, the low frequency oscilloscope buyer has been unable to purchase an instrument which suited his particular measurement needs at a price/performance ratio comparable to that which exists for users of higher frequency oscilloscopes.

To solve this problem, Tektronix designed the 5103N oscilloscope system. It's an entirely new series of oscilloscopes which allows the user with lower bandwidth measurements to choose an instrument for his immediate individual requirements and have unequaled ability to change the configuration when his applications change.

The 5103N oscilloscope system offers completely new, unique dimensions in versatility which was previously unavailable in any other oscilloscope system, regardless of bandwidth or price. Now, for the first time, users of low frequency oscilloscopes have the versatility of plug-ins, PLUS the new versatility of interchangeable display units, PLUS the versatility of converting to and from cabinet or rackmount—PLUS prices consistent with his measurement needs.

Currently the 5103N oscilloscope system consists of four interchangeable display modules, six amplifier plug-ins, three time base plug-ins and one power supply/amplifier module with three plug-in compartments.

The 5103N mainframe module contains the low voltage power supplies, the vertical and horizontal amplifiers and the electronic switching and logic circuitry for dual trace or dual beam operation. Chopped and alternate modes are selected from a push-button on time base plug-ins.

MAINFRAME AND INTERCHANGEABLE DISPLAY UNITS

PRODUCT	PAGE	FEATURES		
5103N MAINFRAME	74	Power Supply/Amplifier Unit compatible with each of four interchangeable display units		
INTERCHANGEABLE DISPLAY UNITS		BEAMS	STORAGE	DISPLAY SIZE
D10	75	Single		8 x 10 div (1/2 in/div)
D11	76	Single	Yes	8 x 10 div (1/2 in/div)
D12	77	Dual		8 x 10 div (1/2 in/div)
D13	77	Dual	Yes	8 x 10 div (1/2 in/div)

AMPLIFIER PLUG-INS

PRODUCT	PAGE	TRACES	MINIMUM DEFLECTION FACTOR	BANDWIDTH —3 dB	CMRR
5A15N	79	Single	1 mV	2 MHz	
5A18N	79	Dual	1 mV	2 MHz	
5A23N	79	Single	10 mV/div	1 MHz	
5A24N	79	Single	50 mV/div straight through plug-in		
5A20N	80	Single	50 μV	1 MHz	100,000:1
5A21N	80	Single (Voltage and Current)	50 μV 0.5 mA	1 MHz	100,000:1

TIME BASE PLUG-INS

PRODUCT	PAGE	DUAL and DELAYED SWEEP	SWEEP RATE	MAG	SINGLE SWEEP	VOLTS/DIV EXT MODE
5B10N	81		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	82	Yes	1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B13N	82		5 μs to 0.5 s			

Reference Information

The four display modules presently available include a single beam unit, a dual beam unit, a single beam storage unit and a dual beam storage unit. Each unit features a large CRT with 8 x 10 divisions (1/2 in/div). All four modules have 3.5 kV accelerating potential and internal graticules. P31 phosphor is standard for the non-storage units and a phosphor similar to P1 is standard for the storage units. These modules include the power switch, a voltage-current-time calibrator, a beam finder, the controls related to the CRT display, and the Z-axis input.

In addition to large, bright displays the D10 Single Beam Display Unit has a front panel output which provides current, voltage and timing calibration sources. A Beam Finder positions the beam on screen regardless of the setting of the vertical and horizontal position and intensity controls. A DC coupled Z-axis input requires only 5 V to modulate the writing beam.

The D11 Single Beam Storage Unit has a bistable, split-screen storage CRT with increased light output, especially in the stored mode. A brightness control allows the user to vary the stored brightness level to retain information for as long as several hours at specified resolution and without damaging the CRT. Even at high output light levels the storage CRT is highly resistant to burns, and requires only the same operating care as a conventional CRT. The stored brightness control used in conjunction with the other storage controls also allows "integration" to increase the effective writing rate.

The D12 Dual Beam Display Unit is the same as the D10 Single Beam unit except the CRT has two writing guns and two pairs of vertical deflection plates. Both beams cover the full 8 x 10 division screen. The D13 Dual Beam Storage Unit has all of the storage features of the D11 Single Beam Storage Unit plus the dual beam capability of the D12.

All plug-ins in the 5103N oscilloscope system stress simplicity of design and operating ease. Logical grouping of controls and the use of color-coded panel markings by function is used extensively. Six vertical amplifiers are currently available. These include a dual trace, 1 mV/div, 2-MHz amplifier and two 50 μV/div, 1-MHz differential amplifiers with CMRR to 100,000:1. Three currently available time bases include a dual-delaying sweep plug-in, and a single sweep plug-in. Both have sweep rate to 100 ns/div.

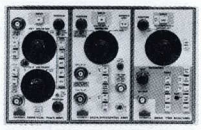
Scale factor readout is provided by back-lighted skirt knobs which automatically indicate the correct reading when using the X10 magnifier and the recommended 1X and 10X probes. The lights turn off when a plug-in or a channel is switched off.

Scale factor readout prevents many measurement errors and provides an easy, quick means of identifying deflection factors and sweep rates and indicating which channels are in use—even in low ambient room light.

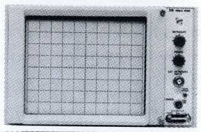
The 5103N is a low frequency oscilloscope system with interchangeable display units with 6 1/2-inch CRT's. The cabinet model converts to and from a rackmount configuration.

SELECT FROM THESE UNITS

The 5103N Mainframe (Shown With Plug-Ins)



Add The D10 Single Beam CRT Unit — **HERE** ►



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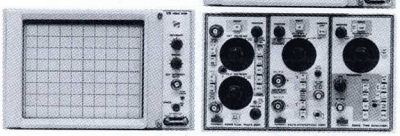

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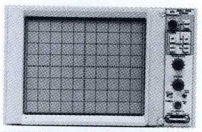
Add The D11 Single Beam Storage Unit — **HERE** ►



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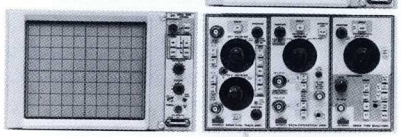
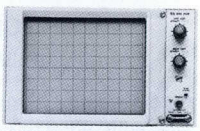


OR

Add The D12 Dual-Beam Unit — **HERE** ►



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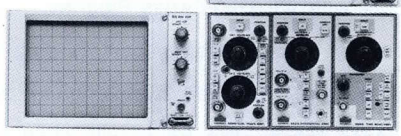
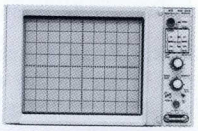


OR

Add The D13 Dual-Beam Storage Unit — **HERE** ►



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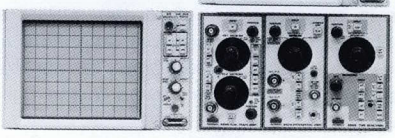


NEW

5103N Mainframe

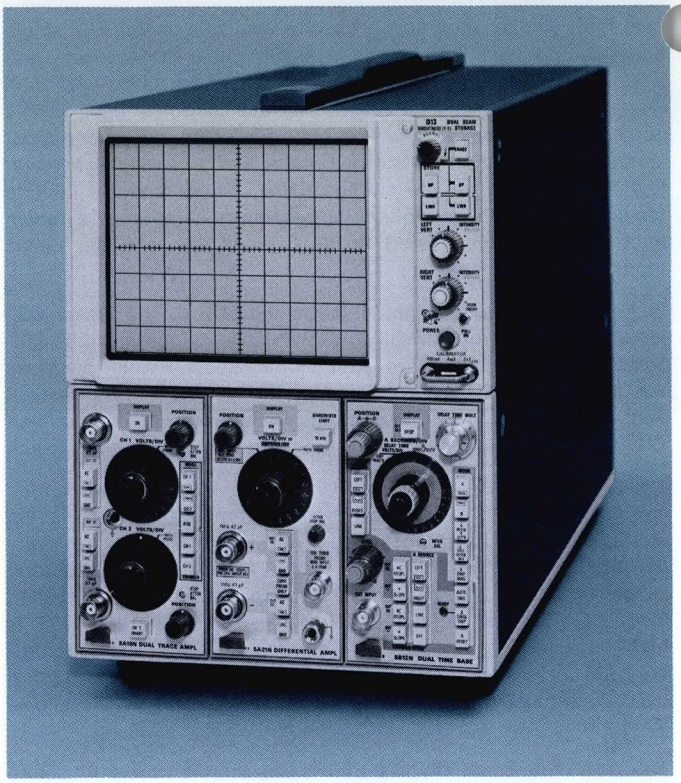
Shown with D13 Storage Display Unit

- DC-to-2 MHz BANDWIDTH
- USE WITH INTERCHANGEABLE SINGLE BEAM, SINGLE BEAM STORAGE, DUAL BEAM AND DUAL BEAM STORAGE DISPLAY UNITS
- USE IN A CABINET OR 5¼-INCH RACKMOUNT CONFIGURATION
- THREE PLUG-IN COMPARTMENTS

The 5103N Mainframe is the power supply/amplifier unit for an oscilloscope system featuring four interchangeable display units. An oscilloscope is assembled by combining the 5103N with any of the four display units. To complete the oscilloscope system, vertical amplifier and time base units are selected and placed into the 5103N plug-in compartments.

There are three plug-in compartments. Any vertical amplifier in this series is compatible with any compartment. Thus, full X-Y performance is available by using a vertical amplifier in the horizontal compartment. The 5103N operates with one vertical amplifier and a time base installed. A second amplifier may be added as required.

The 5103N and the selected display unit assembles into a cabinet or 5-1/4 inch rackmount configuration and may be converted from one configuration to the other with available kits to save the expense of duplicating equipment to meet individual application requirements.



5103N Mainframe shown complete with display unit and plug-ins

5103N/D13 STORAGE OSCILLOSCOPE (without plug-ins) $1370

CHARACTERISTICS

VERTICAL SYSTEM

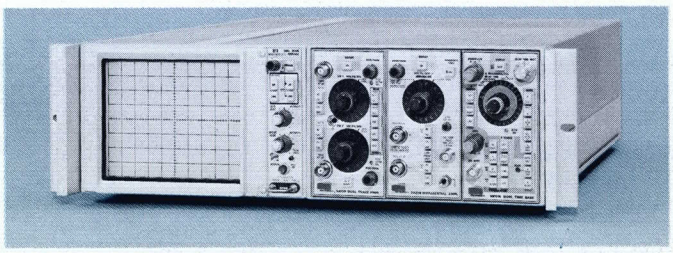
Channels—Two plug-in compartments (left and center) compatible with all 5100-Series Plug-Ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth—Determined by mainframe and plug-in unit.

Chopped Mode—The 5103N will chop between two amplifiers. The chop mode is selected from the time base unit.

Alternate Mode—In this mode the 5103N sweeps each amplifier plug-in twice before switching to the next. A single trace amplifier is swept twice and each channel of a dual trace amplifier is swept once before the 5103N switches to the second amplifier. When two vertical amplifiers are used with the 5B12N Dual Time Base, the left amplifier can be slaved to the A sweep, and the right amplifier slaved to the B sweep in the dual-sweep mode.



HORIZONTAL SYSTEM

Channel—One right-hand plug-in compartment compatible with all 5100-Series Plug-Ins. Dual sweep is available with the 5B12N Time Base.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—PHASE SHIFT is within 1° from DC to 100 kHz, checked with two amplifiers of the same type.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid for the 5103N Mainframe Unit from 0°C to +50°C.

Power Requirements—The 5103N operates from 110 to 120 V (quick-change adapter) 60 Hz sources. Specify option 1 (no extra charge) for operation from 50 to 60 Hz sources, 100, 110, 120, 200, 220 and 240 V. Option 1 instruments are factory connected for 220 V operation.

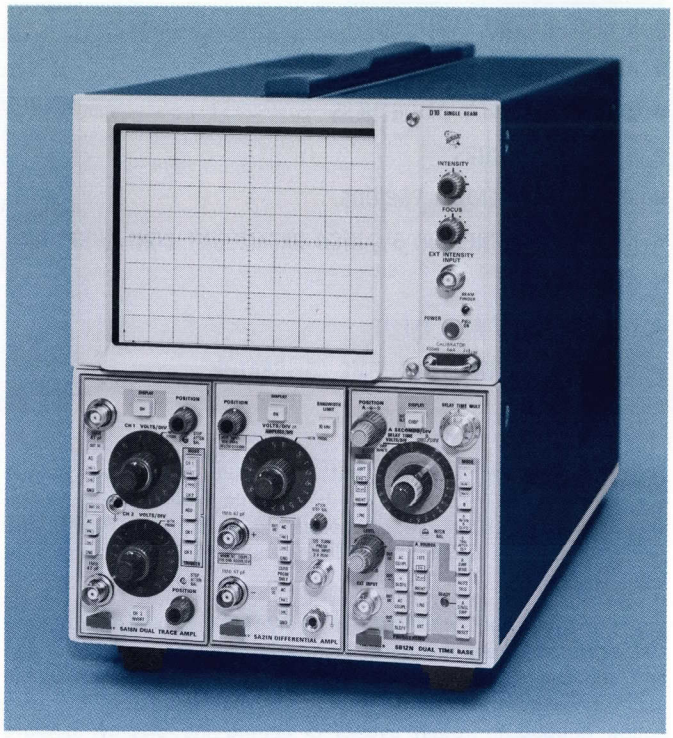
5103N MAINFRAME (without plug-ins or display unit) **$220**
Includes instruction manual 070-1143-00.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Single Beam Display Unit D10
Mainframe 5103N

NEW

- 8 x 10 DIV CRT (½ in/DIV)
- BRIGHT DISPLAYS
- USE IN A CABINET OR 5¼-INCH RACKMOUNT CONFIGURATION
- DC COUPLED Z-AXIS FRONT PANEL INPUT
- BEAM FINDER
- CURRENT, VOLTAGE AND TIME CALIBRATOR



The D10 provides a single beam conventional display for the 5103N Mainframe. The electrostatic-deflection cathode-ray tube has an 8 x 10 division (1/2 in/div) display area with internal graticule. A bright display is provided by a 3.5 kV accelerating potential. Provision is made for application of Z-axis signals. A front-panel current loop provides a calibration signal. The D10 may be ordered with the 5103N in a cabinet or 5-1/4 inch rackmount configuration. A kit is available for converting the oscilloscope from one configuration to the other at the user's convenience.

CHARACTERISTICS

Cathode-Ray Tube— 6-1/2 inches, 8 x 10 divisions (1/2 in/div). P31 phosphor standard, 3.5 kV accelerating potential. Internal graticule.

External Intensity Input— 5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (DC + peak AC).

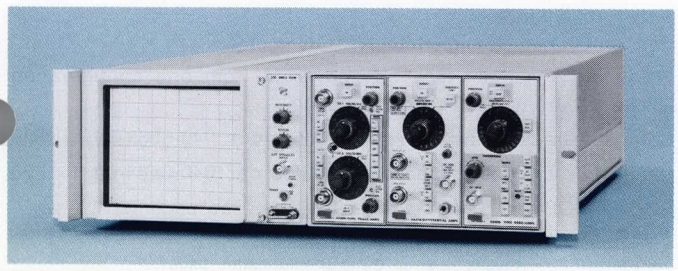
Calibrator—Voltage amplitude is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, positions beam on screen regardless of the vertical, horizontal and intensity control settings.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid for the 5103N Mainframe and D10 Display Unit from 0°C to +50°C.

Power Requirements—The 5103N/D10 and R5103N/D10 operate from 110 to 120 V (quick-change adapter) 60 Hz sources. Specify option 1 (no extra charge) for operation from 50 to 60 Hz sources, 100, 110, 120, 200, 220 and 240 V. Option 1 instruments are factory connected for 220 V operation.



Dimensions & Weights

	CABINET		RACKMOUNT	
	in	cm	in	cm
Length	20.0	50.9	20.0	50.9
Width	8.5	21.5	19.0	48.0
Height	11.5	29.5	5.25	13.5
	lb	kg	lb	kg
Approx weight with plug-ins	27	12	27	12

Cabinet—The 5103N Mainframe Unit and D10 Display Unit may be ordered assembled in a cabinet model configuration equipped with a tilt bail and the instruction manual for each unit.

5103N/D10 OSCILLOSCOPE (without plug-ins) **$540**

Rackmount—The 5103N Mainframe Unit and D10 display Unit may be ordered assembled in a 5-1/4 inch rackmount configuration equipped with a slide-out assembly and the instruction manual for each unit.

R5103N/D10 OSCILLOSCOPE (without plug-ins) **$540**

D10 SINGLE BEAM DISPLAY UNIT **$320**
Includes instruction manual 070-1132-00.

5103N MAINFRAME (without plug-ins or display unit) **$220**
Includes instruction manual 070-1143-00.

CONVERSION KITS

These oscilloscopes may be converted from one configuration to the other as applications change.

Cabinet-to-rackmount conversion kit order 040-0583-00 .. $30

Rackmount-to-cabinet conversion kit order 040-0584-00 .. $30

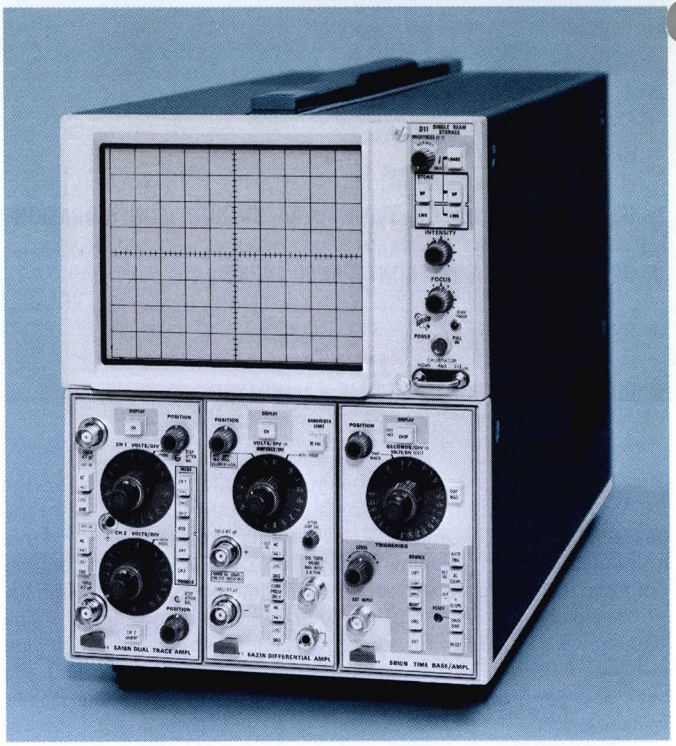
SCOPE-MOBILE® CART AND CAMERA—See page 78.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

D11 Single Beam Storage Display Unit
5103N Mainframe

- 8 x 10 DIV CRT (½ in/div)
- BISTABLE SPLIT-SCREEN STORAGE
- VARIABLE STORED BRIGHTNESS
- STORE FOR HOURS
- VIEW FOR EXTENDED PERIODS
- USE IN A CABINET OR 5¼-INCH RACKMOUNT CONFIGURATION
- BEAM FINDER
- DC COUPLED Z-AXIS INPUT
- CURRENT, VOLTAGE AND TIME CALIBRATOR



The D11 Storage Display Unit is a dual beam, 6-1/2 inch 8 x 10 div (1/2 in/div) CRT with bistable, split-screen storage and an internal graticule. Accelerating potential is 3.5 kV and the phosphor is similar to P1. Storage writing speed is at least 20 div/ms.

Simplified storage operation, a characteristic of Tektronix bistable storage, lets the user leave the oscilloscope unattended and still retain transient events in a view mode. This frees the user to concentrate on the test point, confident that the only action needed to retain events is setting the display to store and the time base to single sweep. The oscilloscope does the rest.

The D11 has a Variable Brightness control which adds new versatility to the bistable storage tube. The brightness of a display, stored at normal intensity, may be adjusted to extend storage time to at least 10 hours, to obtain optimum photographic results and to integrate multiple traces.

CHARACTERISTICS

Cathode-Ray Tube—6-1/2 inches, 8 x 10 divisions (1/2 in/div). Phosphor is similar to P1. 3.5 kV accelerating potential. Internal graticule.

Storage Display—Writing speed is at least 20 div/ms. Storage time is at least 1 hour at normal intensity increasing to 10 hours at reduced intensity. Erase time is ≈ 250 ms.

External Intensity Input—5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (DC + peak AC).

Calibrator—Voltage output is 400 mV within 1%. Current loop output is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, the beam is positioned on screen, regardless of vertical and horizontal position and intensity control settings.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid for the 5103N Mainframe and D11 Display Unit from 0°C to +50°C.

Power Requirements—The 5103N/D11 and R5103N/D11 operate from 110 to 120 V (quick-change adapter) 60 Hz sources. Specify option 1 (no extra charge) for operation from 50 to 60 Hz sources, 100, 110, 120, 200, 220 and 240 V. Option 1 instruments are factory connected for 220 V operation.

Dimensions & Weights

	CABINET		RACKMOUNT	
	in	cm	in	cm
Length	20.0	50.9	20.0	50.9
Width	8.5	21.5	19.0	48.0
Height	11.5	29.5	5.25	13.5
	lb	kg	lb	kg
Approx weight with plug-ins	27	12	27	12

Cabinet—The 5103N Mainframe Unit and D11 Display Unit may be ordered assembled in a cabinet model configuration equipped with a tilt bail and the instruction manual for each unit.

5103N/D11 STORAGE OSCILLOSCOPE (without plug-ins) **$1020**

Rackmount—The 5103N Mainframe Unit and D11 Display Unit may be ordered assembled in a 5 1/4-inch rackmount configuration equipped with a slide-out assembly and the instruction manual for each unit.

R5103N/D11 STORAGE OSCILLOSCOPE (without plug-ins) **$1020**

D11 SINGLE BEAM STORAGE DISPLAY UNIT **$800**
Includes instruction manual 070-1133-00.

5103N MAINFRAME (without plug-ins or display unit) **$220**
Includes instruction manual 070-1143-00.

CONVERSION KITS

These oscilloscopes may be converted from one configuration to the other as applications change.

Cabinet-to-rackmount conversion kit order 040-0583-00 .. $30

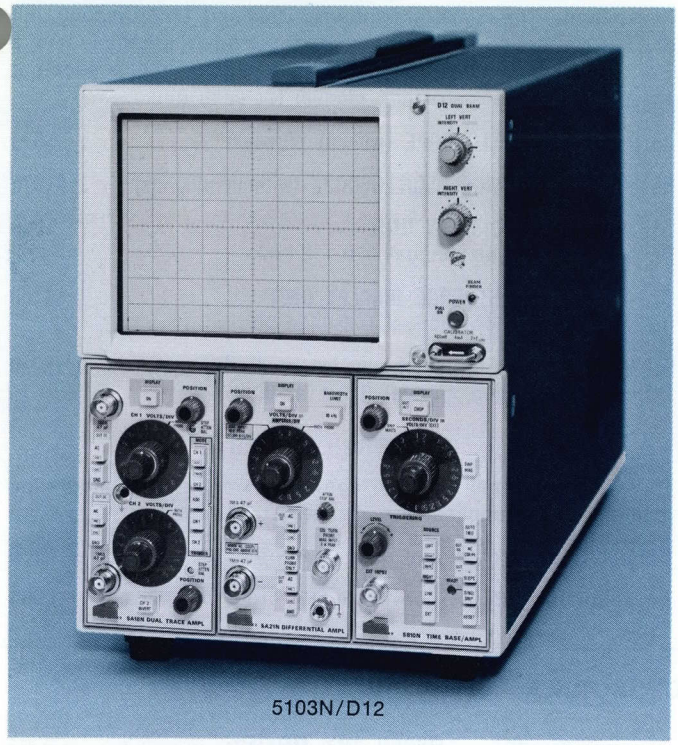
Rackmount-to-cabinet conversion kit order 040-0584-00 .. $30

SCOPE-MOBILE® CART AND CAMERA—see page 78.

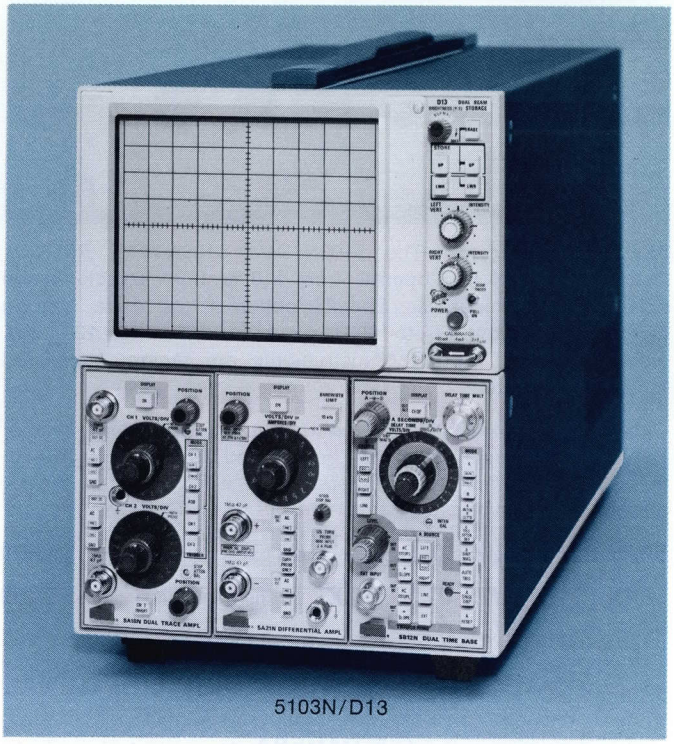
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Dual Beam Display Unit D12
Dual Beam Storage Display Unit D13
Mainframe 5103N

NEW



5103N/D12



5103N/D13

- 8 x 10 DIV CRT (½ IN/DIV)
- DUAL BEAM STORAGE OR CONVENTIONAL
- USE IN A CABINET OR 5¼-INCH RACKMOUNT CONFIGURATION

D12 DUAL BEAM DISPLAY UNIT

The D12 is a dual beam version of the D10 Single Beam Display Unit. Dual beam oscilloscopes are essential to the many applications where two transient events must be compared simultaneously. Application areas include stimulation and reaction events in areas such as medicine, biology, chemistry, engineering mechanics and many other electronic and scientific measurement areas. Both beams of the D12 are driven by a common time base. When two dual trace amplifiers are used, two traces are displayed on each beam.

D12 CRT CHARACTERISTICS

Cathode-Ray Tube—6-1/2 inches, 8 x 10 divisions (1/2 in/div). P31 phosphor standard, 3.5-kV accelerating potential. Internal graticule.

D13 DUAL BEAM STORAGE DISPLAY UNIT

The D13 Storage Display Unit is a dual beam, 6-1/2 inch 8 x 10 div (1/2 in/div) CRT with bistable, split-screen storage and an internal graticule. The storage display characteristics and operation are the same as the D11 Storage Display Unit. New measurement problems are continuously developing which can only be solved with a dual beam storage oscilloscope. Experimenters and researchers in areas such as electronics, mechanics and bio-medicine recognize the expediency and thoroughness of dual beam storage for retaining two related transients.

D13 CRT CHARACTERISTICS

Cathode-Ray Tube— 6-1/2 inches, 8 x 10 divisions (1/2 in/div). Phosphor is similar to P1. Accelerating potential is 3.5 kV. Internal graticule.

Storage Display—Writing speed is at least 20 div/ms. Storage time is at least one hour at normal intensity increasing to 10 hours at reduced intensity. Erase time is ≈250 ms.

D12 AND D13 COMMON CHARACTERISTICS

External Intensity Input— 5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is ≈10 kΩ, paralleled by ≈40 pF. Maximum input is ±50 V (DC + peak AC).

Calibrator—Voltage amplitude is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, positions both beams on screen regardless of vertical, horizontal and intensity control settings.

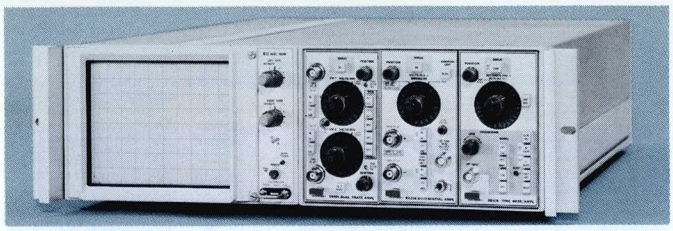
Ambient Temperature—Performance characteristics are valid for the 5103N Mainframe, D12 Display Unit and D13 Storage Display Unit from 0°C to +50°C.

Dimensions & Weights

	CABINET		RACKMOUNT	
	in	cm	in	cm
Length	20.0	50.9	20.0	50.9
Width	8.5	21.5	19.0	48.0
Height	11.5	29.5	5.25	13.5
	lb	kg	lb	kg
Approx weight with plug-ins	27	12	27	12

NEW

D12 Dual Beam Display Unit
D13 Dual Beam Storage Display Unit
5103N Mainframe



Power Requirements—The 5103N/D12, 5103N/D13, R5103N/D12 and R5103N/D13 operate from 110 to 120 V (quick-change adapter) 60 Hz sources. Specify option 1 (no extra charge) for operation from 50 to 60 Hz sources, 100, 110, 120, 200, 220 and 240 V. Option 1 instruments are factory connected for 220 V operation.

Cabinet—The 5103N Mainframe Unit and D12 Display Unit or D13 Storage Display Unit may be ordered assembled in a cabinet model configuration equipped with a tilt bail and the instruction manual for each unit.

5103N/D12 OSCILLOSCOPE (without plug-ins) **$870**

5103N/D13 STORAGE OSCILLOSCOPE (without plug-ins) **$1370**

Rackmount—The 5103N Mainframe Unit and D12 Display Unit or D13 Storage Display Unit may be ordered assembled in a 5-1/4 inch rackmount configuration equipped with a slide-out assembly and the instruction manual for each unit.

R5103N/D12 OSCILLOSCOPE (without plug-ins) **$870**

R5103N/D13 STORAGE OSCILLOSCOPE (without plug-ins) **$1370**

D12 DUAL BEAM DISPLAY UNIT **$650**
Includes instruction manual 070-1134-00.

D13 DUAL BEAM STORAGE DISPLAY UNIT **$1150**
Includes instruction manual 070-1135-00.

5103N MAINFRAME (without plug-ins or display unit) **$220**
Includes instruction manual 070-1143-00.

CONVERSION KITS

These oscilloscopes may be converted from one configuration to the other as applications change.

Cabinet-to-rackmount conversion kit order 040-0583-00 .. $30

Rackmount-to-cabinet conversion kit order 040-0584-00 .. $30

OPTIONAL ACCESSORIES

C-5 CAMERA

This low-cost camera is designed to complement the low-frequency 5100-Series Oscilloscopes. Easy to use, fixed-focus, fixed aperture design simplifies waveform photography. A sliding door in the camera top allows viewing of CRT without removing the camera. When photographs are taken, battery-powered lights inside the camera illuminate the display graticule.

Lens—f/11 fixed aperture, prefocused, 1:0.68 magnification ratio.

Shutter— 3 speeds, Bulb and Time.

Film Back—Polaroid* Pack-film Back accepts 3000-speed film which develops outside the camera in about 15 seconds.

Mounting—fits directly on all 5100-Series Oscilloscopes; no additional adapter is required. Also fits Tektronix 7000-Series Oscilloscopes, Type 528 TV Waveform Monitor, 601 and 602 Display Units, and 4501 Scan Converter.

Dimensions (height, width, length)— 5 1/2 x 7 9/16 x 10 1/2 inches; 14 x 19.2 x 26.7 cm.

C-5 CAMERA **$185**

*Registered Trademark Polaroid Corporation

P6060 10X PROBE

The P6060 is a general-purpose probe for the 5100-Series Oscilloscopes. A special BNC connector activates sensing circuitry in the vertical plug-in units, to automatically change the scale factor readout on the front panel. This convenience eliminates the need to mentally calculate the true deflection factor when using the probe. Accurate 10X attenuation provides common-mode rejection of 52 dB (400:1) when used with 5A20N and 5A21N Differential Amplifiers. Net weight is 8 oz.

P6060 3.5-FT PROBE, order 010-6060-01 ..... **$35**

P6060 6-FT PROBE, order 010-6060-03 ..... **$35**

P6021 CURRENT PROBE

The P6021 is a 125-turn AC Current Probe which can be used directly with the 5A21N amplifier without a termination or amplifier. Accurate current measurement can be made to the upper frequency range of the 5A21N with the P6021 by simply opening a spring-loaded slide and placing the current path into the probe-head slot.

P6021 PROBE 5-Ft Cable, order 010-0237-02 ..... **$94**

P6021 PROBE 9-ft Cable, order 010-0244-02 ..... **$94**

SCOPE-MOBILE® CART

The model 201-3 cart supports the 5100-Series Oscilloscope in any of nine convenient viewing positions. A storage drawer is provided, as well as a carrier for storing up to three 5-Series plug-in units. Bottom tray dimensions are 15 1/2 by 25 inches.

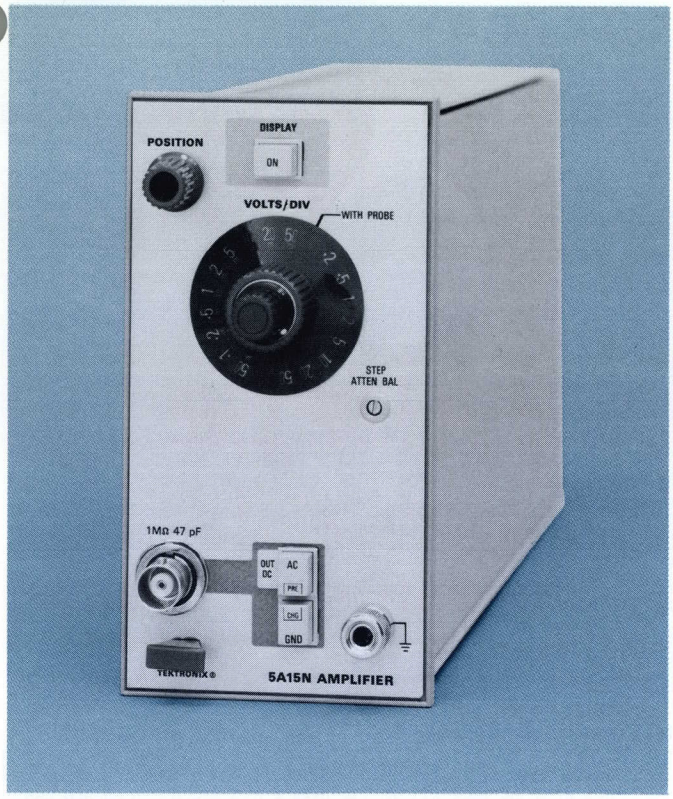
Order 201-3 ..... **$155**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

2 MHz Single Trace Amplifier 5A15N

2 MHz Dual Trace Amplifier 5A18N

NEW



- **1 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**
- **LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT—DIRECT READING FOR 1X AND 10X PROBES**
- **SOLID STATE CIRCUITRY—FET INPUTS**

The 5A15N (single channel) and 5A18N (two identical channels) are amplifiers with solid-state circuits. Both feature simplified front panel controls and are used with the 5103N Mainframe. Two 5A18N Plug-ins are used for four trace capability or dual trace X-Y displays; one 5A18N and another amplifier plug-in can be used for three trace capability. The 5A18N and 5A15N may be used in the 5103N horizontal plug-in compartment for X-Y operation. Bandwidth is at least 2 MHz at all deflection factors.

5A18N operating modes include channel one or two only, channels one and two added, and channel one alternate or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

Scale factor readout for each amplifier is provided by illuminating the knob skirt behind the area which identifies the correct scale factor. When the recommended 10X probe is added, the readout is automatically switched to correct the scale factor readout.

CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 2 MHz at all deflection factors. AC coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C— 1 MΩ within 1% paralleled by approximately 47 pF.

Maximum Input—DC coupled, 350 V (DC + peak AC). AC coupled, 350 VDC.

Channel Isolation (5A18N only)—At least 50 dB with one or both traces displayed.

AMBIENT TEMPERATURE

Performance characteristics are valid for the 5A15N and 5A18N from 0°C to +50°C.

5A15N SINGLE TRACE AMPLIFIER **$115**
Includes instruction manual 070-1136-00.

5A18N DUAL TRACE AMPLIFIER **$265**
Includes instruction manual 070-1137-00.

5A23N SINGLE TRACE AMPLIFIER **$65**
DC to 1 MHz. Deflection factors are 10 mV/div to 10 V/div in decade steps variable between steps to 100 V/div. AC or DC coupled. Input R and C, 1 MΩ within 1% and ≈47 pF. Includes instruction manual 070-1144-00.

5A24N SINGLE TRACE AMPLIFIER **$25**
50 mV/div straight through amplifier with five-way binding post input connector. Includes instruction manual 070-1145-00.

RECOMMENDED PROBES—see page 78.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

5A20N Differential Amplifier
5A21N Differential Amplifier (Current Input)

- **DC-TO-1 MHz BANDWIDTH**
- **50 μV/DIV TO 5 V/DIV CALIBRATED DEFLECTION FACTORS**
- **100,000:1 CMRR**
- **LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT. DIRECT READING FOR 1X AND 10X PROBES**
- **SOLID-STATE STABILITY, FET INPUTS**
- **10-kHz BANDWIDTH LIMITER**
- **VOLTAGE AND CURRENT PROBE INPUTS (5A21N)**

The 5A20N and 5A21N are solid-state, 50 μV/div, DC coupled differential amplifiers for the 5103N Oscilloscope System. The units are identical except that the 5A21N has a current probe input. Each plug-in is compatible with each compartment of the 5103N Mainframe. By inserting a vertical plug-in unit into the horizontal compartment, the user assembles an X-Y oscilloscope. Thus, the oscilloscope can be adapted to solve individual application problems.

Scale factor readout for each amplifier is provided by illuminating the knob skirt behind the area which identifies the correct scale factor. With the recommended 10X probe(s) added, the readout is automatically switched to the correct scale factor. This frees the user from having to mentally calculate the correct scale factor each time a measurement is made with a 10X probe.

5A20N AND 5A21N VOLTAGE CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 2 Hz or less to at least 1 MHz.

Bandwidth Limit—DC coupled, DC to approximately 10 kHz. AC coupled, 2 Hz or less to approximately 10 kHz.

Deflection Factor— 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C—Voltage mode, 1 MΩ within 0.5% paralleled by approximately 47 pF.

Maximum Input Voltage

	DC COUPLED	AC COUPLED
50 μV/div to 50 mV/div	10 V (DC + peak AC)	350 VDC (Coupling cap pre-charged), 10 V peak AC
100 mV/div to 5 V/div	350 V (DC + peak AC)	350 V (DC + peak AC)

Input Gate Current— 100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Displayed Noise— 30 μV or less, tangentially measured.

Common Mode Rejection Ratio—AC coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. DC coupled, at least 100,000:1, DC to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V P-P sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V P-P sinewave. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

5A21N CURRENT PROBE INPUT CHARACTERISTICS (WITH P6021 CURRENT PROBE)

Bandwidth— 15 Hz or less, to at least 1 MHz.

Deflection Factor— 0.5 mA/div to 0.5 A/div in 10 calibrated steps (1-2-5 sequence). Accurate within 3%. Uncalibrated, continuously variable between steps and to 1.25 A/div.

Maximum Input Current— 4 A P-P (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise— 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A20N and 5A21N from 0°C to +50°C.

5A20N DIFFERENTIAL AMPLIFIER **$165**
Includes instruction manual 070-1138-00.

5A21N DIFFERENTIAL AMPLIFIER **$185**
Includes instruction manual 070-1139-00.

P6021 5-Ft Current Probe, order 010-0237-02 ..... $94
P6021 9-Ft Current Probe, order 010-0244-02 ..... $94
VOLTAGE PROBE—see page 78.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

5B10N
Time Base/Amplifier

NEW

- 100 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- TRIGGERING IN EXCESS OF OSCILLOSCOPE BANDWIDTH
- SINGLE SWEEP
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- DIRECT READOUT X10 MAG
- PROVIDES ALTERNATE AND CHOPPED DISPLAYS BETWEEN TWO AMPLIFIERS
- SOLID-STATE STABILITY
- 50 mV/DIV AND 500 mV/DIV CALIBRATED EXTERNAL INPUT

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5103N Oscilloscope System. Sweep rates are 1 μs/div to 5 s/div, extended to 100 ns/div with the X10 magnifier. Circuitry is solid-state and the front panel layout and controls make the 5B10N easy to understand and use. A back lighted skirt inscribed with the sweep rates lets the user instantly read the correct sweep rate even when the magnifier is in use. In the external mode the unit becomes a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Triggering the 5B10N is straightforward even with the many triggering modes which are push button selected. Source positions include left or right plug-in, display (from the mainframe vertical amplifier), line and external. Triggering modes include auto, AC or DC coupled, and single sweep. The 5B10N triggers to frequencies well beyond the oscilloscope bandwidth.

The 5B10N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartments as well.

CHARACTERISTICS

Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div, and within 4% at 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED INT	MIN SIGNAL REQUIRED EXT
AC	50 Hz to 2 MHz	0.4 div	200 mV
DC	DC to 2 MHz	0.4 div	200 mV

Auto Trig—Same as above except signal rate requirements are 15 Hz and above.

Single Sweep—Same as for AC and DC coupled.

External Trigger Input—Maximum input voltage is 350 V (DC + peak AC). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div, accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2% paralleled by ≈70 pF.

Maximum Input Voltage— 350 V (DC + peak AC).

AMBIENT TEMPERATURE

Performance characteristics are valid for the 5B10N from 0°C to +50°C.

5B10N TIME BASE/AMPLIFIER **$175**
Includes instruction manual 070-1140-00.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

5B12N

Dual Time Base

- 100 ns/DIV TO 5 s/DIV CALIBRATED TIME BASE
- DUAL and DELAYED SWEEP
- TRIGGERING IN EXCESS OF OSCILLOSCOPE BANDWIDTH
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- DIRECT READOUT X10 MAG

The 5B12N is a time base for generating single, dual or delayed sweeps in the 5103N Oscilloscope System. The unit features solid-state circuitry, simplified front-panel controls and normal sweep rates from 1 μs/div to 5 s/div; extended to 100 ns/div with the X10 magnifier. The 5B12N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartment as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by push-button switches. Triggering sources for A and B sweep include left and right plug-in, line and display. In the display mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time. The 5B12N triggers to frequencies well beyond the oscilloscope bandwidth.

The display mode push button applies logic levels to the mainframe to select Chop (button pushed in) or Alternate (button out) for time-share switching between vertical plug-ins and amplifier channels.

Scale factor readouts for the time base are provided by illuminating the knob skirt behind the area which identifies the correct scale factor. When the X10 magnifier is used the readout is automatically switched to correct the A sweep scale factor readout.

CHARACTERISTICS

A Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

A Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Magnified, displays accurate within 1% in addition to specified time base sweep accuracy.

B Sweep Rates— 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

B Sweep Accuracy—Within 3% from 0.5 μs/div to 0.1 s/div. Within 4% at 0.5 s/div, 0.2 s/div and 0.2 μs/div.

TRIGGER

The following applies to the A and B trigger except as noted.

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT (A TRIG ONLY)
AC	50 Hz to 2 MHz	0.4 div	200 mV
DC	DC to 2 MHz	0.4 div	200 mV

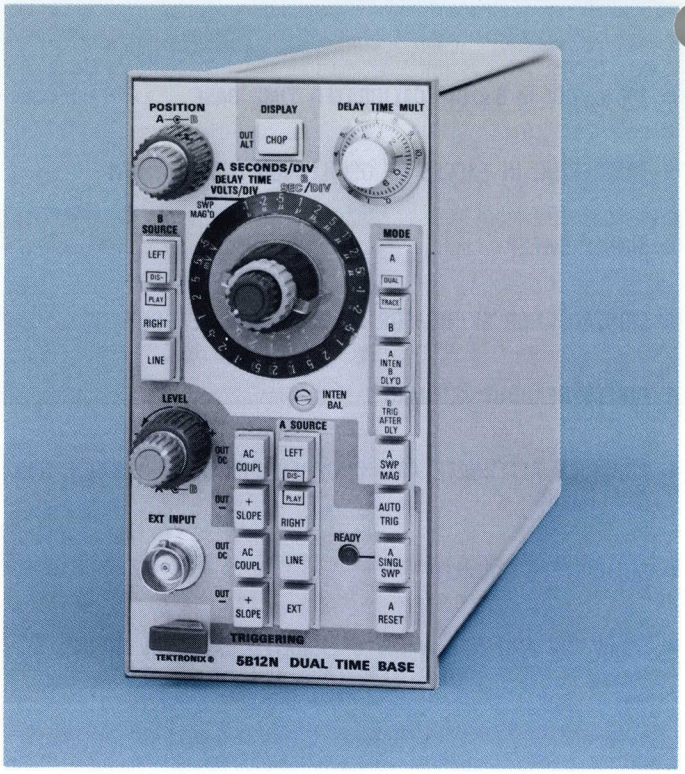
B sweep operates in triggered or free-run mode after delay time.

The following characteristics apply to the A trigger only.

Auto Trig—Same as above on signal rates of 15 Hz and above.

Single Sweep—Same as for AC and DC coupled.

External Trigger Input—Maximum input voltage is 350 V (DC + peak AC). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.



DELAYING SWEEP CHARACTERISTICS

Delay Time Accuracy— 1 μs/div to 5 s/div, within 1%. 1 s/div to 5 s/div, within 2%.

Delay Time Multiplier Range— 0 to 10 times the Time/Div setting.

Delay Time Multiplier Incremental Linearity—Within 0.2%.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5 s delay times.

Jitter— 1 part or less in 20,000 of 10X the Time/Div setting.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2% paralleled by ≈70 pF.

Maximum Input Voltage— 350 V (DC + peak AC).

AMBIENT TEMPERATURE

Characteristics are valid for the 5B12N from 0°C to +50°C.

5B12N DUAL TIME BASE **$550**
Includes instruction manual 070-1141-00.

5B13N TIME BASE **$85**
A basic time base unit with sweep ranges from 5 μs/div to 0.5 s/div in decade steps, variable between steps to 5 s/div. Includes instruction manual 070-1146-00.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

OSCILLOSCOPES		
PRODUCT	**PAGE**	**DESCRIPTION**
561B	84	Plug-in oscilloscope
564B	86	Plug-in oscilloscope with storage
564B MOD 121N	86	Plug-in oscilloscope with storage and auto-erase
565	89	Dual-beam oscilloscope with built-in time bases
POWER SUPPLIES		
129	124	Powers up to four plug-in units
285	118	Powers one S-Series head

PLUG-IN UNITS

PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R
SINGLE TRACE				
2A60	92	50 mV/div	DC to 1 MHz	0.35 μs
3A75	92	50 mV/div	DC to 4 MHz	90 ns
MULTIPLE TRACE				
3A3 Dual-Trace	94	100 μV/div	DC to 500 kHz	0.7 μs
3A6 Dual-Trace	96	10 mV/div	DC to 10 MHz	35 ns
3A72 Dual-Trace	98	10 mV/div	DC to 650 kHz	0.54 μs
3A74 Four-Trace	99	20 mV/div	DC to 2 MHz	0.18 μs
DIFFERENTIAL				
2A63	93	1 mV/div	DC to 300 kHz	1.2 μs
3A3	94	100 μV/div	DC to 500 kHz	0.7 μs
3A7 Comparator	97	1 mV/div	DC to 10 MHz	35 ns
3A9	101	10 μV/div	DC to 1 MHz	350 ns
SPECTRUM ANALYZER				
3L5	208	10 μV/div	10 Hz to 1 MHz	

PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R
SPECIAL PURPOSE				
3A8 Operational	100	20 mV/div	DC to 3.5 MHz	100 ns
3A10 Transducer	103	10 μV/div	DC to 1 MHz	350 ns
3C66 Carrier Amp	105	10 μstrain /div	DC to 5 kHz	70 μs
2B67 Mod 730A 3A74 Mod 730A	297	Engine Analyzer Plug-ins		

TIME-BASE UNITS

PLUG-IN UNIT	PAGE	FASTEST TIME-BASE RATE	MAGNIFIER	FEATURES
2B67	106	1 μs/div	X5	single sweep
3B3	107	0.5 μs/div	X5	calib delayed sweep; single sweep
3B4	108	0.2 μs/div	X1 to X50	single sweep

SAMPLING

3S1 Dual Trace	109	2 mV/div	DC to 1 GHz	350 ps
3S2 Dual Trace	110	2 mV/div	Used with S-Series Heads	
3S5 Programmable	111	2 mV/div	Used with S-Series Heads	
SAMPLING HEADS				
S-1	112	50 Ω	DC to 1 GHz	350 ps
S-2	112	50 Ω	DC to 4.5 GHz	75 ps
S-3A	113	100 kΩ	DC to 1 GHz	350 ps
S-4	113	50 Ω	DC to 14 GHz	25 ps
S-5	114	1 MΩ	DC to 350 MHz	1 ns
S-6	115	50 Ω	DC to 11.5 GHz	30 ps
S-50	116	25-ps Pulse Generator Head		
S-51	116	1-to-18 GHz Trigger Countdown Head		
S-52	117	25-ps Pulse Generator Head		
S-53	117	DC-to-1 GHz Trigger Recognizer Head		
S-54	118	1-ns Pulse Generator Head		

3T2	121	0.2 ns/div	X10	random sampling
3T5 Programmable	122	0.1 ns/div		calib digital sweep delay
3T77A	123	0.2 ns/div	X10	single sweep manual scan sweep delay
TDR SYSTEM				
3S7	119	5 mV/div	140-ps risetime	
3T7	119	100 ps/div	4920 ft direct-reading	

The 560 Series offers 28 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical and horizontal deflection systems (565), a bistable storage oscilloscope with auto-erase (564B MOD 121N) and without auto-erase (564B), and a conventional oscilloscope (561B). The dual plug-in unit feature of the 564B and 561B allows conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling displays, as well as spectrum analysis and raster generation are also available.

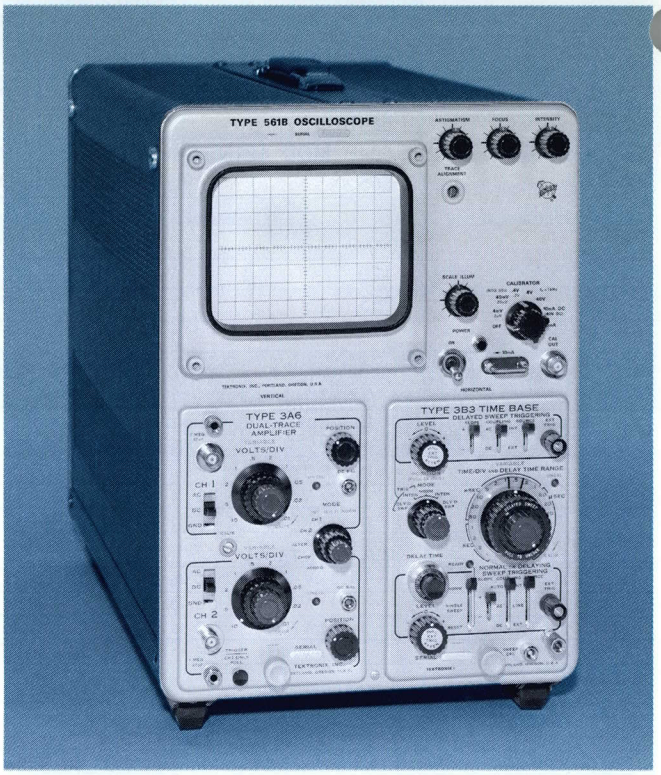
With the 565 the horizontal amplifiers are built-in and can be driven by either of its two built-in sweep generators. The vertical amplifiers can be of any 2-Series or 3-Series plug-in units except spectrum analyzer and sampling units.

The 568 is described in the Automated Measurement Systems Section, but can be used with any of the 560-Series plug-ins when digital readout is not required. The 3A2, 3B2, 3S6, and 3T6 Programmable Plug-Ins are described in the Systems Section.

561B

10-MHz Oscilloscope

- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING TRANSDUCER AND SPECTRUM ANALYZER PLUG-IN UNITS***
- ***8 x 10-cm DISPLAY***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***X-Y DISPLAYS***
- ***SOLID-STATE MAINFRAME***



The Tektronix Type 561B and Type R561B Oscilloscopes have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. Amplifier plug-ins offer a wide range of measurement capabilities with 10-MHz dual-trace plug-ins, 10 μV/div differential plug-ins, 25-ps sampling plug-ins and spectrum analyzer plug-ins covering the spectrum from 10 Hz to 36 MHz. Time-base plug-ins include delayed sweep, X50 magnifier, single time bases and sampling time bases. Two amplifier plug-ins may be used for X-Y or multiple X-Y displays. An automatic-seeking amplifier and time base are also available.

Both the Type 561B and the Type R561B use a cathode-ray tube that features an 8 by 10-cm internal graticule with controllable illumination. You can take photographs with the same ease, but without the parallax of an external graticule.

Occupying only 7 inches of rack height, the Type R561B bolts directly to the rack, but may be ordered with optional slide-out tracks at additional cost.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units including:

Dual trace—DC to 10 MHz, 35 ns.

Differential—DC to 1 MHz, 10 μV/div.

Sampling—DC to 14 GHz, 25 ps.

Spectrum Analyzer—10 Hz to 36 MHz.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier and Time-Base Units.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3.5 kV.

PHOSPHOR—P31.

OTHER

CALIBRATOR—4 mV to 40 V ($\pm$1.5%), 1 kHz ($\pm$1%) squarewave and 40 V DC. Into 50.0 Ω, 2 mV, 20 mV and 200 mV squarewave. Current loop of 10 mA DC and 10 mA squarewave ($\pm$1.5%).

POWER REQUIREMENTS—90 V to 136 V or 180 V to 272 V, 48 Hz to 440 Hz (561B), 48 Hz to 66 Hz (R561B).

561B
10-MHz Oscilloscope

TYPE 561B CHARACTERISTICS

PLUG-IN COMPARTMENTS
Accepts all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6 Plug-Ins.

TEKTRONIX CRT
Flat-faced rectangular 5-inch tube with 3.5-kV monoaccelerator and beam deflection unblanking. The edge lighted graticule is marked in 8 vertical and 10 horizontal cm divisions. The centerlines are marked every 2 mm. Illumination is controlled by a front-panel knob. A P31 phosphor is normally supplied; P2, P7 or P11 are optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability.

DISPLAY CONTROLS
Front-panel controls include Focus, Astigmatism, Intensity and Scale Illumination (of the 8-cm by 10-cm display area), in addition to a screwdriver adjustment for Trace Alignment.

Z-AXIS INPUT
A BNC connector at the rear of the instrument permits external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR
Front-panel selection of calibration signals. Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2 mV, 20 mV or 200 mV ground-to-peak squarewave into 50.0 Ω. Current—Current loop of 10 mA DC or 10 mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C.

Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS
Ambient Temperature

Operating: 0°C to +50°C
Non-operating: —40°C to +65°C

Altitude

Operating: to 15,000 feet; maximum allowable ambient temperature decreased 1°C/1,000 feet from 5,000 to 15,000 feet.
Non-operating: to 50,000 feet.

DC-VOLTAGE SUPPLIES
All voltages required for proper operation of the oscilloscope and the plug-in units are regulated. Supplies operate normally with or without plug-ins.

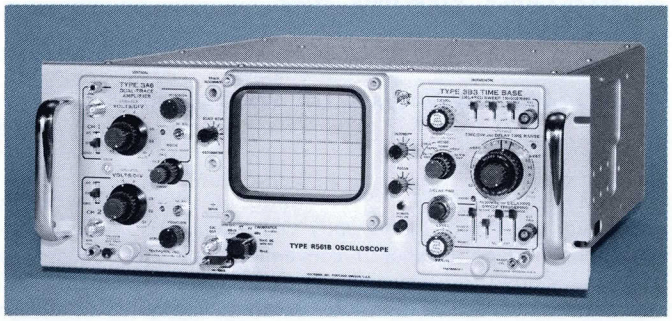
POWER REQUIREMENTS
Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 561B will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 178 watts at 115 VAC, 60 Hz. The Type R561B will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 186 watts at 115 VAC, 60 Hz.

TYPE 561B DIMENSIONS AND WEIGHTS

Height	14¾ in	37.5 cm
Width	9¾ in	24.8 cm
Depth	21½ in	54.7 cm
Net weight	32 lb	14.6 kg
Domestic shipping weight	≈41 lb	≈18.6 kg
Export-packed weight	≈53 lb	≈24 kg

INCLUDED STANDARD ACCESSORIES FOR TYPE 561B
BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); instruction manual (070-0802-00).

TYPE 561B OSCILLOSCOPE, without plug-in units . . **$595**



TYPE R561B DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	20½ in	52.1 cm
Net weight	31¼ lb	14.2 kg
Domestic shipping weight	≈56 lb	≈25.4 kg
Export-packed weight	≈76 lb	≈34.4 kg

INCLUDED STANDARD ACCESSORIES FOR TYPE R561B
Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); instruction manual (070-0803-00).

TYPE R561B OSCILLOSCOPE, without plug-in units . . **$645**

TYPE R561B WITH SLIDE-OUT TRACKS

Type R561B MOD 171A mounts to a standard 19-inch rack on slide-out tracks. It can be pulled out, tilted and locked in any one of 7 positions for convenient servicing. The instrument has the same standard accessories as the Type R561B, but also includes one pair of mounting tracks (351-0084-00).

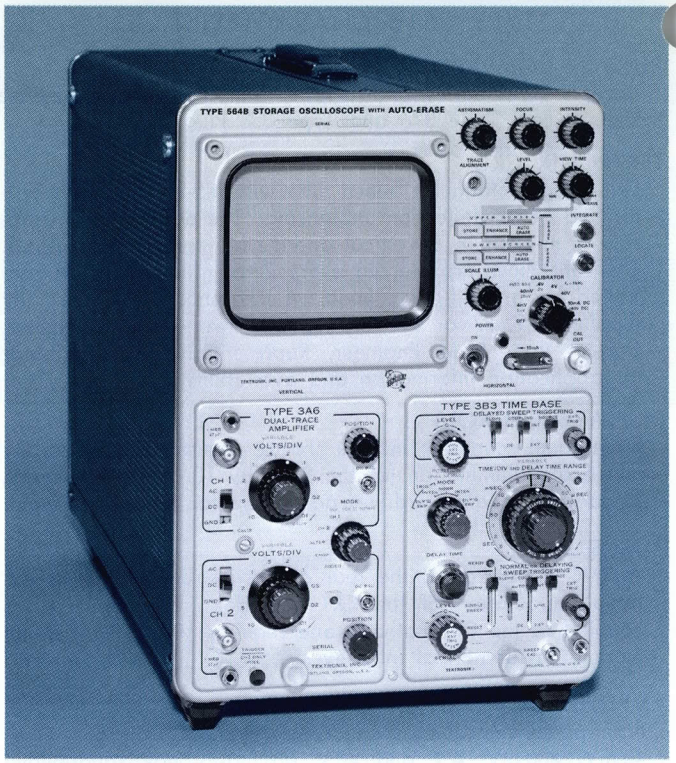
TYPE R561B MOD 171A OSCILLOSCOPE, without plug-in units **$695**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

564B MOD 121N

Auto-Erase Storage Oscilloscope

- ***DC-to-10 MHz BANDWIDTH***
- ***BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS***
- ***UP TO 500 cm/ms WRITING SPEED***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, TRANSDUCER, AND SPECTRUM ANALYZER PLUG-IN UNITS***
- ***REMOTE ERASE***
- ***X-Y DISPLAYS***
- ***SELECTABLE VIEWING TIME 1 s to 12 s***
- ***STORAGE VIEW TIME UP TO 1 HOUR***



The Type 564B MOD 121N Storage Oscilloscope, and its rackmount counterpart, is virtually two instruments in one, offering all the advantages of a conventional plug-in oscilloscope plus the added advantages of a split-screen, storage CRT and the convenience of a variable viewing-time system. Through front panel controls this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied from 1 s to 12 s in the auto-erase mode. A complete selection of plug-ins permits changing the oscilloscope's performance to meet changing measurement needs.

With the split-screen storage feature, either half of the 8 x 10-cm display can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. The contrast ratio and brightness of the stored displays are constant and independent of viewing time, writing and sweep rates, or signal repetition rates.

The Type 564B MOD 121N and R564B MOD 121N have dual plug-in flexibility with vertical and horizontal plug-in units. Amplifier plug-ins offer a wide range of measurement capabilities with 10-MHz multi-trace, 10 μV differential, 25-ps sampling and spectrum analyzer plug-ins. Time-base plug-ins include delayed sweep, X50 magnifier, single time bases and sampling time bases. Amplifier plug-ins may be placed in the horizontal position for X-Y or multiple X-Y displays, and automatic seeking plug-ins are available.

Occupying only 7 inches of rack height, the Type R564B MOD 121N bolts directly to the rack, but may be ordered with optional slide-out tracks at additional cost.

The Type 564B MOD 121N and R564B MOD 121N offer reliable operation with low-heat dissipation through the use of solid-state components.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units.
Dual Trace—DC to 10 MHz, 35 ns.
Differential—DC to 1 MHz, 10 μV/div.
Sampling—DC to 14 GHz, 25 ps.
Spectrum Analyzer—10 Hz to 36 MHz.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through the use of versatile 2-Series and 3-Series Amplifier and Time-Base Units.

STORAGE CRT

DISPLAY AREA—8 x 10 cm.
ACCELERATING VOLTAGE—3.5 kV.
SPLIT-SCREEN STORAGE—Store on either upper or lower half of screen with non-storage on other half; store on entire screen; or non-store on entire screen.
VIEWING TIMES—Up to one hour.
ERASE TIME—Approximately 0.25 second.
WRITING SPEED—Up to 500 cm/ms.
PHOSPHOR—Similar to P1.

OTHER

CALIBRATOR—4 mV to 40 V (±1.5%), 1 kHz (±1%) squarewave and 40 V DC. Into 50.0 Ω, 2 mV, 20 mV and 200 mV squarewave. Current loop of 10 mA DC and 10 mA squarewave (±1.5%).
LINE VOLTAGE REQUIREMENTS—90 V to 136 V or 180 V to 272 V, 48 Hz to 440 Hz (564B), 48 Hz to 66 Hz (R564B).

564B MOD 121N

Auto-Erase Storage Oscilloscope

TEKTRONIX STORAGE CRTS

The CRT is a Tektronix bistable storage tube with beam-deflection blanking and an accelerating voltage of 3.5 kV. It has an 8 x 10-cm storage target divided into two 4 x 10-cm areas, individually controllable for storage and erasure.

There are two storage tubes available for use in the Type 564B Oscilloscopes. Both tubes exhibit characteristics of a conventional CRT when used in the non-stored mode. The standard tube, the T5641-200, has the brighter stored display. The other tube, the T5641-201, has the faster writing speed.

By selecting the proper tube, you can obtain optimum oscilloscope performance for your particular application. Such selection is important because each tube has a different writing speed and brightness for stored-mode operation. The brightness of a stored display for an individual tube is one value regardless of the intensity of the beam that generated it.

WRITING SPEED

Initially, at least 25 cm/ms for the standard CRT T5641-200; at least 100 cm/ms for the MOD 08 CRT T5641-201.

STORAGE CHARACTERISTICS

VIEWING TIME

Displays can be stored and viewed up to 1 hour.

ERASURE TIME

Approx 0.25 second.

STORED WRITING-SPEED ENHANCEMENT

This feature controls the single-sweep storage capabilities of the storage CRT. Through adjustment of the front-panel Level control, single-trace spot velocities up to 250 cm/ms using the standard CRT; up to 500 cm/ms using the fast CRT (MOD 08) can be stored with minimal loss of resolution and contrast in the center 7 x 9 cm.

SINGLE-SHOT SIGNALS

At slow or medium speeds, single-shot signals are easily stored for extended viewing time (within writing-speed capabilities of CRT selected).

INTEGRATE MODE

Increases the effective writing speed for repetitive fast signals with repetition rates that are too low for effective storage, but which may be too fast for satisfactory single-shot storage with enhancement.

REMOTE CONTROL OPERATION

A rear-panel connector permits erasing of upper and/or lower half of split screen from a remote location and permits remote operation of the Save Mode.
Erasure can be initiated in either of two ways:

1. Pulse initiated—Requires a negative pulse of 5 V to 100 V. Rate of change at least 0.1 V/μs.

2. Impedance change initiated—Requires a change from at least 1 MΩ to 50 kΩ or less in 10 μs or less.

AUTO ERASE (MOD 121N only)

In the Auto Erase Mode there is a continuous sequence of storing, viewing time and erasure of either upper screen, lower screen or entire screen. A rear-panel switch provides two modes of operation, either Signal Triggered Sweep or Erase Triggered Sweep.

In the Signal Triggered Sweep Mode, the input Signal initiates a sweep and the viewing time begins as the sweep ends. At the end of the variable viewing time, the selected portion of the screen is automatically erased and the cathode-ray tube is unblanked after the next sweep retrace. This cycle will automatically repeat itself as long as an input signal triggers the sweep.

The Erase Triggered Sweep Mode is primarily useful with sweep rates of 0.1 s/div and slower. In this mode of operation, the CRT is not blanked during the variable viewing time. The sweep unit can be triggered either by the input signal or by the erase pulse output located on the rear of the oscilloscope.

VARIABLE VIEWING TIME. (MOD 121N only)

1 s to at least 12 s. SAVE position disables automatic erasure.

OTHER CHARACTERISTICS

PLUG-IN COMPARTMENTS

The instrument accepts 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6.

LOCATE BUTTON

This button, when depressed, causes a spot or spots to appear at the left of the CRT screen at the vertical position of the next sweep.

EXTERNAL GRATICULE

The graticule is edge lighted and is marked in 8 vertical and 10 horizontal cm divisions. The centerline is marked every 2 mm. Illumination is controlled by a front-panel knob.

Z-AXIS INPUT

Accessible through a BNC connector at the rear of the instrument permitting external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals.

Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2-mV, 20-mV or 200-mV ground-to-peak squarewave into 50.0 Ω.

Current—Current loop of 10 mA DC or 10-mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C. Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

564B MOD 121N

Auto-Erase Storage Oscilloscope

AMBIENT OPERATING TEMPERATURE
0°C to +50°C

OPERATING ALTITUDE
To 15,000 feet

ELECTRONICALLY REGULATED SUPPLIES
Regulated power supplies furnish all voltages required for proper operation of the Indicator and the plug-in units.

POWER REQUIREMENTS
Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 564B MOD 121N will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 196 watts at 115 VAC, 60 Hz. The Type R564B MOD 121N will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 204 watts at 115 VAC, 60 Hz.

DIMENSIONS AND WEIGHTS

	564B		R564B	
	in	cm	in	cm
Height	14¾	37.5	7	17.9
Width	9¾	24.9	19	48.4
Depth	21½	54.7	20½	52.2
	lb	kg	lb	kg
Net weight	36	16.3	37	16.7
Domestic shipping weight	≈45	≈20.4	≈58	≈26.3
Export-packed weight	≈55	≈25	≈80	≈36.3

STANDARD ACCESSORIES FOR TYPE 564B MOD 121N
BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00); instruction manual (070-0806-00).

TYPE 564B MOD 121N OSCILLOSCOPE,
without plug-in units **$1250**
(with CRT for brightest stored display).

TYPE 564B

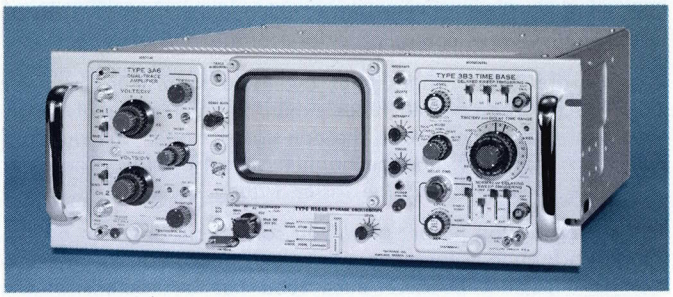
The auto erase and variable viewing time features of the Type 564B MOD 121N are deleted in the Type 564B and Type R564B. A cost savings is thus realized. All other storage characteristics, electrical characteristics and mechanical characteristics remain the same.

INCLUDED STANDARD ACCESSORIES FOR TYPE 564B
BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); instruction manual (070-0804-00).

TYPE 564B OSCILLOSCOPE, without plug-in units **$1095**
(with CRT for brightest stored display).

TYPE R564B

The Type R564B is a rackmount version of the 564B that is also available with or without auto-erase (MOD 121N).



STANDARD ACCESSORIES FOR TYPE R564B MOD 121N
Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00); instruction manual (070-0807-00).

TYPE R564B MOD 121N OSCILLOSCOPE,
without plug-in units **$1300**
(with CRT for brightest stored display).

INCLUDED STANDARD ACCESSORIES FOR TYPE R564B
Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00); instruction manual (070-0805-00).

TYPE R564B OSCILLOSCOPE, without plug-in units .. **$1145**
(with CRT for brightest stored display).

OPTIONAL MODIFICATIONS

FAST CRT
Type 564B, 564B MOD 121N or rackmounts with CRT for fastest stored writing speed. Order MOD 08, no extra charge.

SLIDE-OUT TRACKS
Types R564B or R564B MOD 121N can be mounted in a standard 19-inch rack on slide-out tracks. They can then be pulled out, tilted, and locked in any one of seven positions for convenient servicing. Order MOD 171A ..... ADD $50

OPTIONAL ACCESSORIES

SLIDE-OUT ASSEMBLY
Converts standard Type R564B or R561B for easy withdrawal and tilt of instrument. Order 351-0050-00 ..... $50

CRADLE ASSEMBLY
Provides rear slide support when R564B or R561B with slide-out tracks is mounted in a backless rack. Order 040-0344-00 $10

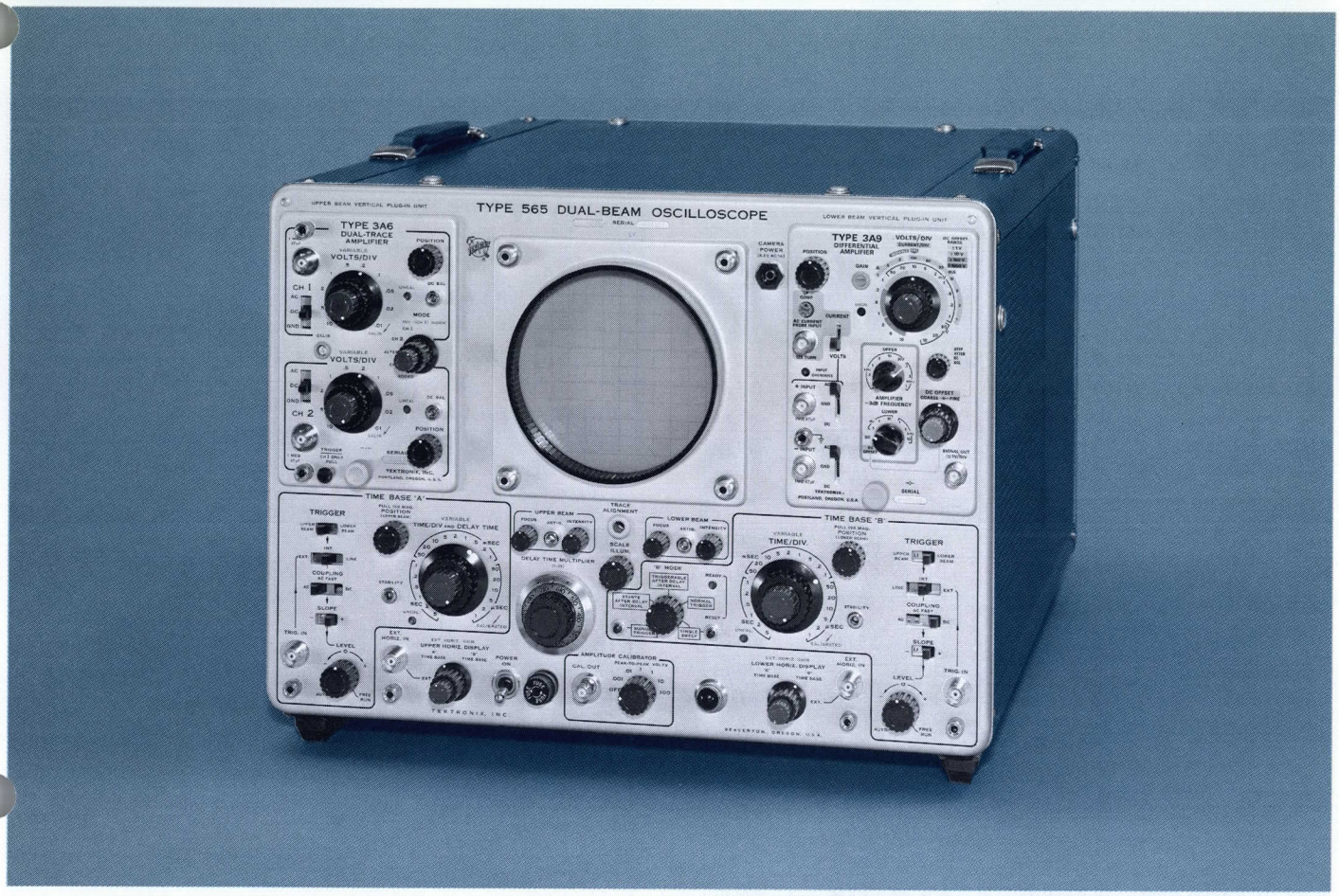
REMOTE-ERASE CONNECTOR
Mates with 9-pin connector on the rear panel of Type 564B or R564B. Supplied without cable. Order 134-0049-00 ..... $6

Refer to accessories pages for probes, cameras, and Scope-Mobile® Carts.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

565

10-MHz Dual-Beam Oscilloscope



- ***TWO VERTICAL AND HORIZONTAL SYSTEMS***
- ***8 x 10-cm DISPLAY PER BEAM***
- ***CALIBRATED DELAYED SWEEP***

A Type 565, or rackmount counterpart Type RM565, is essentially two single-beam oscilloscopes sharing a common cathode-ray tube and power supply. Each beam has separate vertical and horizontal deflection systems, focus, and intensity controls.

The vertical amplifiers can be any of 2-Series or 3-Series Plug-In Units, except Spectrum Analyzer and Sampling Units. The horizontal amplifiers are built-in and can be driven by either of two sweep systems, simultaneously or independently, or from their external inputs. Front-panel controls permit using "A" sweep as a delaying sweep and "B" as the delayed sweep. In this mode of operation the upper beam is intensified for the duration of the "B" sweep. "B" sweep may also be used for single-sweep operation.

There are rear-panel outputs of vertical signals, horizontal signals, + gate, delayed trigger, and auxiliary power.

CHARACTERISTIC SUMMARY

VERTICAL

2 identical vertical-deflection systems

Vertical-deflection characteristics are extremely flexible through use of 2-Series and 3-Series Plug-In Units (see chart).

HORIZONTAL

2 independent horizontal-deflection systems

CALIBRATED TIME BASE—1 μs/div to 5 s/div.

10X MAGNIFIER—Extends time base to 0.1 μs/div.

CALIBRATED SWEEP DELAY—5 μs to 50 s.

EXTERNAL INPUT—Approx 100 mV/div to 30 V/div.

CRT

DISPLAY AREA—10 x 10 cm (each beam scans 8 cm vertical, overlap of the two beams is 6 cm). Major graticule division equals 1 cm, minor division equals 2 mm. Illuminated no-parallax graticule.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P2

OTHER

AMPLITUDE CALIBRATOR—1 mV to 100 V, 1-kHz squarewave.

REAR-PANEL SIGNAL OUTPUTS—Output impedance approx 500 ohms; max load 2 mA.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 600 watts.

VERTICAL DEFLECTION

2 identical systems

Characteristics of the two vertical systems depend upon the 2-Series or 3-Series Amplifier Units used. Please refer to the plug-in chart for more information on these vertical amplifier units. (The 565 does not use Sampling or Spectrum Analyzer Plug-In Units.)

VERTICAL PLUG-IN UNITS*			
PLUG-IN UNIT	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R
MULTIPLE TRACE			
3A3 Dual-Trace	100 μV/div	DC to 500 kHz	0.7 μs
3A6 Dual-Trace	10 mV/div	DC to 10 MHz	35 ns
3A72 Dual-Trace	10 mV/div	DC to 650 kHz	0.54 μs
3A74 Four-Trace	20 mV/div	DC to 2 MHz	0.18 μs
SINGLE TRACE			
2A60	50 mV/div	DC to 1 MHz	0.35 μs
3A75	50 mV/div	DC to 4 MHz	90 ns
SPECIAL PURPOSE			
3A8 Operational Amp	20 mV/div	DC to 3.5 MHz	100 ns
3C66 Carrier Amp	10 μstrain/div	DC to 5 kHz	70 μs
3A10 Transducer Amp	10 μV/div	DC to 1 MHz	350 ns
DIFFERENTIAL			
2A63	1 mV/div	DC to 300 kHz	1.2 μs
3A3	100 μV/div	DC to 500 kHz	0.7 μs
3A7 Comparator	1 mV/div	DC to 10 MHz	35 ns
3A9	10 μV/div	DC to 1 MHz	350 ns
3A10 Transducer Amp	10 μV/div	DC to 1 MHz	350 ns

*2- and 3-Series Time Base Plug-Ins can be used for raster generation.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B

1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable and to approx 12 s/div. A warning light indicates when the variable control is in the uncalibrated position. Either time base can be operated independently, or Time Base B can be delayed by Time Base A. In delayed-sweep operation, Time Base A display is intensified for the duration of the "B" sweep.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 0.1 μs/div. Magnified time base accurate within 5%.

OPERATING MODES

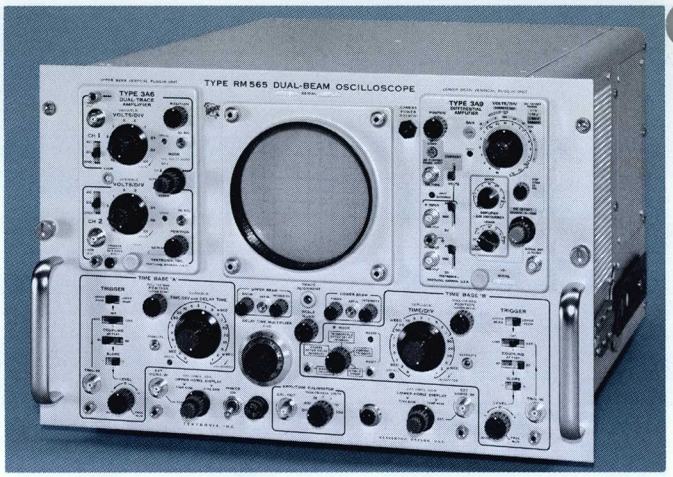
Time Base A—Normal Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY-TIME MULTIPLIER. DELAY TIME control selects 10 μs to 5 s delay time in a 1-2-5 sequence, accurate to within 3% (5, 2, and 1 μs delay time, accuracies not specified). DELAY-TIME MULTIPLIER accurate within 0.5% of full scale. Provides continuously calibrated time intervals from 0.50 to 10.00 times the DELAY TIME. Dial is divided into 1000 parts.



DIFFERENTIAL TIME-MEASUREMENT ACCURACY

Within 3% and 10 minor divisions. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

5 μs to 50 s after start of delaying sweep. Inherent delay to start of delayed sweep is 1.5 μs or less.

EXTERNAL INPUT

Upper and Lower Horizontal Display Switches select Time Base A, Time Base B, or Ext. In the External position, the gain is continuously variable from approx 100 mV/div to 30 V/div, DC to 350 kHz. Maximum input voltage is 300-V RMS. Input RC is approx 100 kilohms paralleled by 30-55 pF depending on gain setting.

TRIGGER

2 identical systems

MODES

Manual, Automatic, Free-run. In Automatic mode, sweep free-runs at approx 50 Hz in the absence of a triggering signal.

COUPLING

AC, AC Fast, DC.

SOURCES

Internal from Upper Beam or Lower Beam, External, or Line.

REQUIREMENTS

0.2 divisions of deflection internal or 0.5 V external up to 50 kHz, increasing to 1 div or 1 V at 2 MHz.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 10 x 10-cm display area; 8 x 10 cm per beam with 6-cm overlap. Tube is aluminized with illuminated, internal, no-parallax graticule. Accelerating potential is 4 kV. P2 phosphor is normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, intensity contrast between A sweep and non-intensified B-zone of A sweep (internal screwdriver adjustment), trace rotation.

Z-AXIS MODULATION

AC-coupled to both CRT grids via rear panel input connectors. Time constant is 3.5 ms nominally, CRT modulation requires approx 10 V at normal intensity.

565
10-MHz Dual-Beam Oscilloscope

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

1-kHz squarewave output, calibrated in 6 steps from 1 mV to 100 V. Accurate within 3%.

REAR-PANEL OUTPUTS

VERTICAL SIGNAL OUT (both upper and lower)—Signal amplitude, DC level, and transient response depend on the vertical plug-in unit used. Typical signal amplitude: 2 V/div to 4 V/div of display; DC level ±20 V. Output impedance: approx 500 ohms; maximum load current 2 mA.

HORIZONTAL OUTPUTS (both upper and lower)—Signal amplitude, at least 50 mV/div of display in External position and 0.5 V/div of display in Sweep position. DC level 0 to +5 volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

A AND B +GATES—Pulse height 20 V minimum; DC level zero volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

DELAYED TRIGGER—Fast-rise pulse amplitude +8 V minimum; DC level zero volts. Output impedance: approx 50 ohms; maximum load current 2 mA.

POWER REQUIREMENTS

600 watts maximum, 50 to 60 Hz. Instrument factory wired for 105-V to 125-V (117 V nominal) operation, or 210 V to 250 V (234 V nominal) upon request. Transformer taps permit operation at nominal voltages ranging from 99 V to 132 V or 198 V to 265 V.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	13¾ in	34.9 cm
Width	16⅞ in	42.8 cm
Depth	23⁹⁄₁₆ in	59.8 cm
Net weight	67 lb	30.5 kg
Domestic shipping weight	≈95 lb	≈43.2 kg
Export-packed weight	≈117 lb	≈53.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	12¼ in	31.1 cm
Width	19 in	48.3 cm
Rack depth	22³⁄₁₆ in	56.4 cm
Net weight	80 lb	36.3 kg
Domestic shipping weight	≈104 lb	≈47.3 kg
Export-packed weight	≈124 lb	≈56.4 kg

RACKMOUNTING

Type RM565 mounts on tilting slide-out tracks to standard 19-inch rack. Additional mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

3-conductor power cord (161-0010-03); smoke-gray light filter (installed) (378-0567-00); clear CRT protection plate (387-0918-00); two patch cords, BNC-to-BNC 18-inch (012-0087-00); post jack, BNC (012-0092-00); instruction manual (070-0269-00). Type RM565 also includes slide-out assembly (351-0086-00); power cord (161-0024-03); instruction manual (070-0353-00).

TYPE 565 OSCILLOSCOPE without plug-in units . **$1675**

TYPE RM565 OSCILLOSCOPE without plug-in units . **$1775**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The probes recommended for use with these instruments are covered on the 2- and 3-Series Plug-In Unit pages. Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERAS

C-27-547: f/1.9—1:0.7 lens, Polaroid Land[1] Pack-Film back provides 10 x 10-cm coverage on 3¼ x 4½ film, order C-27-547 ..... $480

C-27N: f/1.9—1:0.85 lens, no back, provides 10 x 10-cm coverage on 4 x 5 film with optional Graflok[2] back and Polaroid Land film holder, order C-27N $375

Graflok back for 4 x 5 film holder (not included), order 122-0604-00 ..... $50

Type 565, RM565 to C-27-547 or C-27N Camera adapter, order 016-0225-02 ..... $16

SCOPE-MOBILE® CART

Model 205-3: holds 4 plug-in units, has 9-position tilt-lock oscilloscope tray, order 205-3 ..... $160

CRADLE ASSEMBLY

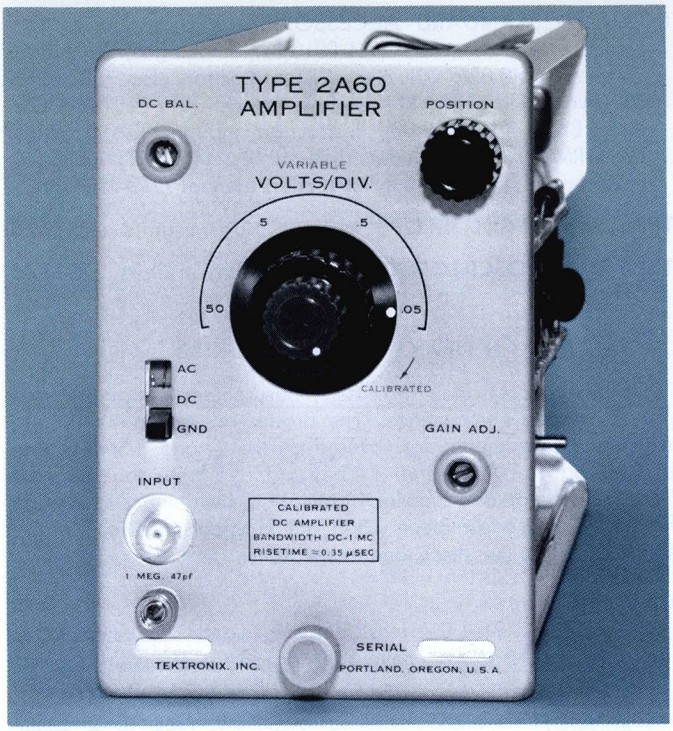
Provides rear slide support when RM565 is mounted in backless rack, order 040-0346-00 ..... $10

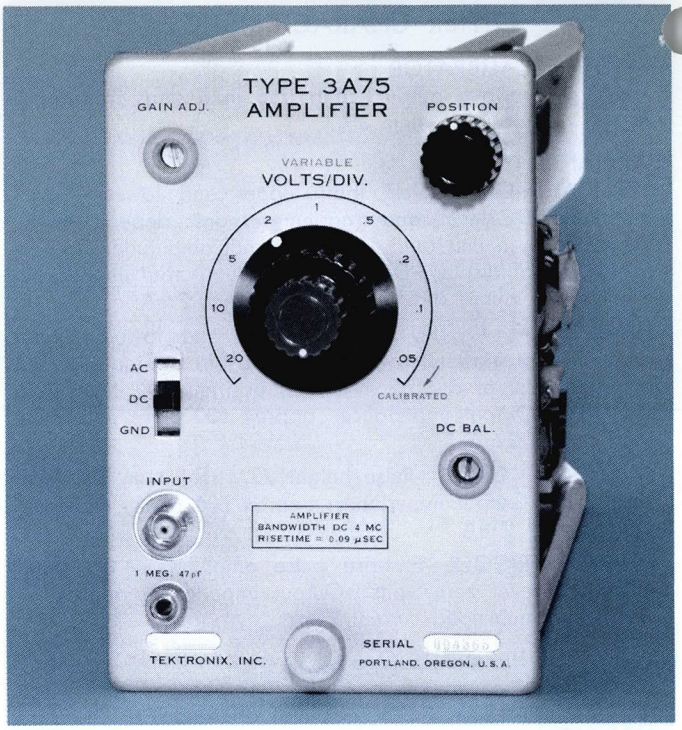
[1]Registered Trademark Polaroid Corporation.

[2]Registered Trademark Graflex Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

2A60 1-MHz Single-Trace Amplifier
3A75 4-MHz Single-Trace Amplifier





- ***50 mV/DIV to 50 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***LOW COST***

The Type 2A60 and Type 3A75 are general purpose plug-in units for use in the Type 561B, 564B or 565 Oscilloscope. They can also be used in the Type 568 Oscilloscope when digital readout is not required. Used in the Type 129 Power Supply, they can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

2A60 CHARACTERISTICS

BANDWIDTH
DC to 1 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
0.35 μs.

DEFLECTION FACTOR
0.05 V/div, 0.5 V/div, 5 V/div and 50 V/div. Calibrated accuracy within 3%. Uncalibrated, continuously variable between steps and to approx 500 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈10 lb	≈4.5 kg

TYPE 2A60 AMPLIFIER **$140**
Includes instruction manual (070-0263-00)

3A75 CHARACTERISTICS

BANDWIDTH
DC to 4 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 90 ns.

DEFLECTION FACTOR
50 mV/div to 20 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

WEIGHTS

Net weight	4 lb	1.8 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈12 lb	≈5.4 kg

TYPE 3A75 AMPLIFIER **$215**
Includes instruction manual (070-0275-00)

OPTIONAL ACCESSORIES

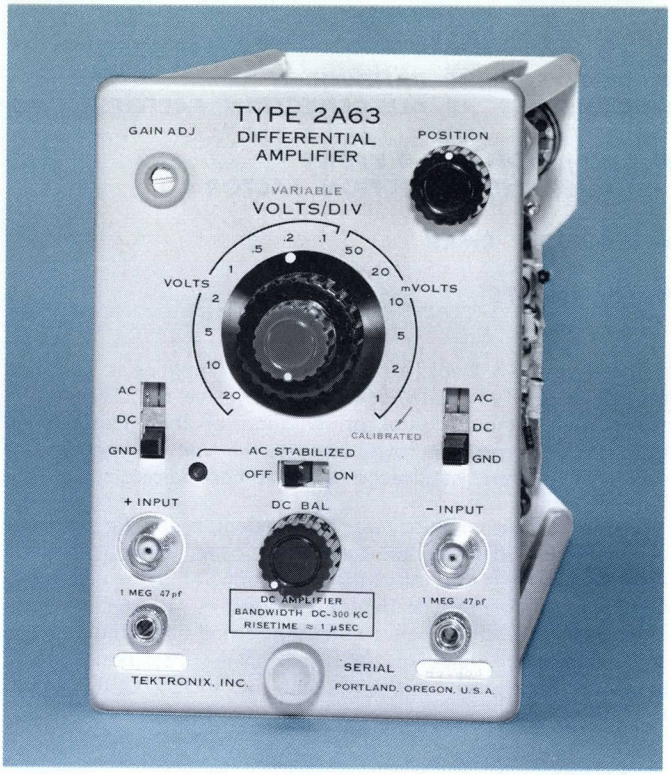
The probes recommended for use with these instruments satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

2A63
Differential Amplifier

- ***DC-to-300 kHz BANDWIDTH***
- ***1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***250:1 CMRR***



The Type 2A63 is a differential amplifier plug-in unit. It can be used to make voltage measurements between two above-ground points while at the same time cancelling in-phase signals such as hum pickup in the connecting leads.

The Type 2A63 may be used in the Type 561B, 564B or 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. Used with the Type 129 Power Supply, the Type 2A63 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

BANDWIDTH
DC to 300 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
1.2 μs or less.

DEFLECTION FACTOR
1 mV/div to 20 V/div in 14 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

DIFFERENTIAL INPUT

DEFLECTION FACTOR	CMRR*	
	1 kHz	50 kHz
1 mV/cm to 50 mV/cm	250:1	150:1
0.1 V/cm to 20 V/cm	25:1	25:1

*With a maximum sinewave amplitude of 5 V P-P.

PHASE SHIFT
Phase shift between two Type 2A63 Units used for X-Y displays is nominally less than 1° at 50 kHz.

INTER-STAGE AC COUPLING
AC STABILIZED switch reduces drift at high gain.

WEIGHTS

Net weight	3¾ lb	1.7 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈11 lb	≈5.0 kg

TYPE 2A63 DIFFERENTIAL AMPLIFIER **$190**
Includes instruction manual (070-0266-00)

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6055 10X Probe Package, adjustable attenuation helps maintain common-mode rejection, order 010-6055-01 ..... $75.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A3

Dual-Trace Differential Amplifier

- ***DC-to-500 kHz BANDWIDTH CONSTANT AT ALL DEFLECTION FACTORS***
- ***100 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***50,000:1 CMRR***
- ***FET INPUTS***

The Type 3A3 Dual-Trace Differential Amplifier is designed for use in the Type 561B, 564B, 565, or in the 568/230 Oscilloscope, but without digital presentation of the measurement. Used in the Type 129 Power Supply, the unit can be used to drive X-Y plotters, oscilloscopes, and other indicators.

The Type 3A3 contains two independent, high-gain amplifier channels with identical characteristics. Either channel may be used to produce a display, or the two channels may be electronically switched to produce dual-trace displays. The unit features high sensitivity with direct-coupled inputs and has a high degree of common-mode rejection. A switch on the front panel selects the upper bandwidth limit of the unit, thus increasing the signal-to-noise-ratio.

BANDWIDTH

DC to Switch - selectable upper —3 dB point of 500 kHz or 5 kHz. Selected bandwidth is constant at all volts/div settings. Low frequency —3 dB point when AC coupled is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

100 μV/div to 10 V/div in 16 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF. Input R can be disconnected by removing internal wire link.

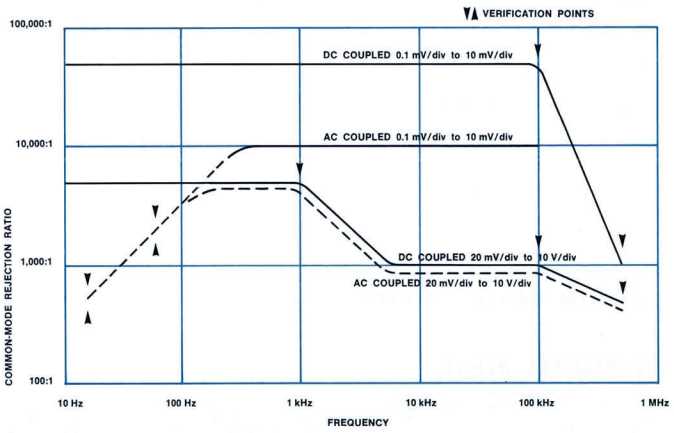
OPERATING MODES

Channel 1, Channel 2, or dual-trace with Alternate or Chopped switching. Chopping frequency is approx 200 kHz. Chopped transient blanking is provided.

DUAL X-Y DISPLAYS

Obtained with two Type 3A3 Plug-In Units. Dual-trace switching is synchronized, so that one Y-channel remains plotted against the same X-channel, once the display is set up. There is no provision for consistent pairing each time the system is operated.

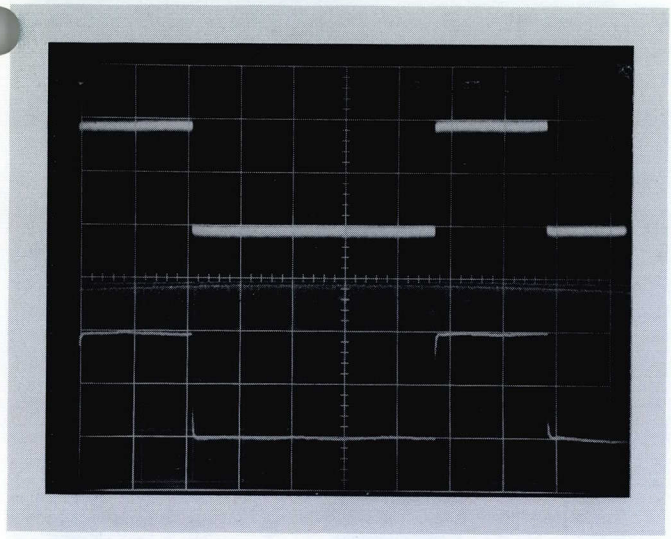
COMMON-MODE REJECTION RATIO



PHASE SHIFT (0.1 mV to 10 mV)

Less than 2° from DC to 100 kHz between two Type 3A3 Amplifiers used in X-Y operation. Phase shift can be adjusted to 0° at any particular deflection factor setting.

3A3
Dual-Trace Differential Amplifier



Upper trace is a 200-μV pulse displayed at 100 μV/cm. Lower trace is the same signal showing significantly lower noise with the use of the bandwidth limiting switch (500 kHz vs 5 kHz).

NOISE
Displayed noise, tangentially measured, is less than 15 μV in the 500 kHz bandwidth position.

DRIFT
Less than 50 μV/°C.

INTERCHANNEL ISOLATION
Electrostatic Isolation is 10^6:1 or better referred to input signal levels. Dual-Trace Isolation in alternate or chopped operation is 100:1 or better referred to divisions of display. Example: 5 divisions displayed on Channel 1 will cause no more than 0.05 divisions of deflection on Channel 2.

TRIGGER PICKOFF
Internally coupled. Can be selected from Channel 1, Channel 2 or the composite signal after switching.

DIFFERENTIAL CF OUTPUTS
Output is available from two of the connector pins at the rear of the plug-in for use in driving recorders or other equipment. Output amplitude is a ground-reference, differential, ≈5-volt signal for each division of displayed signal. Front-panel TRIGGER SWITCH allows signal out selection of CH 1, CH 2 or composite. Bandwidth is DC to ≈400 kHz with a non-capacitive load. Jacks can be easily installed at the rear of the oscilloscope to provide access to the CF outputs.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
Four BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); two instruction manuals (070-0787-00).

TYPE 3A3 DUAL-TRACE DIFFERENTIAL AMPLIFIER . . $950

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6055 10X Probe Package, adjustable attenuation helps maintain common-mode rejection, order 010-6055-01 .. $75.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

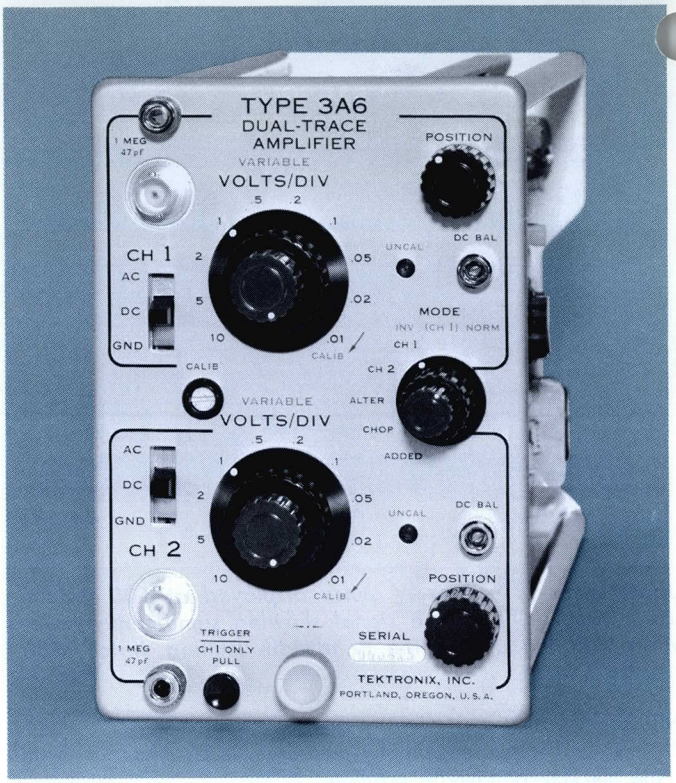
P6006 10X Probe Package, order 010-0127-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A6

10-MHz Dual-Trace Amplifier

- ***10 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***35-ns RISETIME***



The Type 3A6 Amplifier is a general-purpose, dual-trace plug-in unit designed for use in the Types 561B, 564B and 565 Oscilloscopes. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The Type 3A6 features two separate channels with identical characteristics. It can be operated in any one of five modes for a variety of single and dual-trace displays. Two Type 3A6's can be used for X-Y curve tracing, but without synchronized switching or channel pairing.

BANDWIDTH
DC to 10 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 35 ns.

DEFLECTION FACTOR
10 mV/div to 10 V/div in 10 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Includes Channel 1 only (polarity of Channel 1 can be changed to provide 180° inversion); Channel 2 only; alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 4 μs (approx) segments of each channel are displayed at an approx 125-kHz rate per channel (chopped transient blanking is provided); Added—outputs of Channel 1 and 2 added algebraically.

INTERNAL TRIGGER SIGNAL
Selectable from the output of Channel 1 only or from the combined output of the unit. Triggering from Channel 1 only permits viewing the true relationship between two signals when operating the unit in either alternate or chopped mode.

SIGNAL DELAY
Permits viewing of leading edge of fast-rise waveforms.*

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 3A6 DUAL-TRACE AMPLIFIER **$550**
Includes instruction manual (070-0419-00)

OPTIONAL ACCESSORIES

The probes recommended for use with these instruments satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

**The Type 3A6 can be used with a Type 2B67 or Type 3B2 Time-Base Unit, but it will not usually be possible to view the entire leading edge of the triggering waveform. Same applies when the unit is used with Types 565 and RM565 Oscilloscopes.*

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A7
Differential Comparator Amplifier

- ***DC-to-10 MHz BANDWIDTH***
- ***1 mV/DIV to 50 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***20,000:1 CMRR***
- ***±11,000-cm EFFECTIVE SCREEN HEIGHT***

The Type 3A7 High-Gain Differential Comparator adds to the measurement capabilities of Type 561B, 564B, and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. Used with Type 129 Power Supply, the Type 3A7 can drive recording equipment, X-Y plotters, oscilloscopes, or other indicators.

As a differential input amplifier, the dynamic range of the 3A7 Unit permits common-mode signals up to ±15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of about 20,000 to 1 for DC or low-frequency signals, differential signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using the slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage, added differentially to the input signal, makes precise voltage measurements possible. Using this mode of operation, the 3A7 Unit has an effective screen height of ±11,000 cm. This is equivalent to a ±11-volt dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated ±DC comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 μV per mm to be resolved.

CALIBRATED DEFLECTION FACTOR

1 mV/div to 50 V/div, depending on millivolts/div and attenuator settings. Accuracy of millivolts/div positions is within 3%. Uncalibrated, continuous variation between steps and to approx 125 V/div.

BANDWIDTH (—3 dB)†		
mV/DIV	FREQUENCY	RISETIME
50 mV to 10 mV/div	DC to ≥10 MHz	≤35 ns
5 mV/div	DC to ≥ 8 MHz	≤44 ns
2 mV/div	DC to ≥ 6 MHz	≤58 ns
1 mV/div	DC to ≥ 4 MHz	≤88 ns

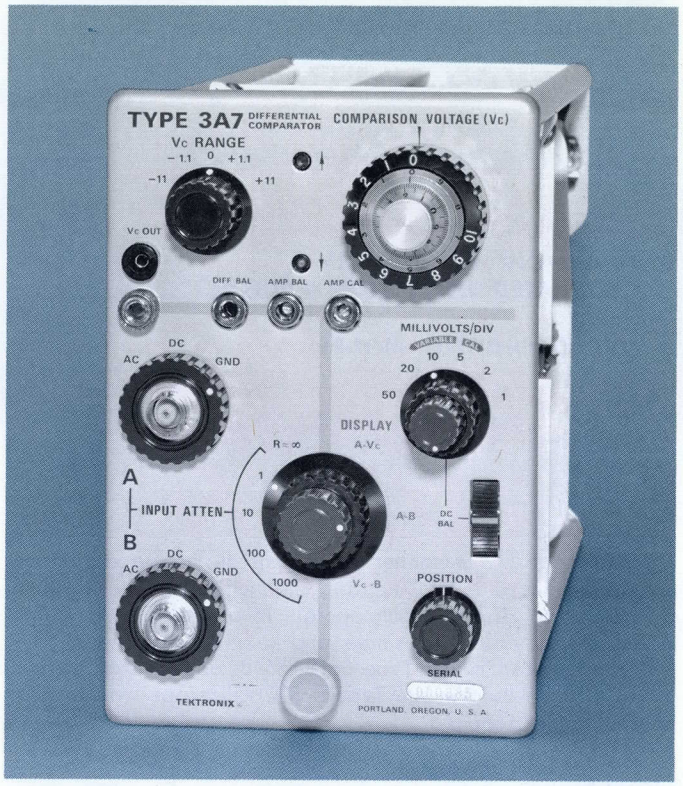
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

INPUT CHARACTERISTICS		
INPUT ATTEN	MAX PEAK INPUT VOLTS Common or Differential Mode	MAX INPUT ATTEN ERROR
R ≈ ∞	±15 V	*
1X	±15 V	**
10X	±150 V	±0.05%
100X	±500 V	±0.15%
1000X	±500 V	±3%

*Input R ≈ 10,000 to 50,000 MΩ.
**1X input R within ±0.1% of 10X input R.

INPUT RC

1 megohm paralleled by approx 20 pF.



COMMON-MODE REJECTION RATIO AT 1 mV/div	
DC COUPLED	≥20,000:1 with ±11 VDC or 30 V P to P AC, DC to 20 kHz
AC COUPLED	≥1000:1 with 30 V P to P at 60 Hz, to ≥20,000:1 at 20 kHz
HF (AC OR DC COUPLED)	≥500:1 with 30 V P to P at 500 kHz, to ≥20,000:1 at 20 kHz

COMPARISON VOLTAGE

0 to ±1.1 V, or 0 to ±11 V. Accuracy: ± (0.15% of indicated value plus 0.05% of V_c Range). V_c OUT jack on front panel.

OVERDRIVE RECOVERY

Recovers to within 10 mV of reference signal within 300 ns after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to 5 mV in the reference level.

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.3 kg

TYPE 3A7 DIFFERENTIAL COMPARATOR $750
Includes instruction manual (070-0477-00).

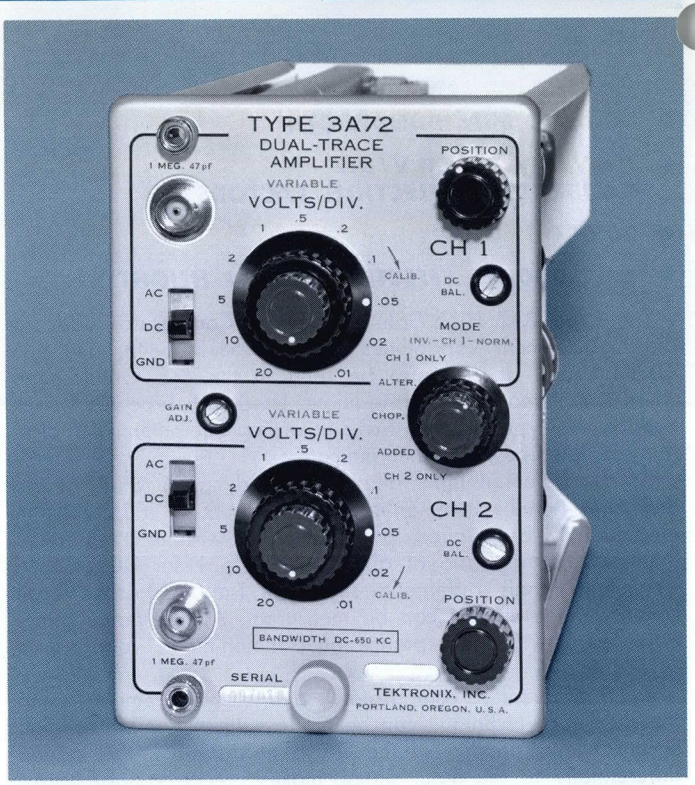
OPTIONAL ACCESSORIES

P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-6055-01 .. $75.00
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A72

650-kHz Dual-Trace Amplifier



- ***10 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***FIVE OPERATING MODES***

The Type 3A72 Amplifier is a general-purpose dual-trace plug-in unit that has two separate channels, each with identical characteristics. The unit can operate in any of five operating modes for a variety of single and dual-trace displays. This unit can be used in the Type 561B, 564B, or 565 Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

BANDWIDTH

DC to 650 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Includes Channel 1 only (normal or inverted); Channel 2 only; Alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 16-μs segments of each channel are displayed at an approx 30-kHz rate per channel. Chopped transient blanking is provided; Added—outputs of Channel 1 and 2 algebraically added.

MULTIPLE X-Y DISPLAYS

Obtained with two Type 3A72 Plug-In Units; both synchronization and automatic pairing are provided. With two Type 3A72's operated in the dual-trace mode, Channel 1 of the left-hand unit is always plotted against Channel 1 of the right-hand unit.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.3 kg

TYPE 3A72 AMPLIFIER UNIT **$310**
Includes instruction manual (070-0274-00).

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

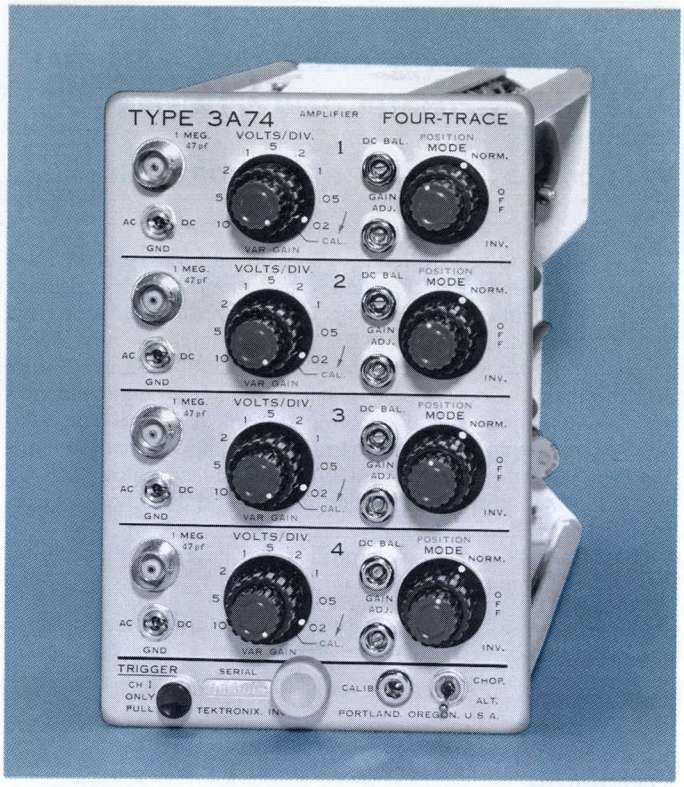
P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6006 10X Probe Package, order 010-0127-00 ..... $29.00
P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A74
2-MHz Four-Trace Amplifier

- ***20 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***CHOPPED or ALTERNATE OPERATION***

The Type 3A74 Amplifier is a general-purpose multi-trace plug-in unit that has four separate channels, each with identical characteristics. The unit can operate in a number of modes for a variety of single and multi-trace displays. The Type 3A74 can be used in the Type 561B, 564B or 565 Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required.



BANDWIDTH
DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 0.17 μs.

DEFLECTION FACTOR
20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Includes any one of the four channels separately (normal or inverted); Alternate—any combination of two or more channels switched electronically on alternate sweeps; Chopped — successive 2-μs segments of each channel are displayed at an approx rate per channel of: 250 kHz when using two channels; 167 kHz when using three channels; and 125 kHz when using four channels. Chopped transient blanking is provided.

MULTIPLE X-Y DISPLAYS
Obtained by using two Type 3A74 Plug-In Units; both synchronization and automatic pairing are provided. With two Type 3A74's, two, three or four independent displays may be obtained, properly paired: Channel 4 of the left-hand unit is always plotted against Channel 4 of the right-hand unit, Channel 3 versus Channel 3, etc.

INTERNAL TRIGGER SIGNAL (for the time-base)
From one of two sources as selected; either from the output of Channel 1 only or the combined output of the amplifier.

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈15 lb	≈6.8 kg

INCLUDED STANDARD ACCESSORIES
Four BNC to binding-post adapters (103-0033-00); instruction manual (070-0347-01).

TYPE 3A74 AMPLIFIER UNIT $695

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

P6006 10X Probe Package, order 010-0127-00 ..... $29.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3A8

Operational Amplifier

- ***TWO INDEPENDENT OPERATIONAL AMPLIFIERS***
- ***10 MHz OR GREATER GAIN-BANDWIDTH PRODUCT***
- ***15,000 OR GREATER OPEN-LOOP GAIN***

The Type 3A8 Operational Amplifier performs precise integration, differentiation, function generation, linear and nonlinear amplification. It contains a display amplifier and two operational amplifiers; each operational amplifier has identical features, including front-panel selection of internal Z_i and Z_f components. External components can be used independently or in combination with the internal resistor-capacitor combinations. The output of either operational amplifier can be applied to the other operational amplifier; either output can be applied to the display amplifier and/or fed to other devices. The unit can be used in the Type 561B, 564B, or Type 565. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The Type 3A8 can drive recorders, X-Y plotters, oscilloscopes and other indicators when used in the Type 129 Power Supply.

DISPLAY AMPLIFIER

BANDWIDTH
DC to at least 3.5 MHz at 3-db down.

RISETIME
100 ns or less.

DEFLECTION FACTOR
20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by 47 pF.

OPERATING MODES
Signal source selection from either operational amplifier or an external signal. AC or DC coupling. The display can be inverted to provide the desired deflection polarity.

OPERATIONAL AMPLIFIERS

OPEN-LOOP GAIN
At least 15,000 at DC.

OPEN-LOOP GAIN-BANDWIDTH PRODUCT
At least 10 MHz.

OUTPUT RANGE
$\pm$25 V, $\pm$7.5 mA. Protected against shorts to ground.

OUTPUT IMPEDANCE
30 Ω or less at 1 MHz for compensated unity-gain amplifier.

INPUT OFFSET
Voltage: adjustable to zero $\pm$500 μV (front-panel control).
Current: adjustable to zero $\pm$50 pA (calibration control).

DRIFT
After 30 minute warmup, typically less than 0.5 mV/hour referred to input (averaged over 10 hours).

FEEDBACK
Provisions for negative and/or positive feedback. Negative feedback utilizes internal and/or external impedances; positive feedback utilizes external impedances only.

SELECTABLE INPUT AND FEEDBACK COMPONENTS
Front-panel switches allow independent selection of the following resistors and capacitors in any combination as Z_i and Z_f: 0.01, 0.1, 0.2, 0.5 and 1 megohm; 10 pF, 100 pF, 0.001, 0.01, 0.1 and 1 μF. All values are $\pm$1% except 10 pF and 100 pF which are adjustable.

INTEGRATION LOW-FREQUENCY REJECT
An RC network which prevents integration below approx 2 Hz (voltage or current offset drift) can be switched in or out as needed. Other networks can be connected externally.

TERMINAL ADAPTERS
Two shielded terminal adapters are included for construction of external circuitry for custom applications. Over one hundred suggested circuits for special applications are shown in the instruction manual.

For additional information on basic operating modes and on optional Log, Compensating, and Gating adapters, refer to Type O Amplifier pages.

WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	$\approx$11 lb	$\approx$5.0 kg
Export-packed weight	$\approx$15 lb	$\approx$6.8 kg

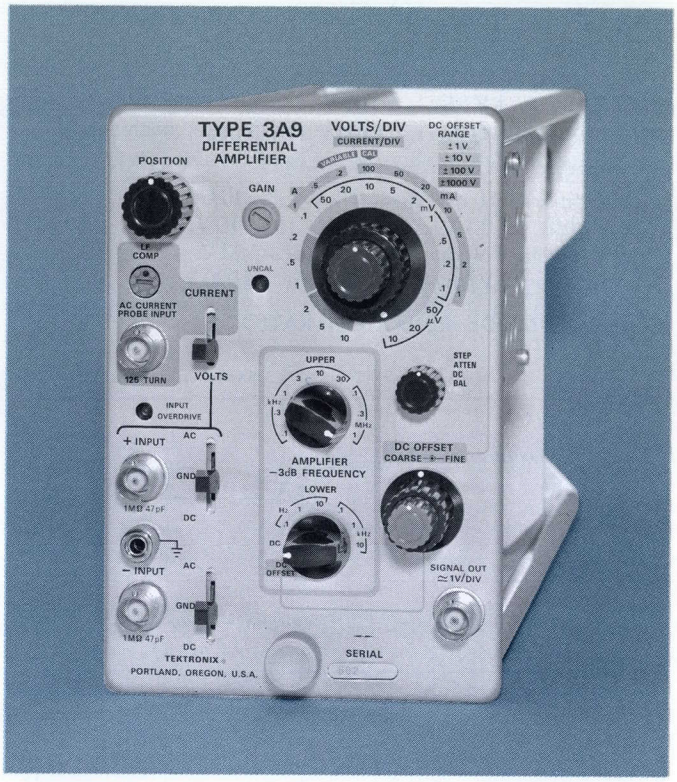
INCLUDED STANDARD ACCESSORIES
Two terminal adapters (013-0048-01); two terminal shields (013-0049-01); two BNC to binding post adapters (103-0033-00); instruction manual (070-0507-00).

TYPE 3A8 OPERATIONAL AMPLIFIER UNIT $715

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3A9
Differential Amplifier

- ***VOLTAGE MEASUREMENTS***
  10 μV/div to 10 V/div
  DC-to-1 MHz BANDWIDTH
- ***CURRENT MEASUREMENTS (with optional current probe)***
  1 mA/div to 1 A/div
  10 Hz-to-1 MHz BANDWIDTH
- ***SELECTABLE UPPER AND LOWER 3-dB POINTS***
- ***100,000:1 CMRR***
- ***INTERNAL DIFFERENTIAL DC OFFSET***
- ***10 μV/hour DC DRIFT***



CHARACTERISTICS

The Type 3A9 is a DC-coupled differential amplifier designed for use in Tektronix 561B, 564B and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. The Type 3A9 can drive recorders, X-Y plotters, oscilloscopes and other indicators when used with the Type 129 Power Supply.

The Type 3A9 represents a significant improvement from previous performance standards in high-gain, differential, DC-coupled amplifiers for the Type 560-Series Oscilloscopes. DC drift is held to 10 μV/h, long term without chopper stabilization; displayed noise (tangentially measured) is 12 μV at 10 μV/div and 1-MHz bandwidth with a 25-Ω source resistance. Bandwidth is maintained at DC-to-1 MHz throughout the deflection factor range of 10 μV/div to 10 V/div. CMRR is at least 100,000:1 from DC-to-100 kHz from 10 μV/div to 10 mV/div. DC differential offset provides an internal voltage to cancel signal DC levels or to inspect signal components over a full differential dynamic range. Bandwidth is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequencies (0.1 Hz).

In addition, the Tektronix P6021 (125-turn) AC current probe provides the convenience of current readings from 1 mA/div to 1 A/div with the AC current probe input. The bandwidth when using the optional current probe is from 10 Hz to 1 MHz.

VOLTAGE CHARACTERISTICS

BANDWIDTH
DC-to-1 MHz independent of deflection factor setting.

FREQUENCY LIMITS— 3-dB POINTS
Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz. A DC offset position provides DC low frequency response and turns on the DC offset control.

INPUT RC
1 megohm, paralleled by 47 pF.

DEFLECTION FACTOR
10 μV/div to 10 V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuously variable between steps and to approximately 25 V/div.

INPUT COUPLING
May be switched to AC, GND or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower —3-dB point is approximately 1.6 Hz when AC coupled at input.

INPUT GATE CURRENT
From 10 μV/div to 10 mV/div, maximum input gate current is ±20 pA at +25°C and ±100 pA at +50°C; 20 mV/div to 10 V/div, maximum input gate current is ±10 pA at +25°C and ±10 pA at +50°C. Display shift at 10 μV/div (+25°C, AC coupled) is ±2 div.

DISPLAYED NOISE
≤12 μV or 0.1 div, whichever is greater, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less.

DC DRIFT
Drift with time (constant ambient temperature and line voltage; DC to 100 Hz bandwidth).

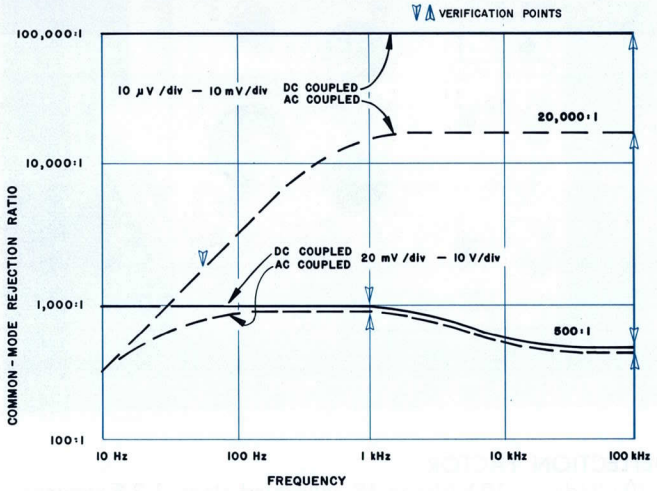
Short term: ≤5 μV/min (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

Long term: ≤10 μV/h (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

DIFFERENTIAL DYNAMIC RANGE
10 μV/div to 10 mV/div—±1 V.
20 mV/div to 0.1 V/div—±10 V.
0.2 V/div to 1 V/div—±100 V.
2 V/div to 10 V/div—±1000 V (500 V max each input).

DC OFFSET
10 μV/div to 10 mV/div—+1 V to —1 V.
20 mV/div to 0.1 V/div—+10 V to —10 V.
0.2 V/div to 1 V/div—+100 V to —100 V.
2 V/div to 10 V/div—+1000 V to —1000 V.

COMMON-MODE REJECTION RATIO



COMMON-MODE DYNAMIC RANGE
10 μV/div to 10 mV/div—±10 V.
20 mV/div to 0.1 V/div—±100 V.
0.2 V/div to 10 V/div—±500 V.

MAXIMUM INPUT VOLTAGE
DC Coupled: 10 μV/div to 10 mV/div—±15 V (DC + peak AC);
20 mV/div to 10 V/div—±500 V (DC + peak AC).
AC-Coupled Input DC Voltage: ±500 V, each input.

OVERDRIVE RECOVERY
≤10 μs to recover to within 0.5% of zero level after removal of a + or — voltage applied for 1 s. Voltage not to exceed differential dynamic range.

INPUT OVERDRIVE LIGHT
Indicates differential overload is being approached.

AC CURRENT CHARACTERISTICS WITH OPTIONAL CURRENT PROBE

BANDWIDTH
10 Hz to 1 MHz with optional AC current probe.

FREQUENCY LIMITS—3-dB POINTS
Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—10 kHz, 1 kHz, 100 Hz. Not calibrated from 10 Hz to DC.

INPUT
Accepts Tektronix P6021 (125-turn) AC current probe.

DEFLECTION FACTOR
1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence accurate within 3%. Uncalibrated continuously variable between steps and to approximately 2.5 A/div.

MAXIMUM INPUT CURRENT
10 A P-P.

FRONT-PANEL SIGNAL OUTPUT
1 V (±20%) per displayed division. DC coupled, internally adjustable to ground reference. Dynamic range is at least +5 V to —5 V. Bandwidth is DC to at least 500 kHz. Output resistance is 100 Ω or less. Minimum load resistance, 10 kΩ.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

TYPE 3A9 PLUG-IN UNIT **$525**
Includes instruction manual (070-0913-00).

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available. See the Tektronix Catalog accessory pages for additional information on these and other items.

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-6055-01 $75.00
P6028 1X Probe Package, order 010-0074-00 ..... $16.50
P6007 100X Probe Package, order 010-0150-00 ..... $29.00
P6021 Current Probe, order 010-0237-02 ..... $94.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

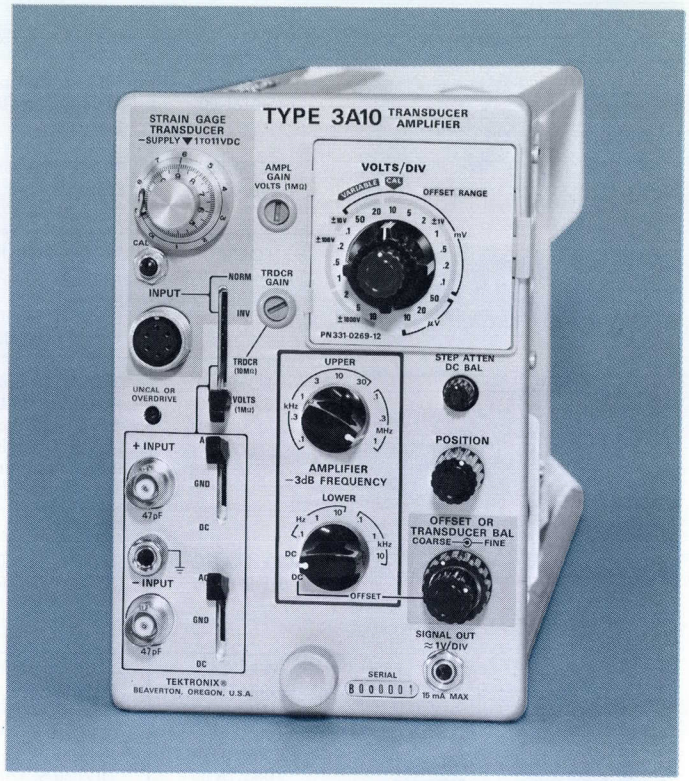
3A10
Transducer Amplifier

NEW

- ***DC to 1 MHz BANDWIDTH***
- ***10 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***100,000:1 CMRR***
- ***DC VOLTAGE SUPPLY FOR TRANSDUCERS***
- ***SELECTABLE UPPER AND LOWER —3 dB POINTS***

The Type 3A10 is well suited for low-amplitude, low-frequency measurements and can be used with standard voltage probes. As a transducer amplifier, its inputs are designed to allow use of piezoelectric and other self-generating transducers, or strain gage and other voltage-excited transducers, using the built-in variable DC voltage supply.

A wide range of physical quantities, such as pressure, force, acceleration, vibration, displacement, strain, and temperature can be measured with optional transducer accessories. Accessory transducer packages include a snap-in, scale-factor plate to permit direct reading of units being measured without computation.



CHARACTERISTICS

BANDWIDTH

DC Coupled: DC to 1 MHz —0, +30% independent of deflection factor setting.

AC Coupled: lower limit is 1.6 Hz, ±5% in 1 MΩ input mode; 0.16 Hz, ±5% in 10 MΩ input mode.

FREQUENCY LIMITS —3 dB POINTS

UPPER— 1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz, ±12%.

LOWER—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, ±12%. A DC offset position provides DC low frequency response and turns on the DC offset control.

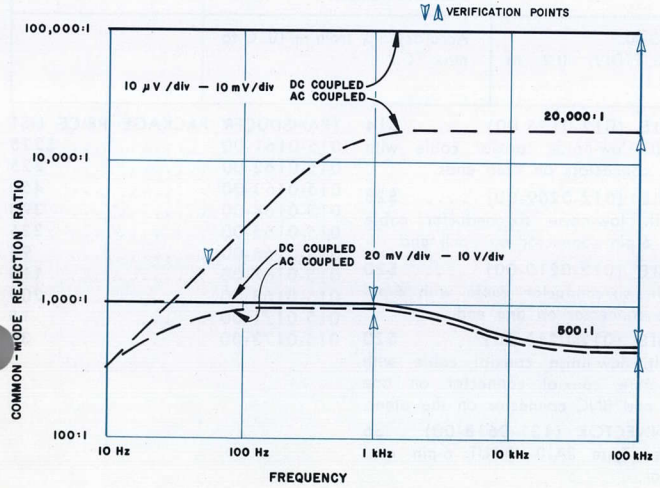
INPUT R and C

1 megohm or 10 megohm paralleled by 47 pF.

DEFLECTION FACTOR

10 μV/div to 10 V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2% (3%, 20 mV/div to 10 V/div). Uncalibrated continuously variable between steps and to approximately 25 V/div.

COMMON-MODE REJECTION RATIO



DISPLAYED NOISE

Less than 12 μV, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less. No more than 1.25 μV RMS with UPPER —3 dB FREQUENCY Switch in 100 Hz position.

SIGNAL OUT

1 V per displayed division, ±20%. Dynamic range is at least +5 V to —5 V. Maximum current is 15 mA. Bandwidth is DC to at least 500 kHz. Output resistance is 50 Ω or less.

STRAIN GAGE/TRANSDUCER POWER SUPPLY

Voltage range is —1 V to —11 V, ±1%. Current range is 0 to at least 60 mA. Maximum (short circuit) current is 90 mA.

For complete specification on DC Drift, Differential Dynamic Range, DC Offset/Transducer Balance, Common-Mode Dynamic Range, Maximum Input Voltage and Overdrive Recovery, please see Type 3A9 description.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

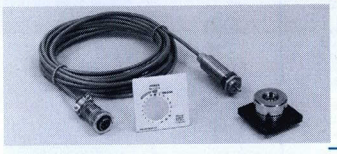
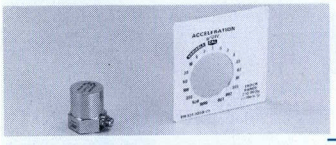
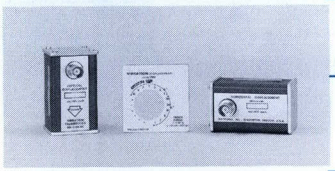
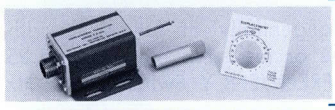
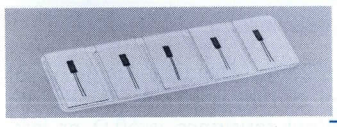
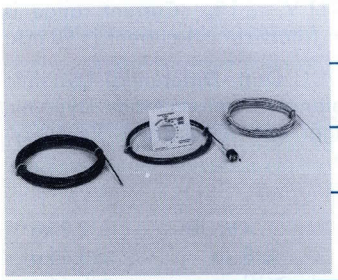
INCLUDED STANDARD ACCESSORIES

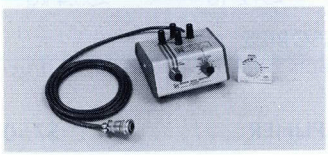
Transducer Measurement Concepts book (062-1246-00); instruction manual (070-1062-00).

TYPE 3A10 TRANSDUCER AMPLIFIER $750

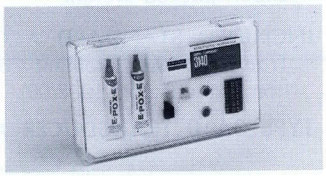
U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3A10
Transducer Amplifier

TRANSDUCER PACKAGE		CONTENTS	DESCRIPTION	RECOMMENDED ACCESSORIES
	PRESSURE 015-0161-00	TRDCR: 3000 psig 119-0246-00. Scale: 1 to 1000 psi/DIV; 0.1 to 100 (kgf/cm^2)/DIV 331-0269-01.	Trdcr element: Bonded STRG 350 Ω; $f_n \approx$ 65 kHz. Accuracy 2%.	20 ft cable 012-0209-00
	PRESSURE 015-0162-00	TRDCR: 300 psig 119-0245-00. Scale: 0.1 to 100 psi/DIV; 0.01 to 10 (kgf/cm^2)/DIV 331-0269-02.	Trdcr element: Bonded STRG 350 Ω; $f_n \approx$ 24 kHz. Accuracy 2%.	20 ft cable 012-0209-00
	FORCE 015-0163-00	TRDCR: 3000 lbs f 119-0243-00. Load button: 214-1400-00. Eye bolt (2): 214-1399-00. Scale: 1 to 1000 lbs f/DIV; 0.5 to 500 kgf/DIV 331-0269-03.	Trdcr element: Bonded STRG 350 Ω. Accuracy 1%.	20 ft cable 012-0209-00
	FORCE 015-0164-00	TRDCR: 50 gram f; 50 lb f 119-0250-00. Adapter: 119-0251-00. Scales: 0.01 to 20 lbs f/DIV; 5 (10^{-3}) to 10 kgf/DIV 331-0269-04. 0.01 to 20 gram f/DIV; 0.02 (10^{-3}) to 40 (10^{-3}) mm/DIV 331-0269-09.	Trdcr element: Unbonded STRG 350 Ω. Accuracy 2%.	
	ACCELERATION 015-0165-00	TRDCR: 10,000 g 119-0244-00. Scale: 0.001 to 1000 g/DIV 331-0269-05.	Trdcr 1.5 Hz to 15 kHz; $f_n \approx$ 30 kHz. Element: Piezoelectric. Accuracy 5%.	20 ft cable 012-0211-00
	VERTICAL VIBRATION 015-0166-00 HORIZONTAL VIBRATION 015-0167-00	TRDCR: ±0.025 inch. Displacement Scale: 1 (10^{-6}) to 10 (10^{-3}) inch /DIV; 0.02 (10^{-3}) to 0.2 mm/DIV 331-0269-06. Velocity Scale: 20 (10^{-6}) to 20 (inch/sec)/DIV; 0.5 (10^{-6}) to 0.5 (10^{-3}) (m/s)/DIV 331-0269-07.	Trdcrs: Inductive self gen 10 Hz to 1 kHz; Damped $f_n \approx$ 8 Hz. Outputs ≈600 mV/inch/s and ≈10 mV/0.001 inch. Accuracy 5%.	20 ft cable 012-0136-00
	DISPLACEMENT 015-0168-00	TRDCR: ±0.2 inch. Feeler gage 0.040-inch 003-0663-00. Scale: 10 (10^{-6}) to 0.1 inch/DIV; 0.2 (10^{-3}) to 2 mm/DIV 331-0269-08.	Element: DC to DC LVDT DC to >120 Hz. Accuracy 2% within ±0.1 inch.	20 ft cable 012-0209-00
	STRAIN 015-0171-00	Strain Gages: 30,000 μ strain. Package of five.	Elements: Foil STRG 120 Ω. Accuracy 1%. 0.125-inch long attached leads.	Strain gage Adapter 015-0169-00 Cement kit 015-0172-00
TEMPERATURE	015-0173-00	Thermocouple:		
	+230°F	+105°C Max 119-0253-00.	PVC Ripcord Insulation; #30 Iron Constantan.	
	+1000°F	+480°C Max 119-0252-00.	Fiberglass Insulation; #30 Iron Constantan.	
	+900°F	+480°C Max with Magnet Mounting 119-0236-00.	Fiberglass Insulation; #24 Iron Constantan.	
		Adapter (2) 103-0033-00. Scale: 0.5 to 500°F/DIV; 0.2 to 200°C/DIV 331-0269-11.	Accuracy 5% from +10°C to max °C.	



STRAIN GAGE ADAPTER (015-0169-00) $75
Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type 3A10. Has variable shunt resistor for gage factor calibration. The adapter has four binding post terminals and a six-foot cable with 6-pin connector. Scale included is 5 to 50,000 μ strain/DIV, 331-0269-10.



CEMENT KIT (015-0172-00) .. $20
Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating, Neoprene pads and metal plates, cementable Wiring terminals, and clear Mylar film.

CABLE (012-0136-00) $14
20 ft. low-noise coaxial cable with BNC connectors on both ends.

CABLE (012-0209-00) $25
20 ft. low-noise six-conductor cable with 6-pin connector on each end.

CABLE (012-0210-00) $20
20 ft. six-conductor cable with 6-pin male connector on one end.

CABLE (012-0211-00) $20
20 ft. low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.

CONNECTOR (131-0618-00) . $6
Mates Type 3A10 INPUT 6-pin connector.

TRANSDUCER PACKAGE PRICE LIST

015-0161-00	$225
015-0162-00	225
015-0163-00	450
015-0164-00	390
015-0165-00	225
015-0166-00	95
015-0167-00	110
015-0168-00	200
015-0171-00	15
015-0173-00	30

3C66
Transducer Amplifier

- ***EQUIVALENT DC SENSITIVITY 10 μV/div***
- ***VARIABLE GAGE FACTORS***
- ***RECORDER OUTPUT***

The Type 3C66 Carrier Amplifier with suitable transducer measures mechanical quantities that can be converted to a change in resistance, capacitance, or inductance. This unit may be used in the Type 561B, 564B and Type 565 Oscilloscopes. It can also be used in the Type 568 Oscilloscope when digital readout is not required. Used with Type 129 Power Supply, the Type 3C66 can drive recorders, X-Y plotters, oscilloscopes and other indicators.

The gap between mechanical engineering and electronic instrumentation is bridged with the Type 3C66 and suitable transducers. The total range of applications is as broad as the mechanical field itself and includes stress analysis, vibration studies, and fatigue tests. Typical quantities measured are force, displacement, acceleration, and strain.

The Type 3C66 operates on an AC carrier principle. It uses an AC bridge at the input to convert transducer signals into an amplitude-modulated carrier signal. The carrier signal is amplified by a high-gain AC amplifier and then demodulated to obtain the CRT deflection voltages.

BANDWIDTH
DC to 5 kHz at 3-dB down.

RISETIME
Approximately 70 μs.

CALIBRATED DEFLECTION FACTOR
10 microstrain/div (micro-inches per inch/div) to 10,000 microstrain/div when the Type 3C66 is used with a single strain gage having a gage factor of approximately 2. Uncalibrated continuous control from 10 microstrain/div to 25,000 microstrain/div. Attenuator accuracy, when set accurately in any one step, is within 2% on all other steps.

AMPLIFIER INPUT
Input is to an AC bridge with 25-kHz excitation voltage. One or more of the four bridge arms can have transducers attached to them. Total bridge voltage is approximately 5 V RMS, regulated.

NOISE
Typically equivalent to an input of 2.0 microstrain (peak to peak) at maximum calibrated sensitivity. This approximates an RMS noise of 0.5 microstrain.

DRIFT
Drift of the over-all system is primarily a function of the transducer stability. The Type 3C66 Amplifier system is essentially drift free.

GAGE FACTORS
Factors from 1 to 6 are usable without changing the steps of the sensitivity control. The range of factors is compensated for by adjusting the Gain Adjust Control.

EQUIVALENT DC SENSITIVITY
A comparable DC amplification system would require approximately 10 microvolts/div sensitivity for the same amount of power applied to the Type 3C66.

CAPACITIVE TRANSDUCERS
Used in conjunction with a four-arm resistive bridge results in the following maximum useful sensitivities: 120-ohm bridge, 1 pF/div; 1000-ohm bridge, 0.2 pF/div; useful sensitivities are slightly lower when using long cables.

INDUCTIVE TRANSDUCERS
Must have characteristics compatible with the 25-kHz carrier frequency to function properly. Linear-variable-differential transformers designed for nominal carrier frequencies of 2 kHz and higher usually operate satisfactorily without additional circuitry.

RECORDER SIGNAL OUTPUT
DC coupled with an output of about 3 V for each major division of CRT display. DC level is adjustable to 0 V by an internal control.

WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
Synchronizing cable, RG174/U (012-0063-00); 4-wire 15-ft shielded connector cable (012-0040-00); instruction manual (070-0357-00).

TYPE 3C66 AMPLIFIER UNIT $495

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

2B67
Time Base

- ***1 μs/DIV to 5 s/DIV CALIBRATED TIME BASE***
- ***5X MAGNIFIER***
- ***SINGLE SWEEP OPERATION***
- ***LOW COST***

The Type 2B67 Time-Base Unit is designed to generate a sweep in the Type 561B and Type 564B. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The unit is recommended for use with 2- and 3-series vertical plug-in units with bandwidths up to 2 MHz.

TIME BASE

1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/div.

5X MAGNIFIER

Operates over full time base, increases the fastest rate to 0.2 μs/div. Magnified display accurate within 5%.

SINGLE SWEEP

For one-shot waveform photography and storage applications.

EXTERNAL HORIZONTAL INPUT

Approx 1 V/div, DC to 750 kHz at —3 dB.

TRIGGER

MODES

Manual, automatic, or free-run.

COUPLING

AC slow, AC fast, or DC.

SOURCES

Internal, external, or line.

REQUIREMENTS

Internal Triggering—0.4 divisions of display, DC to 2 MHz.
External Triggering—0.5 V at DC increasing to 2 V at 2 MHz.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

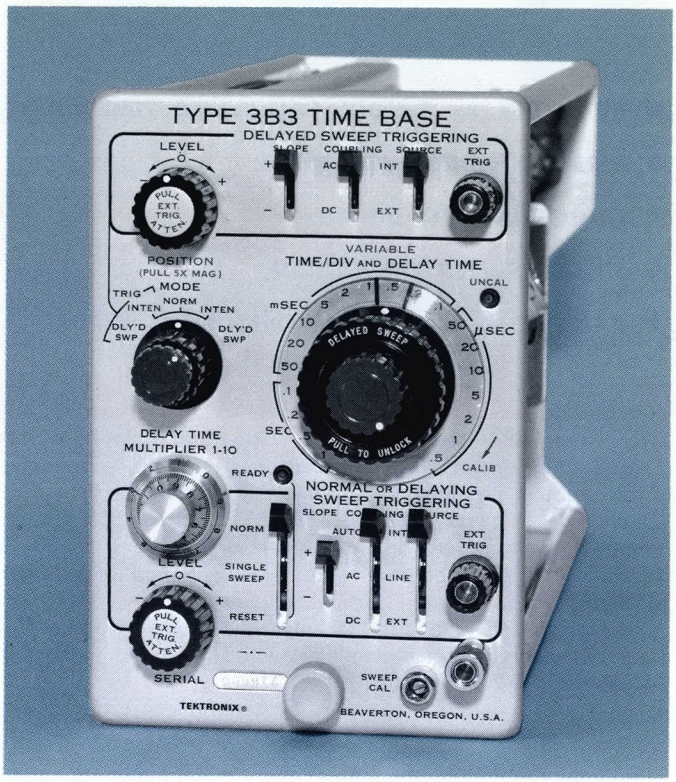
TYPE 2B67 TIME-BASE UNIT **$235**
Includes instruction manual (070-0366-00).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3B3
Delayed Sweep Time Base

- ***500 ns/DIV TO 1 s/DIV CALIBRATED TIME BASE***
- ***CALIBRATED DELAYED SWEEP***
- ***TRIGGERING TO 10 MHz***
- ***SINGLE SWEEP OPERATION***

The Type 3B3 Time-Base Unit is used to generate normal and delayed sweeps. Flexible triggering facilities are similar for both the normal sweep and delayed sweep. Calibrated sweep delay enables accurate delay intervals to be set and measured. The unit can be used with the Type 561B or Type 564B Oscilloscopes. It can also be used with the Type 568 Oscilloscope when digital readout is not required.



DISPLAY MODES

NORMAL SWEEP

The normal sweep generator operates as the display time base in (1) the NORMAL position, (2) the INTENSIFIED position—where the delayed-sweep generator intensifies a portion of the normal sweep trace, indicating the time during which the delayed sweep operates—and (3) the TRIGGERED, INTENSIFIED position—where the delayed sweep is armed at the end of the delay time and starts by the delayed sweep trigger . . . intensifying a segment of the normal sweep trace as above.

DELAYED SWEEP

The delayed-sweep generator operates as the display time base in (1) the DELAYED SWEEP position—displaying the portion of the trace which was intensified in the INTENSIFIED position . . . with time-jitter less than 1 part in 20,000 of the maximum available delay interval—and (2) the jitter-free TRIGGERED, DELAYED SWEEP position—displaying the portion of the trace which was intensified in the TRIGGERED, INTENSIFIED position.

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER.

CHARACTERISTICS

TIME BASE

(Both normal and delayed sweeps.) 0.5 μs/div to 1 s/div in 20 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 2.5 s/div. The Variable control operates with the normal sweep in the normal display mode, and with delayed sweep in all other display modes. Coupled time/div controls may be unlocked for independent setting of delayed sweep time.

5X MAGNIFIER

Expands the fastest sweep rate to 0.1 μs/div. Magnified sweep accurate within 5%.

DELAY TIME (OR TIME/DIV)

0.5 μs to 1s, 20 calibrated steps, 1-2-5 sequence; accurate within 1% of indicated delay from 0.5 μs to 0.2 s.

DELAY TIME MULTIPLIER

Continuously calibrated time interval from 0.50 to 10.00 times the Delay Time (dial divided into 500 parts); accurate within 0.2% of maximum delay (DELAY TIME X10.00).

DELAY RANGE

2.5 μs to 2 s after delaying sweep start with 1% accuracy; to 10 s total. Inherent delay to start of delayed sweep 500 ns or less.

DIFFERENTIAL TIME

Measurement accuracy within 1% and 1.5 minor divisions.

SINGLE SWEEP

Facilitates photographic recordings of waveforms.

TRIGGER MODES

Normal-Sweep Trigger—manual or automatic.
Delayed-Sweep Trigger—manual only.
Coupling—AC or DC.

SOURCES

Internal or External. Line triggering in normal or delaying sweep operation only.
External trigger facility has two ranges: 0.5 to 15 V and 5 to 150 V, plus or minus polarity.

REQUIREMENTS

Internal Triggering—0.4 major graticule divisions from DC to 5 MHz, increasing to 1 major division at 10 MHz.
External Triggering—0.5 V from DC to 5 MHz, increasing to 1.25 V at 10 MHz. Requirements increase below 6 Hz with AC-coupling.

WEIGHTS

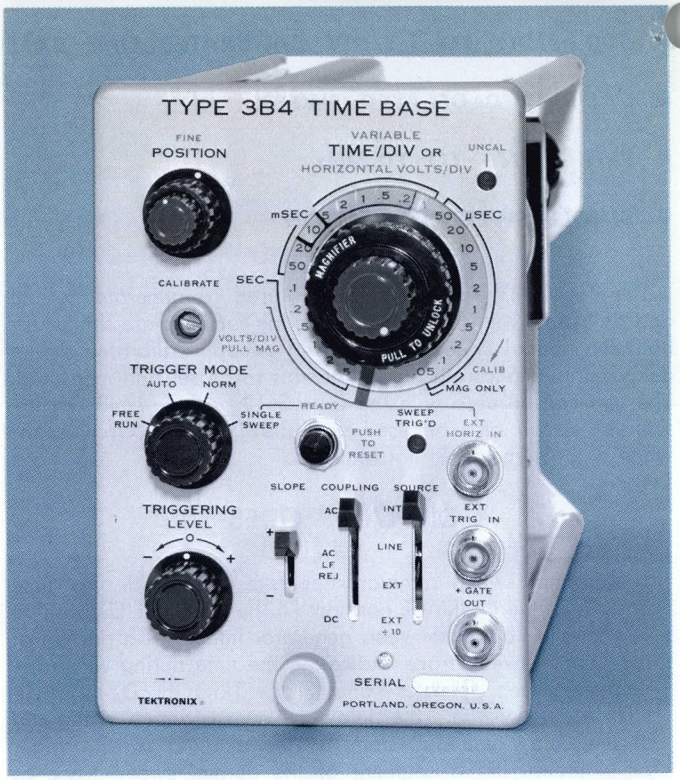
Net weight	6 lb	2.7 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.3 kg

TYPE 3B3 TIME-BASE UNIT **$680**
Includes instruction manual (070-0365-01).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3B4
Time Base

- ***50 ns/DIV to 5 s/DIV CALIBRATED TIME BASE***
- ***DIRECT READING MAGNIFIER***
- ***TRIGGERING TO 20 MHz***
- ***SINGLE SWEEP OPERATION***
- ***CALIBRATED EXTERNAL HORIZONTAL INPUT***



The Type 3B4 Plug-In Unit is a wide-range time base with flexible, high-speed triggering facilities, and a wide-range, direct-reading magnifier for use in the Type 561B or Type 564B Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required. The Type 3B4 is recommended for operation with Type 3A6 and other wide-band (2 MHz or greater) vertical amplifier plug-in units.

In addition to time base facilities, the 3B4 provides a DC-coupled external input amplifier with calibrated deflection factors from 0.2 to 5 V/div.

TIME BASE

0.2 µs/div to 5 s/div in 23 calibrated steps, 1-2-5 sequence; accuracy within 3% from 0.2 µs/div to 2 s/div, within 5% at 5 s/div. Uncalibrated, continuously variable between steps and to 12.5 s/div.

DIRECT READING MAGNIFIER

Provides sweep expansion up to X50 and extends the fastest sweep rate to 50 ns/div. The MAGNIFIER control is concentric with the TIME/DIV control, providing a direct indication of both the sweep rate being magnified and the magnified time/div rate. Up to 5 magnification steps are provided, to X40, or X50, depending on the TIME/DIV control setting before magnification. Magnified sweep rates are confined to the time/div steps on the panel, so there are no "forbidden" (uncalibrated) combinations. Magnified sweep accurate within 5%.

The MAGNIFIER control is also used to set the external input deflection factor when the TIME/DIV control is in the "Ext Input" position.

EXTERNAL HORIZONTAL INPUT

0.2 V/div to 5 V/div in 5 calibrated steps (max input ±20 V); accuracy, when plug-in unit is matched to oscilloscope, is within 3%. The External Input Amplifier is DC-coupled.

SINGLE SWEEP

Facilitates waveform photography and operation in the Type 561B or 564B Oscilloscope.

TRIGGER

MODES

Manual, free-run, automatic (with bright base-line in the absence of a trigger).

COUPLING

AC, AC LF-Reject, DC.

SOURCES

Internal, Line, External, External ÷ 10. A front-panel light indicates when the sweep is receiving a triggering signal—especially convenient when using an external trigger.

REQUIREMENTS

Internal Triggering—1 minor graticule division from DC to 20 MHz, with additional deflection required above 20 MHz. External Triggering—0.5 V to 15 V (EXT) or 5 V to 150 V (EXT ÷ 10) from DC to 20 MHz, with additional signal required above 20 MHz. Requirements increase below 30 Hz with AC-coupling.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.3 kg

TYPE 3B4 TIME BASE UNIT $475

Includes instruction manual (070-0431-00).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3S1
Dual-Trace Sampling Unit

- ***DC-to-1 GHz BANDWIDTH***
- ***2 mV/DIV to 200 mV/DIV DEFLECTION FACTORS***
- ***INTERNAL TRIGGERING AND DELAY LINES***
- ***DISPLAYED NOISE LESS THAN 2 mV (UNSMOOTHED)***

The Type 3S1 Plug-In Amplifier is a dual-trace sampling unit designed for use in the Type 561B, 564B or Type 568 Oscilloscope. The unit can be used with sampling sweep units, or with real-time time base units allowing sweep rates from 20 ps/div to 5 s/div. In the Type 568 Oscilloscope, information can be presented in digital as well as analog form.

The Type 3S1 features fast-rise, low-noise performance coupled with excellent transient response. The unit has two identical channels, each with internal trigger takeoff and a signal delay line. It can be operated in any of five modes for a variety of single, dual-trace, or X-Y displays. A DC-Offset provision allows the display of signals with DC voltages up to ±1 volt. Power is provided at the front panel for use with probes and other accessories.

CHARACTERISTICS

RISETIME
350 ps or less.

BANDWIDTH
Equivalent to DC to 1 GHz at 3-dB down.

TRANSIENT RESPONSE
±2% or less aberrations in the first 5 ns following the step transition, ±1% or less after 5 ns (as observed with a Tektronix Type 281 TDR Pulser).

DEFLECTION FACTOR
2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to 0.8 mV/div, uncalibrated.

DISPLAYED NOISE
2mV or less unsmoothed, or 1 mV smoothed (includes 90% of dots).

INPUT CHARACTERISTICS
Nominally 50 ohms. Safe overload is ±5 V. GR874* input connectors.

DC OFFSET RANGE
At least +1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. Monitor jacks provide 10X actual DC offset (at least +10 V to −10 V) within 2% through 10 kΩ.

TRIGGERING
Separate internal delay lines and trigger pickoffs permit triggering on either input signal. Trigger pickoffs deliver to the timing unit approximately 10% of the input signal amplitude.

DISPLAY MODES
A only, B only, Dual-Trace, Algebraic Addition of A and B signals, and X-Y display of A-vertically and B-horizontally (for observation of hysteresis loops, phase shift and similar displays). Independent controls for each channel permit positioning and inverting displays as desired. Time coincidence between channels is within 30 ps.

VERTICAL OUTPUT
200 mV for each division of displayed signal through 10 kΩ. Zero volt level corresponds to center of screen.

PROBE POWER
Available at front-panel connectors for accessories such as Type 281 TDR Pulsers and Type 282 Adapters for high-impedance probes.

WEIGHTS

Net weight	9 lb	4.1 kg
Domestic shipping weight	≈16 lb	≈7.2 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES
Two 5-ns 50-Ω RG58/AU cables (017-0512-00); two 10X 50-Ω GR attenuators (017-0078-00); instruction manual (070-0632-00).

TYPE 3S1 DUAL-TRACE SAMPLING UNIT $1400

OPTIONAL ACCESSORIES

Type 281 TDR Pulser, order 015-0060-00 ..... $95
Type 282 Probe Adapter, order 015-0074-00 ..... $95
P6040/CT-1 Current Probe, order 015-0041-00 ..... $40
CT-3 Signal Pickoff, order 017-0061-00 ..... $38
VP-1 Voltage pickoff "T", order 017-0073-01 ..... $28
P6034 10X Passive Probe, order 010-0110-00 ..... $44
P6035 100X Passive Probe, order 010-0111-00 ..... $44
Power Divider GR874-TPD*, order 017-0082-00.
Coupling Capacitor, GR874-K*, order 017-0028-00.

*Registered Trademark General Radio Company

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3S2

Dual-Trace Sampling Unit

- ***2 mV/DIV to 200 mV/DIV CALIBRATED DEFLECTION FACTORS***
- ***PLUG-IN SAMPLING HEADS***
- ***VARIABLE INTER-CHANNEL DELAY***

The Type 3S2 Dual-Trace Sampling Unit is designed for use in the Type 561B, 564B or 568 Oscilloscope. The unit can be used with sampling sweep units, including the Type 3T2 and 3T5 Sampling Sweeps, or with real-time time base units to allow sweep rates from 20 ps to 5 s/div. In the Type 568 Oscilloscope, information can be presented in digital as well as analog form.

The Type 3S2 accepts two Sampling Heads that can be inserted directly or located remotely with an optional extender. Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front panel control allows adjustment of the inter-channel time relationship to compensate for signal cables or other external delays.

Five display modes provide for a variety of single-trace, dual-trace or X-Y displays. The 3S2 can also be operated with only one head, for applications not presently requiring dual-trace displays.

CHARACTERISTICS

SAMPLING HEADS

May be plugged into the Type 3S2 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874*	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF BNC	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to approximately 0.8 mV/cm, uncalibrated.

DC OFFSET RANGE

+1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits can be displayed at 200 mV/div. Monitor jacks provide 10X actual DC offset (+10 V to −10 V) within 2% through 10 kΩ.

TRIGGERING

Trigger pickoff within most Sampling Heads permits triggering on either input signal. 50-Ω Trigger Out connector at the front panel delivers pulse signals with approximately 1X gain for AC signals up to 500 mV peak-to-peak and 2-ns risetime to the 50-Ω External Trigger Input of the sweep unit.

*Registered Trademark General Radio Company

B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to −5 ns with respect to Channel A. Accommodates 3-foot difference in signal or Sampling-Head cables.

DISPLAY MODES

A only, B only, Dual Trace, Algebraic Addition of A and B signals, and X-Y display of A-vertically and B-horizontally, (for observation of hysteresis loops, phase shift, and similar displays). Independent controls for each channel permit positioning and inverting displays as desired.

VERTICAL OUTPUT

200 mV for each division of displayed signal through 10 kΩ.

WEIGHTS

Net weight	10 lb	4.5 kg
Domestic shipping weight	≈17 lb	≈7.7 kg
Export-packed weight	≈27 lb	≈12.2 kg

INCLUDED STANDARD ACCESSORIES

10-inch RG58 trigger cable with BNC/BSM connectors (012-0128-00); 18-inch RG58 trigger cable with BNC/BSM connectors (012-0127-00); instruction manual (070-0759-00).

TYPE 3S2 DUAL-TRACE SAMPLING UNIT, without sampling heads **$1000**

OPTIONAL ACCESSORIES

3-ft Sampling-Head extender, order 012-0124-00 . . . . . $64

6-ft Sampling-Head extender, order 012-0125-00 . . . . . $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3S5
Programmable Dual-Trace Sampling Unit

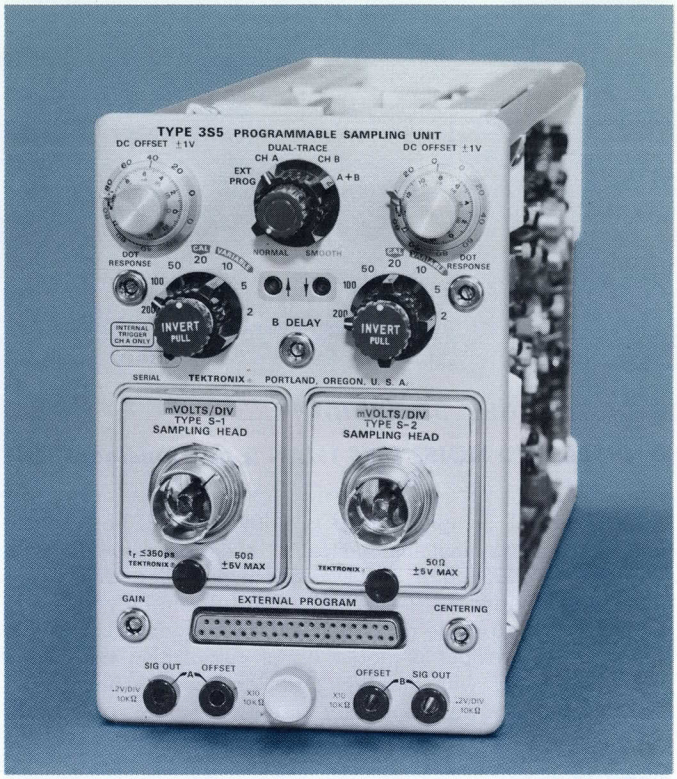
- ***PROGRAMMABLE MEASUREMENTS***
- ***PLUG-IN SAMPLING HEADS***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3S5 can be used in the Type 561B and 564B Oscilloscopes, where it may be operated manually from the front panel or externally programmed.

The Type 3S5 Programmable Sampling Unit also extends the automated measurement capabilities of the Type 568 Digital Readout Oscilloscope by allowing remote programming of the vertical plug-in measurement functions. The 240 and 241 Program Control Units are designed to program control the 3S5 and other products.

The Type 3S5 is a dual-trace programmable vertical unit featuring sampling heads that plug in directly or are located remotely with the optional sampling-head extenders. Most of the measurement functions of the Type 3S5 are externally programmable through use of parallel multi-pin connectors on the front panel of the plug-in and the rear panel of the Type 568 Oscilloscope. Programmable functions include deflection factor, DC offset and smoothing.

Sampling heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.



CHARACTERISTICS

SAMPLING HEADS

May be plugged into the Type 3S5 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874*	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF BNC	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Each channel is programmed with 3 program lines or manual front-panel controls.

DC OFFSET RANGE

+1 V to −1 V. Allows signals between +1-V and −1-V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls between +1 V and −1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and −995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code plus one program line per channel for + or − polarity.

B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to −5 ns with respect to Channel A. Accommodates up to 3-foot difference in signal cable or sampling-head extenders.

*Registered Trademark General Radio Company

PROGRAMMING

The Type 3S5 uses negative logic with *true* being ground or less than 2 V, and *false* being open or more than 6 V. The units/div range is programmed with 3 lines per channel. DC offset is programmed with 9 lines per channel in modified BCD code plus one line per channel for + or − polarity. One line is used to program smoothed or normal operation. A total of 27 program lines plus ground is required to externally program all the measurement functions of the Type 3S5.

DISPLAY MODES

A only, B only, dual trace, algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays as desired.

WEIGHTS

Net weight	11 lb	5.0 kg
Domestic shipping weight	≈19 lb	≈ 8.6 kg
Export-packed weight	≈25 lb	≈11.3 kg

INCLUDED STANDARD ACCESSORIES

Connector (131-0422-00); connector cover (200-0660-00); circuit board connector (388-0805-00); instruction manual (070-0788-00).

TYPE 3S5 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads **$1875**

OPTIONAL ACCESSORIES

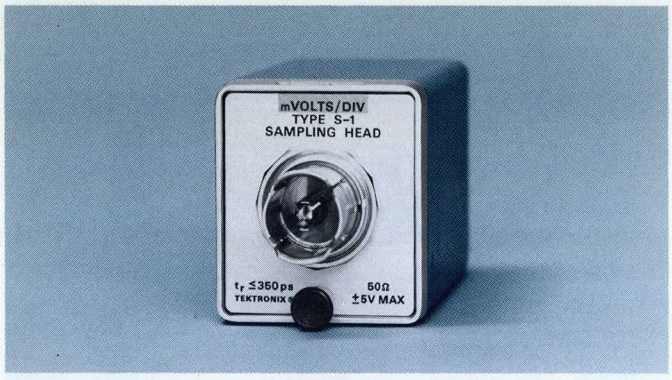
3-ft Sampling-Head extender, order 012-0124-00 ..... $64

6-ft Sampling-Head extender, order 012-0125-00 ..... $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-1 and S-2

Sampling Heads



- ***DC-TO-1 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 2 mV (unsmoothed)***

The Type S-1 Sampling Head is a low-noise, 350-ps risetime unit with a 50-Ω input impedance. It is designed for use with the Type 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the Type S-1 provides a trigger signal output from the plug-in unit. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

RISETIME
Less than or equal to 350 ps.

BANDWIDTH
Equivalent to DC to 1 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations as observed with the Type 284 Pulse Generator are +0.5%, −3% or less, total of 3.5% or less P-P, first 5 ns following the step transition; +0.5%, −0.5% or less, total of 1% or less P-P after 5 ns.

DISPLAYED NOISE
2 mV or less, unsmoothed; 1 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR874* input connectors.

WEIGHTS

Net weight	½ lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
5-ns, 50-Ω RG58/AU cable (017-0512-00); 10X, 50-Ω, GR attenuator (017-0078-00); instruction manual (070-0763-00).

TYPE S-1 SAMPLING HEAD $350

- ***DC-TO-4.5 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 6 mV (unsmoothed)***

The Type S-2 Sampling Head is a 75-ps risetime unit with a 50-Ω input impedance. It is designed for use with the Type 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the Type S-2 provides a trigger signal output from the plug-in unit. When used with the Type 3T2 Random Sampling Sweep Unit, the triggering event may be displayed on the screen without the use of delay lines or a pretrigger.

RISETIME
75 ps or less.

BANDWIDTH
Equivalent to DC to 4.5 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations as observed with the Type 284 Pulse Generator are +5%, −5% or less, total of 10% or less P-P, first 2.5 ns following a step transition; +2%, −2% or less, total of 4% or less P-P after 2.5 ns.

DISPLAYED NOISE
6 mV or less, unsmoothed; 3 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Signals between +2 V and −2 V limits may be displayed at 200 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 200 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

WEIGHTS

Net weight	½ lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
5-ns, 50-Ω RG213 cable (017-0502-00); 10X, 50-Ω, GR attenuator (017-0078-00); instruction manual (070-0764-00).

TYPE S-2 SAMPLING HEAD $400

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe, order 015-0041-00 . . . . . $40
CT-2 Signal Pickoff, order 017-0061-00 . . . . . $38
VP-1 Voltage Pickoff "T", order 017-0073-01 . . . . . $28
P6034 10X Passive Probe, order 010-0110-00 . . . . . $44
P6035 100X Passive Probe, order 010-0111-00 . . . . . $44
Power Divider GR874-TPD*, order 017-0082-00.
Coupling Capacitor, GR874-K*, order 017-0028-00.

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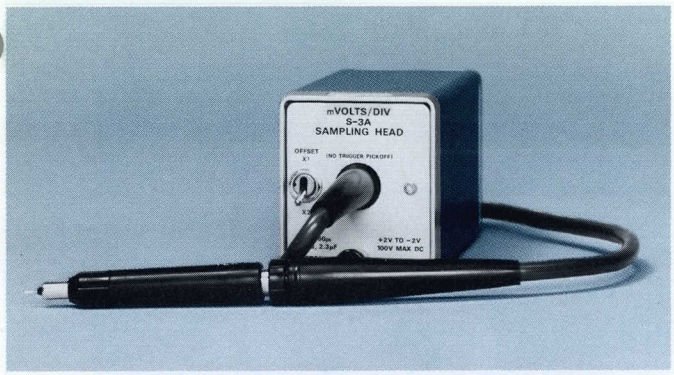
Please refer to General Information page

S-3A and S-4
Sampling Heads

NEW



- ***COMPACT, 3.5-FT, 100-kΩ, 2.3-pF PROBE***
- ***DC-to-1 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 3 mV (unsmoothed)***

The S-3A Sampling Head is an active sampling-probe unit with 100-kΩ, 2.3-pF input impedance. A switch selects a DC offset of X1 or X2 while maintaining a 2-mV/div deflection factor. The S-3A can be plugged in or attached by an optional extender for remote use with 7S11, 7S12, 3S2, 3S5, and 3S6 and the 286.

Optional probe choppers are available; refer to the Type 230 pages.

RISETIME
Probe only, 350 ps or less.

BANDWIDTH
Probe only is equivalent to DC-to-1 GHz at 3-dB down.

TRANSIENT RESPONSE (Probe Only)
Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less P-P, +1%, −1% or less, total of 2% or less P-P after 2 ns, with Type 284 pulse displayed.

DISPLAYED NOISE (Probe Only)
3 mV or less referred to probe tip (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V, X1 range; or +2 V and −2 V, X2 range to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the use of the probe attenuators.

PROBE ACCURACY
Accuracy is within 1% for probe only.

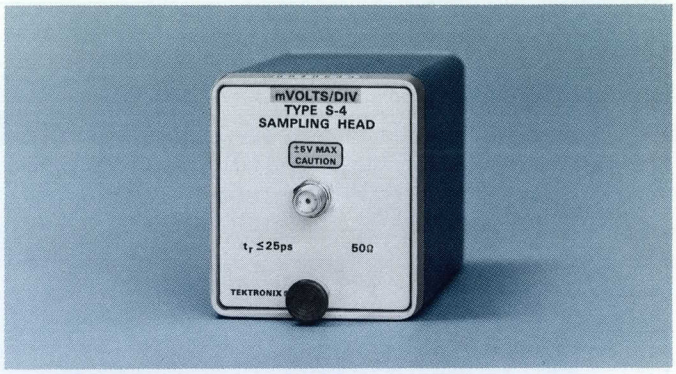
INPUT CHARACTERISTICS
Probe only is 100 kΩ paralleled by 2.3 pF.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

INCLUDED STANDARD ACCESSORIES
10X attenuator head (010-0364-00); 100X attenuator head (070-0365-01); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½-inch ground lead (175-1017-00); 12½-inch ground lead (175-1018-00); 3-inch cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50-Ω voltage pickoff (017-0077-01); carrying case (016-0121-00); instruction manual (070-1148-00).

TYPE S-3A SAMPLING HEAD $550



- ***25-ps SAMPLING HEAD***
- ***DC-to-14 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 5 mV (unsmoothed)***

The S-4 Sampling Head is a 25-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5, 3S6, 7S11, 7S12, and 286. The S-4 can be plugged into the sampling unit or attached by a Sampling-Head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

RISETIME
25 ps or less.

BANDWIDTH
Equivalent to DC-to-14 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations in the first 400 ps following a step are: −10%, +10% or less, total of 20% or less P-P with Type S-50 pulse displayed; from 400 ps to 25 ns following a step, 0%, +10% or less, total of 10% or less P-P with Type 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less P-P with Type 284 pulse displayed.

DISPLAYED NOISE
5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).

SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV P-P.

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload ±5 V. SMA (3-mm) input connector.

WEIGHTS

Net weight	½ lb	≈0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
2-ns cable with SMA connectors (015-1005-00); 10X 50-Ω SMA attenuator (015-1003-00); GR874* to SMA male adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); 5/16-inch wrench (003-0247-00); instruction manual (070-0896-00).

TYPE S-4 SAMPLING HEAD $875

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Please refer to General Information page

- ***1-MΩ, 15-pF INPUT IMPEDANCE***
- ***PASSIVE PROBE***
- ***INTERNAL TRIGGER PICKOFF***

The S-5 Sampling Head is a low noise, 1-ns risetime sampling unit with a 1-MΩ, 15-pF input impedance. When used with the P6010 passive probe the input impedance increases to 10 MΩ, 10 pF while maintaining the 1-ns t_r at the probe tip. A switch on the sampling head selects either AC or DC coupling of the input.

The S-5 Sampling Head is designed for use with the 7S11, 7S12, 3S2, 3S5, 3S6 and 286 and can be plugged in or attached by an optional Sampling-Head extender for remote use.

CHARACTERISTICS

RISETIME

S-5 only, 1 ns or less; with 3.5 foot P6010, 1 ns or less.

BANDWIDTH

Equivalent to DC-to-350 MHz at 3-dB down at input connector or probe tip.

TRANSIENT RESPONSE

S-5 only (driven with a 50-Ω source terminated in 50 Ω): aberrations +2.5%, —5% or less, total of 7.5% or less P-P within 17 ns after step +1%, —1% or less, total of 2% or less P-P thereafter.

S-5/P6010 (3.5-foot probe properly compensated): aberrations +6%, —5% or less, total of 10% or less P-P within 25 ns after step; +1%, —1% or less, total of 2% or less P-P thereafter.

DISPLAYED NOISE

S-5 only, 500 μV or less (includes 90% of dots).

S-5/P6010, 5 mV or less (includes 90% of dots).

SIGNAL RANGE

S-5 only: DC coupled (DC + peak AC)—1 V P-P; AC coupled, DC voltage—100 V.

S-5/P6010: DC coupled (DC + peak AC)—10 V P-P; AC coupled, DC voltage—100 V.

INPUT CHARACTERISTICS

S-5 only is 1 MΩ within 1% paralleled by 15 pF within 1 pF.

S-5/P6010 is 10 MΩ paralleled by approx 10 pF.

ATTENUATION ACCURACY

Probe attenuation is 10X within 3%.

WEIGHT

Net weight	≈9 oz	≈0.2 kg
Domestic shipping weight	≈3 lb	≈1.4 kg

INCLUDED STANDARD ACCESSORIES

P6010 probe package (010-0188-00), 50-Ω termination (011-0129-01); instruction manual (070-0942-00).

TYPE S-5 SAMPLING HEAD $375

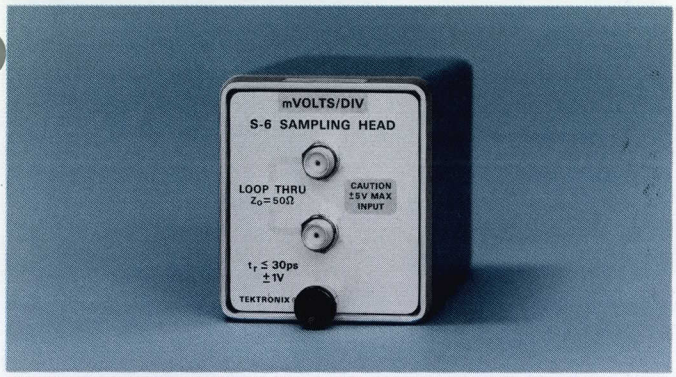
OPTIONAL ACCESSORIES

P6010 passive 10X probe package, order 010-0188-00 .. $41.00
Probe tip-to-BNC adapter, order 013-0084-01 ..... $5.30
Probe tip-to-GR adapter, order 017-0076-00 ..... $8.30

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-6
Sampling Head

NEW



- ***30-ps RISETIME***
- ***DISPLAYED NOISE LESS THAN 7 mV (UNSMOOTHED)***
- ***LOOP-THROUGH INPUT***

The S-6 Sampling Head is a 50-Ω feed-through unit for general-purpose applications in the 3S2, 3S5, 3S6, 286, or 7S11, and TDR applications in the 7S12 Time Domain Reflectometer.

RISETIME
30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

BANDWIDTH
Equivalent to DC to 11.5 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations in the first 5 ns of step are: +5%, −5%, total of 10% P-P with S-52 pulse displayed; after 5 ns, +2%, −2%, total of 4% P-P.

DISPLAYED NOISE
7 mV or less, measured tangentially.

SIGNAL RANGE
+1 V to −1 V (DC plus peak AC). 1 V P-P, maximum operating.

INPUT CHARACTERISTICS
Nominally 50-Ω, loop-through system, unterminated. SMA (3-mm) connectors. Input resistance is 10 kΩ within 1.0%. Maximum safe overload is ±5 V.

WEIGHTS

Net weight	½ lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
50-Ω termination (015-1022-00); 1-ns, 50-Ω cable (015-1019-00); SMA (3-mm) female-to-female adapter (015-1012-00); SMA male-to-GR874* adapter (015-1007-00); combination wrench (003-0247-00); instruction manual (070-1128-00).

S-6 SAMPLING HEAD $875

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OPTIONAL ACCESSORIES FOR SAMPLING HEADS

With SMA (3-mm) Connectors

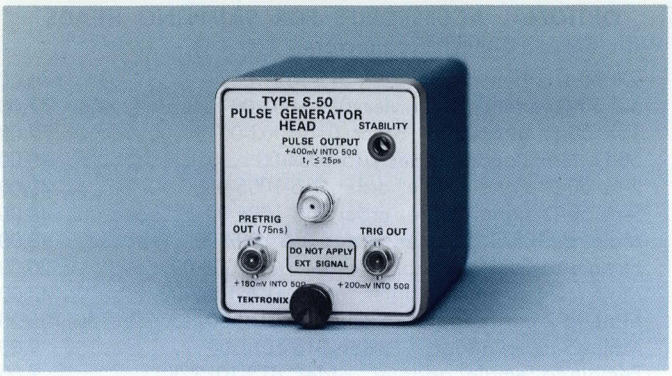
2X 50-Ω attenuator, order 015-1001-00	$66.00
5X 50-Ω attenuator, order 015-1002-00	77.00
10X 50-Ω attenuator, order 015-1003-00	72.00
50-Ω termination, order 015-1004-00	40.00
2-ns 50-Ω signal cable, order 015-1005-00	40.00
5-ns 50-Ω signal cable, order 015-1006-00	40.00
Male-to-GR874 adapter, order 015-1007-00	20.00
Female-to-GR874 adapter, order 015-1008-00	20.00
Male-to-N female adapter, order 015-1009-00	40.00
Male-to-7-mm adapter, order 015-1010-00	105.00
Male-to-male adapter, order 015-1011-00	9.00
Female-to-female adapter, order 015-1012-00	7.00
Coupling capacitor, order 015-1013-00	75.00
50-Ω power divider T, order 015-1014-00	94.00
500-ps 50-Ω semi-rigid cable, order 015-1015-00	24.00
SMA T adapter, order 015-1016-00	18.00
SMA male-to-BNC female adapter, order 015-1018-00	4.50
1-ns 50-Ω cable, order 015-1019-00	22.00
SMA male short-circuit termination, order 015-1020-00	6.60
SMA female short-circuit termination, order 015-1021-00	6.60
SMA male 50-Ω termination, order 015-1022-00	27.50

With BNC Connectors

50-Ω feedthrough termination, order 011-0049-01	$10.00
50-Ω feedthrough (5 watt), order 011-0099-00	18.50
50-Ω 2X attenuator, order 011-0069-01	16.50
50-Ω 2.5X attenuator, order 011-0076-01	16.50
50-Ω 5X attenuator, order 011-0060-01	16.50
50-Ω 10X attenuator, order 011-0059-01	16.50
50-Ω, 18-in, coaxial cable, order 012-0076-00	6.00
50-Ω, 42-in, coaxial cable, order 012-0057-01	6.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-50 Pulse Generator Head
S-51 Trigger Countdown Head



- ***25-ps PULSE RISETIME***
- ***400-mV PULSE AMPLITUDE***
- ***100-ns PULSE WIDTH***

The S-50 Pulse Generator Head is a high-speed, tunnel-diode step generator designed for use in the 7S11, 3S2, 3S5, 3S6, 7S12, 285, and 286. The S-50 when used with the S-4 Sampling Head provides high-resolution 35-ps TDR measurements. The S-50 is also used for verification of sampling system risetimes. A pretrigger output allows operation with sequential sampling systems.

CHARACTERISTICS

PULSE OUTPUT
Risetime is 25 ps or less. Amplitude into 50 Ω is at least 400 mV, positive going. Pulse duration is 100 ns, pulse repetition rate is 25 kHz. Pulse aberrations following the step are: —10%, +10% with a total of 20% or less P-P in the first 400 ps, —5%, +5% with a total of 8% or less P-P from 400 ps to 5 ns; —4%, +1% with a total of 5% or less P-P after 5 ns.

PRETRIGGER OUTPUT
Risetime is 400 ps or less. Amplitude into 50 Ω is at least 180 mV, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 75 ns (±5 ns) before the pulse output. Pretrigger to pulse output jitter is 15 ps or less.

TRIGGER OUTPUT
Risetime is 200 ps or less. Amplitude into 50 Ω is at least 200 mV, positive going. Trigger pulse duration is 100 ns. The trigger output occurs in time coincidence with the pulse output.

POWER REQUIREMENTS
The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

OUTPUT CONNECTORS
Pulse output uses a SMA (3-mm) connector. Pretrigger output and trigger output use BSM connectors. A pretrigger output from the rear of the Type S-50 provides a pretrigger pulse for internal triggering of the sampling sweep unit.

WEIGHTS

Net weight	¾ lb	0.3 kg
Domestic shipping weight	≈3 lb	≈1.4 kg

INCLUDED STANDARD ACCESSORIES
500 ps 50 Ω semi-rigid coax (015-1015-00); instruction manual (070-0897-00).

TYPE S-50 PULSE GENERATOR HEAD $525

- ***18 GHz COUNTDOWN***
- ***10 ps or less TRIGGER JITTER***

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 may be used with the 3S2, 3S5, 3S6, 7S11 Sampling Units and 7S12 TDR Unit or it may be operated separately with the 285 Power Supply or 286. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a sub-harmonic of the input signal. The output from the Type S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

CHARACTERISTICS

INPUT SIGNAL
Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV P-P, as measured separately into 50 Ω; 5 V, P-P maximum.

INPUT CHARACTERISTICS
50-Ω SMA (3-mm) connector. Open termination paralleled by 1 pF.

TRIGGER OUTPUT
Front panel trigger output is at least 200 mV into 50 Ω, Type BSM connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less, with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less, kickout occurs between successive samples.

POWER REQUIREMENTS
The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

WEIGHT

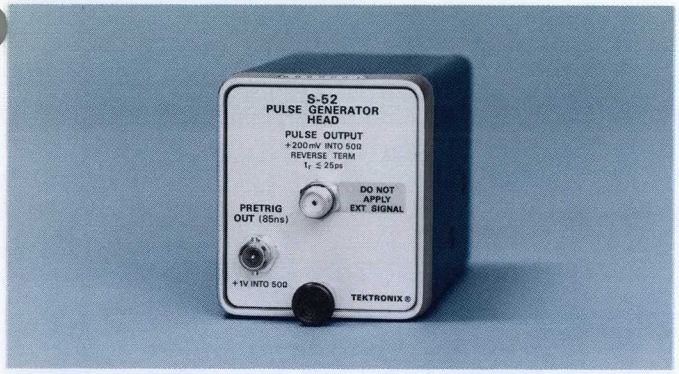
Net weight	½ lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

TYPE S-51 TRIGGER COUNTDOWN HEAD $500
Includes instruction manual (070-0898-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Pulse Generator Head S-52
Trigger Recognizer Head S-53

NEW



- ***25-ps RISETIME***
- ***200-mV AMPLITUDE***
- ***PRETRIGGER OUTPUT***

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 Time Domain Reflectometer. The S-52 is also useful in the 7S11, 3S2, 3S5, 3S6, 285, or 286.

Intended for TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50-Ω, reverse termination minimizes reflections. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

PULSE OUTPUT
Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration is 2.5 μs within 0.5 μs. Pulse aberrations following the step are: +5%, −5%, total of 10% P-P, within 5 ns of step; +2%, −2%, total of 4% P-P after 5 ns.

PRETRIGGER OUTPUT
Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive-going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

POWER REQUIREMENTS
Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

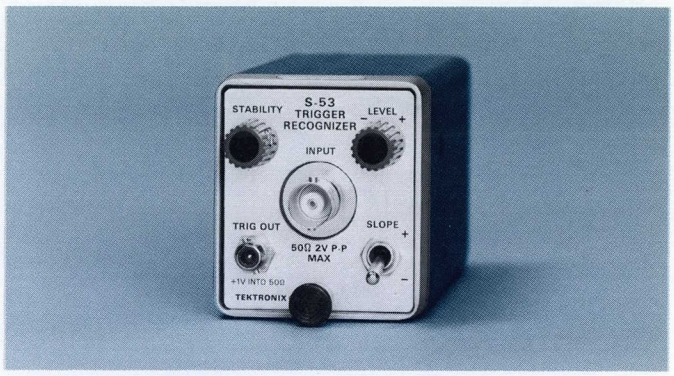
OUTPUT CONNECTORS
Pulse output uses a SMA (3-mm) connector. Pretrigger output uses a BSM connector.

WEIGHTS

Net weight	¾ lb	0.3 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
500-ps, 50-Ω semi-rigid coax (015-1015-00); instruction manual (070-1101-00).

S-52 PULSE GENERATOR HEAD $550



- ***DC-to-1 GHz OPERATION***
- ***10-mV SENSITIVITY***

The S-53 Trigger Recognizer Head is intended for use with the 7S12 Time Domain Reflectometer Unit to permit operation as a general-purpose sampling system. When used in place of the pulse generator head, the S-53 receives the triggering signal at its input and supplies trigger outputs for the 7S12 or for other triggering applications. The S-53 can also be used in the 7S11, 3S2, 3S5, 3S6, 285, or 286.

INPUT CHARACTERISTICS
Frequency range is DC to 1 GHz. Sensitivity range is 10 mV to 2 V P-P into 50 Ω. Kickout at input, ±5 mV or less.

OUTPUT CHARACTERISTICS
Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 5 ns or less. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

POWER REQUIREMENTS
Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

CONNECTORS
Trigger input connector is BNC type. Front-panel, trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

WEIGHTS

Net weight	¾ lb	0.3 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED STANDARD ACCESSORIES
42-inch, 50-Ω cable (012-0057-01); 10X, 50-Ω attenuator (011-0059-01); instruction manual (070-1147-00).

S-53 TRIGGER RECOGNIZER HEAD $375

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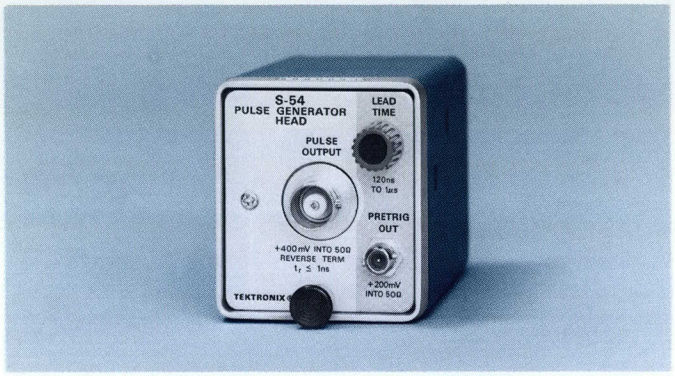
Please refer to General Information page

NEW

S-54 Pulse Generator Head
285 Power Supply for S-50 Series Heads



- ***1-ns RISETIME***
- ***GREATER THAN +400 mV AMPLITUDE***
- ***VARIABLE PRETRIGGER LEAD TIME***

The S-54 Pulse Generator Head is a current-source step generator designed for use with the 7S12 Time Domain Reflectometer Unit. The S-54 is also useful in the 3S2, 3S5, 3S6, 7S11, 285, or 286.

Intended for TDR applications, the S-54 is 50-Ω reverse-terminated to minimize reflections and a zero-volt baseline to eliminate baseline shift with load changes. A front-panel continuously variable control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

PULSE OUTPUT

Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are: +1.5%, —1.5%, total of 1.5% P-P, as displayed with S-1 Sampling Head. Baseline level is 0 V within 20 mV, terminated in 50 Ω.

PRETRIGGER OUTPUT

Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front-panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger to pulse output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

OUTPUT CONNECTORS

Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

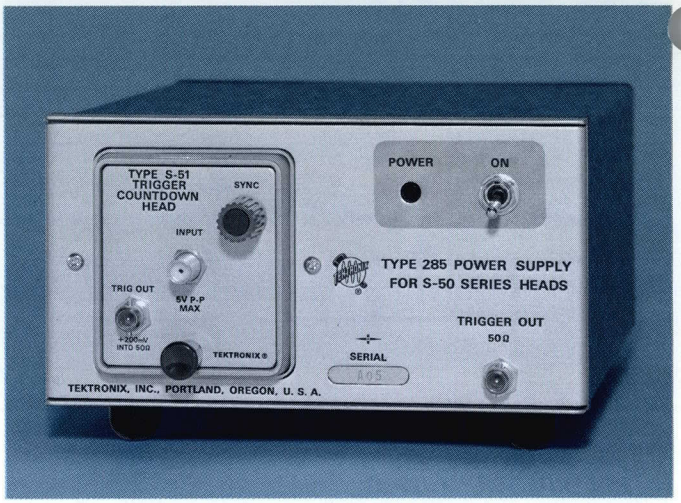
WEIGHTS

Net weights	¾ lb	0.3 kg
Domestic shipping weight	2 lb	0.9 kg

INCLUDED STANDARD ACCESSORIES

BNC T connector (103-0030-00); 8-inch, 50-Ω cable (012-0123-00); instruction manual (070-1093-00).

S-54 PULSE GENERATOR HEAD **$275**



- ***ACCEPTS ONE S-50 SERIES HEAD***
- ***TRIGGER OUTPUT JACK***

The 285 Power Supply provides the regulated power supplies necessary to power one S-50 Series Head. It also has a front panel trigger output jack which provides the internal trigger pulse from the plug-in Head to the front panel of the 285.

CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, 50 Hz to 400 Hz, 8.5 watts at 115 V and 60 Hz. Slide switch on rear panel selects high or low voltage operation.

TRIGGER OUTPUT

BSM Connector provides internal trigger output of S-50 Series Heads to the front panel.

DIMENSIONS AND WEIGHTS

Height	3⅛ in	5.1 cm
Width	5 in	12.7 cm
Depth	8 in	20.3 cm
Net weight	2 lb	0.9 kg
Domestic shipping weight	≈4 lb	≈2.8 kg

INCLUDED STANDARD ACCESSORIES

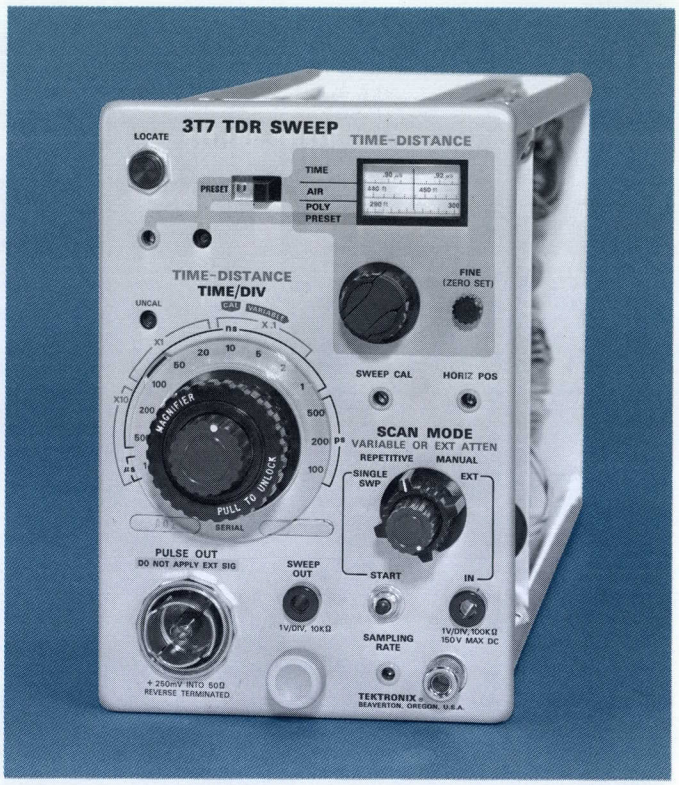
18 inch trigger output cable (012-0127-00); instruction manual (070-0903-00).

285 POWER SUPPLY, without Heads **$165**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3S7/3T7
TDR System

NEW



- ***140-ps TDR SYSTEM RISETIME***
- ***RHO AND VOLTAGE CALIBRATION***
- ***TIME POSITION LOCATE BUTTON***
- ***DIRECT-READING TO 4920 FT***

The 3S7 TDR Sampler and 3T7 TDR Sweep Units function together as a simplified, low-cost, time domain reflectometry system designed to operate in a Type 561B or 564B Oscilloscope.

The 3S7 TDR Sampler is a single channel, loop-through unit calibrated in V/div or ρ/div (rho/div). The 3T7 TDR Sweep Unit has concentric TIME/DIV and TIME-DISTANCE range controls, with time or distance measurements made from a direct-reading tape scale.

A LOCATE push button provides a quick way to determine which portion of the time position range is being displayed. When the button is pressed, the entire range is displayed with a brightened portion indicating which portion was displayed.

The tunnel diode pulse output has an amplitude of about 250 mV into 50 Ω. An automatic bias circuit stabilizes the TD under all conditions of external loading and temperature.

Because of their simplified and specialized design, the 3S7 or 3T7 is not compatible with other plug-in units, nor are they suitable for use as a general-purpose sampling system.

3S7 PERFORMANCE

SYSTEM RISETIME
140 ps or less, for the displayed reflection from a 20-cm air line.

VERTICAL SCALE
Calibrated in ρ (rho) and volts: 0.005 ρ/div to 0.5 ρ/div or 5 mV/div to 500 mV/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Continuous uncalibrated variation between steps.

INPUT CHARACTERISTICS
Nominal 50-Ω feed-through signal channel (termination supplied). GR874* connectors.

DC OFFSET RANGE
+1 V to −1 V. Allows open-circuit reflection to be displayed at full sensitivity.

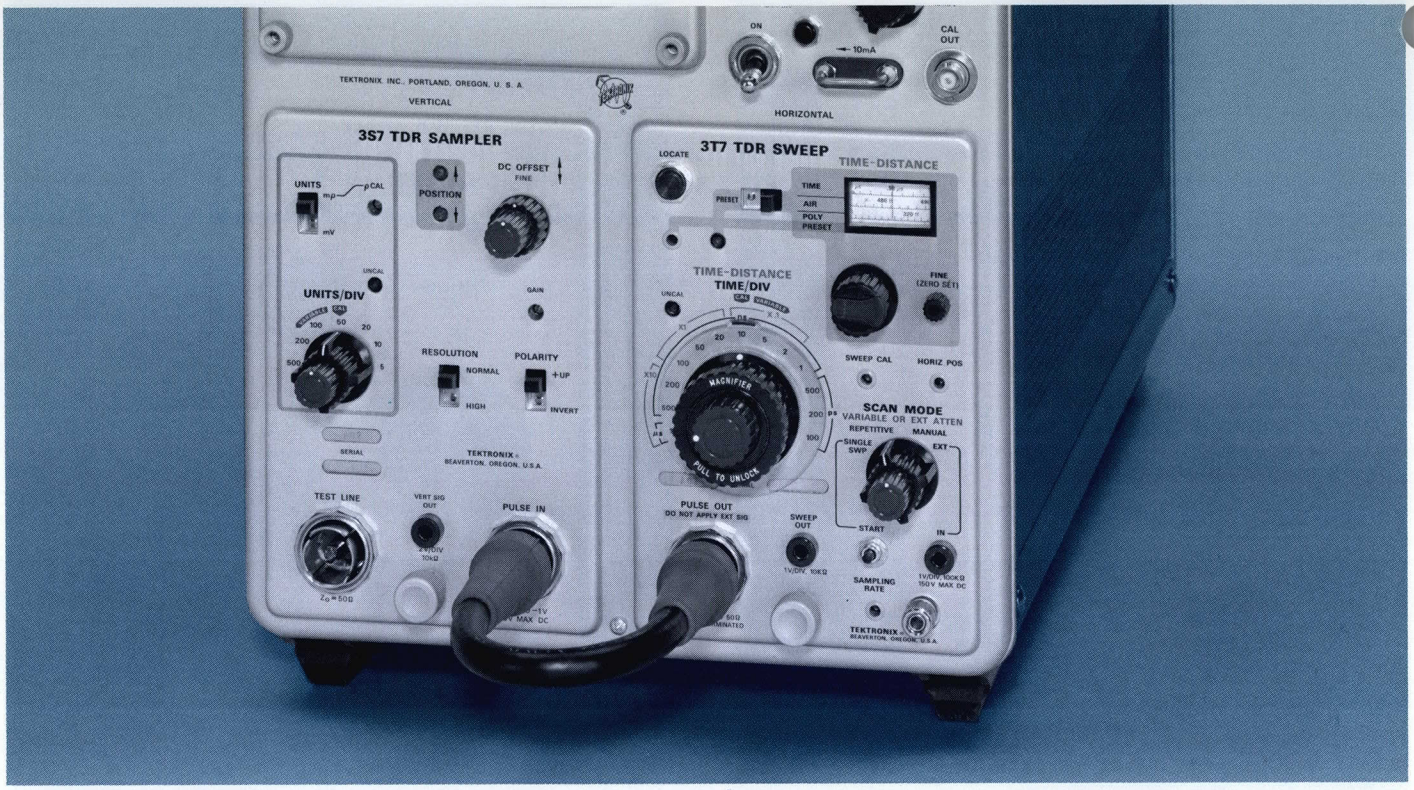
VERTICAL OUTPUT
0.2 V for each division of displayed signal through 10 kΩ.

3T7 PERFORMANCE

TIME/DISTANCE
The direct-reading TIME-DISTANCE tape dial has three scales. TIME reads 0 to 1 μs; AIR dielectric reads 0 to 492 ft; POLY dielectric reads 0 to 324 ft. Round-trip time readings are ac-

*Registered Trademark General Radio Company

3S7/3T7
TDR System



curate within 1%. The TIME-DISTANCE MULTIPLIER provides positions of X0.1, X1, and X10 the tape dial reading. Optional tape dial (see below) is calibrated in metric units.

EQUIVALENT TIME/DIV
100 ps to 1 μs in thirteen calibrated steps, 1-2-5 sequence. Accuracy is within 3%, after arrival of incident edge of pulse.

JITTER
20 ps or less with TIME-DISTANCE MULTIPLIER at X0.1.
0.2 ns or less with TIME-DISTANCE MULTIPLIER at X1.
2 ns or less with TIME-DISTANCE MULTIPLIER at X10.

DIELECTRIC
Calibrated for air (492 ft/μs or 150 m/μs) and poly (324 ft/μs or 98.8 m/μs). PRESET position can be front-panel adjusted from 324 ft/μs to 492 ft/μs or greater.

DISPLAY MODES
Repetitive or single sweep, manual or external scan.

HORIZONTAL OUTPUT
1 V for each division of displayed signal through 10 kΩ.

PULSE SOURCE
Amplitude is 250 mV into 50 Ω, reverse terminated.

WEIGHT 3S7

Net weight	2¾ lb	1.3 kg
Domestic shipping weight	≈4½ lb	≈2.1 kg
Export-packed weight	≈8½ lb	≈3.9 kg

3S7 TDR SAMPLER $425

INCLUDED STANDARD ACCESSORIES
10-inch GR cable (017-0513-00); 20-inch GR cable (017-0515-00); 20-cm Air Line (017-0084-00); 50-Ω termination (017-0081-00); short circuit termination (017-0087-00); instruction manual (070-1092-00); TDR Measurement Concepts Book (062-1244-00).

WEIGHT 3T7

Net weight	3½ lb	1.6 kg
Domestic shipping weight	≈5¼ lb	≈2.4 kg
Export-packed weight	≈9¼ lb	≈4.2 kg

3T7 TDR SWEEP, tape dial in feet $575

3T7 TDR SWEEP MOD 950A, tape dial in meters . . . $575

OPTIONAL ACCESSORIES

Tape dial in meters (331-0273-00) $8
Tape dial in feet (331-0276-00) $8

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3T2
Random Sampling Sweep Unit

- ***RANDOM OR SEQUENTIAL SAMPLING***
- ***20 ps/DIV to 100 μs/DIV CALIBRATED TIME BASE***
- ***NO PRETRIGGER REQUIRED***

The Type 3T2 Random Sampling Sweep Unit provides a unique, state-of-the-art advancement in measurement capabilities. This unit may be used in a Type 561B, 564B or 568 Oscilloscope, in conjunction with a Vertical Dual-Trace Sampling Unit.

Random sampling permits observation of the leading edge (or other portions) of signals even when used with vertical units that have no delay lines and without a pretrigger. Random sampling is especially useful with sampling units such as the Type 3S2 with S-1, S-2, S-3A, S-4, S-5 or S-6 Sampling Heads.

A front-panel switch (START POINT) selects either conventional, sequentially-stepped sampling or random sampling modes of operation.

SWEEP TIME/DIV

100 μs/div to 200 ps/div, 1-2-5 sequence extending to 20 ps/div with X10 DISPLAY MAGNIFIER. Accurate within 3% from 100 μs/div to 2 ns/div, within 5% from 1 ns/div to 200 ps/div. TIME/DIV is a resultant of the combined settings of TIME POSITION RANGE, TIME MAGNIFIER, and DISPLAY MAG. The sweep rate is displayed (digitally) in the TIME/DIV "window" for all combinations of these controls.

DISPLAY MAG

X10 expansion of time scale while maintaining a constant number of dots per division. Display magnifier accurate within 2%, in addition to specified sweep time/div accuracy.

TIME POSITION RANGE

100 ns, 1 μs, 10 μs, 100 μs, and 1 ms. TIME POSITION and FINE variable controls position start of the display through an interval equal to TIME POSITION RANGE setting.

SAMPLES/DIV

Continuously variable adjustment of samples displayed per horizontal division from approx 5 samples/div to an immeasurable number of samples/div. Allows optimum adjustment of display rate and dot density.

DISPLAY MODES

Normal (repetitive), Single Sweep, Manual, or Ext. Horiz. For external input, deflection factor is adjustable from 1.5 V/div to 15 V/div. Front-panel START button for single-sweep operation.

PULSE OUTPUT

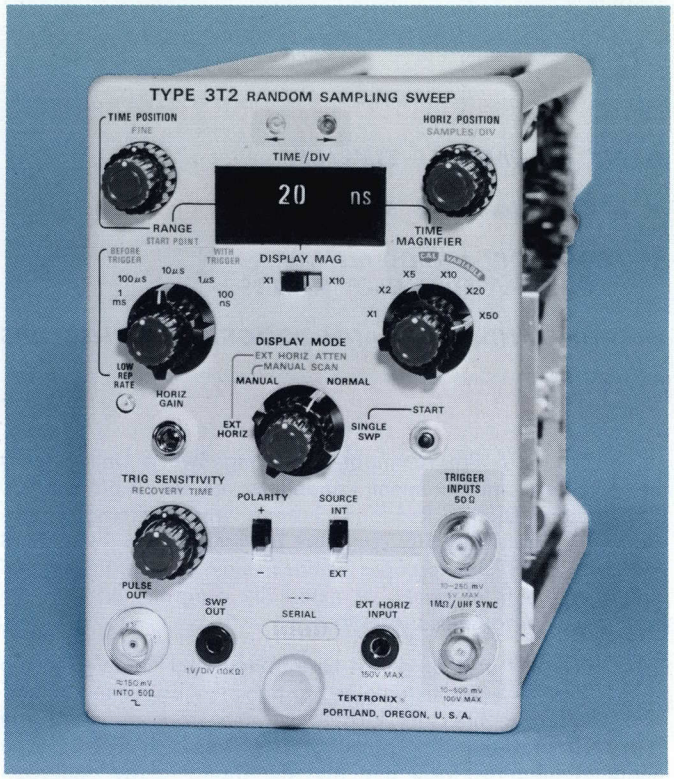
At least 100 mV into 50 Ω, negative going. Coincides with trigger recognition.

TRIGGERING

SOURCES (AC-coupled): Internal—if Sampling Unit contains a trigger pickoff. External, both 1-MΩ (for hi-Z probes) and 50-Ω terminated inputs.

JITTER: Depends on signal shape, repetition rate and amplitude; Less than or equal to 20 ps under optimum conditions.

MINIMUM TRIGGER REPETITION RATE IN "BEFORE TRIGGER" MODE	
TIME/DIV	REPETITION RATE
1 ms and 100 μs	10 Hz
10 μs	100 Hz
1 μs	1 kHz
100 ns	10 kHz



HORIZONTAL OUTPUT

1 V for each division of displayed signal through 10 kΩ.

PULSE TRIGGERING		
SOURCE	REPETITION RATE	AMPLITUDE*
EXTERNAL	10 Hz to 100 MHz	10 mV to 250 mV
1-MΩ/UHF Sync input	600 MHz to 3 GHz	(100 V max DC)
EXTERNAL	10 Hz to 600 MHz	5 mV to 125 mV
50-Ω input		(5 V max DC)

*Either polarity. Minimum rise rate is 150 mV/μs.

SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
EXTERNAL	10 kHz to 100 MHz	10 mV to 500 mV
1-MΩ/UHF Sync input	500 MHz to 3 GHz (+ polarity)	peak-to-peak
	100 kHz to 100 MHz 500 MHz to 3 GHz (— polarity)	
EXTERNAL 50-Ω input	100 kHz to 500 MHz	10 mV to 250 mV peak-to-peak

WEIGHTS

Net weight	8 lb	3.6 kg
Domestic shipping weight	≈15 lb	≈6.8 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES

10X 50-Ω attenuator, BNC (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); instruction manual (070-0631-00).

TYPE 3T2 RANDOM SAMPLING SWEEP UNIT $1250

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3T5

Programmable Sampling Sweep Unit

- ***PROGRAMMABLE TIME/DIV***
- ***PROGRAMMABLE SWEEP DELAY***
- ***100 ps/DIV-to-500 ms/DIV CALIBRATED SWEEP RANGE***
- ***FRONT AND REAR PANEL PROGRAM CONNECTORS***

The Type 3T5 Programmable Sampling Sweep Unit extends the automatic measurement capabilities of the Type 568/230 (Oscilloscope/Digital Readout) System, when externally programmed. The Type 3T5 can also be used in the Type 561B and Type 564B Oscilloscopes where it may be operated manually from the front panel, or externally programmed with the front panel program connector.

The time/div range, delay time range and samples/sweep of the Type 3T5 are externally programmed by means of parallel multipin connectors located on the front panel of the Type 3T5 and the rear panel of the Type 568 Oscilloscope (Serial Number B110000 and above). Digital delay and real-time sampling (1 ms/div to 500 ms/div) are controlled by a clock and digital counter within the plug-in unit. An automatic trigger mode is provided to eliminate the need for trigger adjustments over a wide range of trigger amplitudes, repetition rates, risetimes and pulse widths.

CHARACTERISTICS

SWEEP TIME/DIV

Remotely programmable or front-panel operation from 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. TIME/DIV "window" provides digital readout of all sweep time/div settings in both programmable and manual modes of operation. Programming is accomplished with 7 program lines. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep, that can be programmed off screen.

SAMPLES/SWEEP

100 samples/sweep or 1000 samples/sweep are available in both the manual and external programming modes of operation. In the external program modes, the Type 230 Digital Unit can program the sweep unit to scan quickly (100 samples/sweep) when not making a measurement, but provides maximum measurement resolution (1000 samples/sweep) when making the measurement.

DELAY RANGE

The digital delay is remotely programmable or selectable from the front panel. The delay range is from 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div; 0 to 9.999 μs in 1-ns increments from 1 ns/div to 1 μs/div; 0 to 999.9 μs in 100-ns increments from 2 μs/div to 500 μs/div. Programming is accomplished with 16 program lines.

DELAY JITTER (All Sweep Speeds)

≤0.1 div, independent of the amount of delay.

TRIGGERING

SOURCES: Internal, if sampling unit contains a trigger pick-off; External, 50-Ω terminated input.

JITTER: External automatic, pulse, 30 ps or less with 300-mV pulse, 2 ns or less wide; sinewave, 200 ps or less with 300-mV P-P signal at 30 MHz.

PULSE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE
Internal	1 Hz to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 m

SINEWAVE TRIGGERING		
SOURCE	FREQUENCY	AMPLITUDE peak-to-peak
Internal	100 kHz to 100 MHz	100 m to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

WEIGHTS

Net weight	8 lb	3.6 kg
Domestic shipping weight	≈14 lb	≈6.3 kg
Export-packed weight	≈19 lb	≈8.6 kg

INCLUDED STANDARD ACCESSORIES

5-ns, 50-Ω RG58 cable with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); electrical connector (131-0422-00); electrical connector cover (200-0660-00); circuit board connector (388-0805-00); instruction manual (070-0760-01).

TYPE 3T5 SAMPLING UNIT $1975

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

3T77A
Sampling Sweep Unit

- ***20 ps/DIV to 10 μs/DIV CALIBRATED TIME BASE***
- ***TRIGGERING THROUGH 1 GHz***

The Type 3T77A Sampling Sweep Unit provides sub-nanosecond capabilities when used in conjunction with a Type 3S1, 3S2, 3S5 or 3S6 Sampling Unit in a Type 561B, 564B, or 568 Oscilloscope. In the Type 568 (with Type 230), information can be presented in digital as well as analog form.

CHARACTERISTICS

SWEEP TIME/DIV
10 μs/div to 200 ps/div in 15 calibrated steps, 1-2-5 sequence, extending to 20 ps/div with X10 TIME EXPANDER. Each step accurate within 3%. Variable between steps.

TIME EXPANDER
X10 expansion of time scale while maintaining a constant number of dots per division.

TIME POSITION
Provides a sweep delay range corresponding to at least one screen diameter, unexpanded and at least ten screen diameters (100 div) when expanded.

DOT DENSITY
Either 10 or 100 dots/div.

SWEEP MODES
Normal (repetitive), Single Sweep, Manual, or External Horizontal. For external input, deflection factor is adjustable from 5 V/div to 25 V/div. Front panel RESET button for single-sweep operation.

TRIGGERING
SOURCES (AC-coupled): Internal—if Sampling Unit contains a trigger pickoff. External, 50-Ω termination input.

AMPLITUDE (External): Sinewaves, 10 mV to 400 mV peak-to-peak; Pulses, 10 mV to 200 mV, either polarity. 5-V maximum DC input.

REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 1 GHz. Pulse Triggering from 30 Hz through 1 GHz.

JITTER: Depends on signal shape, repetition rate and amplitude; less than or equal to 50 ps under optimum conditions.

TRIGGER OUTPUT
Approximately 150 mV into 50 Ω, positive going, coincides with trigger recognition.

SWEEP OUTPUT
1 V for each division of displayed signal through 10 kΩ.

WEIGHTS

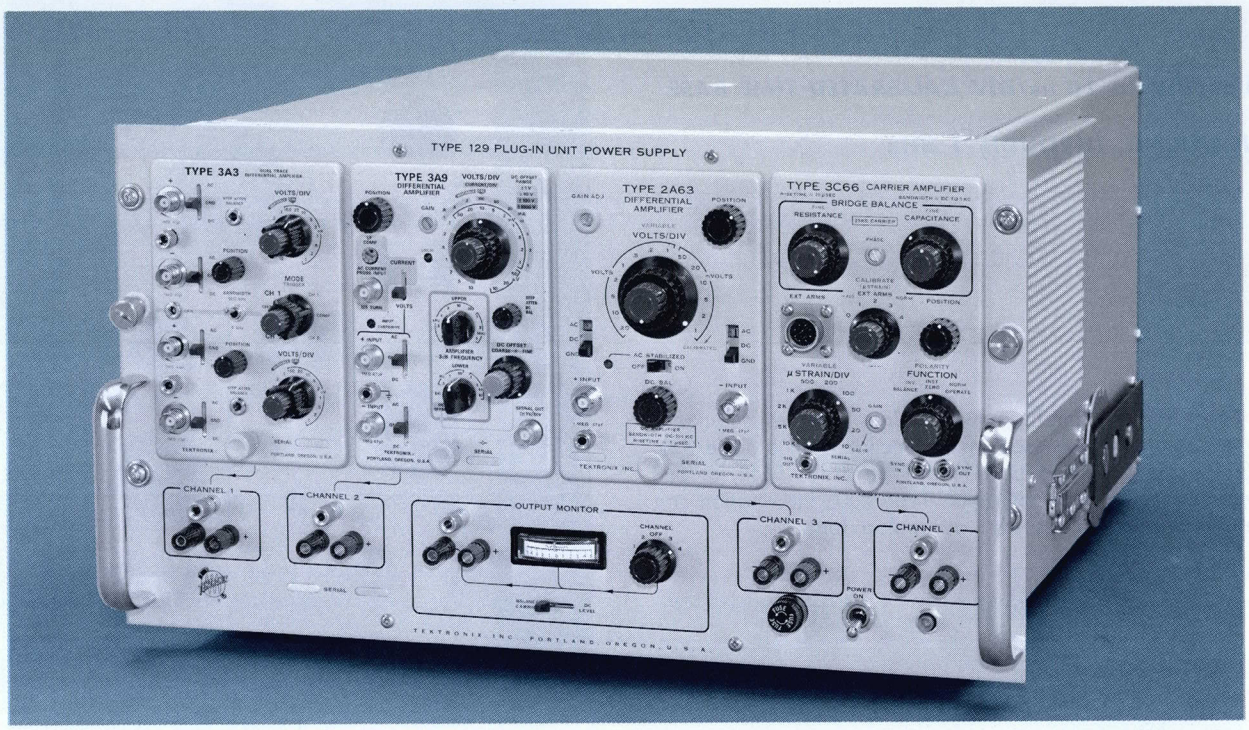
Net weight	8 lb	3.6 kg
Domestic shipping weight	≈12 lb	≈5.4 kg
Export-packed weight	≈16 lb	≈7.2 kg

INCLUDED STANDARD ACCESSORIES
5-ns cable, RG58 with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); instruction manual (070-0546-00).

TYPE 3T77A SAMPLING SWEEP UNIT $900

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

Power Supply for Plug-In Units



- ***1-MHz BANDWIDTH WITH CATHODE-FOLLOWER OUTPUT CARD***
- ***100-kHz BANDWIDTH WITH PASSIVE-DIVIDER OUTPUT CARD***
- ***SINGLE-ENDED OR DIFFERENTIAL VOLTAGE OUTPUTS***

The Type 129 Plug-In Supply provides a method of utilizing 2- and 3-Series Amplifier and Time-Base Plug-In Units in a wide variety of instrumentation systems. With this power supply, the amplifiers can be used to drive recording equipment, X-Y plotters, oscilloscopes, or other external indicators having requirements within the plug-in unit specifications. The unit is designed to mount in a standard 19-inch rack.

The Type 129 is recommended for use with the 2- and 3-Series single-channel low-frequency amplifiers. Multiple-trace plug-ins are usable in the Type 129, but operation should be limited to single-trace modes unless provision is made to operate the multiple-trace switching circuits at a relatively slow rate compatible with the output-circuit bandwidth.

The Type 129 powers up to four 2- and 3-Series plug-in units, singly or in combination.* Each plug-in unit fits into a plug-in compartment having an output connector at the front and rear panels. A selectable cathode-follower or passive circuit card, placed between the plug-in unit and the output connector, controls the output characteristics. All plug-in units that do not have a signal-out provision on the front panel must use one of these cards in order to function properly. Plug-in units with signal-output connectors on the front panel can be used with or without circuit cards.

With the cathode-follower plug-in circuit card installed, push-pull, low-impedance signals (to approximately 8 V peak to peak) are available via cathode followers at front and rear connectors. An automatic DC level-setting circuit keeps the average DC level of the two connectors close to 0 V. Bandwidth of the cathode-follower output circuit is DC to approximately 1 MHz.

With the passive card installed, a high-impedance push-pull signal is available at the front panel for balancing and a single-ended signal at low impedance (approximately 500 ohms) is available at the rear output connector. Bandwidth of the passive divider output circuit is DC to approximately 100 kHz and is dependent upon the plug-in used.

Each output can be switched to a meter for DC balance indication. This allows quick setting of the plug-in position control. In addition to the output-monitor switch, a two-position switch has been included for balancing of the Type 3C66 Carrier Amplifier Plug-In Unit.

**Sampling plug-ins, designed to operate in pairs (one vertical and one sweep), and Spectrum Analyzer or Automatic "Seeking" plug-ins designed to operate in conjunction with another 2- or 3-Series plug-in, must be "paired up" in Channels 1 and 2 or 3 and 4.*

TYPICAL APPLICATIONS

PLUG-IN TYPE	INDICATED DEFLECTION FACTOR	APPROXIMATE SYSTEM GAIN		
			With CF Output Card**	
		With Passive Output Card*	Single Ended	Push-Pull
2A60	50 mV/div	50	20	40
2A63	1 mV/div	2.5×10^3	10^3	2×10^3
3A3	100 μV/div	2.5×10^4	10^4	2×10^4
3A9	10 μV/div	2.5×10^5	10^5	2×10^5
3A10	10 μV/div	2.5×10^5	10^5	2×10^5
	Can be calibrated in units/div of pressure, force, acceleration, vibration, displacement, strain, or temperature.			
3A75	50 mV/div	50	20	40
3C66	10 μstrain/div	0.25 V/μstrain	0.1 V/μstrain	0.2 V/μstrain
3L5	To be used with any 2- or 3-Series Time Base to provide 10 Hz-to-1 MHz Spectrum Analysis.			
	1 mV/div	2.5×10^3	10^3	2×10^3
3S1/3S2/3S5	2 mV/div (max)	Sampling Amplifier (must be paired with Sampling Time Base).		
3T2/3T5/3T77A	0.2 ns/div	Sampling Time Base (must be paired with Sampling Amplifier).		

*Output single ended at rear connector.

**Output at front or rear connector.

In addition to supplying power for the plug-in compartments, the Type 129 provides regulated voltages at a rear-panel connector for powering accessories. Two low-noise fans provide forced-air cooling for the power supply and plug-in compartments.

POWER REQUIREMENTS

Electronically-regulated DC supplies insure stable operation with as much as —10% to +7% variation from design-center line voltage. The instrument is factory wired to operate at a design center of 117 volts, but a multi-tap transformer permits operation at design centers of 110, 117, 124, 220, 234 or 248 volts, 50 to 60 Hz. Instrument can be ordered factory wired for any of the design centers listed. Power consumption is typically 575 watts maximum under full load.

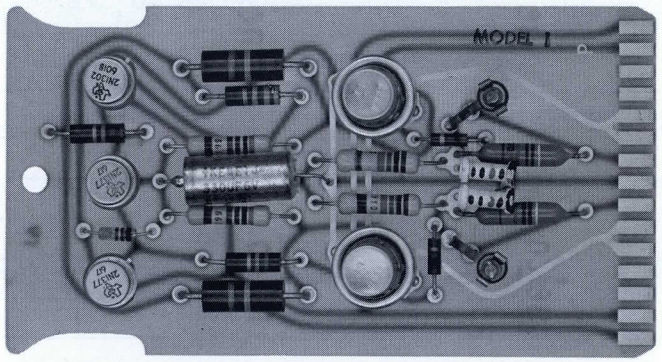
DIMENSIONS AND WEIGHTS

Height	10½ in	26.8 cm
Width	19 in	48.3 cm
Rack depth	23½ in	59.8 cm
Net weight	49½ lb	22.5 kg
Domestic shipping weight	≈ 83 lb	≈37.8 kg
Export-packed weight	≈107 lb	≈48.6 kg

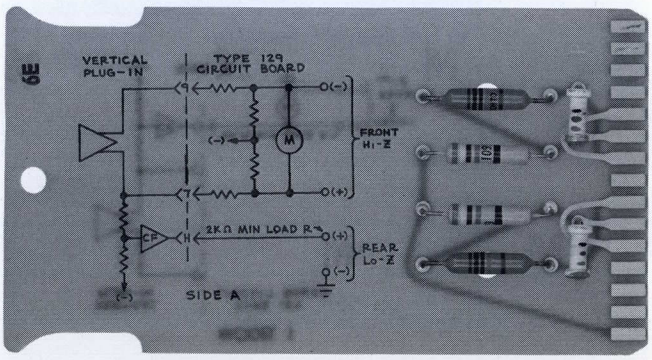
INCLUDED STANDARD ACCESSORIES

Right-angle power cord (161-0024-03); slide-out assembly (351-0085-00); instruction manual (070-0409-00).

TYPE 129 RACKMOUNT PLUG-IN UNIT POWER SUPPLY
(without plug-in units or circuit cards) **$775**



CATHODE-FOLLOWER CIRCUIT CARD **$36.00**
Order 018-0001-00



PASSIVE DIVIDER CIRCUIT CARD **$13.25**
Order 018-0002-00

OPTIONAL ACCESSORIES

BLANK PLUG-IN CHASSIS

Contains necessary mechanical parts for construction of a custom plug-in. Includes frame, blank front panel, blank chassis, 24-pin connector, latch and small hardware; electrical components not included. Order 040-0245-00 ..... $27.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

The Tektronix Type 540-550-Series offer the user *proven performance* in one of the most respected, flexible, versatile oscilloscope systems presently available. Any instrument selected from this fully developed series represents a significant price/performance value which remains difficult to match.

This series of laboratory plug-in oscilloscopes provide an unusually wide range of measurement capabilities. Oscilloscope mainframes are available which have one or more of the following features: Single time base, delayed sweep, alternate-sweep switching, dual beam, or storage. Real-time bandwidths are available up to 50 MHz. Any oscilloscope mainframe and the Type 1S1 sampling plug-in provide equivalent-time bandwidth to 1 GHz. The Mainframe Performance Chart identifies the significant features and bandwidth of individual instruments in this family.

Dual-beam performance is provided in the Type 556. With its many operating modes and display features it is one of today's most versatile oscilloscopes.

The Type 549 storage oscilloscope has the versatility of a delayed sweep/plug-in instrument *plus* storage writing speed of 5 cm/μs—a writing speed which clearly extends storage benefits beyond the usual low frequency applications to which many storage instruments are restricted. Consider these additional features of the Type 549: An Auto mode which frees the operator to devote his complete attention to the test point—up to one hour continuous viewing time—added convenience of writing rate which is variable between its normal and maximum limits—it simplifies many of the "just difficult to make" measurements—and others.

The 1-Series and Letter-Series plug-ins include multi-trace (up to 4), sampling, voltage comparator and/or differential, spectrum analyzers and special purpose units (see the Plug-In Performance Charts for details of each unit). The operator has a significant number of mainframe/plug-in combinations available such that he may select an instrument tailored to solve his particular measurement problems.

TYPE 540-550-SERIES MAINFRAME PERFORMANCE CHART
APPLIES TO CABINET AND RACKMOUNT MODELS

MAINFRAME	PAGE	BANDWIDTH
545B Delayed Sweep	128	DC to 33 MHz
544 Single Time Base	130	DC to 50 MHz
546 Delayed Sweep	130	DC to 50 MHz
547 Delayed/Alternate Sweep		DC to 50 MHz
549 Storage/Delayed Sweep	134	DC to 30 MHz
556 Dual Beam/Delayed Sweep	137	DC to 50 MHz

TYPE 540-550-SERIES MAINFRAME/PLUG-IN PERFORMANCE CHARTS

Bandwidth is in MHz unless noted otherwise. Risetime is in ns unless noted otherwise.

MULTI-TRACE

PLUG-IN	PAGE	NUMBER OF TRACES	MINIMUM DEFLECTION FACTOR	DC to 30 MHz MAINFRAME 549		DC to 33 MHz MAINFRAME 545B		DC to 50 MHz MAINFRAME 544/546/547/556	
				BW	T_R	BW	T_R	BW	T_R
1A1	144	TWO	50 mV/cm 5 mV/cm ≃500 μV/cm	DC to 30 DC to 23 2 Hz to 14	12 16 25	DC to 33 DC to 23 2 Hz to 14	11 16 25	DC to 50 DC to 28 2 Hz to 15	7 13 24
1A2	145	TWO	50 mV/cm	DC to 30	12	DC to 33	11	DC to 50	7
1A4	146	FOUR	10 mV/cm	DC to 30	12	DC to 33	11	DC to 50	7

DIFFERENTIAL AND COMPARATOR

PLUG-IN	PAGE	MINIMUM DEFLECTION FACTOR	MAXIMUM CMRR	DC to 30 MHz MAINFRAME 549		DC to 33 MHz MAINFRAME 545B		DC to 50 MHz MAINFRAME 544/546/547/556	
				BW	T_R	BW	T_R	BW	T_R
1A5	148	5 mV/cm 2 mV/cm 1 mV/cm	20,000:1	DC - 30 DC - 29 DC - 28	12 13 13	DC - 33 DC - 31 DC - 30	11 12 12	DC - 50 DC - 45 DC - 40	7 8 9
1A6	150	1 mV/cm	10,000:1	DC - 2	0.18 μs	DC - 2	0.18 μs	DC - 2	0.18 μs
1A7A	151	10 μV/cm	100,000:1	DC - 1	350	DC - 1	350	DC - 1	350
W	142	50 mV/cm 1 mV/cm	20,000:1	DC - 22 DC - 7	16 50	DC - 23 DC - 8	16 44	DC - 23 DC - 8	16 44

SAMPLING
(Bandwidth is independent of mainframe bandwidth.)

PLUG-IN	PAGE	MINIMUM DEFLECTION FACTOR	BW	T_R
1S1 Sampling	153	2 mV/cm	DC - 1 GHz	350 ps
1S2 TDR and Sampling	155	5 mρ/cm 5 mV/cm	140 ps System Risetime DC - 3.9 GHz	90 ps

SPECTRUM ANALYZERS

PLUG-IN	PAGE	MAXIMUM SENS	CENTER FREQUENCY RANGE	CAL. DISPERSION PER CM	RESOLUTION
1L5	208	10 μV/cm	50 Hz-990 kHz	10 Hz - 100 kHz	10 Hz - 500 Hz
1L20	210	—100 dBm	10 MHz-4.2 GHz	1 kHz - 10 MHz	1 kHz - 100 kHz
1L40	210	—110 dBm	1.5 GHz-40 GHz	1 kHz - 10 MHz	1 kHz - 100

SPECIAL PURPOSE

PLUG-IN	PAGE	MINIMUM DEFLECTION FACTOR	Z_i	Z_f
0 Two Channel op amp	140	50 mV/cm	0.01 - 1 MΩ	10 pF - 1 μF

Optional accessories expand measurement capabilities and provide added operating convenience. The following describes some of the accessories commonly used with these instruments. The accessory section of the catalog contains a complete description of all accessories.

CAMERAS

C-12 has beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid* Land Pack-Film back accepts 3000-speed film. Projected graticule eliminates parallax in oscilloscopes having external graticules, such as the 549, order Standard C-12 ..... $490

C-27 provides direct viewing and maximum transmission of light to film, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back accepts 3000-speed film, order Standard C-27 ..... $460

Bezels for adapting Cameras to Oscilloscopes are listed in the Camera accessory section.

Polaroid Roll-Film back accepts 10,000-speed film for increased writing speed, can be substituted at no additional cost in either camera. Order C-12R or C-27R. Optional lenses are also available.

PROBES

The standard 10X probes supplied with the instrument satisfy most measurement requirements; however, optional probes (recommended on plug-in unit pages) may be better suited for particular applications.

SCOPE-MOBILE® CART

Model 202-2: storage drawer, carrier for 2 plug-in units, 9-position tilt-lock oscilloscope tray, order 202-2 ..... $155

TV ACCESSORIES FOR GENERAL-PURPOSE OSCILLOSCOPES

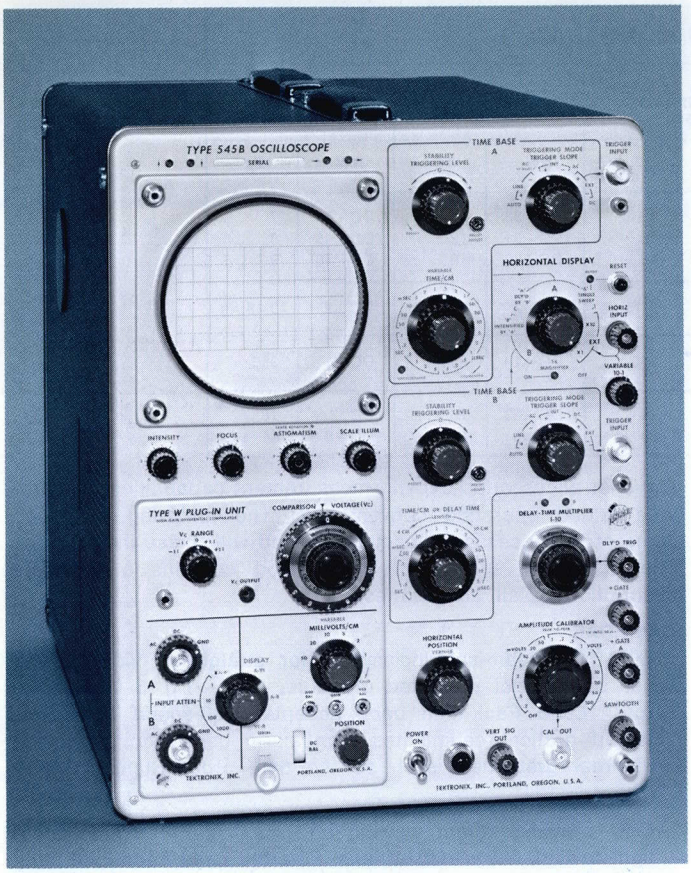
In addition to the Tektronix line of television instruments, accessories are available for use with many Tektronix general-purpose oscilloscopes. A TV Sync Separator provides stable triggering for the display of composite video signals. A Video Staircase Differentiator allows the amplitude linearity of television systems and their components to be measured. See the Television accessory pages for additional information.

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

545B

33-MHz Oscilloscope



- ***CALIBRATED DELAYED SWEEP***
- ***UNIFORM-FOCUS 6 x 10-cm DISPLAY***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-IN UNITS***

The Type 545B and RM545B are versatile laboratory oscilloscopes designed for use with all Tektronix Letter-Series and 1-Series Plug-In Units.

Two separate time-base generators can be used in delayed-sweep operation for highly-accurate time measurements.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of all 1-Series and Letter-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm. Time Base B 2 μs/cm to 1 s/cm.

X5 MAGNIFIER—Extends time base to 20 ns/cm.

DELAY RANGE—2 μs to 10 s.

EXTERNAL INPUT—0.2 V/cm, DC to 350 kHz.

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 500 watts.

VERTICAL DEFLECTION

BANDWIDTH
DC to 33 MHz at 3-dB down, depending on plug-in unit.

RISETIME
11 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
Approx 1.2 V for each centimeter of displayed signal.

HORIZONTAL DEFLECTION

TIME BASE A
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B
2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Sweep length continuously variable from 4 to 10 cm, allowing use of Time Base B as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER
Operates over full time base, increases fastest Time Base A rate to 20 ns/cm, and the fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 2 μs to 1 s delay time in a 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.10 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DELAY RANGE
2 μs to 10 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions. Jitter $\leq$ 1 part in 20,000 of 10 times DELAY TIME.

DELAY MODES
Depending on the setting of the Delayed Sweep stability control, the Delayed Sweep can start immediately at end of delay time, or be triggerable at end of delay time (for jitter-free displays).

545B
33-MHz Oscilloscope

OPERATING MODES
Time Base A—Normal, single sweep, delayed by B.
Time Base B—Normal, intensified by A.

EXTERNAL INPUT
Fixed steps of approx 0.2 V/cm and 2 V/cm, continuously variable between steps and to approx 20 V/cm, DC to ≥350 kHz at −3 dB. 50-V maximum input (DC + peak AC). Input RC approx 1 MΩ paralleled by approx 45 pF.

SIGNAL OUTPUTS
Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from 0 to at least +130 V), and a delayed trigger pulse (positive going from 0 to at least +5 V).

TRIGGER

MODES
Automatic mode or manual level selection. Automatic operation is useful between approx 50 Hz and 10 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 50 Hz), sweep free runs at an approx 40-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC; AC LF reject on Time Base A.

SOURCES
Internal (from oscilloscope vertical amplifier), external, or line. 50-V maximum external input (DC + peak AC).

TIME BASE A REQUIREMENTS
0.2-cm deflection or 0.2 V external from 150 Hz to 10 MHz increasing to 1-cm deflection or 1 V external at 30 MHz. Requirements increase below 30 kHz with AC low-frequency reject. DC coupling requires 0.6-cm deflection or 0.2 V external to 10 MHz. Automatic operation requires 0.5-cm deflection or 0.5 V external at 150 Hz, increased deflection to 10 MHz.

TIME BASE B REQUIREMENTS
0.2-cm deflection or 0.2-V external at 300 Hz to 5 MHz, increasing to 1-cm deflection or 1-V external at 10 MHz. Requirements increase below 300 Hz with AC coupling. DC coupling requires 0.6-cm deflection or 0.2-V external to 5 MHz. Automatic operation requires 0.5-cm deflection or 0.5-V external at 300 Hz, will trigger from 50 Hz to 5 MHz with increased signal.

CRT

TEKTRONIX CRT
5-inch metallized screen, helical post accelerating anode. 10-kV accelerating potential for bright displays. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 15 V peak to peak for beam modulation at normal intensity.

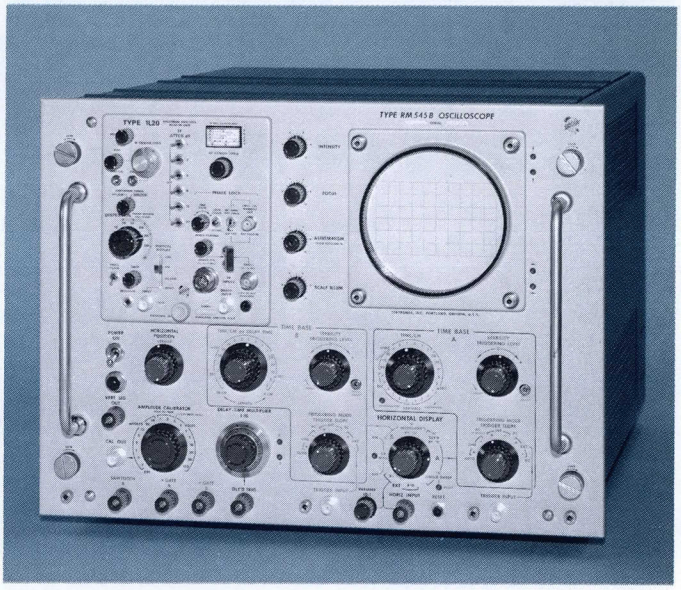
GRATICULE
Internal, parallax-free; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions. Two additional horizontal lines for convenient risetime measurements.

DISPLAY FEATURES
Beam-position indicators show direction of CRT beam when off screen. Multi-trace blanking eliminates switching transients from display when multi-trace plug-in unit is operated in chopped mode.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate. Special output, useful in calibrating sampling plug-ins, provides 0.1 V ±3% into 50 Ω.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 500 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.



RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	$22\frac{11}{16}$ in	57.6 cm
Net weight	85 lb	38.6 kg
Domestic shipping weight	≈111 lb	≈50.5 kg
Export-packed weight	≈130 lb	≈59.1 kg

RACKMOUNTING
Type RM545B withdraws from its cabinet on slide-out tracks, tilts and locks in 7 positions. Further mounting information on catalog instrument dimension page.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	17 in	43.2 cm
Width	$12\frac{15}{16}$ in	32.9 cm
Depth	$23\frac{7}{8}$ in	60.7 cm
Net weight	64 lb	29.1 kg
Domestic shipping weight	≈82 lb	≈37.3 kg
Export-packed weight	≈101 lb	≈45.9 kg

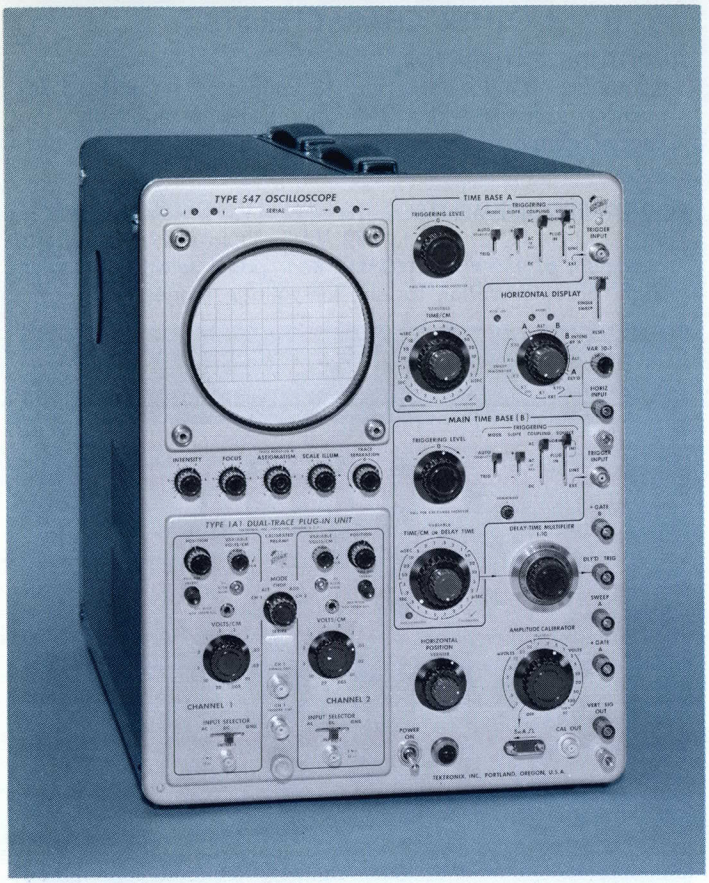
INCLUDED STANDARD ACCESSORIES
Two P6006 10X probes (010-0127-00); BNC-to-BNC 18-inch 50-Ω cable (012-0076-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); BNC-to-banana plug 18-inch patch cord (012-0091-00); BNC-post jack (012-0092-00); smoke-gray light filter, installed (378-0567-00); clear CRT protector plate (387-0918-00); instruction manual (070-0428-02). Type RM545B includes mounting hardware; instruction manual (070-0438-01).

TYPE 545B OSCILLOSCOPE, without plug-in units **$1,700**
TYPE RM545B OSCILLOSCOPE, without plug-in units **$1,800**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

544, 546 and 547

50-MHz Oscilloscopes



- ***HORIZONTAL DISPLAYS***
  - ***544 Single Time Base***
  - ***546 Dual Time Base/Delayed Sweep***
  - ***547 Dual Time Base/Delayed Sweep/ Alternate Display***
- ***UNIFORM-FOCUS 6 x 10-cm DISPLAY***
- ***SINGLE-SWEEP OPERATION***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-IN UNITS***

The Types 544, 546, and 547 provide a wide performance range through mainframe and plug-in versatility.

The significant difference between the three instruments is the horizontal display capabilities. The 544 is a single time-base unit; the 546 is a dual time base, delayed sweep unit; the 547 is a dual time base, delayed sweep unit with horizontal display switching.

Display switching, within certain limitations, simulates dual-beam performance. For example, when using a multi-trace unit such as the 1A1, one plug-in channel may be locked to time base A and the other channel may be locked to time base B. This mode provides a dual display of two nonrelated signals.

Reference charts for this series contains information on the plug-ins available for these instruments.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of all 1-Series and Letter-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, or X10, extends calibrated time base to 10 ns/cm.

DELAY RANGE—0.1 μs to 50 s (applies to 546 and 547 only).

EXTERNAL INPUTS—0.1 V/cm to 1 V/cm, DC to 400 kHz (546 and 547 only); 0.1 V/cm to 10 V/cm, DC to 400 kHz (544 only).

CRT

DISPLAY AREA—6 x 10 cm.

ACCELERATING VOLTAGE—10 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave, 100 V DC, 5 mA DC, 5 mA 1-kHz squarewave.

POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 550 watts.

VERTICAL DEFLECTION

(Applies to 544/546/547)

BANDWIDTH
DC to 50 MHz at 3-dB down, depending on plug-in unit.

RISETIME
7 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT
20-ns risetime, at least 0.3 V for each centimeter of displayed signal.

547 HORIZONTAL DEFLECTION

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER
X2, X5, or X10 magnification over full time-base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

544, 546 and 547
50-MHz Oscilloscopes

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.15 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DELAY RANGE
0.1 μs to 50 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions from 1 μs to 5 s and within 1% and 10 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY MODES
Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DISPLAY MODES
Time Base A only, Time Base B only, A alternated with B, B intensified by A, A delayed by B, B intensified by A alternated with A delayed by B. Single sweep on all the A and the B sweep modes, can be reset at front panel or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

EXTERNAL INPUT
Fixed steps of approx 0.1 V/cm and 1 V/cm, continuously variable between steps and to approx 10 V/cm, DC to ≥400 kHz at —3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

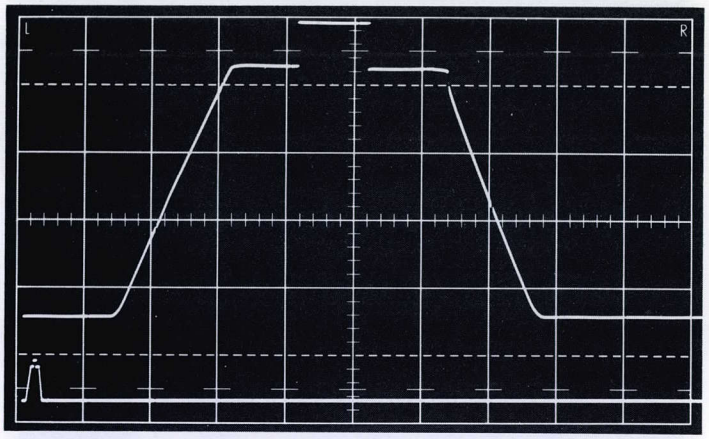
SIGNAL OUTPUTS
Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from approx 0 to at least +90 V), and a delayed trigger pulse (positive going from 0 to at least +10 V).

547 AUTOMATIC DISPLAY SWITCHING

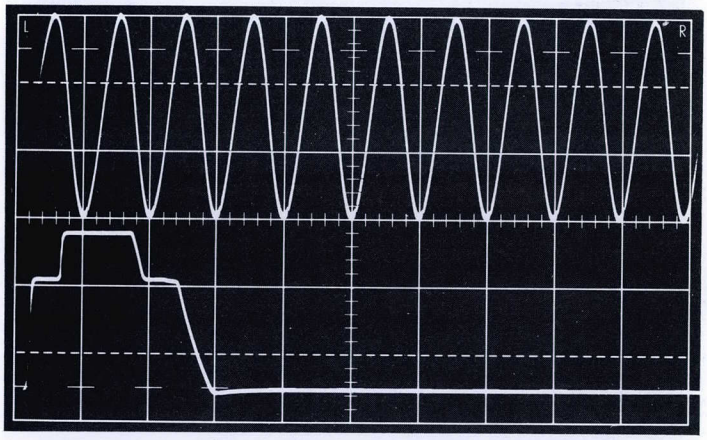
Electronic switching between 2 wide-range time bases allows an alternate presentation of the same signal at 2 different sweep rates. Gallium Arsenide diodes in the switching circuit provide fast switching between time bases, and insure that only the desired time base is displayed at one time.

Two different signals can be alternately displayed at the same or different sweep rates with a Type 1A1 or 1A2 Dual-Trace Unit. With the Type 1A4 Four-Trace Unit, channels 1 and 2 can be locked to time base A, and channels 3 and 4 can be locked to time base B. In many applications, this provides equivalent dual-beam operation without the additional cost and complexity of a dual-beam oscilloscope. Dual displays are equal in quality to the finest single presentations. Also, the full 6 x 10-cm screen area can be used to display signals on either time base. A trace separation control operates in conjunction with the normal vertical position to allow full control of dual displays.

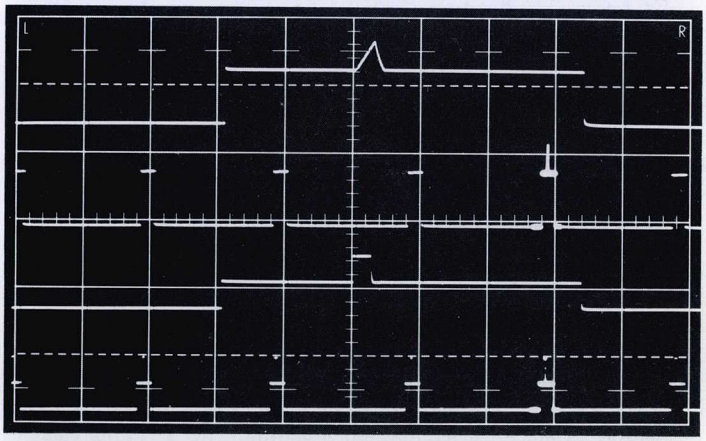
These three photographs pertain to the 547 only.



Vertical and Horizontal Expansion—same signal applied to both channels of the Type 1A1 Dual-Trace Unit with independent control of sensitivity and sweep rate in each channel.



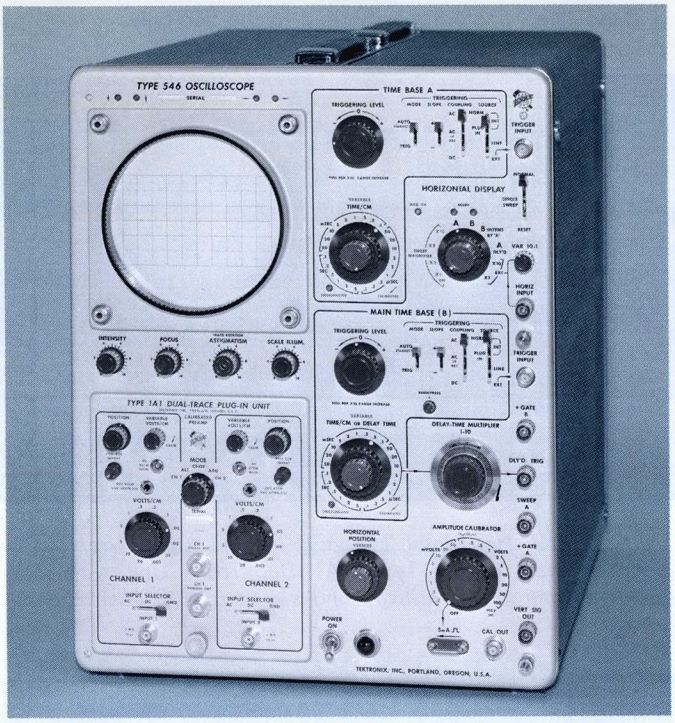
Dual-Scope Operation—independent control of each signal with Channel 1 of the Type 1A1 Dual-Trace Unit locked to Time Base A, and Channel 2 locked to Time Base B.



Calibrated Sweep Delay—alternate presentation of 2 signals brightened over a selected portion, and the selected portion expanded to fill 10 cm.

544, 546 and 547

50-MHz Oscilloscopes



TYPE 546/DUAL TIME BASE/DELAYED SWEEP

546 HORIZONTAL DEFLECTION

TIME BASE A AND B

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER

X2, X5, or X10 magnification over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in 1, 2, 5 sequence accurate to within 1%. DELAY TIME MULTIPLIER accurate within 0.2% of full scale. Provides calibrated time intervals from 0.15 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts.

DELAY RANGE

0.1 μs to 50 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY

Within 1% and 4 minor divisions from 1 μs to 5 s and within 1% and 10 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DISPLAY MODES

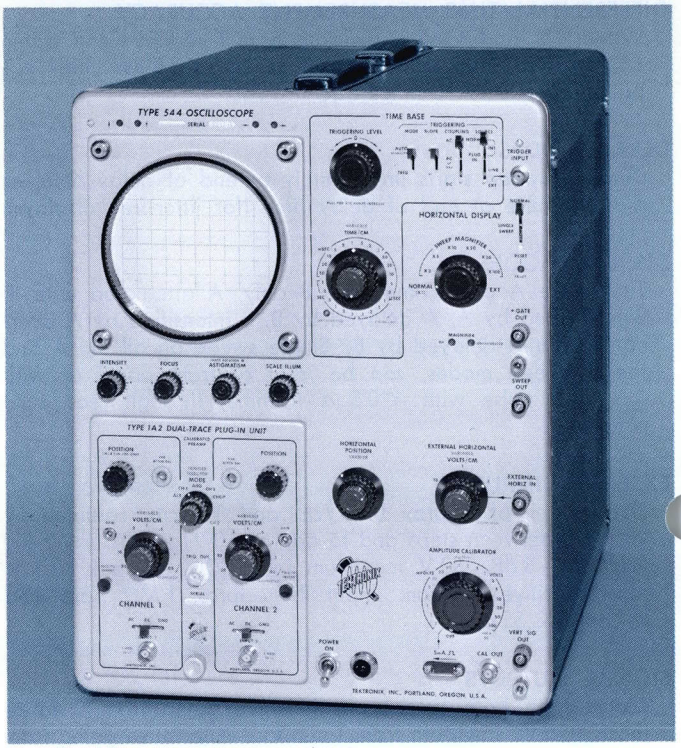
Time Base A—Normal, delayed by B, single sweep of both modes. Time Base B—Normal, intensified by A, single sweep of both modes. Single sweep reset at front panel or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

EXTERNAL INPUT

Fixed steps of approx 0.1 V/cm and 1 V/cm, continuously variable between steps and to approx 10 V/cm, DC to ≥400 kHz at −3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

SIGNAL OUTPUTS

Gates from both time bases (positive going from 0 to at least +20 V), sawtooth from Time Base A (positive going from approx 0 to at least +90 V), and a delayed trigger pulse (positive going from 0 to at least +10 V).



TYPE 544/SINGLE TIME BASE

544 HORIZONTAL DEFLECTION

TIME BASE

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to approx 12 s/cm. Warning light indicates uncalibrated setting.

MAGNIFIER

X2, X5, X10, X20, X50 or X100 magnification. Magnified time base accurate within 5% up to 10 ns/cm. Warning light indicates if time base exceeds 10 ns/cm (uncalibrated).

OPERATING MODES

Normal, single sweep. Single sweep reset at front panel, or with ≥+20-V pulse with <0.5-μs risetime, through rear-panel connector.

EXTERNAL INPUT

0.1, 1, and 10 V/cm, accurate within 5%. Uncalibrated, continuously variable between steps and to approx 100 V/cm. DC to ≥400 kHz at −3 dB. 50-V maximum input (DC + peak AC) in most sensitive position. Input RC approx 1 MΩ paralleled by approx 55 pF.

SIGNAL OUTPUTS

Gate (positive-going from 0 to at least +20 V) sawtooth (positive-going from 0 to at least +90 V).

544, 546 and 547
50-MHz Oscilloscopes

TRIGGER

NOTE: The 544 has a single-trigger system. The 546 and 547 have two identical trigger systems, one for each time base.

MODES
Manual level selection with triggered or automatic operation. Automatic operation provides a convenient reference trace with no trigger-signal input, or repetition rates less than 20 Hz. Reference trace is bright throughout the full time-base range.

COUPLING
AC, DC, or AC LF reject.

SOURCES
Internal (from oscilloscope vertical amplifier or direct from a single channel of Type 1A1, 1A2 or 1A4 Plug-In Unit), external, or line. 30-V maximum external input (DC + peak AC). External trigger input RC approx 1.1 MΩ paralleled by approx 30 pF.

REQUIREMENTS
0.2-cm deflection or 0.2 V external at 1 kHz, increasing to 1-cm deflection or 0.2 V external at 50 MHz. Requirements increase below 2 kHz with AC low-frequency reject. DC coupling requires 0.5-cm deflection or 0.2 V external at DC to 50 MHz. ±2-V or ±20-V trigger level selection.

CRT

TEKTRONIX CRT
5-inch metallized screen, helical post accelerating anode, 10-kV accelerating potential for bright displays. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled to CRT cathode, requires 15 V peak to peak for beam modulation at normal intensity.

GRATICULE
Internal, parallax-free; variable edge lighting. 6 x 10-cm display area. Vertical and horizontal center lines marked in 2-mm divisions. Two additional horizontal lines for convenient risetime measurements.

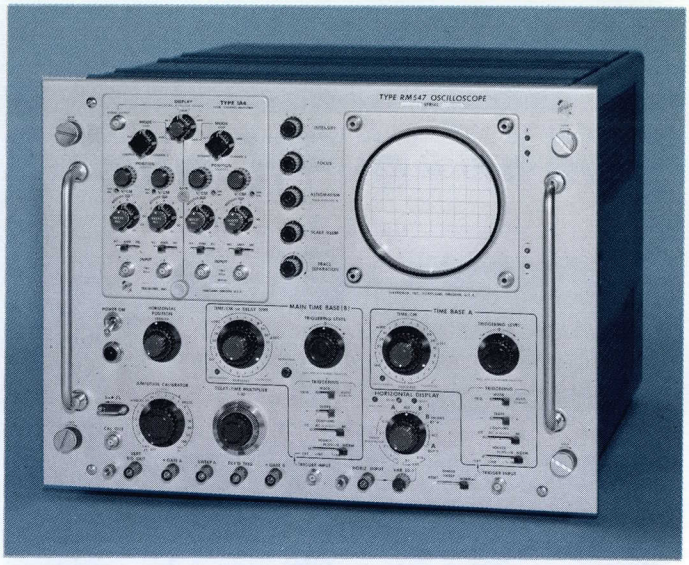
DISPLAY FEATURES
Beam-position indicators show direction of CRT beam when off screen. Multi-trace blanking eliminates switching transients from display when multi-trace plug-in unit is operated in chopped mode.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 3%, approx 1-kHz repetition rate. 50-Ω source resistance from 0.2 mV to 0.2 V. 0.6-μs risetime from 0.2 mV to 5 V; 1-μs from 10 V to 100 V. 100-V DC reference output also provided. Front-panel current loop for 5 mA ±3%, squarewave or DC.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 550 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

RACKMOUNTING
The rackmount instrument withdraws from its cabinet on slide-out tracks, tilts and locks in seven positions. Further mounting information on catalog instruments dimension page.



TYPE RM547 RACKMOUNT CONFIGURATION

CABINET AND RACK MODEL DIMENSIONS AND WEIGHTS

OSCILLOSCOPE	HEIGHT		WIDTH		DEPTH	
	IN	CM	IN	CM	IN	CM
544, 546, 547	17	43.2	12 15/16	32.9	23 7/8	60.7
RM547	14	35.6	19	48.3	22 11/16	57.6

OSCILLOSCOPE	NET WEIGHT		DOMESTIC SHIPPING WT		EXPORT-PACKED WT	
	LB	KG	LB (≃)	KG (≃)	LB (≃)	KG (≃)
544	61	27.8	80	36.4	97	44.1
546	65 1/4	38.2	84	38.2	102	46.4
547	65 3/4	29.9	85	38.6	103	46.8
RM547	86 1/4	39.2	114	51.8	137	62.3

INCLUDED STANDARD ACCESSORIES
Two P6008 10X probes (010-0129-00); BNC-to-banana plug 18-inch patch cord (012-0091-00); BNC-post jack (012-0092-00); smoke-gray light filter, installed (378-0567-00); clear CRT protector plate (387-0918-00); BNC-to-BNC 18-inch patch cords (012-0087-00), two with 544 and three with 546 and 547; instruction manual, 544 (070-0418-00), 546 (070-0367-00), 547 (070-0398-00). Rackmount RM547 includes mounting hardware; power cord (161-0010-03); instruction manual (070-0420-00).

TYPE 544 OSCILLOSCOPE, without plug-in units . **$1,625**
TYPE 546 OSCILLOSCOPE, without plug-in units . **$1,825**
TYPE 547 OSCILLOSCOPE, without plug-in units . **$1,950**
TYPE RM547 OSCILLOSCOPE, without plug-in units **$2,050**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with these instruments are described in the Reference Section for this series.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

549
Storage Oscilloscope

- ***BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS***
- ***UP to 5 cm/μs WRITING SPEED***
- ***BISTABLE STORAGE PROVIDES CONSTANT TRACE INTENSITY FOR FULL VIEW TIME***
- ***ERASES AFTER A SELECTABLE VIEW TIME AND STORES NEW INFORMATION, AUTOMATICALLY***
- ***CALIBRATED DELAYED SWEEP***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-IN UNITS***

The Type 549 extends the exclusive Tektronix split-screen and bistable storage features into research and development applications. Offering a high degree of versatility, it accepts all letter-series and 1-series plug-in units covering many applications including sampling and spectrum analysis.

The split-screen, bistable CRT provides high contrast displays and unparalleled writing speeds. Each half of the 6 x 10-cm display area can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. A stored display can then be compared simultaneously with a conventional display.

A variable-viewing-time system offers a new convenience to storage oscilloscope users. Through front panel controls, this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied from $\leq$0.5 seconds to $\geq$5 seconds with AUTO ERASE selected for either PERIODIC or AFTER-SWEEP operation. Used in conjunction with the SINGLE SWEEP, the "After-Sweep" erase circuit automatically resets the Single-Sweep circuit at the end of the viewing-time interval.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics extremely flexible through use of all Letter-Series and 1-Series Plug-In Units.

HORIZONTAL

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.

X5 MAGNIFIER—Extends time base to 20 ns/cm.

DELAY RANGE—2 μs to 10 s.

EXTERNAL INPUT—0.2 V/cm, DC to 350 kHz.

STORAGE CRT

DISPLAY AREA—6 x 10 cm.

SPLIT SCREEN STORAGE—Store on either upper or lower half of screen with non-storage on other half; store on entire screen; or non-store on entire screen.

LOCATE ZONE—Locate button permits vertical position finding.

VIEWING TIME—Up to one hour.

ERASE TIME—150 ms maximum.

WRITING SPEED—0.5 cm/μs. 5 cm/μs with enhancement.

PHOSPHOR—P1

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V; 5-mA current loop; 1 kHz.

POWER REQUIREMENTS—90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz, 575 watts.

AVAILABLE DISPLAYS

With the wide range of vertical plug-in units, several types of stored and conventional displays are obtainable. The Type 549, by virtue of a bistable split-screen storage CRT capable of unparalleled writing speeds, extends storage-measuring capability into previously unattainable areas.

SINGLE-TRACE AND MULTI-TRACE

Multi-trace displays are obtained by selecting a Type 1A1, 1A2 or 1A4 Amplifier Plug-In Unit. All other 1-Series and Letter-Series Plug-In Units will give single-trace displays. Selection of the Type 1A5, 1A6 or 1A7A gives differential amplifier operation.

SAMPLING

Sampling displays with risetimes in the sub-nanosecond region are obtained using a Type 1S1 or 1S2 Sampling Unit. The Type 1S1 is a general-purpose sampler with 1 GHz bandwidth, delay line and internal triggering. The Type 1S2 is designed specifically for TDR (time-domain reflectometry) applications, but offers general-purpose sampling with 3.9 GHz bandwidth and built-in triggering.

SPECTRUM ANALYSIS

Spectrum displays are obtained using a Type 1L5, 1L20, or 1L40 Spectrum Analyzer Plug-In Unit to cover a frequency range from 10 Hz to 40 GHz.

There are decided advantages in using the storage oscilloscope for spectrum analysis. When slow sweep times are used, it is often difficult to view a complete display; however, by storing the display it can be completely and easily observed.

Signal drift is easily measured using the storage technique. The signal is stored and then as subsequent displays are stored, drift of the signal can be observed. Or, the spectral display can be stored on one half of the screen and simply compared with a similar non-stored display on the other.

STORAGE CRT AND DISPLAY FEATURES

STORAGE CRT

The Type 549 CRT is a split-screen, bistable storage device operated at 4-kV accelerating potential. Phosphor type is P1 (no options).

Tektronix bistable storage offers stored trace brightness independent of viewing time or writing speed.

DISPLAY AREA

6 x 10-cm split-screen storage area with independent or common control, plus locate zone. The graticule is external and edge-lighted.

SPLIT-SCREEN STORAGE

Store on either upper or lower half of screen with conventional display on other half; store on entire screen; or, non-store on entire screen. Independent operation of both halves.

VIEWING TIME

Up to one hour. If ENHANCE MODE is to be used, it is recommended that displays be stored for 20 minutes or less.

ENHANCE MODE

Controls the single sweep storage capabilities of the storage CRT. Through adjustment of ENHANCE LEVEL control, single-trace spot velocities up to 5 cm/μs or better can be stored with minimal loss of resolution and contrast.

LOCATE BUTTON (Serves two functions)

STORAGE—When depressed, the beam appears at the left of the CRT screen marking the vertical position of the next sweep. CONVENTIONAL DISPLAYS—Permits beam finding of off screen signals.

ERASE TIME

150 ms maximum.

AUTO ERASE SYSTEM

Viewing time before erase continuously variable from $\leq$0.5 s to $\geq$5 s.

In the PERIODIC Mode, there is a continuous sequence of storing, viewing time and erasure. This sequence occurs regardless of whether or not a signal is present and is independent of the sweep. In the AFTER SWEEP mode—which is used in conjunction with the SINGLE SWEEP—the sequence begins with the arrival of the signal. The signal initiates a sweep by triggering the Single Sweep circuitry. Viewing time begins as the sweep ends. At the end of the viewing time, erasure automatically resets the SINGLE SWEEP, readying it for the next signal. This cycle will automatically repeat itself as long as a signal is available.

Manual control available through Erase and Reset button or by Reset position of Single Sweep switch.

REMOTE CONTROL OPERATION

The Type 549 has remote control-operation capabilities using contact closure. A 9-pin connector, located on the rear panel, supplies one ground and 7 inputs (plus one spare) that allows the following functions:

1. Remote erase of upper screen.
2. Remote erase of lower screen.
3. Remote resetting of sweep for single-sweep operation.
4. Remote erase of both halves of the screen and resetting of the sweep.
5. Remote switching from conventional operation to storage operation (independently or commonly) of upper or lower screen halves.
6. Remote interruption of the Auto Erase sequence in order to hold a stored waveform.

Operation of these circuits is achieved by grounding the appropriate pin in the connector.

REMOTE CONTROL UNIT

(Optional accessory, part number 012-0102-00). Performs Remote Erase and Reset functions numbers 1, 2, and 3 above.

Z-AXIS INPUT

A CRT grid selector switch on the rear panel allows the CRT grid to be driven from the internal unblanking signal, or from an external source. Bandpass is DC to $\geq$1 MHz at —3 dB. 20 V peak to peak required for beam modulation. Input RC is 100 kΩ and 80 pF. A CRT CATHODE-SELECTOR switch allows the cathode to be driven from the internal chopped-blanking signal, or from an external source, AC coupled. 20 V peak to peak required for beam modulation at normal intensity.

VERTICAL DEFLECTION

BANDWIDTH

DC to $\geq$30 MHz at 3-dB down, depending on plug-in unit.

RISETIME

$\leq$12 ns, depending on plug-in unit.

DELAY LINE

Permits viewing leading edge of displayed waveform.

SIGNAL OUTPUT

DC to $\geq$5 MHz at 3-dB down, $\leq$70-ns risetime, 1.5 V $\pm$20% for each centimeter of displayed signal.

HORIZONTAL DEFLECTION

TIME BASE A

0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

TIME BASE B

2 μs/cm to 1 s/cm in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Sweep length variable from 4 to 10 cm, allowing use of Time Base B as a repetition-rate generator from 0.1 Hz to 40 kHz.

X5 MAGNIFIER

Operates over full time base, increases fastest Time Base A rate to 20 ns/cm, and the fastest Time Base B rate to 0.4 μs/cm. Magnified time base accurate within 5%.

549

Storage Oscilloscope

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 2 μs to 1 s delay time in a 1-2-5 sequence, accurate within 1%. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.10 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts. Accurate within 0.2% of full scale. Inherent delay to start of delayed sweep 200 ns or less.

DELAY RANGE
2 μs to 10 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and 4 minor divisions. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY MODES
Depending on the setting of the Delayed Sweep stability control, the Delayed Sweep can start immediately at end of delay time, or be triggerable at end of delay time (for jitter-free displays).

OPERATING MODES
Time Base A, Time Base B, B intensified by A, and A delayed by B. Single sweep in any mode; reset accomplished with ERASE and RESET button on front panel, NORMAL-SINGLE SWEEP-RESET switch on front panel, automatically with AUTO ERASE switch in AFTER SWEEP and NORMAL-SINGLE SWEEP-RESET switch in SINGLE SWEEP, or by remote control through rear-panel connector.

EXTERNAL INPUT
Fixed steps of approx 0.2 V/cm and 2 V/cm, continuously variable between steps and to approx 20 V/cm, DC to ≥350 kHz at —3-dB with maximum gain. 600-V maximum input (DC + peak AC). Input RC approx 1 MΩ, <60 pF.

SIGNAL OUTPUTS
Gates from both time bases (0 to at least +20 V), sawtooth from Time Base A (0 to at least +130 V), and a delayed trigger pulse (at least +5 V).

TRIGGER

MODES
Automatic or manual level selection. Automatic operation is useful between approx 50 Hz and 1 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes, and repetition rates. With no input (or input less than 50 Hz), sweep free runs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC, DC, or AC LF reject.

SOURCES
Internal from oscilloscope vertical amplifier (or direct from a single channel of Type 1A1, 1A2 or 1A4 Plug-In Units), external, or line. 50-V maximum external input (DC + peak AC).

TIME BASE A REQUIREMENTS
0.2-cm deflection or 0.3 V external from DC to 10 MHz, increasing to 2-cm deflection or 3 V external at 30 MHz. Requirements increase below 300 Hz with AC coupling, below 200 kHz with AC low-frequency reject. Automatic operation requires 0.2-cm deflection or 0.3 V external from 300 Hz to 10 kHz, increasing to 2-cm deflection or 3 V external at 1 MHz.

TIME BASE B REQUIREMENTS
0.2-cm deflection or 0.3 V external from DC to 1 MHz, increasing to 1-cm deflection or 1.5 V external at 10 MHz. Requirements increase below 300 Hz with AC coupling, below 200 kHz with AC low-frequency reject. Automatic operation requires 0.2-cm deflection or 0.3 V external from 300 Hz to 10 kHz, increasing to 2-cm deflection or 3 V external at 1 MHz.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
0.2-mV to 100-V squarewave, 18 calibrated steps (1-2-5 sequence), accurate within 2%. 50-Ω ±2% source resistance from 0.2 mV to 0.2 V. ≈1-μs risetime; 1-kHz ±25% repetition rate; 40% to 60% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA ±2%, squarewave or DC.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz; 575 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

DIMENSIONS AND WEIGHTS

Height	17 in	43.2 cm
Width	12 15/16 in	32.9 cm
Depth	23 7/8 in	60.7 cm
Net weight	67 3/4 lb	30.8 kg
Domestic shipping weight	≈ 89 lb	≈40.5 kg
Export-packed weight	≈114 lb	≈51.8 kg

INCLUDED STANDARD ACCESSORIES
Two P6006 10X probes (010-0127-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); BNC-to-binding post adapter (103-0033-00); smoke-gray light filter (378-0567-00); instruction manual (070-0508-00).

TYPE 549 OSCILLOSCOPE, without plug-in units . . **$2625**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

REMOTE-CONTROL UNIT
Separate controls for erase of upper screen, erase of lower screen, and single-sweep reset. Mates to oscilloscope rear-panel connector, 9-foot cable, order 012-0102-00 $33.00

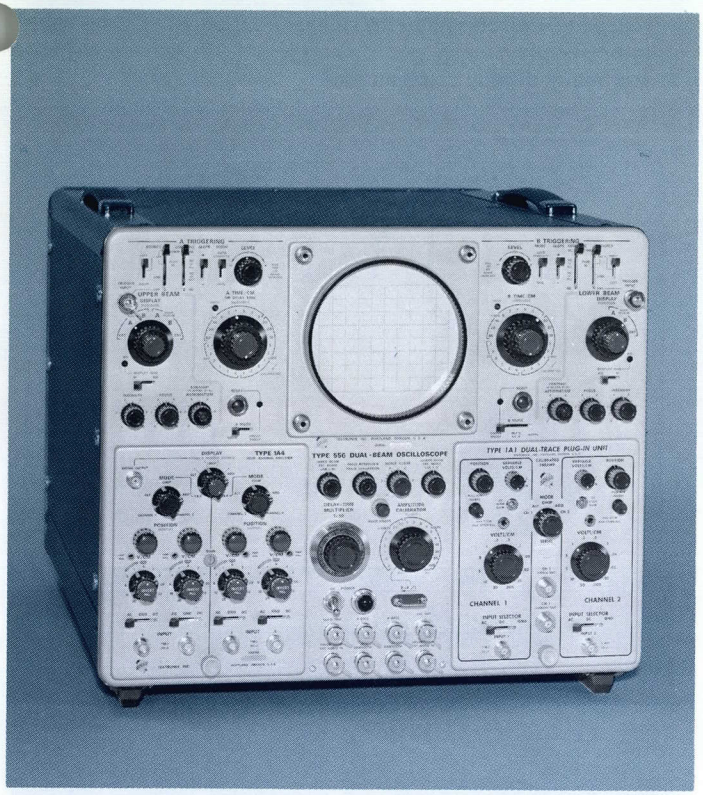
REMOTE-CONTROL CONNECTOR
9-pin cable connector for 5 erase and reset functions plus selection of storage or non-storage operation. Mates to oscilloscope rear-panel connector. Cable and control unit not included, order 134-0049-00 ..... $6

RACKMOUNT ADAPTER
Consists of cradle to support the Type 549 in any standard 19-inch relay rack, and mask to fit around the front panel. Requires 17½-inch panel height, order 040-0281-00 .. $34.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

556

50-MHz Dual-Beam Oscilloscope



- ***TWO VERTICAL AND HORIZONTAL SYSTEMS***
- ***OVER 50 DISPLAY MODES INCLUDING DUAL-BEAM DISPLAY WITH ONE INPUT***
- ***CALIBRATED DELAYED SWEEP***
- ***EMI SUPPRESSION***
- ***6 x 10-cm DISPLAY PER BEAM***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***FULL-BANDWIDTH TRIGGERING***
- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-IN UNITS***

The Type 556 and R556 are dual-beam laboratory instruments for accurate measurement in the DC to 50 MHz range. Features include independent vertical and horizontal deflection systems, trigger selectability for cross triggering, and uniform-focus CRT with 6 x 10-cm scan per beam.

Unique display capability allows simultaneous display of one signal at two different sweep times, using only one probe for minimum circuit loading.

CHARACTERISTIC SUMMARY

VERTICAL

2 identical vertical-deflection systems

Letter-Series and 1-Series Plug-In Units offer wide selection of vertical-deflection characteristics for both beams.

HORIZONTAL

2 independent horizontal-deflection systems

CALIBRATED TIME BASE—0.1 μs/cm to 5 s/cm.
X10 MAGNIFIER—Extends time base to 10 ns/cm.
DELAY RANGE—0.1 μs to 50 s.
EXTERNAL INPUT—≤0.1 V/cm to approx 10 V/cm; DC to ≥400 kHz.

CRT

DISPLAY AREA—6 x 10 cm per beam, 4-cm overlap.
ACCELERATING VOLTAGE—10 kV.
PHOSPHOR—P31

OTHER

ELECTROMAGNETIC INTERFERENCE—Meets MIL-I-6181D, Radiated: 150 kHz to 1 GHz; Conducted: 150 kHz to 25 MHz.
AMPLITUDE CALIBRATOR—1-kHz squarewave; 0.2 mV to 100 V; 100 VDC; 5 mA, 1-kHz squarewave; 5 mA DC.
POWER REQUIREMENTS—90 VAC to 136 VAC, 180 VAC to 272 VAC; 50 to 60 Hz; ≈840 watts, 1 kVA (maximums).

VERTICAL DEFLECTION

2 identical systems

BANDWIDTH
DC to ≥50 MHz at 3-dB down, depending on plug-in unit.

RISETIME
≤7 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

X10 MAGNIFIER
Operates over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in a 1, 2, 5 sequence. Accurate within 1%. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.20 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts. Accuracy within 0.2% of full scale from 1 μs to 5 s and within 0.5% of full scale from 0.1 μs to 0.5 μs. Inherent delay to start of delayed sweep 150 ns or less.

DELAY RANGE
0.1 μs to 50 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and ±2 minor divisions from 1 μs to 5 s and within 1% and ±5 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

556

50-MHz Dual-Beam Oscilloscope

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

OPERATING MODES

Time Base A—Normal and Single Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

EXTERNAL INPUT

≤0.1 V/cm with X10 Display Mag, ≤1 V/cm with X1 Display Mag, continuously variable from ≤0.1 V/cm to approx 10 V/cm. DC to ≥400 kHz at 3-dB down. 50 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by ≈65 pF.

SIGNAL OUTPUTS

Gates from both time bases (≥ +9 V), sawtooths from both time bases (≥9 V/cm), delayed trigger pulse (≥7 V).

TRIGGER

(2 identical systems)

MODES

Triggered and Auto Stability. Latter mode free runs sweep in absence of triggering signal, triggers on signals ≥30 Hz.

COUPLING

AC, DC, AC LF reject, AC HF reject.

SOURCES

Internal from left or right vertical amplifier, left or right plug-in, external, or line. External trigger input RC approx 1 megohm paralleled by approx 35 pF. 50-V maximum external input (DC + peak AC). External trigger signals that have an amplitude greater than 2 V and a rate of rise exceeding 1/3 V/ns may cause erratic triggering. Internal source selectable from the oscilloscope vertical amplifier, or direct from a single channel of Type 1A1, 1A2, and 1A4 Plug-In Units. The latter mode displays the true time relationship between signals when plug-ins are in chopped or alternate operation.

REQUIREMENTS

AC INTERNAL—0.2-cm, 60 Hz to 10 MHz; 1 cm to 50 MHz.

AC EXTERNAL—0.2 V, 60 Hz to 10 MHz; 0.4 V at 50 MHz.

AC LF REJECT—INT or EXT requirement increases below 2.5 kHz.

AC HF REJECT—INT or EXT requirement increases above 60 kHz (≥2-cm deflection or ≥2 V at 2 MHz).

DC INTERNAL—0.35-cm, DC-to-10 MHz; 2 cm at 50 MHz.

DC EXTERNAL—0.2 V, DC-to-10 MHz; 0.4 V at 50 MHz.

DISPLAY LOGIC

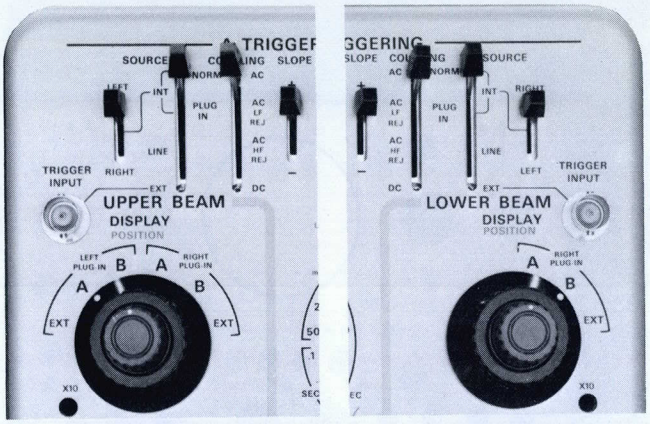
A dual-beam oscilloscope, with two horizontal and vertical deflection systems, presents the ability to select the driving source to the deflection systems . . . thereby greatly increasing the versatility.

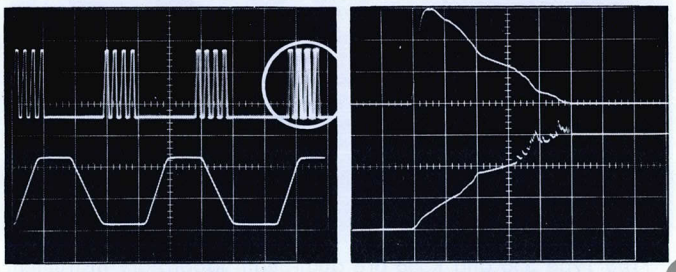
The Time Base generators can be switched to either UPPER-BEAM horizontal or LOWER-BEAM horizontal to give independent or identical time-based displays, or simultaneous display of one time base delayed accurately by the other.

The signal under test has the potential to be channeled from the plug-ins to either vertical amplifier. In the Type 556, the RIGHT plug-in unit output can be directed to either the UPPER-BEAM vertical or the LOWER-BEAM vertical or both. This means, among other things, only one probe need be attached to the signal source to perform delaying sweep operations. This reduces the loading effect on sensitive circuitry. The LEFT plug-in unit can be coupled to the UPPER-BEAM vertical only.

The triggering signal source to each Time Base trigger circuit can be selected from either UPPER-BEAM or LOWER-BEAM vertical (NORM), RIGHT or LEFT plug-in unit (necessary only in 1-series multi-trace plug-ins), or EXTERNAL.

Following are presentations of the front-panel controls which program display logic, and descriptions (with waveforms) of a few of many display combinations.



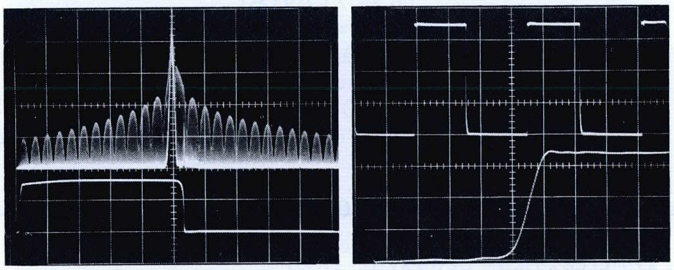


SINGLE-INPUT DUAL-BEAM DISPLAY (Above left)

Upper beam shows bursts of 2.5-MHz pulses on Time Base A with time variation between bursts. This shows up as increasing time-jitter between the first and successive bursts. The lower beam shows Time Base B (0.1 μs/cm) delayed by Time Base A and triggered on the second pulse of the last burst to provide a jitter-free expanded display of the A Sweep intensified zone. The use of only one probe and one plug-in input simplifies signal connection and provides minimum loading on the signal source.

SIMULTANEOUS SINGLE-SHOT DISPLAYS (Above right)

Current versus voltage display of a 0.75 ampere, fast-blow fuse during destructive overload. Both beams are driven by B Time Base (50 μs/cm) which is delayed by pre-triggered A Time Base to provide base reference lines before and after the event. The upper beam shows the current through the fuse at 30 A/cm while the lower beam shows the corresponding voltage across the fuse at 100 V/cm.



TIME AND FREQUENCY DISPLAYS (Above left)

Upper beam shows the spectral output of a 200-MHz gated oscillator applied as IF feedthrough to a Type 1L20 Spectrum Analyzer; the calibrated dispersion is 1 MHz/cm. The lower beam shows a real-time display of the 10-kHz gating pulse (0.5 μs/cm).

SAMPLING AND REAL-TIME DISPLAYS (Above right)

Upper beam shows a squarewave at 1 μs/cm, as applied to a Type 1A2 Plug-In. The lower beam shows the leading-edge of the same waveform at 1 ns/cm, as applied to a Type 1S1 Wide-Band Sampling Plug-In.

556

50-MHz Dual-Beam Oscilloscope

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 8 x 10-cm display area; ≥6 x 10 cm per beam with 4-cm overlap. Spot size, focus uniformity and geometry equivalent to our finest single-beam tubes. Aluminized construction, helical post acceleration. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires 10 V peak to peak for CRT modulation at normal intensity.

INTERNAL GRATICULE

Variable edge lighting. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, upper and lower beam intensity contrast controls between A sweep and non-intensified-B-zone of A sweep, trace rotation (screwdriver adjustment), and trace separation. BEAM FINDER button functions in both X-Y systems, indicates direction of off-screen signals.

OTHER CHARACTERISTICS

ELECTROMAGNETIC INTERFERENCE

Oscilloscopes meet interference specifications of MIL-I-6181 D over the following frequency ranges: Radiated (with CRT mesh filter and BNC connector covers installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), accuracy within ±2%. 50-Ω source resistance from 0.2 mV to 0.2 V. ≤1.5-μs risetime; 1-kHz ±25% repetition rate; 45% to 55% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA ±2%, squarewave or DC.

POWER REQUIREMENTS

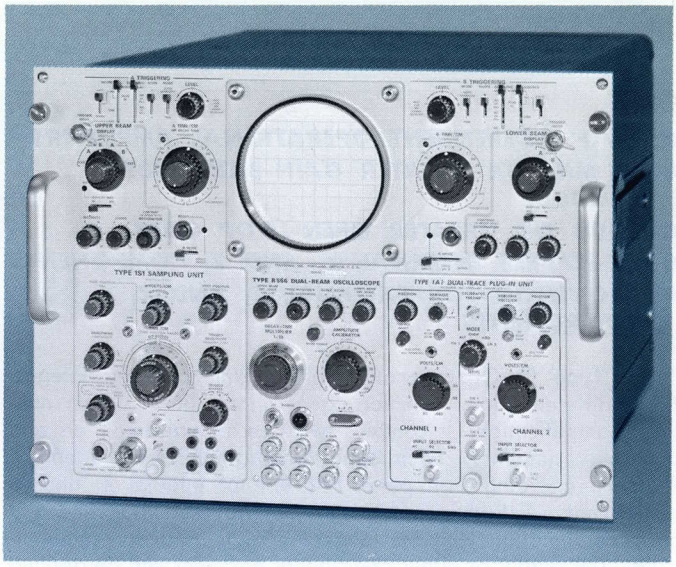
90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz source with less than 2% harmonic distortion; approx 840 W maximum, approx 1 kVA maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	15 3/16 in	38.6 cm
Width	16 15/16 in	43.0 cm
Depth	24 in	61.0 cm
Net weight	83 lb	37.7 kg
Domestic shipping weight	≈135 lb	≈61.5 kg
Export-packed weight	≈148 lb	≈67.3 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	22 13/16 in	57.9 cm
Net weight	87 3/4 lb	39.9 kg
Domestic shipping weight	≈151 lb	≈68.6 kg
Export-packed weight	≈162 lb	≈73.6 kg



RACKMOUNTING

Type R556 mounts on tilting slide-out tracks to standard 19-inch rack. Further mounting information on catalog instrument dimension page.

INCLUDED STANDARD ACCESSORIES

Four P6008 10X probes (010-0129-00); eighteen BNC caps, ten installed (016-0088-00); 3-conductor power cord (161-0030-01); smoke-gray light filter (378-0567-00); clear CRT protector plate (387-0918-00); graticule cover (200-0382-00); CRT mesh filter, installed (378-0572-00); instruction manual (070-0757-00). Type R556 also includes mounting tracks (351-0086-00) and mounting hardware; instruction manual (070-0758-00).

TYPE 556 OSCILLOSCOPE, without plug-in units . . **$3700**
TYPE R556 OSCILLOSCOPE, without plug-in units . **$3800**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

SCOPE-MOBILE® CART

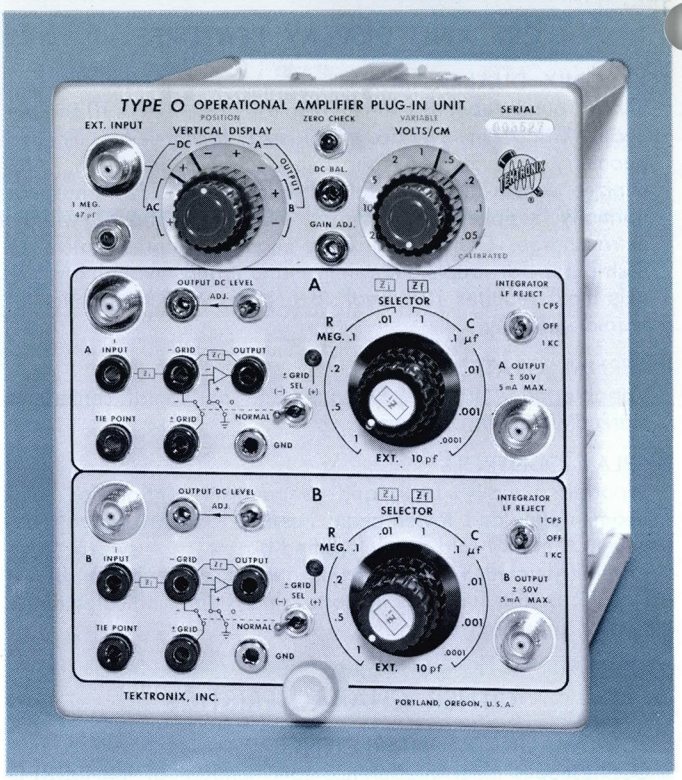
Model 205-2: storage drawer, carrier for 3 plug-in units, 9-position tilt-lock oscilloscope tray, order 205-2 . . . . . $160

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

- ***TWO INDEPENDENT OPERATIONAL AMPLIFIERS***
- ***15 MHz OR GREATER GAIN-BANDWIDTH PRODUCT***
- ***2500 OR GREATER OPEN-LOOP GAIN***
- ***SELECTABLE INTERNAL Z_i AND Z_f COMPONENTS***
- ***PROVISION FOR EXTERNAL Z_i AND Z_f COMPONENTS***

The Type O Operational Amplifier Unit performs integration, differentiation, function generation, linear and nonlinear amplification. It contains two operational amplifiers and a display amplifier. Each operational amplifier has identical features, including front-panel selection of internal Z_i and Z_f components. External components can be used independently or in combination with the internal resistor-capacitor combinations. The output of either operational amplifier can be applied to the other operational amplifier; either output can be applied to the display amplifier. The results can be viewed on Tektronix Type 530, 540, 550, and 580* Series Oscilloscopes and/or fed to other devices.

The Type 132 Power Supply is available to operate this plug-in unit outside an oscilloscope. See description of this instrument for details.



DISPLAY AMPLIFIER

TYPE O UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
535A	DC to 14 MHz	25 ns
544, 545B, 546, 547, 556, 585A*	DC to 25 MHz	14 ns
549, 551	DC to 23 MHz	16 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT
1 megohm paralleled by approx 47 pF.
600 V DC + peak AC max input voltage.

OPERATING MODES
Signal source selection from either operational amplifier or an external signal. AC or DC coupling. The display can be inverted to provide the desired deflection polarity.

OPERATIONAL AMPLIFIERS

OPEN-LOOP GAIN
2500 minimum.

OPEN-LOOP GAIN-BANDWIDTH PRODUCT
15 MHz or greater; checked at 10 MHz for open-loop gain greater than 1.5.

CLOSED-LOOP BANDWIDTH
750 kHz or greater at unity gain with internal input and feedback resistors, up to 10 MHz with external compensation (such as provided by the optional Compensating Adapter).

OUTPUT RANGE
± 50 V, ± 5 mA.

OUTPUT DC LEVEL
Adjustable to ground at front panel.

OUTPUT IMPEDANCE
Approx 30 Ω at 1 MHz for compensated unity-gain amplifier.

DC STABILITY
Drift is typically <10 mV/hour referred to input (after warm-up).

NOISE
Typically <0.5 mV peak-to-peak (equivalent input noise), approx 3 mV peak-to-peak additional output noise when $R_f =$ 1 megohm.

GRID CURRENT
<0.5 nA for each input grid; adjustable to <0.3 nA for —grid and <0.15 nA for +grid.

CROSSTALK BETWEEN AMPLIFIERS
$\geq 300{:}1$ with 1-kHz squarewave.

FEEDBACK
Provision for negative and/or positive feedback. Negative feedback utilizes internal and/or external impedances; positive feedback utilizes external impedances only.

SELECTABLE INPUT AND FEEDBACK COMPONENTS
Front-panel switches allow independent selection of the following resistors and capacitors in any combination as Z_i and Z_f: 10, 100, 200 and 500 kΩ, 1 MΩ; 10 and 100 pF, 0.001, 0.01, 0.1, and 1 μF. All values are $\pm 1\%$ except 10 and 100 pF which are adjustable.

INTEGRATION LOW-FREQUENCY REJECT
For high-frequency integration applications, reduces integration of drift and signals below approx 1 Hz or 1 kHz; can be switched out when desired.

TERMINAL ADAPTERS

Two shielded adapters included for construction of external circuitry for custom applications. Suggested circuits for special applications are shown in the instruction manual.

WEIGHTS

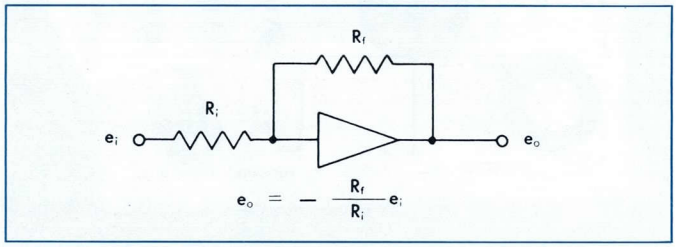
Net weight	5½ lb	2.5 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES

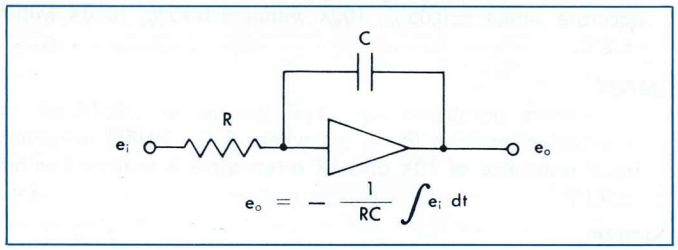
Two terminal adapters (013-0048-01); two terminal shields (013-0049-01); two BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00); instruction manual (070-0323-01).

TYPE O PLUG-IN UNIT **$625**

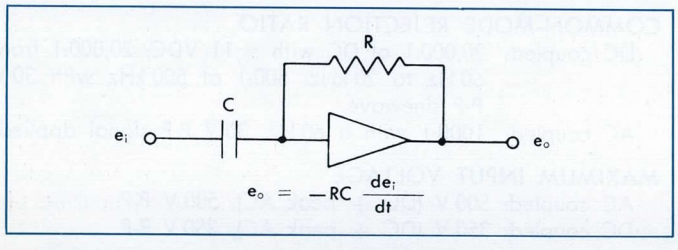
BASIC OPERATING MODES



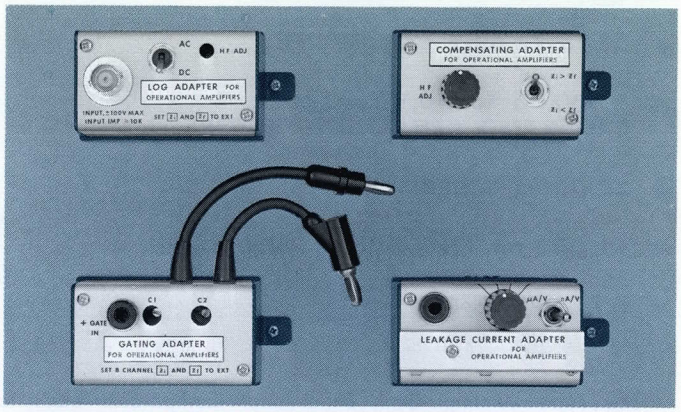
AMPLIFICATION is determined by the ratio of input to feedback resistors. This provides convenient signal step-up or step-down, with low output impedances, to over 750 kHz. Use of external compensation extends the closed-loop gain-bandwidth product to 10 MHz or more.



INTEGRATION is obtained by placing a capacitor in the feedback loop. Unlike the RC integrator, this circuitry permits loading of the output, and integration without loss of signal level. Integration at repetition rates of approximately 5 MHz is possible. Low-frequency rejection allows drift-free repetitive-waveform integration.



DIFFERENTIATION is accomplished by placing a capacitor in the input circuit. The unique characteristic of differentiation is its ability to extract higher frequency waveform components. It can advantageously detect minute information such as transients and slope changes. Differentiation of waveforms with significant components as high as 1.5 MHz is possible.



OPTIONAL ACCESSORIES

LOG ADAPTER

The Log Adapter allows the display and measurement of high-amplitude signals mixed with low-amplitude signals. Pulses and transient waveforms differing in amplitude by up to 1000 to 1 can be displayed and measured on the same trace. The Log Adapter is a logarithmic feedback network that converts the two operation amplifiers from linear amplifiers to essentially logarithmic amplifiers.

Order 013-0067-00 ..... $83

COMPENSATING ADAPTER

The Compensating Adapter extends the high-frequency performance of either operational amplifier when the internal Z_i and Z_f resistors are used in any combination for either gain or attenuation.

The adapter compensates for stray capacitance associated with the internal resistors, providing for an adjustment for optimum HF response.

Order 013-0081-00 ..... $40

GATING ADAPTER

The Gating Adapter allows integration and display of repetitive signals, by resetting the integrator to zero during the oscilloscope's retrace time. The adapter uses Operational Amplifier "B" to gate Amplifier "A" on and off in response to an external gating signal, such as the +Gate from the oscilloscope. The signal applied to Amplifier "A" is then amplified, integrated, or differentiated only during the "on" time.

Order 013-0068-00 ..... $83

LEAKAGE CURRENT ADAPTER

Used with the Type O Plug-In Unit, the Leakage Current Adapter provides the facility for measuring leakage current of semiconductor diodes and small signal transistors.

The adapter plugs into the operational jacks located on the front panel of the Type O Unit. A positive-going sawtooth voltage is required for driving the adapter. Tektronix Oscilloscopes that accept the Type O Plug-In Unit have a Sawtooth or Sweep-Out jack conveniently located on the front panel for supplying the required sawtooth voltage.

Order 013-0086-00 ..... $94

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

W
Differential Comparator Amplifier

- ***DC-to-26 MHz BANDWIDTH***
- ***1 mV/cm to 50 V/cm CALIBRATED DEFLECTION FACTORS***
- ***20,000:1 CMRR***
- ***11,000 cm EFFECTIVE SCREEN HEIGHT***
- ***FET INPUTS***

The Type W High-Gain Differential Comparator adds to the measurement capabilities of Tektronix Type 530, 540, 550 and 580* Series Oscilloscopes. Used with Type 132 Power Supply, the Type W can drive recording equipment, X-Y plotters, oscilloscopes, or other indicators.

As a differential input preamplifier, the dynamic range of the W Unit permits common-mode signals up to ±15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of 20,000 to 1 for DC or low-frequency signals, signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using the slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage added differentially to the input signal makes more precise voltage measurements possible. Using this mode of operation, the W Unit has an effective screen height of ±11,000 cm. This is equivalent to a ±11-volt dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated ±DC comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 μV per mm to be resolved.

CONVENTIONAL PREAMPLIFIER

TYPE W UNIT AND OSCILLOSCOPE	MILLIVOLTS/CM SETTING	BANDWIDTH† (—3 dB)	RISETIME
535A	50	DC to 13 MHz	27 ns
	1	DC to 7 MHz	50 ns
544, 545B, 546, 547, 556, 585A*	50	DC to 26 MHz	14 ns
	1	DC to 8 MHz	44 ns
549	50	DC to 22 MHz	16 ns
	1	DC to 7 MHz	50 ns
551	50	DC to 20 MHz	18 ns
	1	DC to 7.5 MHz	47 ns

*A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
1 mV/cm to 50 V/cm, determined by millivolts/cm and attenuator settings. Millivolts/cm positions accurate within 3%. Uncalibrated, continuously variable between steps and to approx 125 V/cm.

ATTENUATORS
4 decade steps covering range of 1 to 1,000. 10X position accurate within ±0.05%; 100X within ±0.15%, 1000X within ±3%.

INPUT
1 megohm paralleled by 20 pF (except in additional 1X attenuation position ($R \approx \infty$) where $R > 10{,}000$ megohm). Input resistance of 10X and 1X attenuators is matched within ±0.1%.

NOISE
No more than 150 μV peak to peak, measured tangentially.

DC STABILITY
Drift with time: 1 cm or less during any 5 minute interval after 20 minute warm-up period.

DIFFERENTIAL-INPUT PREAMPLIFIER

COMMON-MODE REJECTION RATIO
DC coupled: 20,000:1 at DC with ±11 VDC; 20,000:1 from 60 Hz to 20 kHz, 500:1 at 500 kHz with 30 V P-P sinewave.
AC coupled: 1000:1 with a 60 Hz, 30 V P-P signal applied.

MAXIMUM INPUT VOLTAGE
AC coupled: 500 V (DC + peak AC), 500 V P-P.
DC coupled: 350 V (DC + peak AC), 350 V P-P.

HIGH-RESOLUTION VOLTAGE MEASUREMENT using the slide-back technique

A 150-volt sawtooth waveform is applied and clipped with a zener diode, shown in Figure 1. The knee of the curve is shown expanded vertically and horizontally in Figures 2 and 3. This resolution is made possible in the Type W Unit by using the slide-back technique. Figure 3 clearly shows zener noise. X10 more "vertical magnification", to 1 mV/cm, could be used, if desired.

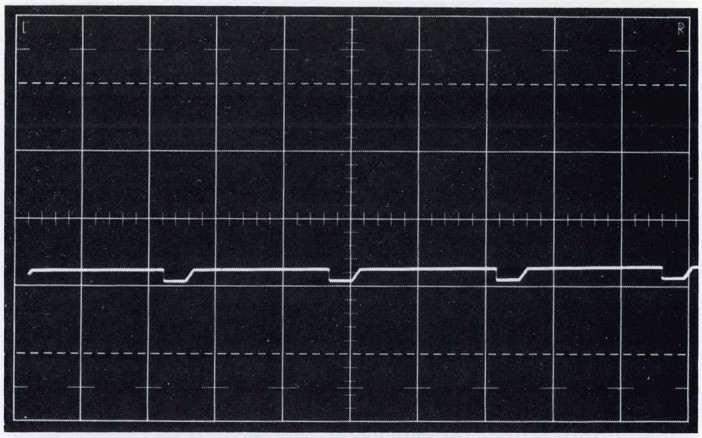


Figure 1—50 V/cm, 5 ms/cm.

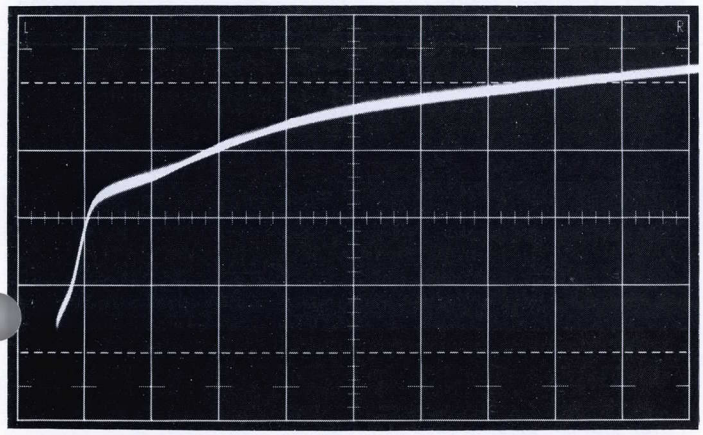


Figure 2—50 mV/cm, 0.2 ms/cm.

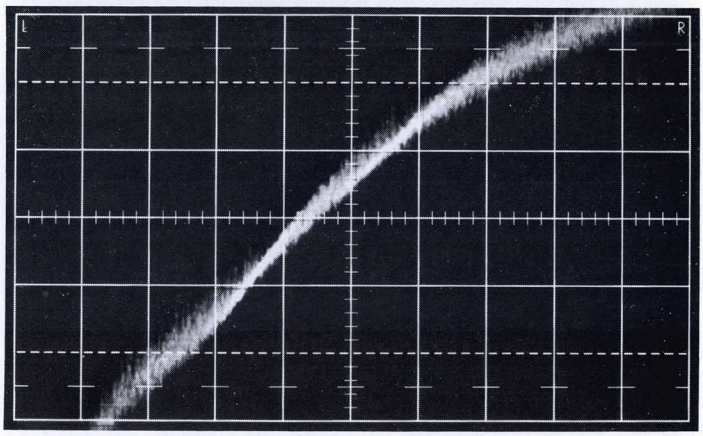


Figure 3—(Single sweep), 10 mV/cm, 100 μs/cm.

CALIBRATED DIFFERENTIAL COMPARATOR

COMPARISON VOLTAGE
0 to ±1.1 V, or 0 to ±11 V. Accuracy: ±(0.15% of indicated value plus 0.05% of Vc range).

Vc SUPPLY RESOLUTION
0 to ±1.1 V range: 100 μV per minor dial div; 0 to ±11 V range: 1 mV per minor dial div.

MAXIMUM PEAK INPUT
Same as for Differential-Input.

OVERDRIVE RECOVERY
Recovers to within 10 mV of the reference point within 300 ns after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to 5 mV in the reference level (overdrive DC shift).

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.5 kg

TYPE W PLUG-IN UNIT **$625**
Includes instruction manual (070-0432-00).

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6007 100X Probe Package, order 010-0150-00 .... $29.00

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-6055-01 .. $75.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1A1
Dual-Trace Amplifier

- ***5 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***≈500-μV/cm SINGLE CHANNEL***
- ***CHANNEL 1 SIGNAL & TRIGGER OUTPUTS***
- ***1-MHz CHOPPING RATE***
- ***FET INPUTS***

Type 1A1 provides dual-trace displays in Type 530, 540, 550 and 580* Series Oscilloscopes. Maximum bandwidth is achieved in Type 544, 546, 547, 556, and 585A Oscilloscopes. Input channels are identical with separate controls for coupling, attenuating, inverting and positioning the signal.

Used with the Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscilloscope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

Solid state components are used throughout except for the output stage.

TYPE 1A1 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
535A	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 15 MHz DC to 14 MHz 2 Hz to 10 MHz	24 ns 25 ns 35 ns
545B	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 33 MHz DC to 23 MHz 2 Hz to 14 MHz	11 ns 16 ns 25 ns
544, 546, 547, 556, 585A*	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 50 MHz DC to 28 MHz 2 Hz to 15 MHz	7 ns 13 ns 24 ns
549	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 30 MHz DC to 23 MHz 2 Hz to 14 MHz	12 ns 16 ns 25 ns
551	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 27 MHz DC to 21 MHz 2 Hz to 13 MHz	13 ns 17 ns 27 ns

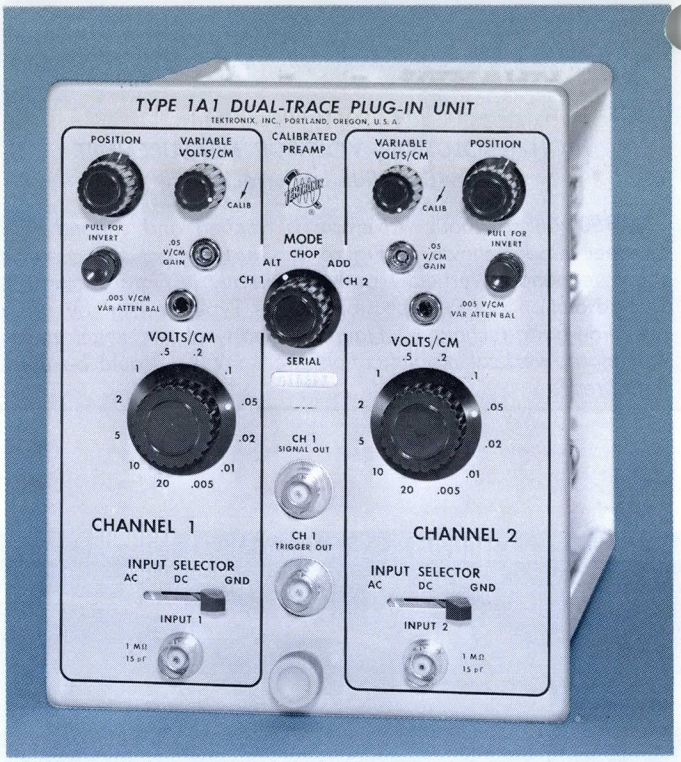
*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
5 mV/cm to 20 V/cm in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 500-ns segments of each channel displayed at an approx 1-MHz rate per channel. Chopped transient blanking except in Type 551 and 585A Oscilloscopes.



SIGNAL OUTPUT
Channel 1 Output provides up to X10 gain, can be AC coupled into Channel 2 for approx 500-μV/cm deflection factor. Noise or frequency filters can be inserted between channels if desired. Output impedance is approx 50 Ω. Maximum bandwidth of output alone is DC to 35 MHz; see chart for bandwidths at 500 μV/cm.

TRIGGER OUTPUT
Channel 1 output for external triggering permits viewing true time relationship between signals in alternate or chopped operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. Approx 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	6 lb	2.6 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
BNC-to-BNC 50-Ω cable (012-0076-00), instruction manual (070-0885-00).

TYPE 1A1 PLUG-IN UNIT $650

OPTIONAL ACCESSORIES

See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 .... $46.50
P6009 100X Probe Package, order 010-0140-00 ..... $66.00
P6028 1X Probe Package, order 010-0074-00 ..... $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1A2
Dual-Trace Amplifier

- ***50 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***CHANNEL 1 OR 2 TRIGGER OUTPUT***
- ***220-kHz CHOPPING RATE***
- ***FET INPUTS***

Type 1A2 plug-in unit provides dual-trace displays in 530, 540, 550, and 580* Series Oscilloscopes. Unit has identical input channels with separate controls for coupling, attenuating, inverting and positioning the signal. Chopped or alternate electronic switching is used for dual-trace displays.

When the unit is used with Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscilloscope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

The Type 132 Power Supply is available to operate the Type 1A2 outside an oscilloscope. See the description of this instrument for details.

Solid state components are used throughout except for one tube in the output stage.

TYPE 1A2 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
535A	DC to 15 MHz	24 ns
545B	DC to 33 MHz	11 ns
544, 546, 547, 556, 585A*	DC to 50 MHz	7 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
50 mV/cm to 20 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 2-μs segments of each channel displayed at an approx 220-kHz rate per channel. Chopped transient blanking except in Type 551 and 585A Oscilloscopes.

COMMON-MODE REJECTION
$\geq$20:1 throughout full bandwidth for signals up to 0.5 V peak-to-peak (measured at maximum gain).

TRIGGER OUTPUT
Channel 1 or 2 output for external triggering permits viewing true time relationship between signals in alternate or chopped operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. At least 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	4½ lb	2.0 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.4 kg

TYPE 1A2 PLUG-IN UNIT **$360**
Includes instruction manual (070-0430-01).

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 ..... $46.50
P6009 100X Probe Package, order 010-0140-00 ..... $66.00
P6028 1X Probe Package, order 010-0074-00 ..... $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1A4
Four-Trace Amplifier

- ***10 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***FOUR-CHANNEL ADDING (±1±2) + (±3±4)***
- ***SIGNAL OUTPUT***
- ***FET INPUTS***

This plug-in unit for Type 530, 540, 550, and (with adapter) 580*-Series Oscilloscopes through versatile switching logic provides the equivalent of two wide-band, dual-trace units connected to a third wide-band, dual-trace unit. Maximum bandwidth of DC to 50 MHz is achieved with Type 544, 546, 547 and 556 Oscilloscopes. The Type 1A4 provides a new standard of multi-channel versatility in all Tektronix Oscilloscopes that accept Letter-Series or 1-Series Plug-In Units.

Unique display logic provides unprecedented display flexibility: any channel can be viewed separately, alternately with any other channel(s), chopped with any other channel(s), added to or subtracted from any other channel(s). Alternate, chopped and added modes can also be used together: for example, Channel 1 added to Channel 2, and the resultant alternated with a chopped display of Channel 3 and 4. Used with Type 547 or RM547 Oscilloscopes, the alternate switching circuit in the plug-in unit can be slaved to the display switching circuit in the oscilloscope. For many applications, this provides the equivalent of a dual-beam oscilloscope, without the added complexity and cost.

The four input channels are identical. Each has separate controls for coupling, attenuating, inverting, positioning, and identifying the signal. Solid-state design, with FET inputs, provides low drift and fast stabilization time.

The Type 132 Power Supply is available to operate the Type 1A4 outside an oscilloscope. See the description of this instrument for details.

CHARACTERISTICS

TYPE 1A4 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
544, 546, 547, 556, 585A	DC to 50 MHz	7 ns
545B	DC to 33 MHz	11 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns
535A	DC to 15 MHz	24 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: ≤2 Hz, ≤0.2 Hz with 10X probe.

DEFLECTION FACTOR
10 mV/cm to 20 V/cm in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm (±1%) paralleled by approx 20 pF.

MAXIMUM INPUT VOLTAGE
600 V DC + peak AC.

DISPLAY MODES
Any single-channel; any two channels (alternated, chopped, or added); three channels (alternated, chopped, or added in any combination); and four channels (Channels 1 and 2 alternated, chopped, or added with Channels 3 and 4). Four channel addition is useful in single-shot displays of four different signals, as in delay and coincidence studies.
Channels are always displayed in numerical sequence in chopped and alternate modes. One channel will run twice when only three are turned on. In chopped operation, successive 2.5-μs (approx) segments of each channel are displayed. Chopping rate is approx 400 kHz. Chopped transient blanking with all oscilloscopes except Type 551, and 585A.

DISPLAY SWITCHING with Type 547 and RM547 Oscilloscopes
Alternate switching circuit in the Type 1A4 can be slaved to the Automatic Display Switching in Type 547 and RM547 Oscilloscopes to lock Channels 1 and 2 to Time Base A, and Channels 3 and 4 to Time Base B. For dual-trace slaving, Channel 1 or 2 is alternated with Channel 3 or 4. Alternation of up to 8 traces with each signal displayed on 2 different time bases is also possible when the 1A4 is not slaved to the oscilloscope.

COMMON-MODE REJECTION
At least 20:1, DC to 10 MHz common-mode signals up to 10 cm in amplitude.

CHANNEL ISOLATION
At least 50:1 for signals from DC to 20 MHz.

1A4
Four-Trace Amplifier

SIGNAL OUTPUT AND TRIGGER SOURCE

Signal from any channel can be used to externally trigger the oscilloscope, thus indicating the true time relationship between signals displayed in alternate and chopped mode. Selected output also applied internally to Type 544, 546, 547, 549 and 556 Oscilloscopes. The front-panel output can also be cascaded with another channel, providing additional gain useful in many applications. Signal output amplitude is >0.5 V/cm of display signal, unterminated at 1 kHz. Bandwidth is ≤20 Hz to ≥10 MHz (to approx 500 kHz with any channel operated in chopped mode). Approx 50-Ω output impedance.

WEIGHTS

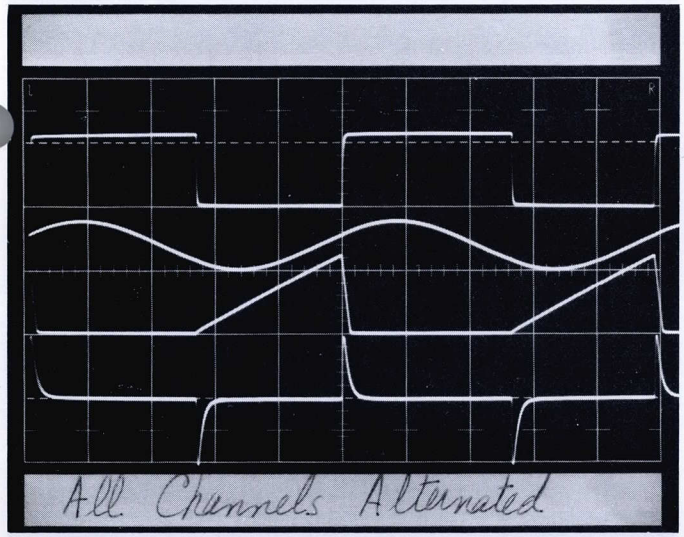
Net weight	6½ lb	3.1 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈16 lb	≈7.3 kg

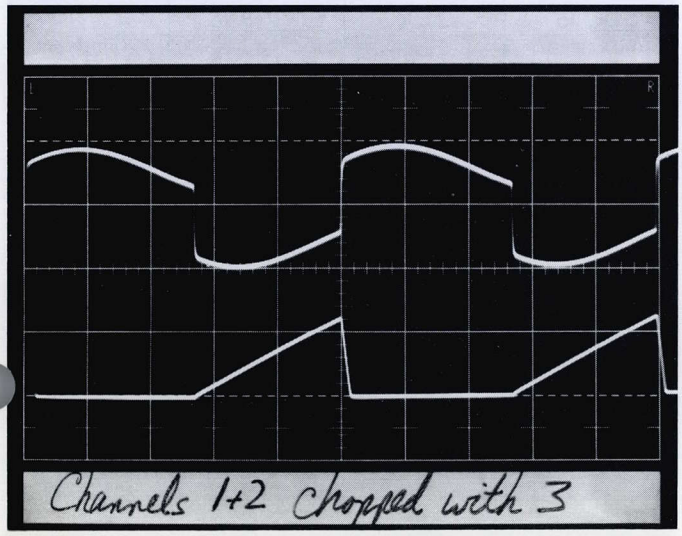
INCLUDED STANDARD ACCESSORIES

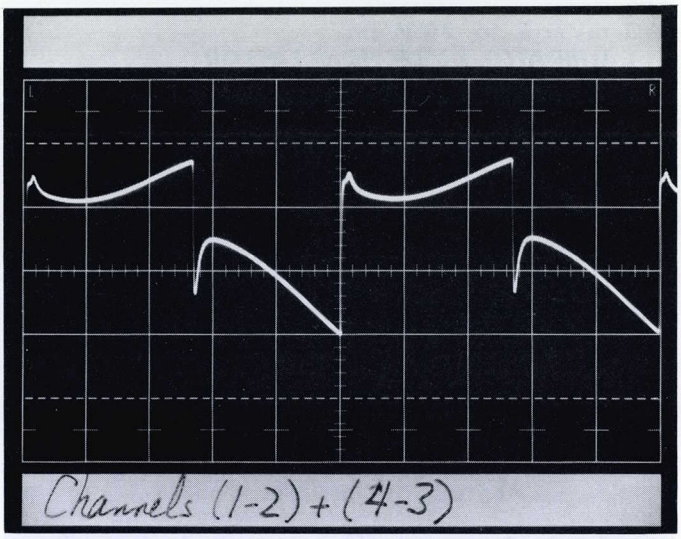
BNC-to-BNC 18-inch cable (012-0076-00); instruction manual (070-0545-00).

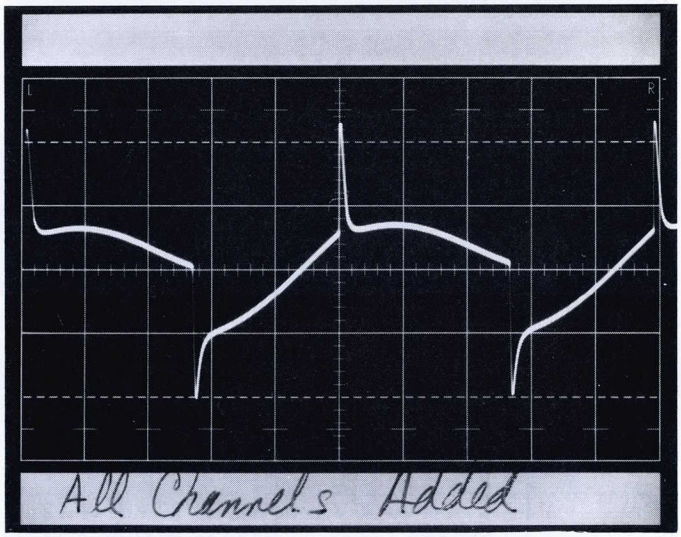
TYPE 1A4 PLUG-IN UNIT $895

SOME OF MANY POSSIBLE DISPLAY MODES









Waveforms photographed with C-12 Camera, Projected Graticule, Type 547 Oscilloscope.

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package, order 010-0129-00 ..... $46.50

P6009 100X Probe Package, order 010-0140-00 ..... $66.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1A5
Differential Comparator Amplifier

- ***1 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***20,000:1 CMRR***
- ***±5-V COMPARISON VOLTAGE***
- ***FET INPUTS***

This wide-band differential unit for Type 530, 540, 550, and 580*-Series Oscilloscopes achieves a new high in common-mode rejection. Gain-bandwidth products exceed those previously available in a differential amplifier. Maximum bandwidth is obtained with Type 544, 546, 547, 556, and 585A Oscilloscopes. The Type 132 Power Supply is available to operate the Type 1A5 outside an oscilloscope. See the description of this instrument for details.

Solid state design, with FET inputs, provides low drift and eliminates microphonics.

CHARACTERISTICS

TYPE 1A5 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
544, 546, 547, 556, 585A*	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 50 MHz DC to 45 MHz DC to 40 MHz	7 ns 8 ns 9 ns
545B	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 33 MHz DC to 31 MHz DC to 30 MHz	11 ns 12 ns 12 ns
549	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 30 MHz DC to 29 MHz DC to 28 MHz	12 ns 13 ns 13 ns
551	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 27 MHz DC to 26 MHz DC to 25 MHz	13 ns 14 ns 14 ns
535A	5 mV/cm to 20 V/cm 2 and 1 mV/cm	DC to 15 MHz DC to 14 MHz	24 ns 25 ns

†Low-frequency 3-dB point, AC coupled: ≤10 Hz.

*A Type 81A Adapter is required.

DEFLECTION FACTOR
1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 2.5% (within 2% from 1 mV/cm to 20 mV/cm). Uncalibrated, continuously variable between steps and to ≥ 50 V/cm.

INPUT RC
1 megohm paralleled by approx 20 pF.

INPUT COUPLING
May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.

MAXIMUM INPUT VOLTAGE
±400 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ±500 V (DC + peak AC) from 10 mV/cm to 20 V/cm.

COMMON-MODE DYNAMIC RANGE
≥±5 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ≥±50 V from 50 mV/cm to 0.2 V/cm, ≥±500 V from 0.5 V/cm to 20 V/cm. The ±50 V range can be extended from 50 mV/cm to 10 mV/cm, and the ±500 V range can be extended from 0.5 V/cm to 0.1 V/cm by pulling and turning the VOLTS/CM control.

COMMON-MODE REJECTION RATIOS*

FREQUENCY	REJECTION RATIO	SINEWAVE AMPLITUDE	DEFLECTION FACTOR
DC to 100 kHz	≥20,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
100 kHz to 1 MHz	≥10,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
1 MHz to 10 MHz	≥10,000:1 divided by freq. in MHz	±5 V P to P divided by freq. in MHz	1 mV/cm to 20 mV/cm
DC to 10 kHz	≥2,000:1	±50 V P to P	10 mV/cm to 2 V/cm
DC to 10 kHz	≥100:1	±50 V P to P	5 V/cm to 20 V/cm
60 Hz (AC coupled)	≥1,000:1	±5 V P to P	1 mV/cm to 20 mV/cm

*At 0°C to 50°C

1A5
Differential Comparator Amplifier

DC STABILITY
Drift with time: ≤200 μV/h at 25°C. With temperature: ≤200 μV/°C. With line voltage change: ≤300 μV from 105 to 125 VAC.

NOISE
≤50 μV RMS.

DC SHIFT DUE TO OVERDRIVE
Within 1% of ± overdrive signal, but not exceeding 10 mV in the 5 V input signal range, 0.1 V in the 50 V input signal range, or 1.0 V in the 500 V input signal range.

OVERDRIVE RECOVERY
Recovers to within 10 mV of DC-shifted level after 0.15 μs in the 5 V input signal range.

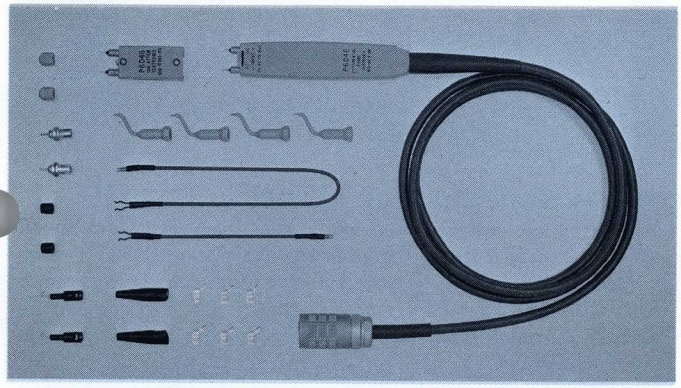
COMPARISON VOLTAGE
0 to ±5 V, internally applied to + input or — input, monitorable at front panel. Accuracy within 7 mV or 0.5% of comparison voltage, whichever is greater.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 1A5 PLUG-IN UNIT **$625**
Includes instruction manual (070-0638-00).

Differential Probe P6046



The P6046 expands the differential measurement capabilities of the Type 1A5 Plug-In Unit. With this probe, the differential-signal-adding takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. This differential probe-tip performance minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 assures DC-to-45 MHz performance at the probe tip where the measurements are made.

CHARACTERISTICS
Probe with Type 1A5 Plug-In Unit

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, ±1%.

INPUT CAPACITANCE is approx 10 pF.

COMMON-MODE LINEAR DYNAMIC RANGE is ±5 V (DC + peak AC), ±50 V with 10X attenuator.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/cm to 20 mV/cm are 10,000:1 at DC, 1,000:1 at 45 MHz. Min AC-coupled CMRR from 1 mV/cm to 20 mV/cm is 1000:1 at 20 MHz decreasing to 500:1 from 40 MHz to 45 MHz.

BANDWIDTH/RISETIME

TYPE 1A5 DEFLECTION FACTOR	BANDWIDTH*	RISETIME*
200 mV/cm to 5 mV/cm	DC to 45 MHz	7.8 ns
2 mV/cm	DC to 43 MHz	8.1 ns
1 mV/cm	DC to 38 MHz	9.2 ns

*With Oscilloscope Types 544, 546, 547, 556, or 585A with Type 81A Adapter.

MAXIMUM INPUT VOLTAGE is ±25 V (DC + peak AC), ±250 V with 10X attenuator.

NOISE (periodic and random deviation) is 200 μV or less.

THERMAL DRIFT at the probe head is 250 μV/°C or less.

PROBE CABLE is 6 feet long, terminated with a special nine-pin connector.

P6046 PROBE PACKAGE (010-0213-00) **$470**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

1A6
Differential Amplifier

- ***DC-to-2 MHz BANDWIDTH***
- ***1 mV/cm to 50 V/cm CALIBRATED DEFLECTION FACTORS***
- ***10,000:1 CMRR***
- ***±15-V COMMON-MODE SIGNAL RANGE***

The Type 1A6 Plug-In Unit is a DC coupled differential amplifier designed for Tektronix 530, 540, 550 and 580* Series Oscilloscopes. It features a differential input with a high rejection ratio for in-phase signals, allowing the cancellation of unwanted or interfering signals. The differential measuring capability is particularly useful in the display of instantaneous voltage difference between signals.

The plug-in unit is simple to operate. Only one control is used to select the deflection factor and the common-mode signal range.

The Type 132 Power Supply is available to operate the Type 1A6 outside an oscilloscope. See the description of this instrument for details.

CHARACTERISTICS

BANDWIDTH
DC to ≥2 MHz (≤2 Hz to ≥2 MHz AC-coupled) at 3-dB down. Bandwidth independent of deflection factor.

RISETIME
≤0.18 μs.

DEFLECTION FACTOR
1 mV/cm to 50 V/cm in 15 calibrated steps, 1-2-5 sequence; ±1.5% accuracy from 1 mV/cm to 50 mV/cm, ±2.5% accuracy from 0.1 V/cm to 50 V/cm. Uncalibrated continuous variation between steps and to approx 125 V/cm.

INPUT RC
1 megohm paralleled by 33 pF.

MAXIMUM INPUT VOLTAGE
DC coupled: 1 mV to 50 mV — ±200 V (DC + peak AC)
0.1 V to 50 V — ±600 V (DC + peak AC)
AC coupled: 1 mV to 50 mV — ±200 V (AC peak to peak)
0.1 V to 50 V — ±600 V (DC + peak AC)

DC STABILITY
Drift with temperature: ≤ 200 μV/°C.

INPUT COUPLING
AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.

COMMON-MODE REJECTION

1 mV/cm to 50 mV/cm	0.1 V/cm to 50 V/cm
≥10,000:1 from DC to 100 kHz	†≥1000:1 from DC to 100 kHz
≥2000:1 at 60 Hz (AC-coupled)	≥1000:1 at 60 Hz (AC-coupled)

*A Type 81A Adapter is required. †Adjustable.

COMMON-MODE DYNAMIC RANGE
±15 V (combined DC and peak AC) from 1 mV/cm to 50 mV/cm, ±150 V from 0.1 V/cm to 0.5 V/cm, ±500 V from 1 V/cm to 50 V/cm. The ±150-V range can be extended from 0.1 V/cm to 10 mV/cm, and the ±500-V range can be extended from 1 V/cm to 0.1 V/cm by pulling and turning the V/cm control.

WEIGHTS

Net weight	4 lb	1.8 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.4 kg

TYPE 1A6 PLUG-IN UNIT **$295**
Includes instruction manual (070-0537-00).

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

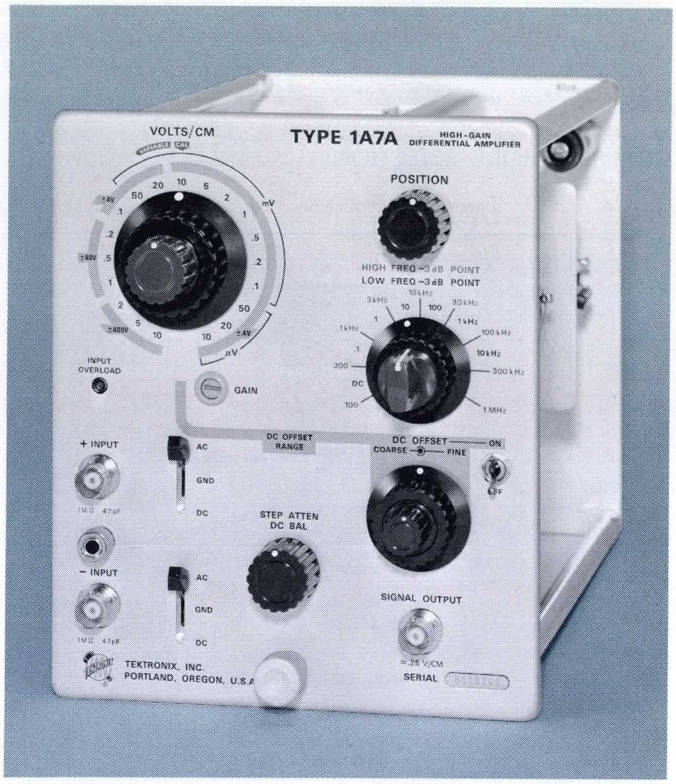
P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-6055-01 .. $75.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1A7A
Differential Amplifier

- ***DC-to-1 MHz BANDWIDTH***
- ***10 μV/cm to 10 V/cm CALIBRATED DEFLECTION FACTORS***
- ***SELECTABLE UPPER AND LOWER —3-dB POINTS***
- ***100,000:1 CMRR***
- ***DC OFFSET***
- ***FET INPUTS***
- ***10-μV/HOUR DC DRIFT****



CHARACTERISTICS

Designed for use with any Tektronix 530, 540, 550, or (with Type 81A Adapter) 580-Series Oscilloscopes. Used with Type 132 Power Supply, the Type 1A7A can drive recording equipment, X-Y plotters, oscilloscopes or other indicators.

Type 1A7A characteristics represent a significant performance level for high gain, differential, DC-coupled amplifiers. DC drift is held to 10 μV/h, long term, without chopper stabilization; displayed noise (tangentially measured) is 16 μV at 10 μV/cm and 1 MHz, with ≤25-Ω source resistance. Bandwidth is maintained at DC to 1 MHz throughout the deflection factor range of 10 μV/cm to 10 V/cm. CMRR is at least 100,000:1 from DC to 100 kHz at 10 μV/cm to 10 mV/cm. DC differential offset provides an internal voltage to cancel residual DC levels for inspect signal components over the full differential dynamic range.

Passband is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequency (0.1 Hz).

Input circuitry is protected (fused) against accidental severe overload. A differential overload light indicates overload is being approached.

BANDWIDTH
DC-to-1 MHz bandwidth independent of deflection factor. Selectable high and low-frequency 3-dB points.

HIGH-FREQUENCY —3-dB POINTS
1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz and 100 Hz.

LOW-FREQUENCY —3-dB POINTS
0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, and 10 kHz. DC mode is included on this control.

DEFLECTION FACTOR
10 μV/cm to 10 V/cm in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuous variation between steps and to approx 25 V/cm.

INPUT RC
1 megohm, paralleled by 47 pF.

*With constant temperature. See DC STABILITY specifications.

INPUT COUPLING
May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower —3-dB point is 1.6 Hz (±5%) when AC coupled at input.

MAXIMUM INPUT CURRENT

DEFLECTION FACTOR	INPUT	at 25°C	at 50°C
10 μV/cm to 10 mV/cm	each input	±20 pA	±100 pA
	both inputs	±40 pA	±200 pA
20 mV/cm to 10 V/cm	each input	±10 pA	±10 pA
Display shift at 10 μV/cm (AC coupled)	each input	±2 cm	±10 cm

DISPLAYED NOISE
≤16 μV or 0.1 cm, whichever is greater, measured tangentially at full bandwidth (DC to 1 MHz), source resistance 25 Ω or less. See catalog glossary for definition of "tangential noise measurement".

DC STABILITY
Drift with time (ambient temperature and line voltage constant).

Short term: 5 μV/minute (P-P) after 1 hour warm up.

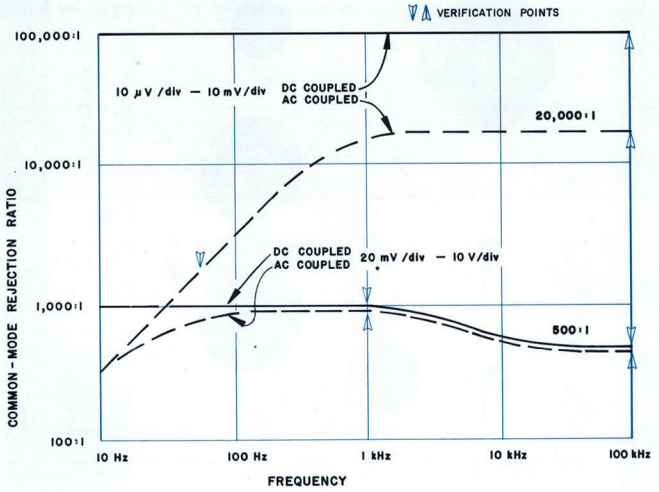
Long term: 10 μV/hour (P-P) after 1 hour warm up.

Drift with ambient temperature (line voltage constant): 50 μV/°C.

DIFFERENTIAL DYNAMIC RANGE
10 μV/cm to 10 mV/cm — ±400 mV
20 mV/cm to 0.1 V/cm — ±4 V
0.2 V/cm to 1 V/cm — ±40 V
2 V/cm to 10 V/cm — ±400 V

DC OFFSET (within ±10%)
±400 mV from 10 μV/cm to 10 mV/cm; ±4 V from 20 mV/cm to 0.1 V/cm; ±40 V from 0.2 V/cm to 1 V/cm; ±400 V from 2 V/cm to 10 V/cm.

COMMON-MODE REJECTION



COMMON-MODE DYNAMIC RANGE
10 μV/cm to 10 mV/cm — ±10 V (DC + peak AC).
20 mV/cm to 0.1 V/cm — ±100 V (DC + peak AC).
0.2 V/cm to 10 V/cm — ±500 V (DC + peak AC).

MAXIMUM INPUT VOLTAGE
DC Coupled: 10 μV/cm to 10 mV/cm — ±20 V (DC + peak AC)
20 mV/cm to 10 V/cm — ±500 V (DC + peak AC)
AC Coupled Input DC Voltage:
10 μV/cm to 10 V/cm — ±500 V

OVERDRIVE RECOVERY
≤10 μs to recover within 0.5% of zero level after removal of a + or — voltage applied for 1 s, applied voltage within the differential dynamic range.

DIFFERENTIAL OVERLOAD LIGHT
Indicates differential overload is being approached.

FRONT-PANEL SIGNAL OUTPUT
0.25 V per displayed cm, ±10%. Output is DC coupled, output impedance ≤750 Ω. Minimum load resistance, 10 kΩ.

WEIGHTS

Net weight	4¾ lb	2.1 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 1A7A PLUG-IN UNIT $525
Includes instruction manual (070-0782-00)

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

The P6055 low-capacitance probe is well suited for use with most Tektronix differential units.

The probe can be adjusted to match preamplifier nominal input capacitance ranging from 20 pF to 47 pF. The attenuation ratio can be adjusted to 10X to compensate for differences in the input resistance of the preamplifier. When two P6055 probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other, helps to maintain the common-mode rejection ratio of the system.

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection, order 010-6055-01 .. $75.00

P6007 100X Probe Package, order 010-0150-00 ..... $29.00

P6028 1X Probe Package, order 010-0074-00 ..... $16.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

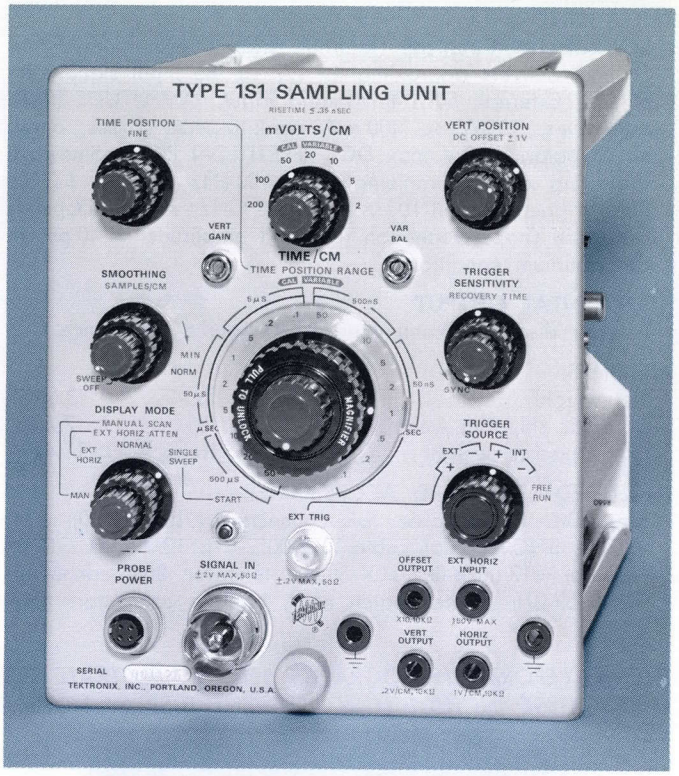
1S1
Sampling Unit

- ***350-ps RISETIME***
- ***2 mV/cm to 200 mV/cm CALIBRATED DEFLECTION FACTORS***
- ***NO PRETRIGGER REQUIRED***
- ***100 ps/cm to 50 μs/cm CALIBRATED TIME BASE***

Used with any of the Type 530, 540, 550 or 580*-Series Oscilloscopes, the Type 1S1 Sampling Unit extends the measuring capabilities to 1 gigahertz. Operation is like a conventional oscilloscope—but with a combination of bandwidth and sensitivity possible only through sampling.

The Type 1S1 features internal triggering with a built-in delay line—no need for pretriggers or external delay lines. The tunnel-diode trigger circuit assures stable triggering through 1 gigahertz. Calibrated sweep range is from 100 ps/cm to 50 μs/cm. A single control is used to select the sweep range and magnify the display up to X100 when desired. This single-control feature allows direct read-out of the sweep time/cm even when magnified.

Calibrated vertical deflection factors range from 2 mV/cm to 200 mV/cm. Noise in the display is less than 1 mV, and can be reduced by a smoothing control. A DC-offset control permits observation of millivolt signals in the presence of up to ±1 volt input levels. Output signals are available at the front panel for driving chart recorders.



VERTICAL SYSTEM

RISETIME
Less than or equal to 350 ps.

BANDWIDTH
Equivalent to DC-to-1 GHz at 3-dB down.

DEFLECTION FACTOR
2 mV/cm to 200 mV/cm in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to 500 μV/cm, uncalibrated.

DISPLAYED NOISE
1mV or less unsmoothed; 500 μV, smoothed (includes 90% of dots).

INPUT CHARACTERISTICS
Nominally 50 Ω. Safe overload is ±5 V. GR874† input connectors. Trigger input is BNC, nominally 50 Ω.

DC OFFSET RANGE
+1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/cm. Signals between +2 V and −2 V limits may be displayed at 200 mV/cm. Monitor jacks provide X10 actual DC offset through 10 kΩ.

VERTICAL OUTPUT
200 mV for each centimeter of displayed signal through 10 kΩ.

PROBE POWER
Available at front-panel connector for cathode-follower probe, Type 281 TDR Pulser, and Type 282 Adapter for high-impedance probes.

*A Type 81A Adapter is required.
†Registered Trademark General Radio Company

HORIZONTAL SYSTEM

TIME BASE
50 μs/cm to 100 ps/cm in 18 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps.

MAGNIFIER
Displays at sweep rates from 1 ns/cm to 50 μs/cm can be magnified up to X100 (depending on sweep rate) while maintaining a constant number of samples/cm and the same Time Position Range. Magnification occurs from a fixed time-reference point at the left end of the trace.

TIME POSITION RANGE
500 μs, 50 μs, 5 μs, 500 ns and 50 ns, depending on unmagnified TIME/CM setting. Coarse and fine TIME POSITION controls position start of the display through a time interval equal to the TIME POSITION RANGE setting.

SAMPLES/CM
Continuously variable adjustment of samples displayed per centimeter horizontally from approximately 5 samples/cm to an immeasurable number. Allows optimum adjustment of display rate and dot density.

DISPLAY MODES
Repetitive, single display, manual scan, or external scan. Front-panel START button for single-display operation.

INTERNAL DELAY LINE
Permits viewing the leading edge of the input waveform.

TRIGGERING

SOURCE (AC-Coupled): Internal, trigger pickoff in signal channel delivers approximately 1/7 of the input signal amplitude; External, 50-Ω terminated input. AMPLITUDE (EXT): Sinewaves, 10 mV to 400 mV, peak-to-peak; Pulses, 5 mV, either polarity. 2 V max DC. REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 1 GHz. Pulse triggering from 10 Hz through 1 GHz. JITTER: Depends on signal shape, repetition rate and amplitude; ≤40 ps under optimum conditions.

HORIZONTAL OUTPUT

1 V per displayed centimeter; 10 kΩ source impedance.

WEIGHTS

Net weight	7¾ lb	3.5 kg
Domestic shipping weight	≈17 lb	≈ 7.7 kg
Export-packed weight	≈25 lb	≈11.4 kg

INCLUDED STANDARD ACCESSORIES

5-ns 50-Ω RG58 cable, GR connectors (017-0512-00); 50-Ω 42-inch BNC coaxial cable (012-0057-01); 10X 50-Ω GR attenuator (017-0078-00); 10X 50-Ω attenuator, BNC connectors (011-0059-01); 18-inch patch cord, banana connectors (012-0039-00); 18-inch patch cord, BNC-banana plugs (012-0090-00); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00) instruction manual (070-0475-00).

TYPE 1S1 SAMPLING UNIT **$1400**

OPTIONAL ACCESSORIES

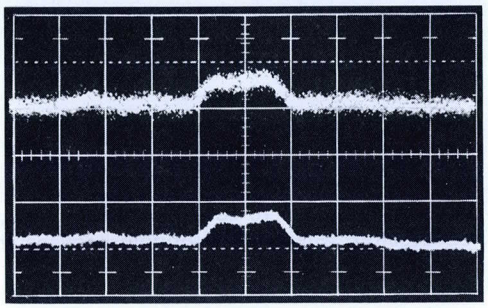
TYPE 281 TDR PULSER, order 015-0060-00 ..... $95
TYPE 282 PROBE ADAPTER, order 015-0074-00 ..... $95
P6034 10X Probe, order 010-0110-00 ..... $44
P6035 100X Probe, order 010-0111-00 ..... $44
P6040/CT-1 CURRENT PROBE, order 015-0041-00 ..... $40
VP-1 VOLTAGE PICKOFF "T", order 017-0073-01 ..... $28
POWER DIVIDER GR874-TPD*, order 017-0082-00.
COUPLING CAPACITOR, GR874-K*, order 017-0028-00.

This represents only a partial listing of the many useful items available for sampling systems. Please refer to the catalog accessory section for a more complete listing.

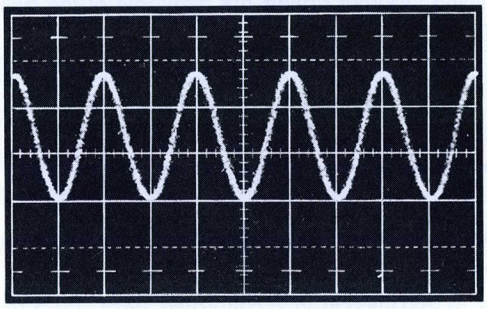
*Registered Trademark General Radio Company

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

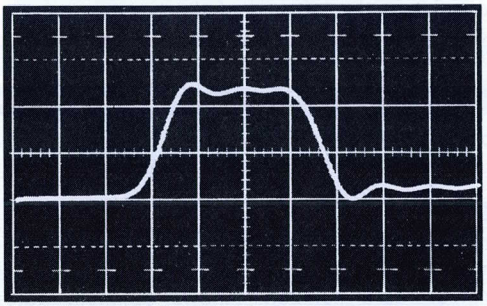
THE WAVEFORM PHOTOGRAPHS BELOW ILLUSTRATE THE PERFORMANCE CAPABILITIES OF THE TYPE 1S1 SAMPLING UNIT. THESE INCLUDE LOW INHERENT DISPLAY NOISE, STABLE TRIGGERING AND REAL-TIME SAMPLING.



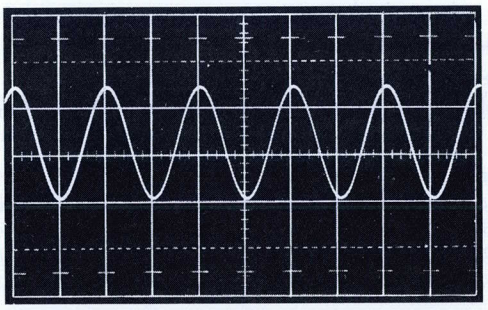
TANGENTIAL NOISE—A 1-mV, 2-ns wide pulse externally triggered. Upper waveform is unsmoothed. The lower is smoothed. Vert: 2 mV/cm. Horiz: 1 ns/cm.



TRIGGERING AT 1 GHz—A 1-GHz sinewave; internally triggered. Vert: 100 mV/cm. Horiz: 0.5 ns/cm.



PULSE TRIGGERING—A 50-mV, 2-ns wide pulse; internally triggered. Vert: 20 mV/cm. Horiz: 0.5 ns/cm.



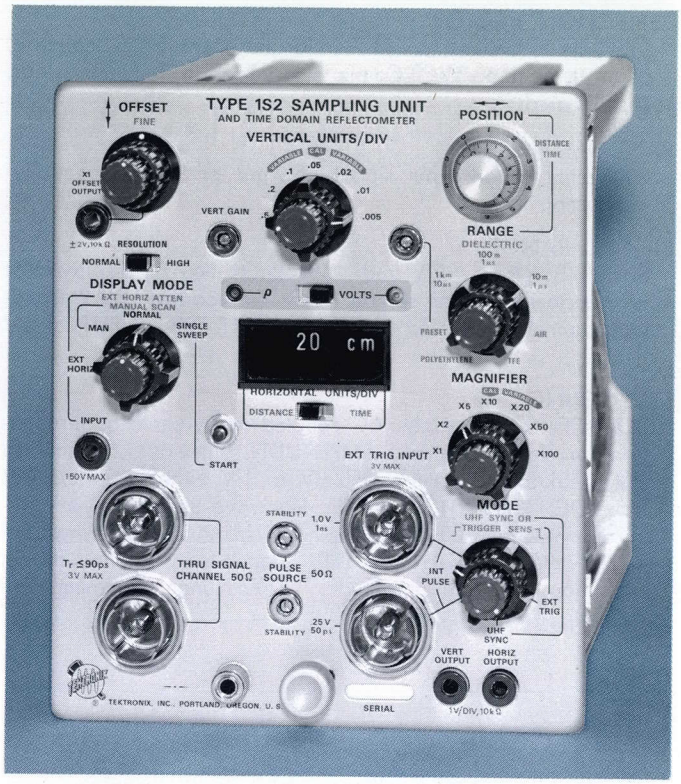
REAL-TIME SAMPLING DISPLAY—A 1-kHz sinewave; Internal Main Frame triggering. Vert: 100 mV/cm (free running sampler). Horiz: 0.5 ms/cm (realtime—main frame).

1S2
Reflectometer and Sampling Unit

- ***140-ps TDR SYSTEM RISETIME***
- ***90-ps SAMPLING RISETIME***
- ***RHO AND VOLTAGE CALIBRATION***
- ***TWO INTERNAL PULSE SOURCES***

The Type 1S2 Sampling Plug-In converts any Tektronix 530, 540, or 550-Series Oscilloscope to a time-domain reflectometry measurement system. As a TDR, the Type 1S2 has a system risetime of 140 ps and is calibrated in rho (ρ) from 0.005 ρ/div to 0.5 ρ/div. The horizontal is calibrated from 1 cm/div to 100 m/div for dielectrics of air, tfe and polyethylene. Two pulse outputs provide either 50 ps t_r, 250 mV into 50 Ω, or 1 ns t_r, 1 V into 50 Ω.

The 90-ps risetime, 5-mV/div deflection factor, 100-ps/div sweep and built-in triggering capability make the Type 1S2 useful for many other sampling measurements. A pretrigger is required.



SYSTEM PERFORMANCE AS REFLECTOMETER

VERTICAL

SYSTEM RISETIME
Less than or equal to 140 ps, for the displayed reflection from a short-circuited 20-cm air line.

VERTICAL SCALE
Calibrated in ρ (rho) and volts: 0.005 ρ/div to 0.5 ρ/div or 5 mV/div to 500 mV/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Continuous variation between steps, uncalibrated.

RESOLUTION
Reflection coefficients as small as 0.001 can be observed.

INPUT CHARACTERISTICS
Nominal 50-Ω feed-through signal channel, (termination supplied). GR874 connectors.

DC OFFSET RANGE
+2 ρ to −2 ρ (or +2 V to −2 V). Allows open-circuit reflections to be displayed at full sensitivity. Actual DC offset may be monitored at 1 ρ/V through 10 kΩ.

VERTICAL OUTPUT
1 V for each division of displayed signal through 10 kΩ.

HORIZONTAL

HORIZONTAL SCALE
Calibrated in distance and time: full-scale, 10-div display (without magnification) of 10 m, 100 m, or 1 km; 100 ns, 1 μs, or 10 μs. Accurate within 3% from 1 μs/div to 500 ps/div, within 5% from 200 ps/div to 100 ps/div.

MAGNIFIER
X1 to X100 in 7 calibrated steps (1-2-5 sequence). Continuously variable between steps. Allows display to be magnified from a fixed on-screen reference point, 1 major division from the left edge of the graticule.

UNITS/DIV READOUT
Horizontal scale factor (combination of horizontal range and magnification settings) readout, directly at front panel, indicates either distance or time/div.

DISTANCE OR TIME POSITION
Ten-turn dial directly reads one-way distance or round-trip time to test-line discontinuity. Round-trip time readings are accurate to within ±1%. Range of 10-turn dial is the same as the full-scale, 10-div display without magnification.

JITTER
Less than or equal to 20 ps with internal pulse sources.

DIELECTRIC
Calibrated for air, tfe and polyethylene lines. Preset mode adjustable for lines with velocity of propagation from 0.6 to 1.0X velocity of light.

DISPLAY MODES
Repetitive or single sweep, manual or external scan.

HORIZONTAL OUTPUT
1 V for each division of displayed signal through 10 kΩ.

PULSE SOURCES

FAST-RISE OUTPUT
Approximately 50-ps risetime, 250 mV. 50-Ω source (reverse terminated).

LARGE-AMPLITUDE OUTPUT
Approximately 1-ns risetime, 1 V. 50-Ω source (reverse terminated).

PERFORMANCE AS SAMPLER

RISETIME
Less than or equal to 90 ps.

BANDWIDTH
Equivalent to DC-to-3.9 GHz at 3-dB down.

1S2

Reflectometer and Sampling Unit

DEFLECTION FACTOR
5 mV/div to 500 mV/div in 7 calibrated steps, 1-2-5 sequence, accurate within 3%. Continuous variation between steps, uncalibrated.

RANDOM NOISE
Equivalent to an input signal of 2 mV or less (tangentially-measured).

SIGNAL RANGE
Signals between +2 V and −2 V limits may be displayed at any deflection-factor setting. Safe overload is ±3 V if signal channel is coupled directly into EXT TRIG INPUT, ±5 V if not.

TRIGGERING
SOURCE: External only, AC coupled—may serve as termination for signal channel. AMPLITUDE: Sinewaves, 100 mV to 2 V, peak-to-peak; Pulses, 50 mV to 1 V either polarity. 3 V max DC. REPETITION RATE: Sinewave triggering or synchronizing from 100 kHz through 5 GHz. Pulse triggering from 10 Hz through 5 GHz. JITTER: Depends on signal shape, repetition rate and amplitude; ≤30 ps under optimum conditions.

WEIGHTS

Net weight	8 lb	3.3 kg
Domestic shipping weight	≈18 lb	≈ 8.2 kg
Export-packed weight	≈28 lb	≈12.7 kg

INCLUDED STANDARD ACCESSORIES
10-inch GR cable (017-0513-00); 5X attenuator (017-0079-00); 2X attenuator (017-0080-00); 50-Ω termination (017-0081-00); 20-cm air line (017-0084-00); 50-Ω termination, short circuit (017-0087-00); 5-ns, 50-Ω RG213 cable (017-0502-00); 18-inch patch cord (012-0039-00); 18-inch BNC-to-banana plug patch cord (012-0090-00); instruction manual (070-0889-00).

TYPE 1S2 SAMPLING UNIT $1525

OPTIONAL ACCESSORIES

P6034 10X Probe Package, order 010-0110-00 ..... $ 44
P6035 100X Probe Package, order 010-0111-00 ..... $ 44
Power Divider, GR874-TPD*, order 017-0082-00.
Coupling Capacitor, GR874-K*, order 017-0028-00.

This listing covers only a few of the more commonly useful items for sampling instruments. A more complete listing can be found in the accessory section of this catalog.

*Registered Trademark General Radio Company

113

Delay Cable

The Tektronix Type 113 Delay Cable has a delay of 60 ns and a characteristic impedance of 50 Ω. In general it is used in those sampling applications where the vertical amplifier does not contain internal delay lines and the triggering of the sweep is external and signal delay is required.

CHARACTERISTIC IMPEDANCE
50 Ω ±1%.

HIGH QUALITY CABLE
Approximately 1.5-dB loss per 100 feet at 1000 MHz. Rise-time approximately 0.1 ns.

DIMENSIONS AND WEIGHTS

Height	22⅜ in	57.1 cm
Width	8⅝ in	21.9 cm
Depth	21⅞ in	55.5 cm
Net weight	44¾ lb	20.3 kg
Domestic shipping weight	≈60 lb	≈27.3 kg
Export-packed weight	≈75 lb	≈34.1 kg

TYPE 113 DELAY CABLE $310

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

132
Power Supply for Plug-In Units

- ***DC-to-16 MHz BANDWIDTH***

- ***ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER, AND SPECIAL PURPOSE PLUG-IN UNITS***

The Type 132 provides a regulated power supply and amplifier for any Tektronix Letter-Series or "1" Series Plug-In Unit.

Convenient front-panel terminals for either push-pull or single-ended output facilitate connections to associated equipment.

CHARACTERISTICS

BANDWIDTH
DC to 16 MHz at 3-dB down, depending on plug-in unit and load impedance. See chart.

GAIN
10 (push-pull) when using a Tektronix Plug-In Unit at 50-mV/cm deflection factor, terminated with a 93-Ω load (approximately 5 into 50-Ω load).

OUTPUT
Push-pull, or single-ended + or — outputs on front panel.

OUTPUT VOLTAGE
Source impedance is ≈5 kΩ with ±10 mA available short circuited. With 93-Ω load, voltage swing is ≈±1 V max. No load, voltage is ±50 V single ended or ±100 V push-pull.

DUAL-TRACE OPERATION
Back-panel jacks and switching arrangements provide for use of the alternate and chopped modes of operation including blanking, with a Tektronix Multi-Trace Plug-In Unit (1A1, 1A2 or 1A4).

POWER REQUIREMENTS
Wired for 105 to 125 VAC (117 V nominal); transformer taps permit operation at 110, 117, 124, 220, 234, or 248 VAC; 50 to 60 Hz. Approx 320-W power consumption. Can be factory wired for any of the above nominal voltages, if so indicated on order.

DIMENSIONS AND WEIGHTS

Height	$10\frac{3}{16}$ in	25.9 cm
Width	$6\frac{7}{8}$ in	17.5 cm
Depth	$18\frac{15}{16}$ in	48.1 cm
Net weight	21 lb	9.5 kg
Domestic shipping weight	≈26 lb	≈11.8 kg
Export-packed weight	≈33 lb	≈15.0 kg

INCLUDED STANDARD ACCESSORIES
Two 93-Ω terminations (011-0056-00); two 93-Ω cables (012-0075-00); 3-conductor power cord (161-0010-03); instruction manual (070-0288-01).

TYPE 132 POWER SUPPLY, without plug-in units . . . **$545**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

TYPE 132 TYPICAL PERFORMANCE†				
PLUG-IN TYPE	TERMINATED IN 93 Ω		DOUBLE TERMINATED 93 Ω	
	SYSTEM GAIN‡	BANDWIDTH	SYSTEM GAIN‡	BANDWIDTH
L	100 10	14 MHz 14 MHz	50 5	16 MHz 16 MHz
O	10	14 MHz	5	16 MHz
Q		6 kHz		6 kHz
W	500 10	7 MHz 14 MHz	250 5	7 MHz 16 MHz
1A1	100	14 MHz	50	16 MHz
1A2	10	14 MHz	5	16 MHz
1A4	50	14 MHz	25	16 MHz
1A5	500 250	13 MHz 14 MHz	250 125	15 MHz 16 MHz
1A6	500	2 MHz	250	2 MHz
1A7A	Useful to 20,000	1 MHz	Useful to 10,000	1 MHz
1L5	500	1 MHz	250	1 MHz
	Spectrum Analyzer 10 Hz to 1 MHz			
1L10	Spectrum Analyzer 1 MHz to 36 MHz			
1L20	Spectrum Analyzer 10 MHz to 4.2 GHz			
1L40	Spectrum Analyzer 1.5 GHz to 40 GHz			
1S1	250	Equiv to 1 GHz	125	Equiv to 1 GHz
1S2	100	Equiv to 3.9 GHz	50	Equiv to 3.9 GHz

†Push-pull output, monitored with DC-to-24 MHz oscilloscope.
‡System Gain = Overall gain from input of plug-in to the push-pull output cables.
Spectrum Analyzer Units require an external sweep voltage (positive going from 0 to at least +90 V). This can be supplied from an associated oscilloscope with this output.

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TYPE 10A1, DC-TO-55 MHz DIFFERENTIAL AMPLIFIER 161

TYPE 10A2A, DC-TO-100 MHz DUAL-TRACE AMPLIFIER 163

TYPE 11B1, TIME-BASE 164

TYPE 11B2A, DELAYED-SWEEP TIME-BASE 165

If temperature operating range, vibration, altitude, shock, and humidity are considerations in YOUR selection of an oscilloscope, the 647A-Series represents excellent value in a versatile plug-in type package.

The Types 647A and R647A, with 10-Series and 11-Series Plug-in Units, comprise a complete high-performance system built to withstand operating and storage conditions far more severe than those found in the laboratory.

This series of oscilloscopes provides the widest temperature operating range (—30° C to +65° C) presently available from Tektronix. This wide operating range allows operation in severe temperature environments with a margin of safety elsewhere unavailable.

The Types 10A1 Differential Unit (with slide-back voltage offset) and 10A2A Dual-Trace Unit afford plug-in versatility coupled with reliable, higher-than-normal accuracy performance. These vertical plug-in units provide the capability to meet all but very specialized measurement needs. The Types 11B1 Time Base and 11B2A Time Base (with normal and delayed sweeps) complete the 647A-Series plug-in line.

VERTICAL DEFLECTION

BANDWIDTH AND RISETIME
Bandwidth figures are at 3-dB down.

PLUG-IN	DEFLECTION FACTOR	BANDWIDTH**		RISETIME	
		0°C to +40°C	—30°C to +65°C	0°C to +40°C	—30°C to +65°C
10A1	5 mV/cm to 20 V/cm	55 MHz	50 MHz	6.4 ns	7 ns
	1 mV/cm and 2 mV/cm	35 MHz	35 MHz	10 ns	10 ns
10A2A	10 mV/cm to 20 V/cm	100 MHz	90 MHz	3.5 ns	3.9 ns

**Stated frequencies are upper bandwidth limits. Lower limit is DC (when DC coupled). With AC coupling, low-frequency 3-dB-down point is ≈ 1.6 Hz without probe, or ≈ 0.16 Hz with P6054 10X Probe.

HORIZONTAL DEFLECTION

Two Time-Base Plug-In Units are available for use with the Type 647A and R647A Oscilloscopes.

PLUG-IN UNIT	CALIBRATED RANGE	SWEEP MAGNIFIER	SWEEP SYSTEM
Type 11B1	0.1 μs/cm to 2 s/cm	Direct reading up to X50, 10 ns/cm max	Single Time Base Generator
Type 11B2A	0.1 μs/cm to 5 s/cm	X10, Extends Range to 10 ns/cm	Dual Time Base Generator with Sweep Delay

Both plug-in units have single-sweep and external-horizontal-amplifier capability.

ACCURACIES

SWEEP RATES	0° C to +40° C	—30° C to +65° C
0.1 μs/cm to 50 ms/cm	±1.5%	±2.5%
0.1 s/cm to 5 s/cm*	±3%	+4%, —6%
MAG sweep accuracy		
10 ns/cm to 20 ns/cm	±3.5%	±5%
50 ns/cm to 5 ms/cm	±2.5%	±4%
10 ms/cm to 0.5 s/cm	±4%	+5.5%, —7.5%

*The Type 11B1 sweep rate is from 0.1 s/cm to 2 s/cm for the same listed accuracies.

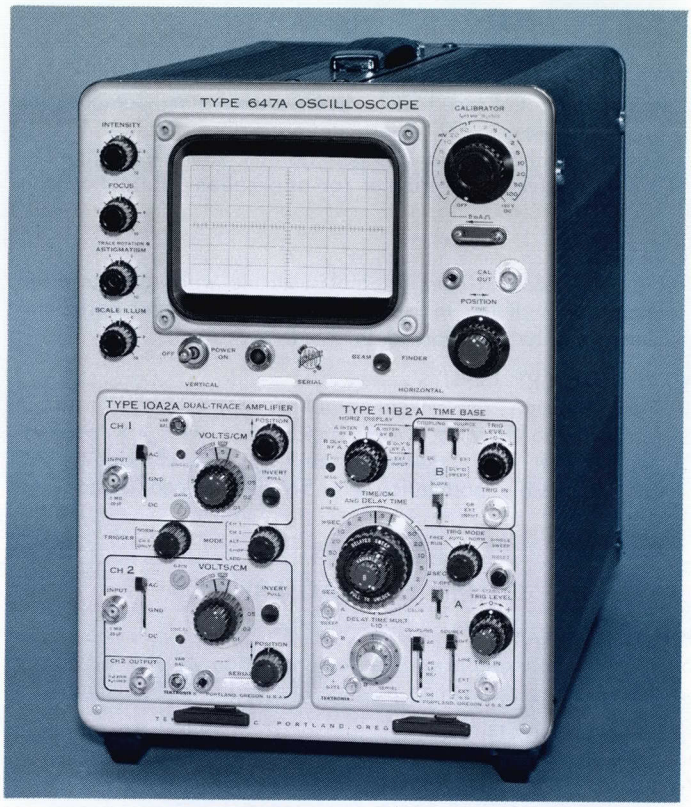
647A
100-MHz Oscilloscope

- ***RUGGEDIZED***
- ***BUILT FOR SEVERE ENVIRONMENTS***
- ***HIGH WRITING SPEED***
- ***ILLUMINATED NO-PARALLAX GRATICULE***
- ***6 x 10-cm DISPLAY***
- ***ALL SOLID STATE***

The Type 647A and R647A Oscilloscopes offer bandwidths from DC to 100 MHz with or without probes when used with the Type 10A2A Dual-Trace Plug-in Amplifier. Triggering over the entire 100-MHz bandwidth is possible with a Type 11B2A Delayed-Sweep Time-Base.

An accelerating potential of 14 kV provides a small, bright CRT spot with corresponding high writing speed. An internal, 6 x 10-cm graticule with variable illumination offers parallax-free measurements.

A quick-change line-voltage selector permits simple and convenient adaptation to 6 different line-voltage ranges.



CHARACTERISTIC SUMMARY

VERTICAL

Two vertical plug-in units are available: Type 10A1 Differential Amplifier featuring voltage-comparator capability, and Type 10A2A Dual-Trace Amplifier with 100-MHz bandwidth. Operating modes of Type 10A2A include CH 1, CH 2, ALTERNATE, CHOP (≈1-MHz rate), and ADD.

HORIZONTAL

Two time-base plug-in units are available: Type 11B1 with single time base and direct reading magnifier, and Type 11B2A with dual time bases and sweep delay; both units equipped with single sweep for photographic recording.

CRT

DISPLAY AREA—6 x 10 cm

ACCELERATING VOLTAGE—14 kV

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—0.2 mV to 100 V, 1-kHz square-wave.

POWER REQUIREMENT—90 V to 136 V and from 180 V to 272 V in six ranges; range selection accomplished by quick-change, switching device. Maximum power approx 200 watts at 115 V and 60 Hz. Type 647A: 45 to 440 Hz, Type R647A: 45 to 66 Hz.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE

Operating: Type R647A: —30°C to +65°C. Type 647A: —30°C to +65°C, continuous, when instrument is not tipped more than 20° in any direction from level position. When instrument is operated vertically (with front panel up), the maximum ambient temperature is +55°C. Non-operating: —55°C to +75°C.

VIBRATION*

Operating: 0.025 inch peak to peak, 10 to 55 to 10 c/s in 1 minute sweeps (4 g at 55 c/s) for 15 minutes on each axis.

ALTITUDE

Operating: 15,000 feet maximum. Maximum operating temperature of the Type 647A reduced to +55°C at 15,000 feet. Non-operating: 50,000 feet, maximum.

SHOCK

Non-operating: 20 g's, one-half sine, 11-millisecond duration. Two shocks each direction along each of the three major axes; total of 12 shocks.

HUMIDITY

Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202B, method 106A (omit freezing and vibration, and allow 24-hour post-test drying period before operating).

TRANSPORTATION

Meets National Safe Transit test when factory-packaged: Vibration for one hour at slightly greater than one g. Drop on any corner, edge or flat surface; 18-inch drop for Type R647A, 30-inch drop for Type 647A.

*Applicable to R647A when mounted in a rack with rear support kit 016-0065-00.

647A

100-MHz Oscilloscope

CRT

TEKTRONIX CRT

Rectangular, flat-faced CRT. 14-kV accelerating potential for bright displays. P31 phosphor normally supplied, P11 is optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

GRATICULE

No-parallax, 6 x 10-cm, internal graticule with variable edge illumination. Ruled in 1-cm divisions, vertical and horizontal centerlines further marked in 2-mm increments.

EXTERNAL CRT INPUTS

Input through unblanking amplifier to CRT grid, usable from DC to 10 MHz; visible modulation with 4-V peak-to-peak signal. An additional input to CRT cathode is AC coupled; visible modulation with 5-V peak-to-peak signal.

OTHER CHARACTERISTICS

SIGNAL DELAY

Permits observation of the leading edge of the waveform that triggers the sweep. Delay line requires no tuning.

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), 1-kHz squarewave. Crystal-controlled frequency accurate within 0.1% from −30° C to +65° C.

Output resistance 50 Ω from 0.2 mV to 0.2 V. Squarewave duty cycle 49.9% to 50.1%. Risetime $\leq$1 μs. For current-probe calibration, a 5-mA squarewave is available through a front-panel current loop. The calibrator also provides a 100-V DC output.

AMPLITUDE ACCURACY	0°C to +40°C	−30°C to +65°C
100 V and 100 mV	±1%	±1.5%
All other positions	±2%	±3%

POWER REQUIREMENTS

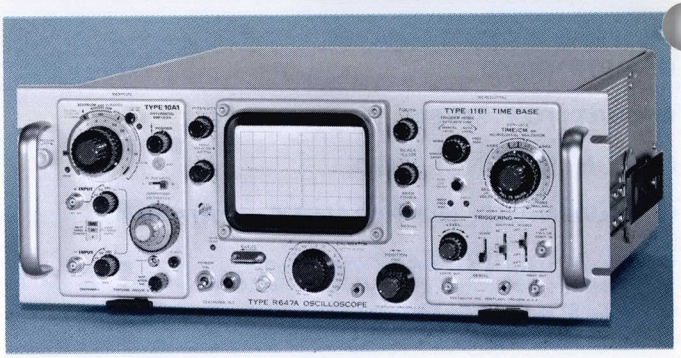
Quick-change line-voltage selector permits selection of the following ranges: 90 V to 110 V, 104 V to 126 V, 112 V to 136 V, 180 V to 220 V, 208 V to 252 V, or 224 V to 272 V. Approx 200 watts maximum at 115 V and 60 Hz. Type 647A: 45 to 440 Hz. Type R647A: 45 to 66 Hz.

TYPE 647A DIMENSIONS AND WEIGHTS

Height	14⅝ in	37.1 cm
Width	9⅞ in	25.2 cm
Depth	22 in	56.0 cm
Net weight	40 lb	17.8 kg
Domestic shipping weight	≈49 lb	≈21.9 kg
Export-packed weight	≈62 lb	≈27.6 kg

TYPE R647A DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	19 in	48.3 cm
Net weight	50 lb	22.2 kg
Domestic shipping weight	≈73 lb	≈32.4 kg
Export-packed weight	≈96 lb	≈42.6 kg



INCLUDED STANDARD ACCESSORIES

Two P6054 Probes (010-6054-01); smoke-gray filter, installed (378-0548-00); 8-inch, 93-Ω cable, BNC to BNC (012-0123-00); clear implosion shield (337-0573-00); 18-inch patch cord, BNC to BNC (012-0087-00); 18-inch patch cord, BNC to banana plug (012-0091-00); BNC post jack (012-0092-00); 6-inch patch cord, BNC to BNC (012-0085-00); 2 red plastic graticule-light inserts (377-0105-00); Type 647A: instruction manual (070-0614-00); Type R647A: instruction manual (070-0627-00); set mounting tracks and hardware (351-0085-00); rackmount rear support kit (016-0065-00); hardware kit (016-0099-00).

TYPE 647A OSCILLOSCOPE, without Plug-In Units . **$1725**

TYPE R647A OSCILLOSCOPE, without Plug-In Units (45-to-66 Hz power source) **$1850**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probe supplied with the instrument satisfies most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

REAR-PANEL CONNECTOR

10-pin connector for remote single-sweep reset and external use of power-supply voltages. Order 131-0300-00 . . . . $14.50

C-27-662 R CAMERA

Equipped with a special lens to permit single-sweep photography of oscilloscope displays at fast writing speeds. 1:0.5, f/1.3 lens, Polaroid Land* Roll-Film back.

Order C-27-662 R $640
Order Mounting Adapter 016-0223-00 . . . . . $16

PROBES

P6055 10X Low-Capacitance Probe for use with Tektronix differential amplifiers.

Order P6055 Probe Package 010-6055-01 . . . . . $75

SCOPE-MOBILE® CART

Model 201-2: Storage drawer, carrier for two plug-in units, 9-position tilt-lock oscilloscope tray.

Order Type 201-2 . . . . . $155

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

10A1
Differential Comparator Amplifier

- ***DC-to-55 MHz BANDWIDTH***
- ***1 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***20,000:1 CMRR***
- ***EQUIVALENT OFFSET VOLTAGE UP TO ±600 V PROVIDES 4-DIGIT RESOLUTION FOR ACCURATE AMPLITUDE MEASUREMENTS***

The Type 10A1 combines the features of a conventional amplifier, a differential amplifier, and a calibrated differential comparator in a single plug-in unit for Type 647A and R647A Oscilloscopes. Rapid recovery from large differential overload allows detailed study of pulse-top flatness as well as comparator measurement of transient amplitudes. The effective 6,000-cm slide-back scale and 20,000:1 common-mode rejection ratio permit accurate measurements and comparisons. Rugged design insures accuracy over the same range of environmental conditions as stated for Type 647A and R647A Oscilloscopes.

CONVENTIONAL AMPLIFIER

BANDWIDTH AND RISETIME

Bandwidth is specified at 3-dB down. Bandwidth may be limited to 1 MHz ±10%, when desired, for noise reduction at higher sensitivities. AC coupling provides a low-frequency 3-dB point at ≈1.6 Hz. Use of the P6054 10X probe with AC coupling extends the low-frequency 3-dB point to 0.16 Hz. For bandwidth ranges refer to preceding reference section.

MAXIMUM INPUT VOLTAGE

Maximum combined DC and Peak AC is ±20 V when using 1-mV/cm to 20-mV/cm deflection factors, ±600 V when using the 50-mV/cm to 20-V/cm deflection factors.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 50 V/cm. Deflection factor can be calibrated at any step with front-panel GAIN adjustment. When GAIN has been accurately adjusted at 5 mV/cm, accuracies are as follows:

VOLTS/CM ACCURACY		
DEFLECTION FACTOR	0°C to +40°C	−30°C to +65°C
1 mV/cm (also 10 mV/cm and 0.1 V/cm with Vc range extended)	±2.5%	±4%
2 mV/cm through 2 V/cm (except 10 mV/cm and 0.1 V/cm with Vc range extended)	±1.5%	±2.5%
5 V/cm through 20 V/cm	±3%	±4%

INPUT RC

1 megohm paralleled by 20 pF.

DIFFERENTIAL AMPLIFIER

COMMON-MODE REJECTION RATIOS

Values stated apply at a deflection factor of 1 mV/cm and from 0° C to +40° C.

COMMON-MODE REJECTION DC COUPLED		
FREQUENCY RANGE	REJECTION RATIO	RANGE OF PEAK-TO-PEAK INPUT SINEWAVE
DC to 100 kHz	20,000:1	0 V to 10 V
100 kHz to 1 MHz	10,000:1	0 V to 10 V
1 MHz to 10 MHz	10,000:1* divided by freq in MHz	0 V to 10 V* divided by freq in MHz
20 MHz	100:1	0 V to 1 V
AC COUPLED		
60 Hz	2,000:1	0 V to 10 V

*Divide CMRR and voltage by the frequency in MHz; e.g., at 2 MHz the CMRR is 5,000:1 up to 5 V input amplitude.

At 10 mV/cm, using the internal 10X attenuator, CMRR is 2,000:1 for 20-V peak-to-peak 10 kHz sinewave.

RECOVERY TIME

≤0.5 μs for a return to within ±2 mV after differential offset. Recovery DC error ≤0.5 mV after 1-ms recovery time. Characteristics apply from 0° C to +40° C.

10A1
Differential Comparator Amplifier

CALIBRATED DIFFERENTIAL COMPARATOR

Comparison Voltage (Vc) can be used to offset the input waveform via the slide-back technique. The internal Vc source allows measurement, with 4-digit resolution, of signal amplitudes up to ±600 V. Equivalent Vc range is normally selected simultaneously with deflection factor, but may be extended for two additional steps. Bandwidth and risetime in the extended Vc positions are the same as at 1 and 2 mV/cm.

INPUT VOLTAGE		
DEFLECTION FACTOR	LINEAR DYNAMIC RANGE and EQUIVALENT Vc RANGE	MAXIMUM COMBINED DC AND PEAK AC
1 mV/cm through 20 mV/cm	±6 V	±20 V
10 mV/cm through 0.2 V/cm	±60 V	±600 V
0.1 V/cm through 20 V/cm	±600 V	±600 V

	Vc CHARACTERISTICS		
EQUIVALENT Vc RANGE	SLIDEBACK MEASUREMENT ACCURACY		DEFLECTION FACTOR
	0°C to +40°C	−30°C to +65°C	
6 volts	±(0.1% + 5 mV)	±(0.15% + 8 mV)	1 mV/cm through 20 mV/cm
60 volts	±(0.225% + 50 mV)	±(0.4% + 80 mV)	10 mV/cm through 0.2 V/cm*
600 volts	±(0.35% + 0.5 V)	±(0.65% + 0.8 V)	0.1 V through 20 V/cm*

*Pull knob to retain Vc range at two lowest deflection factors.

Vc OUTPUT

Available at front panel as well as internally. Output continuously variable from 0 to ±6 V (0 to ±0.6 V when deflection factor is set at 5, 10, or 20 V/cm). Accuracy is within ±(0.1% + 5 mV) from 0° C to +40° C and within ± (0.15% + 8 mV) from −30° C to +65° C. (Open circuit values).

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 10A1 DIFFERENTIAL AMPLIFIER $1025

Includes instruction manual (070-0464-00).

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information.

PROBE

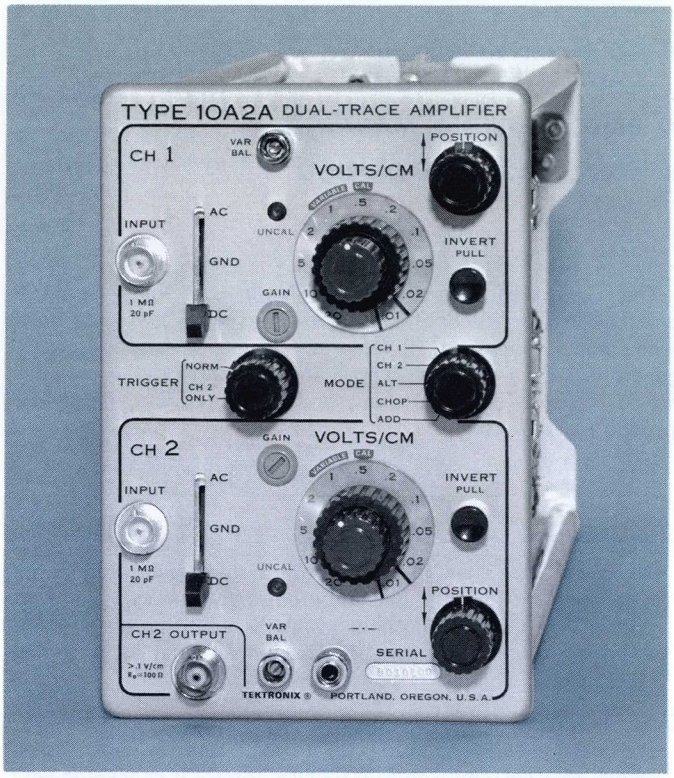
P6055 Low-Capacitance Probe for use with differential amplifiers is provided with an adjustable attenuation ratio to 10X; helpful in maintaining common-mode rejection ratio of the system.

P6055 Probe Package (010-6055-01) $75

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

10A2A
Dual-Trace Amplifier

- ***DC-to-100 MHz BANDWIDTH***
- ***10 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***5 OPERATING MODES***
- ***FRONT-PANEL CHANNEL-2 OUTPUT***
- ***TRIGGER SELECTION***



Bandwidth from DC to 100 MHz, with or without probe, makes the Type 10A2A an especially versatile plug-in unit for the Type 647A and Type R647A Oscilloscopes. Two identical channels can be added algebraically, operated singly with either polarity, or operated dual trace with alternate or chopped switching. The Type 10A2A is built to meet the same environmental requirements as Type 647A and R647A Oscilloscopes.

BANDWIDTH
Without probe or with P6054 10X probe: DC to 100 MHz (3-dB down) from 0°C to +40°C or DC to 90 MHz (3-dB down) from −30° C to +65° C. Low-frequency 3-dB point with AC coupling is ≈1.6 Hz, ≈0.16 Hz with 10X probe.

RISETIME
Without probe or with P6054 10X probe: 3.5 ns from 0°C to +40°C or 3.9 ns from −30°C to +65°C.

DEFLECTION FACTOR
Without probe: 10 mV/cm through 20 V/cm in 11 calibrated steps (1-2-5 sequence). After calibration at 0.01 V/cm, and at the operating temperature, deflection-factor accuracy is within 2% for the other 10 steps. Deflection factor can be calibrated at any step with front-panel GAIN adjustment. Deflection factor continuously variable (uncalibrated) between steps and to approx 50 V/cm. With P6054 10X probe: All deflection factors multiplied by 10. Probe attenuation accurate within 2% from −30°C to +65°C.

MAXIMUM INPUT VOLTAGE
600 V, DC + peak AC (≤1 kHz). Peak-to-peak AC not to exceed 600 V.

INPUT RC
1 megohm paralleled by 20 pF.

CHOPPED MODE
Switches channels at 1 MHz (±15%) rate, displaying approx 500-ns segments of each channel. Chopped-transient blanking is provided.

CHANNEL INVERSION
The display of either channel can be inverted for comparing signals 180° out of phase.

ADDED MODE
Common-mode rejection ratio 20:1 in added-algebraically mode for frequencies to 50 MHz and amplitudes to 10 cm.

CHANNEL ISOLATION (ATTENUATOR)
10,000:1 or greater for frequencies to 25 MHz.

CHANNEL-2 OUTPUT
Front-panel output with amplitude ≥100 mV per centimeter of Channel-2 display. Can be connected to Channel 1 in cascade for overall deflection factor of approx 1 mV/cm and bandwidth from DC to 40 MHz (3-dB down).

INTERNAL TRIGGER
Selectable triggering from common output amplifier or from Channel 2 only. Triggering from Channel 2 provides common time relationship between channels in Alternate or Chopped operation.

WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 10A2A DUAL-TRACE AMPLIFIER $885
Includes instruction manual (070-0615-00).

OPTIONAL ACCESSORIES

The standard P6054 probe supplied with the Type 647A satisfies most measurement requirements. Optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages for additional information on these and other items.

PROBES
P6011 1X Passive Probe Package, order 010-0193-00 . . $21
P6009 100X Passive Probe Package, order 010-0170-00 . . $66

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

11B1
Time Base

- ***10 ns/cm to 2 s/cm CALIBRATED TIME BASE***
- ***DIRECT-READING MAGNIFIER***
- ***SINGLE-SWEEP OPERATION***

The Type 11B1 is a Time-Base Plug-In Unit for Type 647A and R647A Oscilloscopes, and is built to meet the same environmental requirements. It features a single, wide-range sweep generator with a direct reading X1 to X50 magnifier. It provides normal sweeps to 0.1 μs/cm and direct-reading magnified sweeps to 10 ns/cm.

TIME BASE

0.1 μs/cm to 2 s/cm in 23 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 5 s/cm. Free-run light warns the operator when sweep is not triggered. For time base accuracies refer to preceding reference section.

DIRECT-READING MAGNIFIER

Provides sweep expansion up to X50 and extends fastest sweep to 10 ns/cm. The MAGNIFIER control is concentric with the TIME/CM control, providing a direct indication of both the sweep rate being magnified and the magnified time/cm rate. Up to 5 magnification steps are provided to X40 or X50, depending on the TIME/CM control setting before magnification. Magnified sweep rates are confined to the TIME/CM steps on the panel, so there are no "forbidden" (uncalibrated) combinations.

EXTERNAL INPUT

0.1 V/cm to 2 V/cm in 5 steps, accurate within 2%; or, using ÷10 input attenuator, 1 V/cm to 20 V/cm in 5 steps, accurate within 5%. Continuously variable (uncalibrated) between steps. DC to 3 MHz (3-dB down). Low-frequency 3-dB point 16 Hz with AC coupling, 17 kHz with AC low-frequency reject. Input RC approx 1 megohm paralleled by approx 35 pF (EXT) or approx 10 megohm and 6 pF (EXT ÷ 10).

SIGNAL OUTPUTS

+ Gate (approx 15 V) and positive-going sawtooth (approx 10 V) outputs via front-panel BNC connectors.

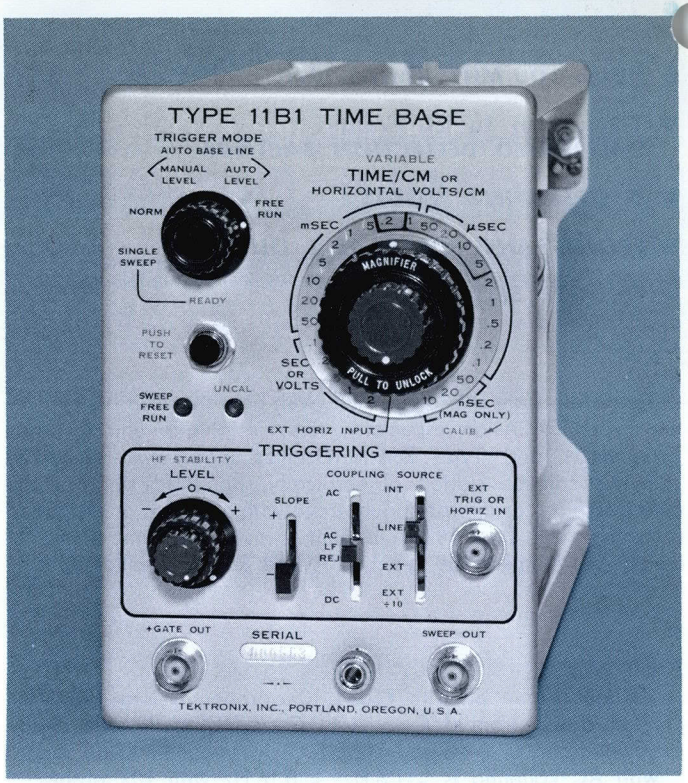
TRIGGER

MODES

Free-run, single-sweep, normal and 2 types of automatic baseline operation (manual or auto trigger level). Automatic baseline triggering is useful above 20 Hz and minimizes trigger adjustment for signals of different amplitudes, shapes and repetition rates. With no triggering signal, a recurring sweep provides a convenient reference trace.

AUTO-LEVEL AUTOMATIC OPERATION

Establishes triggering level near waveform average. Offers triggering convenience for most waveforms.



MANUAL-LEVEL AUTOMATIC OPERATION

Full operator control of triggering level for triggering on either + or — slope. Provides for effective triggering with small amplitude or low duty cycle signals.

COUPLING

DC, AC (3-dB down at approx 16 Hz) or AC LF Reject (3-dB down at approx 17 kHz).

SOURCES

Internal, external, external ÷ 10, or line. External trigger input RC approx 1 megohm paralleled by 35 pF (EXT) or 10 megohm and 6 pF (EXT ÷ 10).

REQUIREMENTS

2-mm deflection or 125 mV external from DC to 50 kHz, increasing to 1-cm deflection or 250 mV external at 50 MHz. Requirements applicable to normal triggering or automatic baseline, manual level.

HIGH-FREQUENCY STABILITY

Changes time-base recovery time to reduce high-frequency jitter.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈13 lb	≈5.9 kg

TYPE 11B1 TIME BASE **$765**
Includes instruction manual (070-0424-01).

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

11B2A
Delayed Sweep Time Base

- ***10 ns/cm to 5 s/cm CALIBRATED TIME BASE***
- ***FULL-BANDWIDTH TRIGGERING***
- ***NORMAL AND DELAYED SWEEPS***
- ***SINGLE-SWEEP OPERATION***

The Type 11B2A is a Time-Base Plug-In Unit for Type 647A and R647A Oscilloscopes, and is built to meet the same environmental requirements. Two separate time-base generators and a calibrated delayed sweep are provided. Time base A is the normal sweep and is also used to delay the start of Time Base B.

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence). Continuously variable (uncalibrated) between steps and to approx 12.5 s/cm. For time base accuracies refer to preceding reference section.

X10 SWEEP MAGNIFIER
Operates over the full range of both time bases. Increases the fastest rate to 10 ns/cm.

DELAY RANGE
1 μs to 50 s, after delaying sweep start.

DELAY TIME SETTING	DELAY ACCURACIES	
	0°C to +40°C	−30°C to +65°C
1 μs to 50 ms	Within 1%	Within 2%
0.1 s to 5 s	Within 2.5%	+3%, −6%
MULTIPLIER	Within 0.15% of full scale (1.5 minor dial divisions)	Within 0.2% of full scale (2 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENTS		
1 μs to 50 ms	Within 1% and 3 minor dial divisions	Within 2% and 4 minor dial divisions
0.1 s to 5 s	Within 2.5% and 3 minor dial divisions	+3%, −6% and 4 minor dial divisions
JITTER	1 part or less in 20,000 of 10X DELAY TIME	

OPERATING MODES
A only, A intensified by B, B delayed by A. In the two latter modes, B can be started automatically at the end of A, or is triggerable following the end of the delay period (providing a steady display of time-modulated pulses and signals with inherent jitter).

EXTERNAL INPUT
1 V/cm ±10% without magnification or 0.1 V/cm ±10% with X10 magnifier. Bandwidth is DC to 3 MHz (3-dB down). Low-frequency 3-dB point is 16 Hz with AC coupling.

TRIGGER

MODES
Normal, automatic, single-sweep, or free-run on Time Base A. Automatic operation is useful between approx 20 Hz and 100 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), a recurring sweep provides a convenient reference trace.

COUPLING
AC, AC Low-frequency reject, or DC on Time Base A.

SOURCES
Internal source selected from oscilloscope vertical amplifier, external, external ÷ 10, or line. External trigger input RC approx 1 megohm paralleled by approx 20 pF (EXT) or approx 10 megohm and approx 5 pF (EXT ÷ 10).

TIME-BASE A REQUIREMENTS
3-mm deflection or 125 mV external from DC to 20 MHz increasing to 2-cm deflection or 250 mV external at 100 MHz. Requirements increase below 60 Hz with AC coupling; below 50 kHz with AC low-frequency reject.

TIME BASE B REQUIREMENTS
5-mm deflection or 200 mV external from DC to 20 MHz increasing to 3-cm deflection or 300 mV external at 100 MHz. Requirements increase below 60 Hz with AC coupling.

OTHER CHARACTERISTICS

SIGNAL OUTPUTS
Positive gates (approx 15 V) and positive-going sawtooths (approx 10 V) from both time bases.

WEIGHTS

Net weight	6½ lb	3.0 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
BNC female to BSM female adapter (103-0036-00); instruction manual (070-0640-00).

TYPE 11B2A TIME BASE $970

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

NON-PLUG-IN OSCILLOSCOPE REFERENCE

PRODUCT	PAGE	BW	MINIMUM DEFLECTION FACTOR	DUAL BEAM	CMRR	SWEEP RATES	MAG	STORAGE	X-Y	DISPLAY SIZE
502A	**167**	1 MHz	100 μV	Yes	50,000:1	1 μs to 5 s	X20 max		Yes	8 x 10 cm
503/RM503	**169**	450 kHz	1 mV		100:1	1 μs to 5 s	X50 max		Yes	8 x 10 cm
504/RM504	**171**	450 kHz	5 mV			1 μs to 0.5 s				8 x 10 cm
5030/R5030	**173**	1 MHz	10 μV	Yes	100,000:1	1 μs to 5 s	X50 max		Yes	8 x 10 div (1.27 cm/div)
5031/R5031	**173**	1 MHz	10 μV	Yes	100,000:1	1 μs to 5 s	X50 max	Yes	Yes	8 x 10 div (1.22 cm/div)

The characteristics and features of Tektronix non-plug-in oscilloscopes are particularly suited for solving a wide range of measurement problems. Application areas include design laboratories, production testing, process control, field maintenance, medical and other scientific research, plus many others.

Many of these applications require high sensitivity differential inputs, trace stability, low noise, dual beam and storage. The conventional 5030/R5030 and the storage 5031/R5031 offer these characteristics in a performance range tailored to your individual application. Both are dual beam instruments with identical amplifiers which have differential or single-ended voltage inputs. Each input has 19 calibrated deflection factors to 10 μV/div for solving difficult low-level measurements which require rejection of unwanted signals or DC levels. Each amplifier has a current probe input with 10 Hz to 1 MHz bandwidth and eight calibrated deflection factors ranging from 1 mA to 200 mA/div.

The 5030 and 5031 display all the scale factor data in the viewing area where it's used to make your measurement. Scale factor values are read out directly to the right of the large, high-resolution 6½-inch CRT. The readout is automatically corrected when 10X probes are attached and when the magnifier is used. There are numerous other advantages to scale-factor readout. The Tektronix C-70 Camera automatically records scale factors directly on the photo to save hand labeling. You no longer have to search for knob settings when you make measurements in darkened areas. The errors caused by forgetting to correct for probes and magnifiers are reduced.

With the dual beam feature, measurements are quickly solved in applications such as stimulation and reaction events. Single beam instruments will usually miss the reaction event unless a significant amount of time elapses between the events. The 5031 Storage Oscilloscope records both single events simultaneously for detailed examination at the operator's convenience. Storage also solves the time consuming problem of photographing transient events. However, once the desired data is obtained, it photographs easily from the storage area onto high quality prints. The Tektronix storage CRT used in the 5031's is a high performance, durable, reliable device which only requires standard CRT operating care since it is highly resistant to burns.

The complementary color scheme of the control panel of these instruments aids the user in readily distinguishing various functions. Current probe inputs are identified by a salmon color, and green outlines a greatly simplified trigger circuit. The area around the mode switching controls is blue to help locate the only button which is pressed to change between dual beam Y vs T and Y vs X displays.

Using the 503 and 504 Oscilloscopes will improve process control in applications such as precision machining, component evaluation and system instrumentation. The range of measurement modes of each instrument allows test stations to be multi-purpose. The accuracy and repeatability of the instruments help you maintain tighter controls in any application. In addition to process controls, the 503 and 504 fulfill the needs of many other application areas such as educational labs, field maintenance and computer readout.

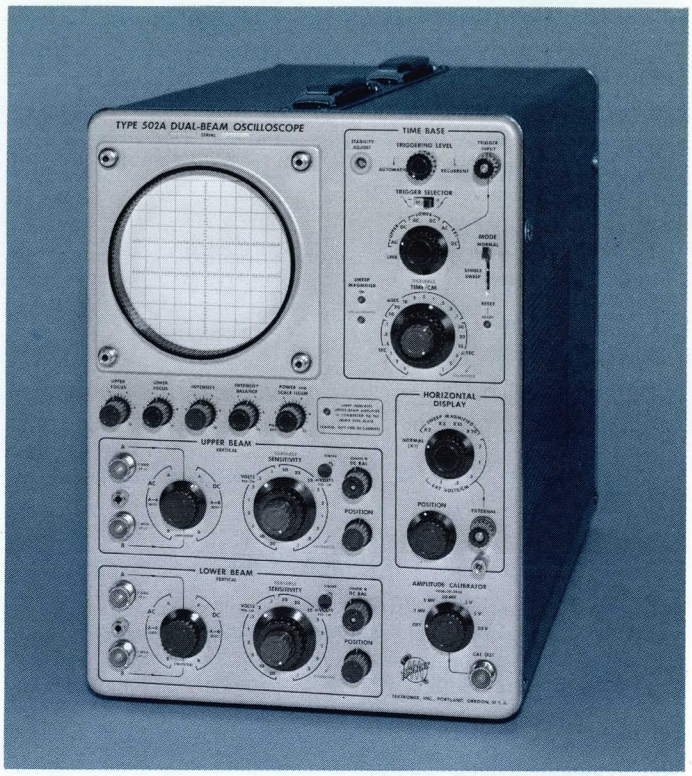
Four of the instruments listed in this section are capable of true X-Y operation. In this mode of operation, input signals may be applied to both the horizontal and vertical amplifiers and the display is a graph of the waveform on one channel versus the waveform on the other channel. The horizontal sweep is disabled. Examples of the use of the X-Y mode of operation are the plotting of hysteresis loops, of voltage across a semiconductor versus the current through it, and of force or pressure versus deformation or strain in a material. Use can be made of the differential input feature on one or both channels.

502A

1-MHz Dual-Beam Oscilloscope

- ***100 μV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***50,000:1 CMRR***
- ***X-Y CURVE TRACING WITH 1 or 2 BEAMS***
- ***FET INPUTS***

A wide range of measurement capabilities makes the 502A useful in a variety of applications including education, biology, and production control. Differential or single-ended inputs can be used for dual-beam or single-beam X-Y displays as well as dual-beam or single-beam time-based displays. With one of the vertical amplifiers switched to provide horizontal deflection, full sensitivity is available for both axes. Phase shift is less than 1 degree from DC to 100 kHz. With the external horizontal amplifier switched to provide horizontal deflection, dual-beam X-Y plots can be displayed at full vertical sensitivity, and at 0.1 V/cm to 2 V/cm horizontally.



VERTICAL DEFLECTION

Two identical systems

BANDWIDTH

DC to at least 100 kHz (3-dB down) at 100 μV/cm, increasing to DC to at least 1 MHz (3-dB down) from 5 mV/cm to 20 V/cm. Low-frequency 3-dB-down point is 2 Hz or less with AC coupling, 0.2 Hz or less with included 10X probe.

DEFLECTION FACTOR

100 μV/cm to 20 V/cm in 17 calibrated steps (1-2-5 sequence), accurate within 2% (3% at 100 μV/cm). Uncalibrated, continuously variable between steps and to approx 50 V/cm.

COMMON-MODE REJECTION RATIO

DC Coupled

100 μV to 2 mV/cm: at least 50,000:1 from DC to 50 kHz; ±5-V signal.

5 mV to 200 mV/cm: ½-mm or less deflection from DC to 50 kHz; ±5-V signal.

500 mV to 20 V/cm: Adjustable to at least 500:1 from 1 kHz to 50 kHz; adjustable to at least 5,000:1 from DC to 1 kHz; ±50-V signal.

AC Coupled

2000:1 (60 Hz).

COMMON-MODE DYNAMIC RANGE

100 μV/cm to 0.2 V/cm — ±15 V.
0.5 V/cm to 20 V/cm — ±350 V.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE (DC to 1 MHz)

50 V (combined DC + peak AC) from 100 μV/cm to 0.2 V/cm. 350 V (combined DC + peak AC) from 0.5 V/cm to 20 V/cm.

DC DRIFT

Typically 400 μV/hour or less averaged over 10 hours, temperature and line voltage constant. 300 μV or less with line variation from 105 to 125 V AC.

DIRECT-COUPLED SIGNAL OUTPUTS

CF outputs for each amplifier at rear panel. Approx 2 V for each centimeter of displayed signal.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 1 MHz from 5 mV/cm to 20 V/cm, decreasing to DC to 100 kHz at 100 μV/cm.

CALIBRATED DEFLECTION FACTOR—100 μV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 47 pF.

COMMON-MODE REJECTION—At least 50,000:1 (DC to 50 kHz).

HORIZONTAL

CALIBRATED TIME BASE—1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, X10, X20.

EXTERNAL INPUT—0.1, 0.2, 0.5, 1 and 2 V/cm.

CRT

DISPLAY AREA—8 x 10 cm (each beam).

ACCELERATING VOLTAGE—2.9 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—0.5 mV to 50 V, 1-kHz square-wave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz; 290 watts.

502A

1-MHz Dual-Beam Oscilloscope

HORIZONTAL DEFLECTION

Common to both beams

TIME BASE

1 μs/cm to 5 s/cm in 21 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

SWEEP MAGNIFIER

X2, X5, X10, or X20 magnification; magnified time base accurate within 5%.

DISPLAY MODES

Normal or single sweep.

EXTERNAL INPUT

0.1 V/cm to 2 V/cm in 5 calibrated steps (1-2-5 sequence), accuracy within ±5%, DC to 100 kHz. 20 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by approx 70 pF.

X-Y OPERATION

SINGLE-BEAM CURVE TRACING

100 μV/cm to 20 V/cm calibrated deflection factor in each axis, differential or single-ended input. Panel light indicates upper beam amplifier switched to provide horizontal deflection. X-Y phase difference between amplifiers is 1° or less from DC to 100 kHz, measured at 100 μV/cm.

DUAL-BEAM CURVE TRACING

100 μV/cm to 20 V/cm calibrated vertical deflection factor, separately selectable for upper and lower beams, differential or single-ended input; 0.1 V/cm to 2 V/cm calibrated horizontal deflection factor using external horizontal input common to both beams.

TRIGGER

MODES

Automatic or manual level selection, free run (recurrent). Automatic operation minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, sweep free-runs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING

AC or DC.

SOURCES

Internal from either amplifier, external, or line. Input R approx 1 megohm.

REQUIREMENTS

INTERNAL

DC: 2 mm, DC to 200 kHz, increasing to 1 cm at 1 MHz.
AC: 2 mm, 50 Hz to 200 kHz, increasing to 1 cm at 1 MHz.

EXTERNAL

DC: 0.5 V to 10 V, DC to 200 kHz, increasing to 2 V to 10 V at 1 MHz.

AC: 0.5 V to 10 V, 50 Hz to 200 kHz, increasing to 2 V to 10 V at 1 MHz.

OTHER CHARACTERISTICS

TEKTRONIX DUAL-BEAM CRT

8 x 10-cm display per beam. Separate vertical-deflection plates; common horizontal deflection plates. 2.9-kV accelerating potential. P2 phosphor normally supplied; P1, P7, P11 or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±25 V peak to peak for beam modulation at normal intensity.

GRATICULE

External; variable edge lighting. 10 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY FEATURES

Push button beam finder for each beam, separate focus for each beam, common intensity, intensity balance.

AMPLITUDE CALIBRATOR

0.5 mV to 50 V in 6 calibrated decade steps, accurate within 3%. 1-kHz ±30% repetition rate.

POWER REQUIREMENT

Wired for 105 to 125 VAC (117-V nominal). Transformer taps permit operation at nominal voltages of 110, 117, 124, 220, 234 and 248 VAC, 50 to 60 Hz. Power consumption 290-W maximum.

DIMENSIONS AND WEIGHTS

Height	15⅞ in	40.4 cm
Width	11⅜ in	29.0 cm
Depth	23⅞ in	60.7 cm
Net Weight	53 lb	24 kg
Domestic shipping weight	65 lb	29.5 kg
Export-packed weight	87 lb	39.5 kg

INCLUDED STANDARD ACCESSORIES

Two P6006 10X probes (010-0125-00); banana-to-banana cable (012-0031-00); 3-conductor power cord (161-0010-03); instruction manual (070-0382-02).

TYPE 502A OSCILLOSCOPE $1265

OPTIONAL ACCESSORIES

SCOPE-MOBILE® CART

Model 202-1: storage drawer and 9-position tilt-lock oscilloscope tray, order 202-1 ..... $145.00

Order tray adapter 040-0365-00 ..... $3.00

CAMERAS

C-27-547: f/1.9—1:0.7 lens,. Polaroid Land[1] Pack-Film back provides 10 x 10-cm coverage on 3¼ x 4½ film.
Order C-27-547 ..... $480.00

C-27N: f/1.9—1:0.85 lens, provides 10 x 10-cm coverage on 4 x 5 film when used with 4 x 5 Polaroid Land film holder (not included) and 4 x 5 Graflok[2] back (order below).
Order C-27N $375
4 x 5 Graflok back, order 122-0604-00 ..... $50

Type 502A to C-27-547 or C-27N Camera adapter, order 016-0225-02 ..... $16.00

PROBES

P6055 10X Probe: for more-accurate differential measurements, order 010-6055-01 ..... $75.00
P6027 1X Probe, order 010-0070-00 ..... $16.50

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

503

450-kHz X-Y Oscilloscope

- ***1 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***100:1 CMRR***
- ***IDENTICAL VERTICAL & HORIZONTAL AMPLIFIERS***
- ***DIFFERENTIAL INPUTS***
- ***CABINET OR RACK MODELS***

The Type 503 and RM503 provide accurate measurements and signal-handling versatility in DC-to-450 kHz applications. Differential or single-ended inputs can be used for X-Y displays or conventional time-based displays. Large display area, simple operation, and low cost make the Type 503 ideal for classroom and production-line uses.

The Type RM503, for the same reasons, is ideal for inclusion in a variety of systems, or other monitor applications.

VERTICAL AND HORIZONTAL DEFLECTION

Two identical systems

BANDWIDTH
DC to 450 kHz at 3-dB down. Low-frequency 3-dB point is 10 Hz or less with AC coupling.

DEFLECTION FACTOR
1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/cm.

COMMON-MODE REJECTION RATIO (From DC to 50 kHz)
At least 100:1 at calibrated deflection factors from 1 mV/cm to 0.2 V/cm with 4-V peak to peak input, at least 30:1 at calibrated deflection factors from 0.5 V/cm to 20 V/cm with 40-V peak to peak input (400-V peak to peak from 5 V/cm to 20 V/cm).

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
350 V combined DC + peak AC.

PHASE DIFFERENCE IN X-Y MODE
1° or less to 450 kHz at equal calibrated deflection factors from 1 mV/cm to 0.2 V/cm, 2° or less to 50 kHz at equal calibrated deflection factors from 0.5 V/cm to 20 V/cm. Same polarity inputs in both cases.

CHARACTERISTIC SUMMARY

VERTICAL & HORIZONTAL

BANDWIDTH—DC to 450 kHz.

CALIBRATED DEFLECTION FACTOR—1 mV/cm to 20 V/cm.

COMMON-MODE REJECTION RATIO—100:1 at 1 mV/cm deflection factor. DC to 50 kHz, 4 V P to P, max.

INPUT RC—1 megohm paralleled by approx 47 pF.

SWEEP GENERATOR

CALIBRATED TIME BASE—1 μs/cm to 5 s/cm.

SWEEP MAGNIFIER—X2, X5, X10, X20, X50.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—5 mV and 0.5 V, approx 350 Hz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 120 watts, max.

503

450-kHz X-Y Oscilloscope

HORIZONTAL DEFLECTION

TIME BASE
1 μs/cm to 5 s/cm in 21 calibrated steps (1-2-5 sequence) accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12 s/cm.

MAGNIFIER
X2, X5, X10, X20 or X50 magnification; magnified time base accurate within 5% up to 0.1 μs/cm.

TRIGGER

MODES
Automatic or manual level selection, free run. Automatic operation is useful from 50 Hz to 450 kHz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, sweep free runs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal, external or line.

REQUIREMENTS
½-cm deflection from DC to 50 kHz, increasing to 2-cm deflection at 450 kHz; ½ V external from DC to 450 kHz. Requirements increase below 50 Hz with AC coupling. Automatic operation requires 4/5-cm deflection from 50 Hz to 50 kHz, increasing to 2.5 cm at 450 kHz; ½ V external from 50 Hz to 450 kHz.

OTHER CHARACTERISTICS

TEKTRONIX CRT
3-kV accelerating potential. P2 phosphor normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±10 V for CRT modulation at normal intensity.

GRATICULE
External; variable edge lighting. 8 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

AMPLITUDE CALIBRATOR
5-mV and 500-mV squarewaves, accurate within 3%. Approximately 350-Hz repetition rate, RC time-constant controlled.

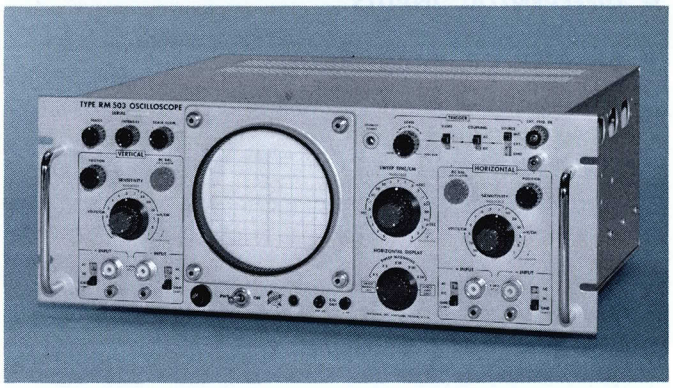
POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal); transformer taps permit operation from 210 to 250 VAC (234-V nominal); 50 to 60 Hz. Operates from 112 to 132 or 224 to 264 VAC at 400 Hz, 120 to 140 or 240 to 280 VAC at 800 Hz. 120-W maximum power consumption (125 V at 50 Hz).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	14 11/16 in	37.3 cm
Width	9 3/4 in	24.8 cm
Depth	21 5/8 in	55.0 cm
Net weight	32 lb	14.5 kg
Domestic shipping weight	≈40 lb	≈18.1 kg
Export-packed weight	≈53 lb	≈24 kg

INCLUDED STANDARD ACCESSORIES
Instruction manual (070-0218-01).

TYPE 503 OSCILLOSCOPE **$695**



RACKMOUNTING
Type RM503 mounts directly to standard 19-inch rack. MOD 171A provides slide-out tracks. Instrument can be conveniently withdrawn, tilted, and locked in 7 positions.

RACKMOUNT MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	17 in	43.2 cm
Net weight	30 lb	13.6 kg
Domestic shipping weight	≈51 lb	≈23.2 kg
Export-packed weight	≈72 lb	≈32.7 kg

INCLUDED STANDARD ACCESSORIES
3-conductor power cord (161-0024-03); mounting hardware; instruction manual (070-0314-01).

TYPE RM503 OSCILLOSCOPE **$710**

TYPE RM503 OSCILLOSCOPE, MOD 171A **$760**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capabilities and provide added convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

504

450-kHz Oscilloscope

- ***5 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***CABINET OR RACK MODELS***
- ***LOW COST***

The Type 504 and RM504 provide accurate measurements in DC-to-450 kHz applications. Features include 1-2-5 sequence on Vertical Sensitivity and Horizontal Time/cm switches, and easy-to-use triggering. Large display area, simple operation, and low cost make the Type 504 ideal for classroom and production-line uses.

The Type RM504, for the same reasons, is ideal for inclusion in a variety of systems, or other monitor applications.

VERTICAL DEFLECTION

BANDWIDTH
DC to 450 kHz at 3-dB down. Low-frequency 3-dB point is ≤10 Hz with AC coupling. Bandwidth constant at all deflection factors.

DEFLECTION FACTOR
5 mV/cm to 20 V/cm in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/cm.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
350 V combined DC + peak AC.

HORIZONTAL DEFLECTION

TIME BASE
1 μs/cm to 0.5 s/cm in 18 calibrated steps (1-2-5 sequence) accurate within 3%. Uncalibrated, continuously variable between steps and to at least 1.2 s/cm.

EXTERNAL INPUT
0.5 V/cm, variable.

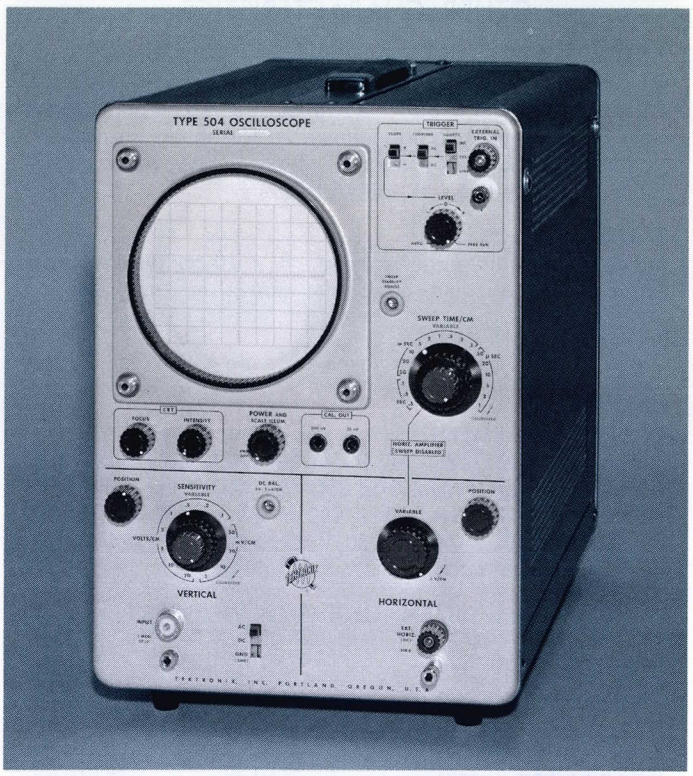
TRIGGER

MODES
Automatic or manual level selection, free run. Automatic operation is useful from 50 Hz to 450 kHz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, the sweep runs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal, external or line.

REQUIREMENTS
½-cm deflection from DC to 50 kHz, increasing to 2-cm deflection at 450 kHz; ½ V external from DC to 450 kHz. Requirements increase below 50 Hz with AC-coupling. Automatic operation requires 4/5-cm deflection from 50 Hz to 50 kHz, increasing to 2.5 cm at 450 kHz; ½ V external from 50 Hz to 450 kHz.



CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 450 kHz.

CALIBRATED DEFLECTION FACTOR—5 mV/cm to 20 V/cm.

INPUT RC—1 megohm paralleled by approx 47 pF.

HORIZONTAL

CALIBRATED TIME BASE—1 μs/cm to 0.5 s/cm.

EXTERNAL INPUT—0.5 V/cm, variable.

CRT

DISPLAY AREA—8 x 10 cm.

ACCELERATING VOLTAGE—3 kV.

PHOSPHOR—P2.

OTHER

AMPLITUDE CALIBRATOR—25 mV and 0.5 V, approx 350-Hz squarewave.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 115 watts, max.

OTHER CHARACTERISTICS

TEKTRONIX CRT
3-kV accelerating potential. P2 phosphor normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires ±10 V for beam modulation at normal intensity.

GRATICULE
External; variable edge lighting. 8 x 10-cm display area. Vertical and horizontal centerlines marked in 2-mm divisions.

AMPLITUDE CALIBRATOR
25-mV and 500-mV squarewaves, accurate within 3%. 350 Hz ±50% repetition rate.

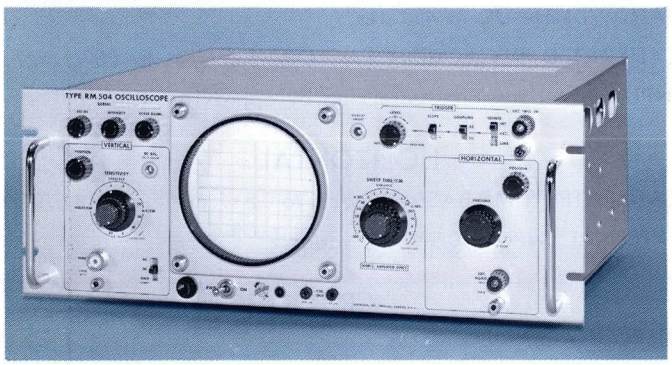
POWER REQUIREMENTS
Wired for 105 to 125 VAC (117-V nominal); transformer taps permit operation from 210 to 250 VAC (234-V nominal); 50 to 60 Hz. Operates from 112 to 132 or 224 to 264 VAC at 400 Hz, 120 to 140 or 240 to 280 VAC at 800 Hz. 115-W maximum power consumption (125 V at 50 Hz).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$14^{11}/_{16}$ in	37.3 cm
Width	$9^{3}/_{4}$ in	24.8 cm
Depth	$21^{5}/_{8}$ in	55.0 cm
Net weight	29 lb	13.1 kg
Domestic shipping weight	≈36 lb	≈16.4 kg
Export-packed weight	≈50 lb	≈22.7 kg

INCLUDED STANDARD ACCESSORIES
Instruction manual (070-0224-00).

TYPE 504 OSCILLOSCOPE $595



RACKMOUNTING
Type RM504 mounts directly to standard 19-inch rack. MOD 171A can be withdrawn from rack on slide-out tracks, tilted and locked in 7 positions.

RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack Depth	17 in	43.2 cm
Net Weight	28 lb	12.7 kg
Domestic shipping weight	≈49 lb	≈22.3 kg
Export-packed weight	≈69 lb	≈31.4 kg

INCLUDED STANDARD ACCESSORIES
3-conductor power cord (161-0024-03); mounting hardware; instruction manual (070-0315-00).

TYPE RM504 OSCILLOSCOPE $605

TYPE RM504 OSCILLOSCOPE, MOD 171A $655

OPTIONAL ACCESSORIES

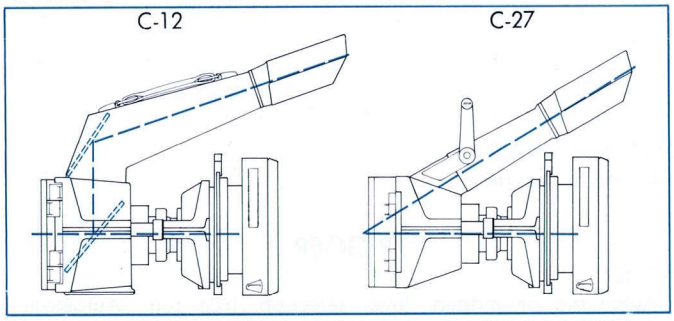
PROBES
P6006 10X Probe Package, order 010-0125-00 ..... $29.00
P6007 100X Probe Package, order 010-0134-00 ..... $29.00
P6027 1X Probe Package, order 010-0070-00 ..... $16.50

SCOPE-MOBILE® CART

Model 201-1: storage drawer and 9-position tilt-lock oscilloscope tray, order 201-1 ..... $145.00

SLIDE-OUT ASSEMBLY
Convert standard Type RM504 to MOD 171A, provide easy withdrawal and tilt of instrument, order 351-0050-00 .. $50.00

CAMERAS



Standard C-12 provides straight-on viewing, f/1.9—1:0.85 lens, Polaroid Land* Pack Film back, order C-12 ..... $490.00

Optional projected graticule for C-12 eliminates parallax in oscilloscopes having external graticules, such as the 504 and RM504. Order 016-0204-00 (115 V) or 016-0234-00 (230 V) $175.00

Type 504 or RM504 to C-12 Camera adapter.
Order 016-0226-01 ..... $16.00

Standard C-27 has rotating and removable viewing hood allowing mounting on adjacent Type RM504's, f/1.9-1:0.85 lens. Polaroid Land Pack Film back, order C-27 ..... $460.00

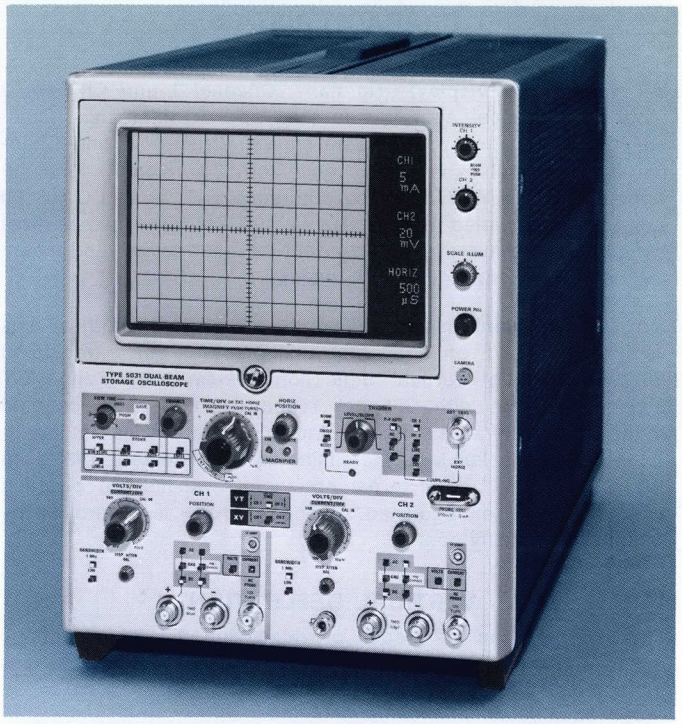
Type 504 or RM504 to C-27 Camera adapter.
Order 016-0225-02 ..... $16.00

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1-MHz Dual-Beam Oscilloscope 5030
Dual-Beam Storage Oscilloscope 5031

- SPLIT-SCREEN, BISTABLE STORAGE AND CONVENTIONAL DISPLAYS
- ERASES AFTER A SELECTABLE VIEW TIME AND STORES NEW INFORMATION, AUTOMATICALLY
- 10 μV, DIFFERENTIAL, DC COUPLED
- AUTO SCALE-FACTOR READOUT
- CALIBRATED CURRENT INPUTS



The 5030 and 5031 are the first dual-beam oscilloscopes offering calibrated current-probe inputs, high-gain differential voltage inputs, auto scale-factor readout, and 1-MHz bandwidth. The 5031 offers split-screen, bistable storage; the 5030 is a conventional, non-storing instrument.

Design of the instruments stresses usability: simplified switching, color-coded functional controls, auto scale-factor readout, plus a large viewing area. Each beam has a full scan of 8 x 10 divisions (1.22 cm/div for 5031, 1.27 cm/div for 5030). In the 5031, the split-screen, bistable, storage CRT provides high-contrast displays and new convenience through a variable viewing-time system. Through front-panel controls this system can be directed to automatically erase either or both halves of the display area after a predetermined viewing time. Viewing time can be varied up to 5 s in the auto-store mode. Used in conjunction with single sweep, the auto-store mode automatically resets the single-sweep circuit at the end of the viewing-time interval.

Two identical, solid-state input channels provide single-beam X-Y, or dual-beam Y-T displays either directly coupled or through a current or voltage probe. Vertical-channel bandwidth can be selected as 1 MHz or Low (5 kHz). Any unique bandwidth can be provided in the Low position by changing internal components.

A direct-reading (via fiber-optics) magnifier of up to X50 is provided. A sweep-magnifier locate feature intensifies the sweep to show the time position of the magnified sweep. A new automatic-trigger mode provides a stable, triggered display regardless of other control settings for most repetitive waveforms, yet maintains trigger level and slope selection. Convenience features include combination intensity/beam finder controls, and illuminated push buttons that indicate operating modes. Mode switching from a dual-beam Y vs T display to a X vs Y display is as simple as pressing a button.

Both the 5030 and 5031 provide vertical sensitivity of 10 μV/div, calibrated current-probe inputs, as well as differential-voltage inputs and a constant bandwidth at all deflection factors. These measurement capabilities, plus the many convenience features, make these instruments useful in a wide variety of applications. The 5030 and 5031 are each available in three models: a conventional upright benchmount, a low-profile benchmount, and a 5 1/4-inch rackmount. Both the rackmount and cabinet models are designed for use in a laboratory environment.

CHARACTERISTIC SUMMARY

(Characteristics are common to both units unless noted)

VERTICAL

Bandwidth—Selectable: DC to 1 MHz or DC to 5 kHz.

Deflection Factor— 10 μV/div to 10 V/div or 1 mA/div to 200 mA/div.

Input RC— 1 megohm paralleled by approximately 55 pF.

Common-Mode Rejection Ratio—At least 100,000:1 (DC to 100 kHz).

HORIZONTAL

Time Base— 1 μs/div to 5 s/div.

Magnifier—Up to 5 magnification steps (X50 mag max). Fastest sweep speed limited to 1 μs/div.

External Input— 20 mV/div to 0.5 V/div.

CRT

Display Area—Each beam is 8 x 10 div. 5030, 1.27 cm/div; 5031, 1.22 cm/div.

Phosphor— 5030, P31; 5031, P1.

Accelerating Voltage— 4 kV.

OTHER

Amplitude Calibrator— 0.5 V and 5 mA, 1-kHz squarewave.

Power Requirements— 90 to 140 V or 180 to 275 V, 48 to 440 Hz; 130 watts.

5030 1-MHz Dual-Beam Oscilloscope
5031 Dual-Beam Storage Oscilloscope

CHARACTERISTICS
DISPLAY MODES

Y-T (Two-Beam Display)—Normally, Channel 1 and Channel 2 plotted on vertical axes versus time on horizontal axis. Dual-beam curve tracing provided by plotting Channel 1 and Channel 2 on vertical axes against an external horizontal signal on horizontal axis. Y, Y, X phase difference is 5° from DC to 100 kHz, or AC coupled from 1 kHz to 100 kHz. The two vertical deflection systems are independent of each other and share the same horizontal deflection system.

X-Y (Single-Beam Display)—Channel 1 plotted on vertical axis versus Channel 2 on horizontal axis provides curve tracing at full sensitivity of vertical deflection system (10 μV/div). X-Y phase difference with Channel 1 and Channel 2 DC coupled at the same calibrated deflection factor (unused inputs grounded) is 1° or less to 200 kHz, increasing to 6° or less at 1 MHz. In X-Y mode, time and external horizontal systems are disabled and lamps are extinguished. Trace intensity is controlled by Channel 1 intensity control.

VERTICAL DEFLECTION

Two identical channels, each provided with differential voltage inputs and a separate current input. Voltage or current modes are selected by push buttons.

When current mode is enabled, lamps associated with voltage inputs are extinguished to avoid confusion. VOLTS switch extinguishes current lamp. Full 1-MHz bandwidth or Low (5-kHz) bandwidth for eliminating wide-band noise, selectable by push button.

Bandwidth—DC to 1 MHz within +50%, −10%, or DC to approximately 5 kHz, selectable by push button. Lower −3 dB limit: AC coupled 2 Hz or less; current mode 10 Hz or less.

Deflection Factor—VOLTAGE MODE: 10 μV/div to 10 V/div in 19 calibrated steps (1-2-5 sequence). Accurate within 3% from 50 μV/div to 10 V/div. Accurate within 5% for 10 μV/div and 20 μV/div positions. Uncalibrated, continuously variable between steps to approximately 25 V/div. CURRENT MODE: 1 mA/div to 200 mA/div in 8 calibrated steps (1-2-5 sequence) accurate within 5%. Uncalibrated, continuously variable between steps, extends deflection factor to approximately 500 mA/div. STORE MODE: The accuracy of each specification decreases 1%.

Input RC— 1 MΩ within 1% paralleled by approximately 55 pF.

Displayed Noise (tangentially measured)—Voltage Mode, 15 μV or less; Current Mode, 200 μA or less.

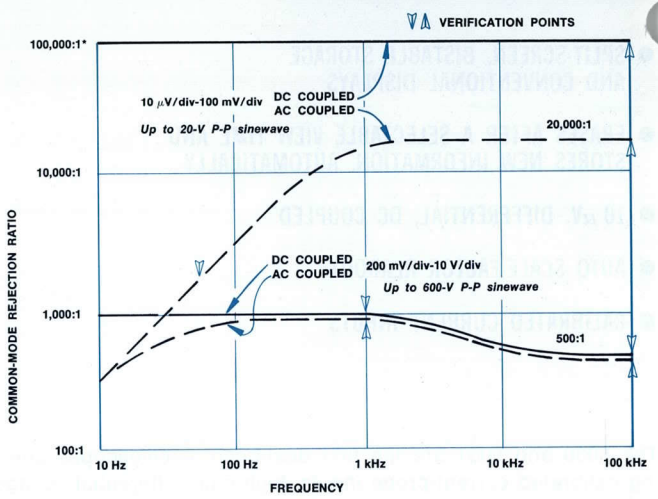
Input Gate Current— 200 pA or less.

Max Input Voltage (Inputs are fuse protected—no damage will occur).

RANGE	DC	AC†
10 μV to 100 mV/div	10 V (DC + Peak AC)	300 V DC, 10 V Peak AC
200 mV to 10 V/div	300 V (DC + Peak AC)	300 V (DC + Peak AC)

†To protect the device under test, the input switch must be initially set to ground when signal is applied to input to charge (or discharge) input coupling capacitor.

Max Input Current— 10 A peak-to-peak with 125-turn current probe.



**CMRR is not specified when display is 0.1 div or less from DC to 1 kHz, 0.2 div or less from 1 kHz to 100 kHz.*

DC Stability—Drift with Time: 5 μV or less per minute after one-hour warm up. Drift with Temperature: 50 μV or less per degree C.

HORIZONTAL DEFLECTION

Full-range time base (1 μs to 5 s/div), up to 5 magnification steps (X50 maximum) and a unique magnifier locate featur Full-bandwidth calibrated external-horizontal input permits dua beam X-Y presentations. Horizontal deflection common to both beams.

Time Base Sweep Rate— 1 μs to 5 s/div in 21 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Accurate within 4% when using split-screen storage. Uncalibrated, continuously variable between steps and to approximately 12 s/div.

Sweep Magnifier—Up to 5 magnification steps (1-2-5 sequence) from the initial unmagnified time/div control setting. Maximum magnified sweep limited to 1 μs/div. Magnified time base accurate within 5% in the center 8 divisions of display. Accurate within 6% when using split-screen storage. Locate push button disables magnifier and restores normal sweep display, intensifies that portion of sweep to be magnified. Horizontal position control acts as time position of that portion of sweep to be magnified.

Sweep Modes—Normal or single sweep; ready indicator lights when sweep circuit is triggerable.

External Horizontal Input—Bandwidth is DC to at least 900 kHz. Deflection factor is 20 mV/div to 500 mV/div in 5 calibrated steps (1-2-5 sequence) accurate within 3% in the center 8 divisions. Accurate within 4% when using split-screen storage. Uncalibrated, continuously variable between steps to approximately 1.25 V/div. Input RC is 1 MΩ within 2% paralleled by approximately 50 pF. Maximum input is 100 V (DC + peak AC) decreasing to 100 V peak-to-peak at 1 MHz. Y, Y, X phase difference is 5° or less from DC to 100 kHz; AC coupled from 1 k to 100 kHz.

1-MHz Dual-Beam Oscilloscope 5030
Dual-Beam Storage Oscilloscope 5031

TRIGGER

A simplified trigger circuit combines the trigger LEVEL and SLOPE controls and provides a peak-to-peak auto mode. When in peak-to-peak auto, the range of level adjustment is automatically established at the positive and negative peaks of the displayed waveforms. Also, the sweep is always triggered, or reverts to a free-running mode in the absence of a trigger signal or when the trigger signal is less than 15 Hz.

Coupling—Peak-to-peak auto, AC or DC coupling. These push buttons select the coupling of trigger and external-horizontal input signals.

Source—Internal (Channel 1 or Channel 2), Line, or External.

Sensitivity

COUPLING	SWEEP	INTERNAL	EXTERNAL
Peak-to-Peak Auto	Norm	0.5 div, 15 Hz to 1 MHz	0.6 V, 15 Hz to 1 MHz
	Single	1.5 div, 15 Hz to 1 MHz	2.0 V, 15 Hz to 1 MHz
AC		0.3 div, 15 Hz to 1 MHz	0.4 V, 15 Hz to 1 MHz
DC		0.3 div, DC to 1 MHz	0.4 V, DC to 1 MHz

Maximum Input— 100 V (DC + peak AC) decreasing to 100 V peak-to-peak at 1 MHz.

REAR PANEL INPUTS AND OUTPUTS

Z-Axis Inputs—Separate inputs for Channel 1 and Channel 2, DC to 1 MHz; 0 V to +12 V equal to full-intensity range, negative signal intensifies. Input RC is approximately 20 kΩ paralleled by 60 pF. Maximum input is 50 V (DC + peak AC).

Vertical Signal Outputs—Channel 1 and Channel 2 connectors provide an output of the vertical deflecting signal, DC coupled, of at least 0.2 V per displayed division. Source impedance is approximately 10 kΩ. Bandwidth is DC to approximately 100 kHz.

+Gate Output—Approximately 5 V from source impedance of approximately 5 kΩ.

Sawtooth Output—At least 5 V from source impedance of 10 kΩ.

Camera—Power to camera and sweep reset from camera to oscilloscope.

DISPLAY FEATURES

Auto Scale-Factor Readout—Reads out scale-factors associated with Channel 1, Channel 2, and Horizontal. CH 1 and CH 2 read 10 μV to 10 V in 19 steps or 1 mA to 200 mA in 8 steps (1-2-5 sequence). HORIZ reads 1 μs to 5 s in 21 steps or 20 mV to 500 mV in 5 steps (1-2-5 sequence). Scale illumination control selects intensity of readout. A greater than (>) symbol appears before each readout when the related control is uncalibrated.

Display Controls—Combination push-button beam finder and intensity control for each beam. Dynamic focus eliminates requirement for control.

DUAL-BEAM STORAGE CRT - 5031

The CRT is a split-screen, bistable, storage device operated at 4-kV accelerating potential. Phosphor Type is P1 (no options). Each beam has a full scan of 8 x 10 divisions (1.22 cm/div). Separate vertical deflection plates; common horizontal. Internal graticule.

Split-Screen Storage—Store on either upper or lower half of screen with conventional display on other half. Store on entire screen or non-store on entire screen. Independent operation of both halves.

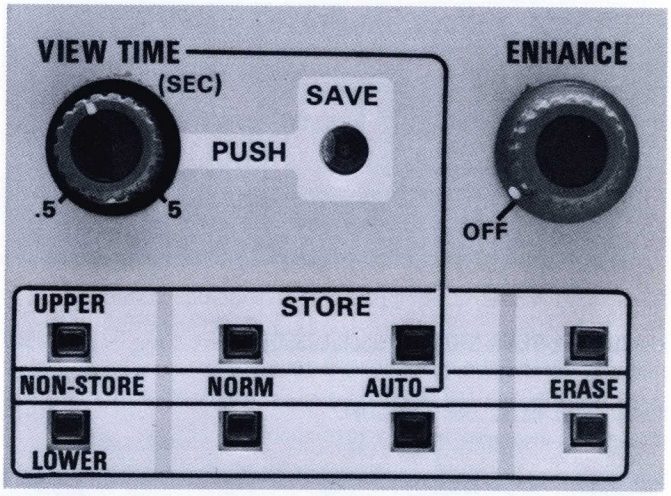
Writing Speed—At least 20 div/ms.

Storage Viewing Time—Up to one hour.

Erase Time— 250 ms within 20%.

Enhance Mode—Controls single-sweep writing capabilities of the storage CRT. Increases storage capabilities beyond 20 div/ms with minimal loss of resolution and contrast.

Auto-Store Mode—Viewing time continuously variable up to 5 s before the screen is erased and the sweep reset (Single-Sweep Mode). A SAVE mode disables automatic erasure.



DUAL-BEAM CRT - 5030

8 x 10 div per beam (1.27 cm/div). Separate vertical deflection plates; common horizontal. 4-kV accelerating potential provides a bright display. Internal, variable illumination graticule. P31 phosphor normally supplied; P7 optional, without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

OTHER CHARACTERISTICS

Probe Test— 0.5 V into 1 MΩ and 5 mA accurate within 2%. Repetition rate is 1 kHz accurate within 15%.

Power Requirements—Quick-change, line-voltage selector permits operation from 90 to 121 V, 103.5 to 140 V, 180 to 242 V, or 207 to 275 V. The instruments will operate over a line-frequency range of 48 Hz to 440 Hz with a power consumption of 130 watts at 115 V AC, 60 Hz.

5030 1-MHz Dual-Beam Oscilloscope
5031 Dual-Beam Storage Oscilloscope

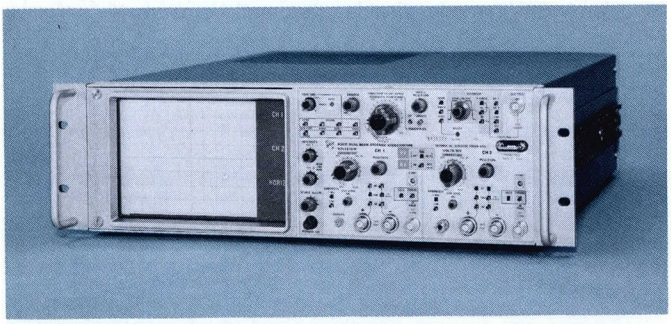
Dimensions and Weights

	UPRIGHT CABINET		RACKMOUNT		LOW-PROFILE CABINET	
	in	cm	in	cm	in	cm
LENGTH	22 1/2	57.2	22 1/2	57.2	22 1/2	57.2
WIDTH	10	25.5	19	48.4	17 5/8	44.8
HEIGHT	13	33.1	5 1/4	13.4	6	15.3
	lb	kg	lb	kg	lb	kg
NET WEIGHT	36	16.3	33	14.9	33	14.9
DOMESTIC SHIPPING WEIGHT	45	20.4	43	19.5	43	19.5
EXPORT-PACKED WEIGHT	56	25.4	63	28.6	63	28.6

Upright cabinet model is equipped with tilt bail, feet, and handle.

5031 DUAL-BEAM STORAGE OSCILLOSCOPE **$2500**
Includes instruction manual (070-1004-00).

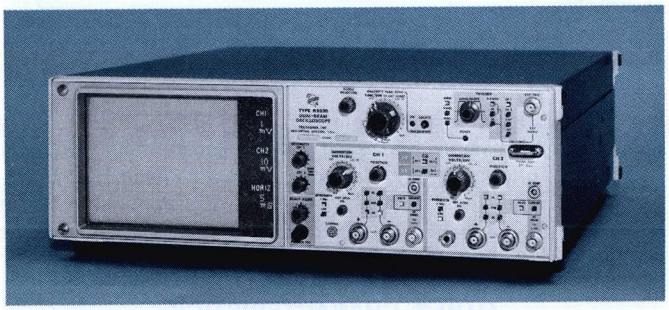
5030 DUAL-BEAM OSCILLOSCOPE **$1850**
Includes instruction manual (070-0999-00).



Rackmount model is equipped with a slide-out assembly.

R5031 DUAL-BEAM STORAGE OSCILLOSCOPE **$2500**
Includes instruction manual (070-1005-00).

R5030 DUAL-BEAM OSCILLOSCOPE **$1850**
Includes instruction manual (070-1000-00).



Low-profile cabinet model (Option 4) is equipped with tilt bail, feet, and handle.

R5031 DUAL-BEAM STORAGE OSCILLOSCOPE, Option 4 ..... **$2500**
Includes instruction manual (070-1005-00).

R5030 DUAL-BEAM OSCILLOSCOPE, Option 4 ..... **$1850**
Includes instruction manual (070-1000-00).

OPTIONAL ACCESSORIES

Optional accessories increase measurement capabilities and provide added convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.

Probes

P6052 10X, 1X selectable attenuation probe package, order 010-0241-00 ..... $55

P6021 AC current probe package, order 010-0237-02 .... $94

Scope-Mobile® Carts

Model 205-1, storage drawer, and 9-position, tilt-lock oscilloscope tray, suitable for R5031 or R5030, order 205-1 .... $150

Model 204-3 includes scope holddown, suitable for 5031 or 5030, order 204-3 ..... $125

Cameras

C-70 provides an f/1.9—1:0.575 lens for complete coverage of CRT and readout areas. Polaroid* Land Pack-Film back, order C-70-P (includes mounting bezel) $785

Standard C-12 provides a rotating back, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back, order C-12 ..... $490

Standard C-27 has a rotating back and removable viewing hood, f/1.9—1:0.85 lens. Polaroid Land Pack-Film back order C-27 ..... $460

Camera Adapters

The C-70 mounts directly to the 5031 or 5030. If a C-12 or C-27 is to be used, the adapter-frame/corrector lens and adapter is required.

Either the C-12 or C-27 Camera can be used with the 5031 or 5030 through use of an adapter-frame/lens combination. The adapter frame accepts camera-mounting adapter normally used for Tektronix 5-inch round CRT's order 016-0264-01 ..... $35

C-12 to 5-inch round CRT adapter, order 016-0226-01 ..... $16

C-27 to 5-inch round CRT adapter, order 016-0225-02 ..... $16

Remote-Control Unit

Separate controls for erase of upper screen, erase of lower screen, and single-sweep reset. Mates to 5031 Oscilloscope rear-panel connector, 9-foot cable, order 012-0102-00 ..... $33

Remote-Control Connector

9-pin cable connector for selection of storage, non-storage, erase and reset functions. Mates to 5031 Oscilloscope rear-panel connector. Cable and control unit not included, order 134-0049-00 ..... $6

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U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

PORTABLE OSCILLOSCOPE REFERENCE

PRODUCT	PAGE	BW	MINIMUM DEFLECTION FACTOR	DUAL TRACE	DELAYED SWEEP	SWEEP RATE (WITH MAG)	MAG	BATTERY POWER	DISPLAY SIZE
321A	**179**	6 MHz	10 mV/div			0.1 μs/div	X5	Yes	6 x 10 div 1/4 in/div
323	**181**	4 MHz	10 mV/div			0.5 μs/div	X10	Yes	6 x 10 div 1/4 in/div
324	**184**	10 MHz	10 mV/div			0.2 μs/div	X5	Yes	6 x 10 div 1/4 in/div
422/ R422	**187**	15 MHz	10 mV/div	Yes		50 ns/div	X10	Yes	8 x 10 div 0.8 cm/div
453A/ R453A	**191**	60 MHz	5 mV/div	Yes	Yes	10 ns/div	X10		8 x 10 div 0.8 cm/div
454A R454A	**195**	150 MHz	2 mV/div	Yes	Yes	2 ns/div	X10		8 x 10 div 0.8 cm/div

The Tektronix family of portable oscilloscopes is designed first of all to solve measurement problems with laboratory precision—in the field or in the lab. Secondly, these instruments are designed to be carried comfortably in a position which places the front panel in a vertical plane rather than the horizontal format which is usually used for non-portable oscilloscopes. Thirdly, these ruggedized oscilloscopes will withstand severe environments wherever you go without the additional costs usually associated with militarized instruments.

Beginning with the first Tektronix portable oscilloscope, measurements compromised by adverse field conditions have been significantly reduced. Today, with the introduction of three new and improved portables, compromised field measurements are even less likely to occur.

454A/R454A The 454 set a standard of performance for portable laboratory oscilloscopes. Now, the new dual-trace, 150-MHz, solid-state 454A Oscilloscope offers even more in high-performance portable oscilloscopes. "454" means that many of the features which made that instrument so popular are retained; "A" means that other features are expanded and many new ones are added.

The result is the 454A, a new oscilloscope, much of which is already field proven. This new oscilloscope, in a highly preferred model, features an 8 x 10 div CRT (each division is 0.8 cm) which provides 33% more high-resolution viewing area. FET inputs provide more stability to complement the increased sensitivity at higher bandwidths. Bandwidth-sensitivity specs are 10 mV/div at 150 MHz, 5 mV/div at 100 MHz and 2 mV/div at 50 MHz/div. At 2 ns/div with X10 magnification, more time resolution is available than ever before in a portable laboratory oscilloscope. Calibrated mixed sweep, another Tektronix first, provides more delayed sweep measurement capabilities. With calibrated mixed sweep, accuracy replaces trial and error in measuring the elapsed time from beginning of delaying sweep to beginning of the mixed sweep. Now, this elapsed time can be measured accurately, the same as other delayed sweep measurements. More panel color coding and smaller knobs mean easier measurements with less guesswork. Measurement time is a signifimant part of the value of any product. Providing more clarity and understanding of the various operating modes means more effective use of the user's time by reducing the time spent making each measurement.

The 454A is designed to provide more reliability and maintenance ease. FET inputs and other new circuitry means cooler operation. Circuit boards which are easy to repair while installed, and easier to remove, mean less down time and fewer field maintenance problems. Cleaner step response at all sensitivities plus more accuracy throughout, adds to the precision of the new 454A.

There are other features which advance the measurement capabilities of the new 454A. It is clearly a precision laboratory instrument with portability, and major new features enhance the many characteristics which provide the capability of solving complex measurement problems.

453A/R453A Customer preference made the 50-MHz 453 a widely used service and laboratory oscilloscope in virtually an unlimited range of applications throughout the world. The reasons are many and include 453 features such as delayed sweep, which is easy to use, simplified full-range triggering and other straightforward functions which remove the guesswork from oscilloscope operation. The 453 is durable, reliable and easy to maintain which keeps down time to a minimum and on-site operating time to a maximum. The new 453A dual-trace 60-MHz solid-state oscilloscope retains these features of the 453 and offers many new ones. For instance, the CRT of the 453A is expanded to 8 x 10 div (each division is 0.8 cm), providing 33% more viewing area. A carefully designed front panel provides space for this large, high-resolution CRT. Properly spaced, logically arranged controls let the user easily understand the 453A operating modes and quickly switch among these to obtain positive solutions to even his most complex measurement problems.

The majority of laboratory problems are solved by high-performance, dual-trace oscilloscopes. These are the laboratory measurements which the 453A will solve. Its large CRT provides more display area, more writing speed, and more resolution than many plug-in oscilloscopes. The 453A price-performance value offers sound solutions to the majority of laboratory measurements.

324 The new SONY®/TEKTRONIX® 324 is a single channel 10 mV/div oscilloscope with 10-MHz bandwidth which operates from internal rechargeable batteries, AC or external batteries. The dimensions of the 324 are 10 5/8 (depth) x 8 1/2 (width) x 4 1/4 (height) inches. The weight is about eight pounds, including batteries. The 324 extends to 10 MHz the capabilities of the widely used 4-MHz 323. Higher performance solves more measurement problems in many new areas; the small size and power options make the 324 ideal for application where space and power sources are at a premium. Performance, size and complete power options are features of the 324 which eliminate many trade-offs that were formerly limiting factors in field maintenance.

RUGGEDIZED PORTABLES

This family of Tektronix oscilloscopes are solid-state instruments that combine small size, light weight and the ability to make precision waveform measurements. As such, these instruments must withstand the shock, vibration, and other extremes of environment associated with portability.

The environmental characteristics of these instruments allow them to operate over a temperature range of −15°C to +55°C and be stored for long periods from −55°C to +75°C. For those instruments including batteries, the storage temperatures are −40°C to +60°C.

These environmentalized instruments will operate at an altitude of 15,000 feet, but can be carried, non-operating, to altitudes as high as 50,000 feet. The effects of high humidity have been minimized since these instruments meet 5 cycles of a test as defined by MIL-STD-202C method 106B, or MIL-E-16400F. Non-nutrient materials are used where possible.

These instruments will withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in one-minute cycles, while operating. They will also withstand shock of 30 g's, (20 g's for the 321A) half sine, 11-ms duration, two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Electromagnetic interference (EMI) must be considered in both laboratory and field applications. These portable instruments, with the exception of the Type 321A, have been subjected to tests as specified in MIL-1-6181D where EMI radiated from the instrument is held within the given limits from 150 kHz to 1 GHz. EMI conducted out of the instrument through the power cord is held within the given limits from 150 kHz to 25 MHz (not specified for the 323 and 324).

BATTERY OPERATION

Four of these instruments (Types 321A, 323, 324 and 422) are battery operated. With battery operation, the user moves from one remote location to another without concern for power connections. Battery powered instruments are especially suited for maintenance at sites such as remote microwave installations, mobile communications equipment, aircraft and marine instrumentation and production control equipment.

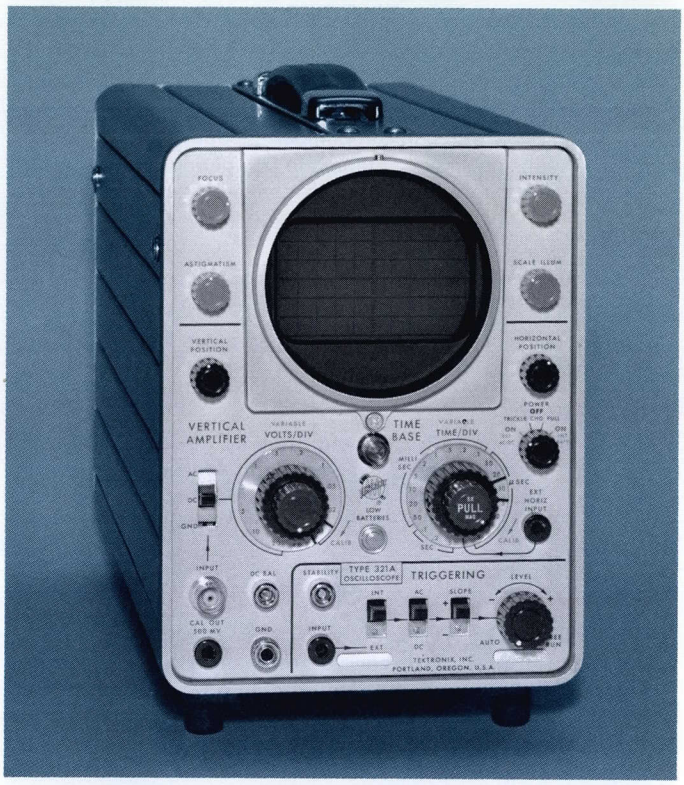
The nickel cadmium battery cells used in Tektronix instruments have been selected after extensive evaluation. Each battery cell in the battery pack receives an ampere-hour test, has met or exceeds the ampere-hour storage requirement and has been rigidly inspected. The battery cells used in the battery pack should provide a useful operating life extending over several hundred charge-discharge cycles with routine care.

Each Tektronix portable oscilloscope is a complete measuring system. Standard accessory items such as probes, adapters, cords, filters and a manual are included at no extra cost. Additional value is provided by a complete line of optional items: a new spectrum analyzer module compatible with these oscilloscopes, voltage probes, current probes, special adapters, cameras, protective covers, and Scope-Mobile® Carts. The Accessory Section lists all accessories with detailed descriptions.

321A
6-MHz Oscilloscope

- ***10 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***AC, DC, OR BATTERY OPERATED***
- ***SMALL SIZE—LIGHT WEIGHT***
- ***ALL SOLID STATE***
- ***LOW POWER CONSUMPTION***
- ***UP TO 8-HOURS OPERATION FROM INTERNAL BATTERIES***
- ***DESIGNED FOR SEVERE ENVIRONMENTS***

The Type 321A is a high-performance DC-to-6 MHz Oscilloscope. Its rugged mechanical and electrical design plus a choice of power options make it ideal for field operations requiring accurate waveform measurements. FET inputs provide low drift and fast stabilization time. With internal batteries, it weighs 17½ pounds; without batteries, it weighs 14 pounds.



VERTICAL DEFLECTION

BANDWIDTH
DC to 6 MHz at 3-dB down. Low-frequency 3-dB-down point with AC coupling is ≤2 Hz, extended to ≤0.2 Hz when using the included 10X probe.

RISETIME
≤58 ns.

DEFLECTION FACTOR
10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT R and C
1 megohm within 2%, paralleled by approx 41 pF.

MAXIMUM INPUT VOLTAGE
500 V (DC + peak AC), <500 V P-P AC.

HORIZONTAL DEFLECTION

TIME BASE
0.5 μs/div to 0.5 s/div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 divisions. Uncalibrated, continuously variable between steps and to approx 1.5 s/div.

X5 MAGNIFIER
Extends all time base steps, the fastest to 0.1 μs/div. Magnified display accurate within 5% over center 8 divisions.

EXTERNAL INPUT
1 V/div ±10% with X5 magnifier. DC to ≥1 MHz at −3 dB. Input R and C 100 kΩ within 5% paralleled by approx 25 pF.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 6 MHz.

RISETIME—58 ns

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div.

INPUT R and C—1 megohm paralleled by approx 35 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.5 μs/div to 0.5 s/div.

X5 MAGNIFIER—Extends time base to 0.1 μs/div.

EXTERNAL INPUT—1 V/div, DC to 1 MHz.

CRT

DISPLAY AREA—6 x 10 div. Each div equal to ¼ inch.

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31

OTHER

AMPLITUDE CALIBRATOR—500-mV squarewave peak to peak and internal 40-mV squarewave peak to peak at approx 2 kHz.

POWER OPTIONS—10 size D batteries; external DC supply of 11.5 to 35 V, ≤700 mA; 115 VAC ±10% or 230 VAC ±10%, 45 to 800 Hz, 20 W max.

321A

6-MHz Oscilloscope

TRIGGER

MODES
Automatic or manual level selection, or free run. Automatic operation is useful above 50 Hz, minimizes trigger adjustment for signals of different amplitudes, shapes, and repetition rates. With no input, automatic triggering occurs at an approx 50-Hz rate, providing a convenient reference trace.

COUPLING
AC or DC.

SOURCES
Internal or external. External trigger input R 100 kΩ within 20% paralleled by approx 9 pF.

REQUIREMENTS
0.2-div deflection or 1 V external from DC to 1 kHz, increasing to 1-div deflection or 3 V external at 6 MHz. Requirements increase below 1 kHz for internal AC-coupled triggering, and below approx 30 Hz with external AC-coupled triggering.

CRT

TEKTRONIX CRT
6 x 10-div display area; each div is 1/4 inch. 3-inch tube provides bright trace, utilizes low heater power. 4-kV accelerating potential. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input is AC coupled, 5 V P-P at 1 kHz gives visible trace modulation at normal intensity.

GRATICULE
External; variable edge lighting when instrument is operated from AC line. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE
Operating (without batteries) −15°C to +55°C.
(with batteries installed) Charge Range, 0°C to +40°C; Discharge Range, −15°C to 40°C.
Non-operating (without batteries) −55°C to +75°C.
(with batteries installed) −40°C to +60°C.

ALTITUDE
Operating: 15,000 ft max.
Non-operating: 50,000 ft max.

VIBRATION
Operating: 15 minutes along each of 3 axes at 0.025 in peak to peak displacement (4 g's at 55 c/s), 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating: 20 g's, 1/2 sine, 11-ms duration. Two guillotine-type shocks per axis each direction for a total of 12 shocks. Non-operating: 60 g's, 1/2 sine, 11-ms duration. One guillotine-type shock per axis each direction for a total of 6 shocks.

HUMIDITY
Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +20°C and 25% to 80% relative humidity).

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
500 mV at external jack; accurate within 3% throughout operating range. 40 mV applied internally to vertical amplifier; accurate within 2% throughout operating range. Approx 2 kHz repetition rate.

POWER OPTIONS
Wired for 115 V RMS ±10%, 45 to 800 Hz; tapped transformer also allows operation at 230 V ±10%; 20-W maximum power consumption for oscilloscope only, 30-W maximum with internal batteries under full charge. Operates on external DC supply from 11.5 to 35 V DC; draws ≤600 mA. Operates on 10 internal size D batteries. NiCd rechargeable cells provide approx 8 hours continuous operation. Front-panel light indicates when internal batteries are low, or (using external power) when the voltage source drops too low for proper power supply regulation. Recharge requires at least 16 hours.

BATTERY CHARGER
Internal charger provides two different charging currents to the internal batteries. A trickle charge or a full charge is applied to the internal batteries when the instrument is turned off, but connected to the AC line.

DIMENSIONS AND WEIGHTS

Height	8 3/4 in	22.2 cm
Width	5 3/4 in	14.6 cm
Depth	16 1/2 in	41.9 cm
Net weight	14 1/4 lb	6.5 kg
Domestic shipping weight	≈22 lb	≈10.0 kg
Export packed weight	≈33 lb	≈15.0 kg

INCLUDED STANDARD ACCESSORIES
P6006 10X probe (010-0127-00); two 18-inch BNC-to-banana plug patch cords (012-0091-00); DC power cord (161-0016-01); AC power cord (161-0015-01); instruction manual (070-0891-00).

TYPE 321A OSCILLOSCOPE, without batteries **$1045**

OPTIONAL ACCESSORIES

CARRYING CASE
Protects Type 321A, provides convenient accessory storage compartment, order 016-0026-00 . . . . . $50

RECHARGEABLE BATTERIES
Each NiCd cell, order 146-0010-00 . . . . . $8
Set of 10 NiCd cells, order 016-0077-01 . . . . . $77

PROBES
P6007 100X Probe Package, order 010-0150-00 . . . . . $29
P6011 1X Miniature-Probe Package, order 010-0193-00 . . $21

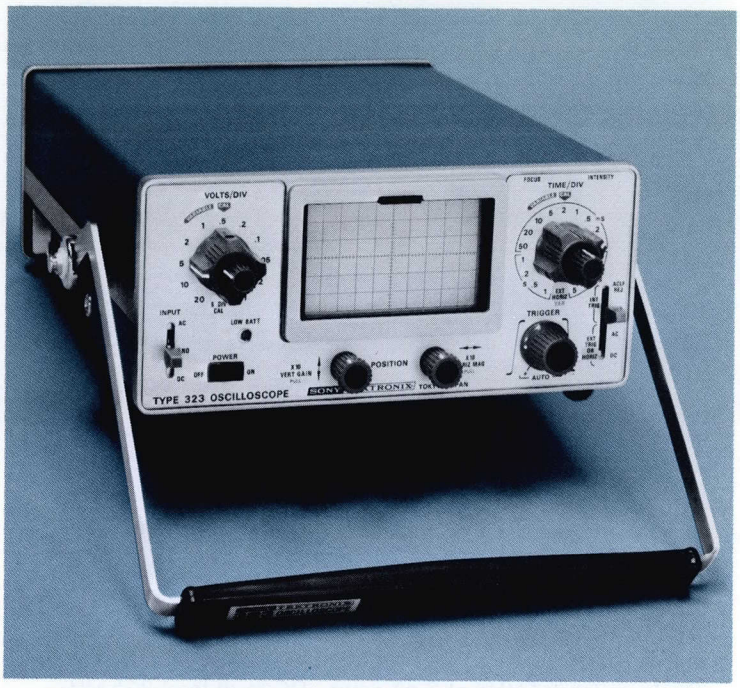
CAMERAS
C-30A, f/1.9 lens, 1:1.5 to 1:0.7 magnification $480
C-32, f/1.4 lens, 1:1 or 1:0.85 magnification $625
321A to C-30A or C-32 Camera adapter, order 016-0242-00 . . . . . $16
See Camera Section for complete details.

MESH FILTER
Improves display contrast for high ambient light conditions and also serves as an EMI filter, order 378-0577-00 . . . . . $15

*Registered Trademark Polaroid Corporation

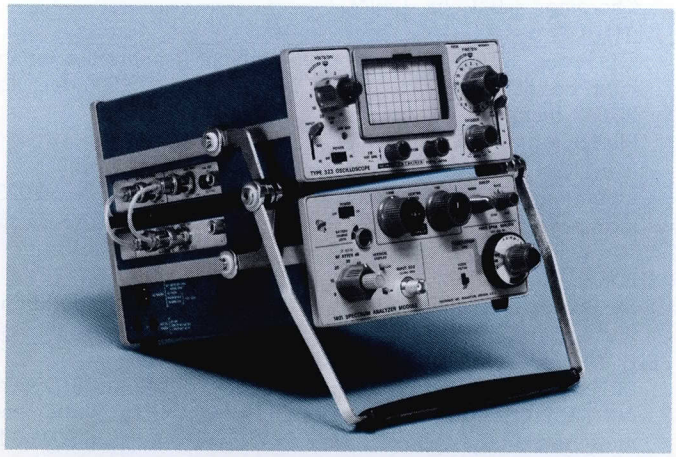
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

4-MHz Oscilloscope



- ***1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***AC, DC OR BATTERY POWERED***
- ***COMPACT SIZE—WEIGHT ≈7 lb***
- ***ALL SOLID STATE***
- ***UP to 7-HOURS OPERATION FROM INTERNAL BATTERY PACK***
- ***DESIGNED FOR SEVERE ENVIRONMENTS***
- ***CONVENIENT ACCESSORY STORAGE***

The Type 323 is an all solid-state, single-channel, 4-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 323 features small size and light weight, together with extremely low power consumption. Depth is 10⅝ inches, width—8½ inches, height—4¼ inches, weight—≈7 pounds. Power consumption is up to 4.5 watts, typically 1.6 watts from an external DC source and 14 watts when powered from the AC line. Internal rechargeable batteries will provide up to 7 hours continuous operation, sufficient for a full working day. The portability/performance provided by the Type 323 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications; for example, industrial control equipment, communication systems, business machines and computers.



PORTABLE SPECTRUM ANALYZER SYSTEM

The 323 Oscilloscope becomes a frequency domain measurement tool when used with the Tektronix 1401 1-to-500 MHz Spectrum Analyzer Module. AC, DC, or battery power may be used for this 15-pound system. A complete description of the 1401 and the 1401/323 System is found in the Spectrum Analyzer section.

CHARACTERISTIC SUMMARY

VERTICAL

BANDWIDTH—DC to 4 MHz.

RISETIME—90 ns.

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div at full bandwidth, 1 mV/div at 2.75-MHz bandwidth.

INPUT R and C—1 megohm paralleled by approx 47 pF.

HORIZONTAL

CALIBRATED TIME BASE—5 μs/div to 1 s/div.

X10 MAGNIFIER—Extends time base to 0.5 μs/div.

EXTERNAL INPUT—20 mV/div to 30 V/div, continuously variable, DC to 10 kHz.

CRT

DISPLAY AREA—6 x 10 divisions (¼ inch/division).

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—Internal, 0.5 V at external jack.

POWER SOURCES—Internal batteries; external DC supply of 6 to 16 V, 4.5 W max; 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 440 Hz, 14 W max at 115 VAC.

EASY TO CARRY
Adjustable handle and included shoulder strap make this 7-pound oscilloscope easy to carry.

VERTICAL DEFLECTION

BANDWIDTH
DC to at least 4 MHz at 3-dB down. DC to at least 2.75 MHz at 3-dB down using X10 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

RISETIME
90 ns or less; 130 ns or less using X10 gain.

DEFLECTION FACTOR
10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 1 mV/div to 2 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT R and C
1 megohm within 2% paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
500 V (DC + peak AC).

Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

HORIZONTAL DEFLECTION

TIME BASE
5 μs/div to 1 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.2 s/div; accurate within 4% from 0.5 s/div to 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 MAGNIFIER
Operates over full time base, increases fastest sweep rate to 0.5 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/div, 50 ms/div, and 0.1 s/div.

EXTERNAL INPUT
Continuously variable from approx 20 mV/div to approx 30 V/div, AC or DC coupled. DC to at least 10 kHz at 3-dB down.

TRIGGER

MODES
Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

COUPLING
AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

AMPLITUDE REQUIREMENTS
0.3-div deflection or 75 mV external to 400 kHz, increasing to 0.75-div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 30 kHz with AC LF REJ coupling.

CRT

CRT
6 x 10-div display area; each div is 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150-V maximum input voltage (combined DC + peak AC).

GRATICULE
Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4-inch division.

ENVIRONMENTAL CAPABILITIES

AMBIENT TEMPERATURE
Operating: −15°C to +55°C.
Non-operating: −55°C to +75°C (without batteries).
−40°C to +60°C (with batteries).
Charging: −0°C to +40°C.

ALTITUDE
Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet.
Non-operating: 50,000 feet.

VIBRATION
Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating and non-operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

ELECTROMAGNETIC INTERFERENCE
Meets radiated interference requirements of MIL-I-6181D and MIL-I-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated with CRT mesh filter (378-0596-00) installed. Installation of the CRT mesh filter diminishes the usefulness of the internal non-illuminated graticule.

HUMIDITY
Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of Mil-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

PROBE

The P6049 is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

POWER SOURCES

Internal DC source: removable power pack contains 6 size "C" NiCd cells providing 3 to 7-hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: operates from an external DC source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.

External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 VAC.

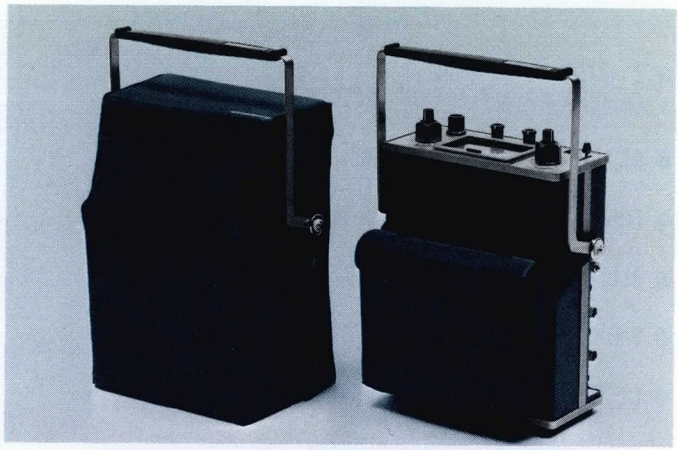
DIMENSIONS AND WEIGHTS

Height	4¼ in	10.8 cm
Width with handle	8½ in	21.6 cm
Width with AC power cord	9¼ in	23.6 cm
Depth with handle not extended	10⅝ in	27.0 cm
Depth with handle extended	12¾ in	32.3 cm
Net weight without accessories	≈7 lb	≈3.2 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

INCLUDED STANDARD ACCESSORIES

P6049 10X probe (010-0223-00); patch cord (012-0089-00); accessory pouch (016-0113-00); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00); instruction manual (070-0750-00).

TYPE 323 OSCILLOSCOPE, including power pack . . **$960**



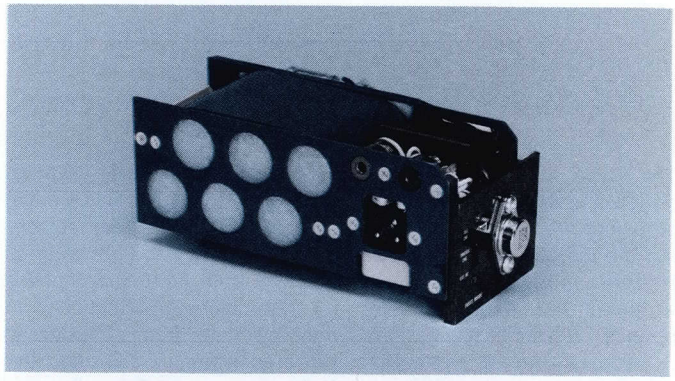
Optional protective cover (left) slips over the Type 323 and its included accessory pouch (right).

The SONY®/TEKTRONIX® Type 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the Type 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

PROTECTIVE COVER

The protective cover for the Type 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $10



POWER PACK

Extra power pack, in addition to the one supplied with the Type 323 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0119-02 ..... $98

BATTERY SET

Set of 6 NiCd cells, order 146-0012-01 ..... $23

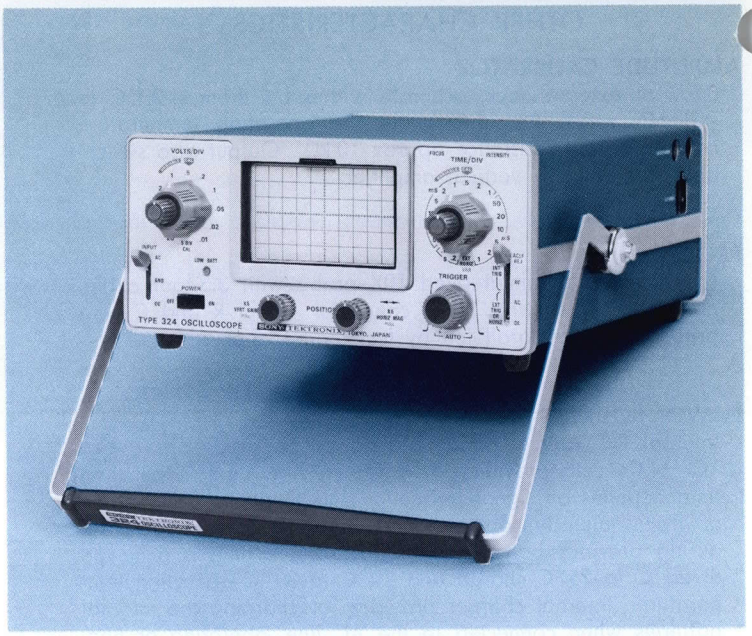
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

324 SONY/TEKTRONIX

10-MHz Oscilloscope

- 2 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC, DC OR BATTERY POWERED
- COMPACT SIZE—WEIGHT ≈8 lb
- ALL SOLID STATE
- 8-MHz BANDWIDTH AT 2 mV/DIV
- DESIGNED FOR SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE



The Type 324 is an all solid-state, single-channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 324 features small size and light weight, together with low power consumption. Depth is 10 5/8 inches, width—8 1/2 inches, height—4 1/4 inches, weight—≈8 pounds. Power consumption is only 8.5 watts from an external DC source and 20 watts when powered from the AC line. Internal rechargeable batteries will provide up to 3 hours continuous operation. The portability/performance provided by the Type 324 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

CHARACTERISTIC SUMMARY

VERTICAL

Bandwidth—DC to 10 MHz.

Risetime— 36 ns.

Calibrated Deflection Factor— 10 mV/div to 20 V/div at full bandwidth, 2 mV/div at 8-MHz bandwidth.

Input R and C— 1 megohm paralleled by approx 47 pF.

HORIZONTAL

Calibrated Time Base— 1 μs/div to 0.2 s/div.

X5 Magnifier—Extends time base to 0.2 μs/div.

External Input— 70 mV/div to 4.5 V/div, continuously variable, DC to 200 kHz.

CRT

Display Area— 6 x 10 divisions (1/4 inch/division).

Phosphor—P31.

OTHER

Amplitude Calibrator—Internal, 0.5 V at external jack.

Power Sources—Internal batteries; external DC supply of 6.5 to 16 V, 8.5 W; 115 V ± 10% or 230 V ± 10%, 48 Hz to 440 Hz, 20 W at 126 VAC.

SONY TEKTRONIX 324

10-MHz Oscilloscope

NEW

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 8 MHz at 3-dB down using X5 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime— 36 ns or less; 45 ns or less using X5 gain.

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 2 mV/div to 4 V/div using X5 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage—500 V (DC + peak AC).

Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

HORIZONTAL DEFLECTION

Time Base—1 μs/div to 0.2 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.1 s/div; accurate within 4% at 1 μs/div, 2 μs/div and 0.2 s/div. Uncalibrated, continuously variable between steps and to approx 0.5 s/div.

X5 Magnifier—Operates over full time base, increases fastest sweep rate to 0.2 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 1 μs/div to 20 ms/div, within 5% at 0.2 μs/div, 0.4 μs/div, and 40 ms/div.

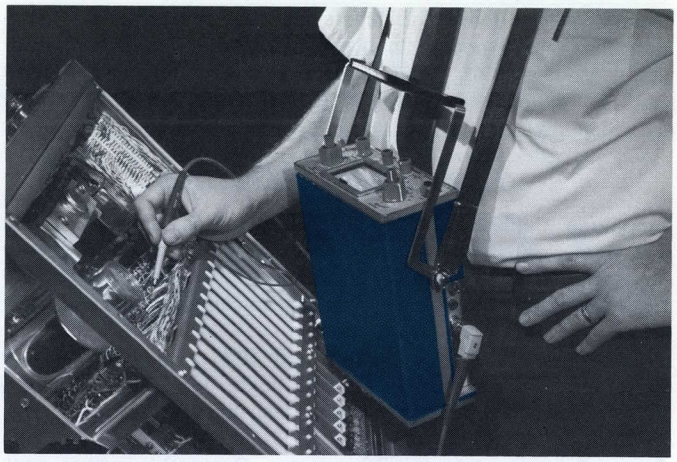
External Input—Continuously variable from approx 70 mV/div to approx 4.5 V/div, AC or DC coupled. DC to at least 200 kHz at 3-dB down.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements— 0.3-div deflection or 100 mV external to 1.5 MHz, increasing to 1-div deflection or 300 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 15 kHz with AC LF REJ coupling.



EASY TO USE—Small size of the Type 324 makes it easy to carry around the neck or support in the lap.

CRT

CRT— 6 x 10-div display area; each div is 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4 inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: −0°C to +40°C.

Altitude—Operating: 15,000 feet maximum. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated with CRT mesh filter (378-0596-00) installed. Installation of the CRT mesh filter diminishes the usefulness of the internal non-illuminated graticule.

Humidity—Non-operating: Meets electrical performance specifications after exposure to five cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The P6049 is a miniaturized 10X probe with 3.5 foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 6 size "C" NiCd cells providing 1 to 3 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 6.5 V to 16 V, requires up to 8.5 W.

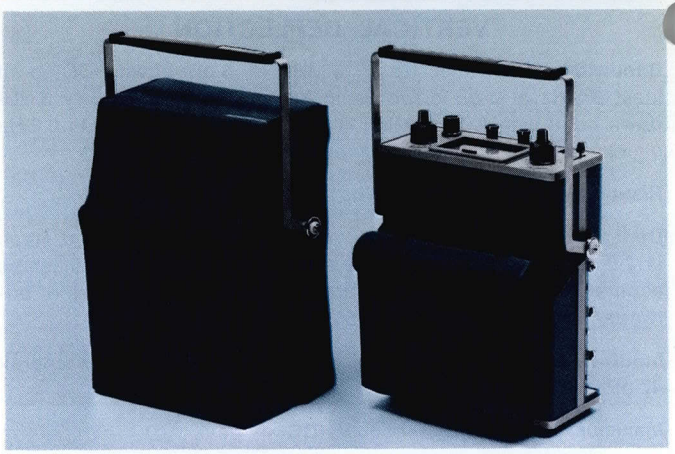
External AC source: Operates from an external AC source of 115 V ±10%, or 230 V ±10%. 48 to 440 Hz, 20 W maximum at 126 VAC.

Dimensions and Weights—

Height	4 1/4 in	10.8 cm
Width with handle	8 1/2 in	21.6 cm
Width with AC power cord	9 1/4 in	23.6 cm
Depth, handle not extended	10 5/8 in	27.0 cm
Depth, handle extended	12 3/4 in	32.3 cm
Net weight without accessories	≈ 8 lb	≈ 3.6 kg
Domestic shipping weight	≈14 lb	≈ 6 kg
Export-packed weight	≈22 lb	≈10 kg

Included Standard Accessories—P6049 10X probe (010-0223-00); patch cord (012-0089-00); accessory pouch (016-0113-00); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00); instruction manual (070-1032-00).

TYPE 324 OSCILLOSCOPE, including power pack **$1225**

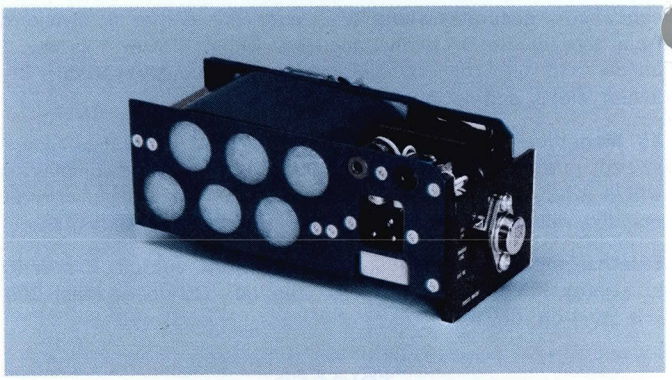


Optional protective cover (left) slips over the Type 324 and its included accessory pouch (right).

The SONY®/TEKTRONIX® Type 324 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the Type 324 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the Type 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $10



Power Pack—Extra power pack, in addition to the one supplied with the Type 324 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0160-02 ..... $98

Battery Set—Set of 6 NiCd cells, order 146-0012-01 .... $23

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

422

15-MHz Dual-Trace Oscilloscope

- ***1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***AC AND AC/DC VERSIONS***
- ***DUAL TRACE, FET INPUTS***
- ***ALL SOLID STATE***
- ***DESIGNED FOR SEVERE ENVIRONMENTS***
- ***UP TO 5 HOURS OPERATION FROM INTERNAL BATTERY PACK (AC/DC VERSION)***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***

The Type 422 is a portable dual-trace oscilloscope that combines small size and light weight with the ability to make precise waveform measurements. It weighs under 22 pounds and is ruggedly constructed to withstand shock, vibration, and other extremes of environment. Solid-state design, using FET input circuitry, provides minimum drift and fast stabilization time. No longer need measurements be compromised due to adverse field conditions; the Type 422 brings the precision of the laboratory to the field.

Two models are available. One operates on AC; the other on AC or DC, with an optional battery pack providing up to 5 hours operating time for completely portable operation. The AC model is also available as Type R422, arranged in a rack-mount panel assembly with a hinged-door compartment for storing accessories. The hinged door can be removed to allow the installation of a second Type 422 for applications that require two instruments. The entire assembly is mounted to the rack with slide-out tracks.

VERTICAL DEFLECTION
(2 Identical Channels)

BANDWIDTH

DC to 15 MHz at 3-dB down (each channel); 5 Hz to 5 MHz at 3-dB down, on X10 gain (channel 2). Low-frequency 3-dB-down point is <2 Hz with AC coupling (each channel), <0.2 Hz with included 10X probe.

RISETIME

24 ns each channel; 70 ns at X10 gain (channel 2).

DEFLECTION FACTOR

10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence (each channel). Deflection factor extended to 1 mV/div in X10 position (channel 2). All steps accurate within 3%; 7.5% on X10 GAIN (channel 2). Uncalibrated, continuously variable between steps and to approx 50 V/div. Warning light indicates uncalibrated setting.

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

BANDWIDTH—DC to 15 MHz.

RISETIME—24 ns.

CALIBRATED DEFLECTION FACTOR—10 mV/div to 20 V/div.

INPUT R and C—1 megohm paralleled by 33 pF.

HORIZONTAL

CALIBRATED TIME BASE—0.5 μs/div to 0.5 s/div.

X10 MAGNIFIER—Extends fastest time-base to 0.05 μs/div.

EXTERNAL INPUT—1 V/div to 100 V/div, DC to 500 kHz.

CRT

DISPLAY AREA—8 x 10 divisions (0.8 cm/div).

ACCELERATING VOLTAGE—6 kV.

PHOSPHOR—P31.

OTHER

AMPLITUDE CALIBRATOR—0.2 V peak to peak, internally; 2 V peak to peak, front-panel jack; 1-kHz squarewave (approx).

POWER OPTIONS—

AC Model: 90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz, approx 34 W. AC/DC Model: AC mode—92 to 137 VAC or 184 to 274 VAC. 48 to 440 Hz, maximum 25 W. DC mode—11.5 to 33 VDC, maximum 23 W. Also accepts 24-V battery pack.

DISPLAY MODES
Channel 1 only; Channel 2 only; Channels 1 and 2 added algebraically; dual-trace chopped; dual-trace alternate. In chopped operation, successive segments of each channel are displayed at an approx 150-kHz rate. Channel 2 has polarity inversion.

INPUT R and C
1 megohm ±2% paralleled by approx 33 pF.

MAXIMUM INPUT VOLTAGE
300 V (DC plus peak AC), AC not to exceed 300 V P-P at 1 kHz or less.

DELAY LINE
Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

TIME BASE
0.5 μs/div to 0.5 s/div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 div. Uncalibrated, continuously variable between steps and to approx 1.25 s/div. Warning light indicates uncalibrated vernier settings.

X10 MAGNIFIER
Operates over full time base, increases fastest rate to 50 ns/div. Accuracy of magnified time base is within 5% over center 8 div.

EXTERNAL INPUT
Variable between approx 1 V/div to 100 V/div. DC to ≥500 kHz at 3-dB down. Input R 300 kΩ ±10% paralleled by approx 35 pF.

OTHER
Gate output (on front panel) is a negative-going rectangular pulse with same duration as time base; approx 0.5-V; approx 620-ohm output resistance.

TRIGGER

MODES
Automatic or Normal. Automatic operation useful between 20 Hz and 15 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates.

COUPLING
DC; AC; AC LOW FREQ REJECT.

SOURCES
Internal: Channels 1 and 2, Channel 1 only;
External: Input RC is 100 kΩ ±3% paralleled by approx 33 pF. Positive or Negative slope. Trigger level range at least +10 V to −10 V. Maximum input voltage 250 V (DC plus peak AC).

REQUIREMENTS
DC: 0.2-div deflection or 125 mV ext up to 5 MHz, increasing to 1 div or 0.6 V at 15 MHz.
AC: Same as DC above 50 Hz.
AC LOW FREQ REJECT: Same as DC above 50 kHz.

ENVIRONMENTAL FEATURES

AC MODEL

Ambient Temp:	Operating: −15°C to +55°C. Storage: −55°C to +75°C.
Altitude:	Operating: 15,000 ft. maximum. Storage: 50,000 ft. maximum.
Humidity:	Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.9.5.1, Class 4).
Vibration:	Operating: 15 minutes along each of 3 axes at 0.025 inch peak to peak displacement (4 g's at 55 c/s), 10-55-10 c/s in 1-minute cycles.
Shock:	Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.
EMI:	Meets interference requirements of MIL-I-6181D, Power line conducted: 150 kHz—25 MHz. Radiated (with optional CRT mesh filter installed): 150 kHz—1000 MHz.

AC/DC MODEL, with batteries
Same as AC MODEL, with these exceptions:

Temperature:	Charging: 0°C to +40°C. Storage: −40°C to +60°C.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR
1-kHz squarewave, negative-going. Provides 0.2 V, internally, ±1.5% (+20°C to +30°C), and 2 V, ±0.5% (+20°C to +30°C), at Probe Cal jack on front panel.

POWER OPTIONS
AC Model: 90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz, 34 watts at 115 VAC.

AC/DC Model: AC mode: 92 to 137 VAC or 184 to 274 VAC, 48 to 440 Hz, 25 W maximum. DC mode: 11.5 to 33 VDC, 23 W maximum. 24-V battery pack (part number 016-0066-02) provides up to 5-hours continuous operation.

TEKTRONIX CRT
Rectangular, 4-inch, with 0.8-cm divisions; 8 x 10-div display area. Illuminated internal graticule. 6-kV accelerating potential. External blanking, DC-coupled +2 V and greater will completely blank trace. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DIMENSIONS AND WEIGHTS (Type R422)

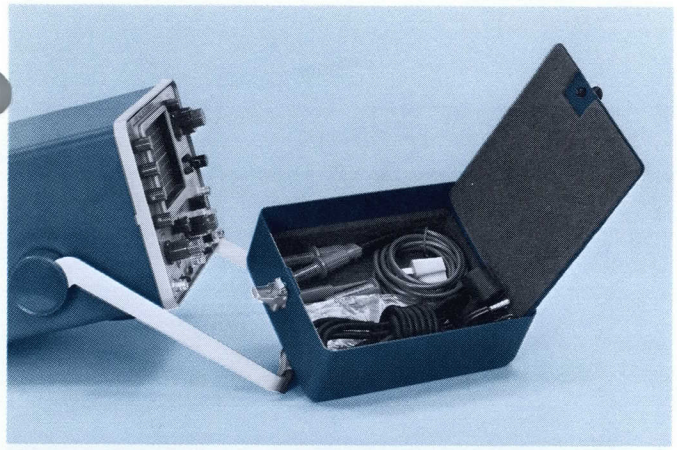
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth behind front panel	12½ in	31.8 cm
Net weight	23¼ lb	10.6 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈73 lb	≈33.2 kg

422
15-MHz Dual-Trace Oscilloscope

DIMENSIONS AND WEIGHTS (Type 422)

Height	$6^{15}/_{16}$ in	17.7 cm
Width	$9^{3}/_{8}$ in	23.8 cm
Depth (including panel cover)		
AC Model	$15^{3}/_{4}$ in	40.0 cm
AC/DC Model	$18^{9}/_{16}$ in	47.2 cm
Depth (with extended handle)		
AC Model	$17^{13}/_{16}$ in	45.4 cm
AC/DC Model	$20^{5}/_{8}$ in	52.4 cm
Weight (with front cover and accessories)		
AC Model	$21^{1}/_{4}$ lb	9.7 kg
AC/DC Model without batteries	23 lb	10.5 kg
AC/DC Model with batteries	30 lb	13.7 kg
Domestic shipping weight		
AC Model	≈30 lb	≈13.6 kg
AC/DC Model without batteries	≈32 lb	≈14.6 kg
Export-packed weight		
AC Model	≈44 lb	≈20.0 kg
AC/DC Model without batteries	≈46 lb	≈20.9 kg

TYPE 422 AC POWERED PORTABLE



Panel cover provides storage for standard accessories.

INCLUDED STANDARD ACCESSORIES

Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00), both installed; clear, CRT protector plate (386-0118-00); AC power supply (016-0072-00); power cord, 117 V, 3-conductor right-angle, female with straight male plug (161-0024-03); instruction manual (070-0894-00).

TYPE 422 OSCILLOSCOPE **$1500**

CONVERSION KITS

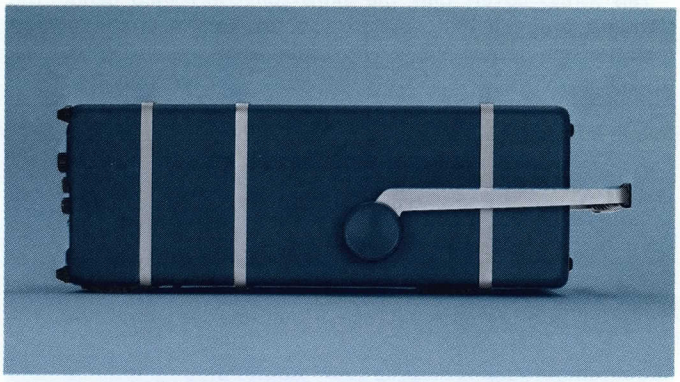
PORTABLE TO RACKMOUNT CONVERSION KIT

This mounting kit includes hardware and instructions to convert existing Type 422 Oscilloscopes (AC version) for rackmount installation. Order 040-0419-00 ..... $95

RACKMOUNT TO PORTABLE CONVERSION KIT

This kit includes the cabinet and necessary hardware to convert existing Type R422 Oscilloscopes for portable operation. Order 040-0421-00 ..... $66

TYPE 422 AC/DC POWERED PORTABLE
MOD 125B



422 MOD 125B *(Shown with protective cover in place)*

INCLUDED STANDARD ACCESSORIES

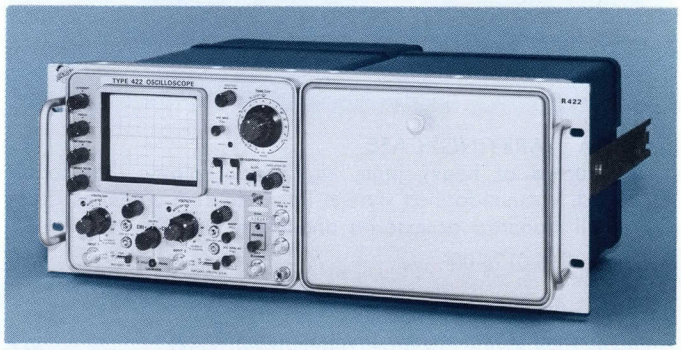
Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00), both installed; clear, CRT protector plate (386-0118-00); AC/DC power supply (016-0073-00); 3-wire AC with female connector and male plug power cord (161-0015-01); 3-wire DC with female connector power cord (161-0016-01); instruction manual (070-0895-00).

TYPE 422 MOD 125B OSCILLOSCOPE, without Battery Pack **$1850**

BATTERY PACK FOR TYPE 422 MOD 125B

Order 016-0066-02 ..... $140

TYPE R422 AC POWERED RACKMOUNTS



Type R422 Oscilloscope (mounted on left side) includes accessories listed for Type 422 above plus slide-out assembly (351-0100-00); and mounting hardware.

TYPE R422 OSCILLOSCOPE **$1575**

OSCILLOSCOPES SIDE BY SIDE, MOD 150B

Two Type 422's mounted in a rackmount panel include two sets of accessories listed for Type 422 above plus slide-out assembly (351-0100-00); and mounting hardware.

TYPE R422 MOD 150B OSCILLOSCOPE **$3050**

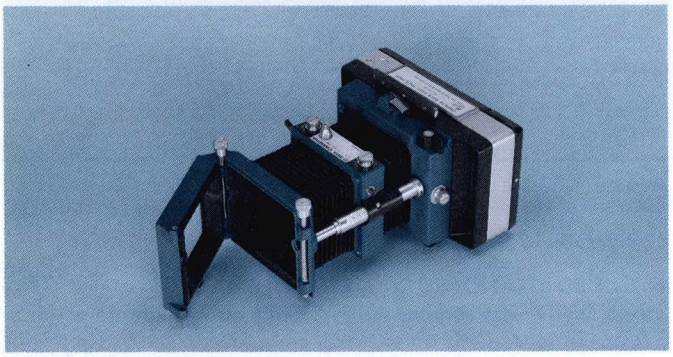
OSCILLOSCOPE WITHOUT CABINET, MOD 146B

Type 422 Oscilloscope without cabinet for rackmount conversion includes accessories listed for Type 422.

TYPE 422 MOD 146B OSCILLOSCOPE **$1475**

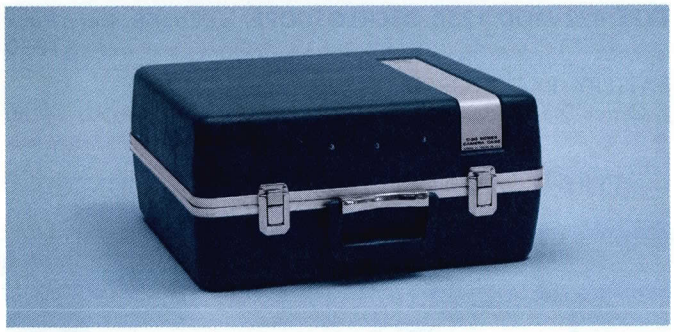
OPTIONAL ACCESSORIES

This listing covers only the more commonly used items. The standard probes (10X) supplied with the instrument satisfy most measurement requirements. In addition to the listed optional probes, other probes are available for current and high-voltage measurements. A complete list of accessory items can be found in the catalog accessory pages.



C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480



CAMERA CARRYING CASE

Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30 Series Camera, all standard accessories and extra film.

Order 016-0126-00 ..... $38

PROBES

P6007 100X Probe Package, order 010-0150-00 ..... $29

P6011 1X Miniature Probe Package, order 010-0193-00 .. $21

OSCILLOSCOPE COVER

Provides protection for Type 422 during transport or storage.

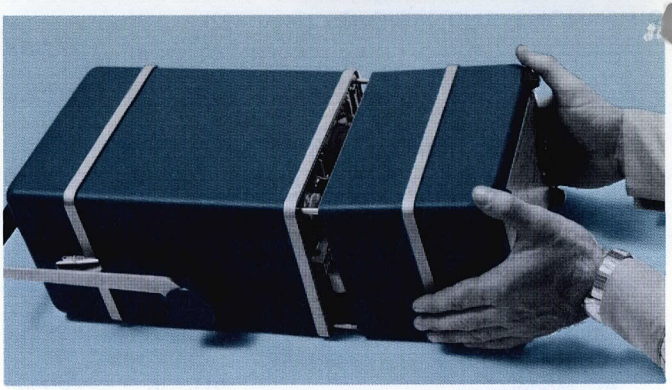
Type 422 (with battery pack) COVER, 016-0075-00 .... $10

Type 422 (without battery pack) COVER, 016-0076-00 .. $10

MESH FILTER

Improves display contrast for high ambient light conditions, and also serves as an EMI filter, order 378-0648-00 .... $15

*Registered Trademark Polaroid Corporation



AC/DC POWER SUPPLY WITHOUT BATTERY PACK

Converts Type 422 Portable Oscilloscope for DC or (with battery pack) battery operation.

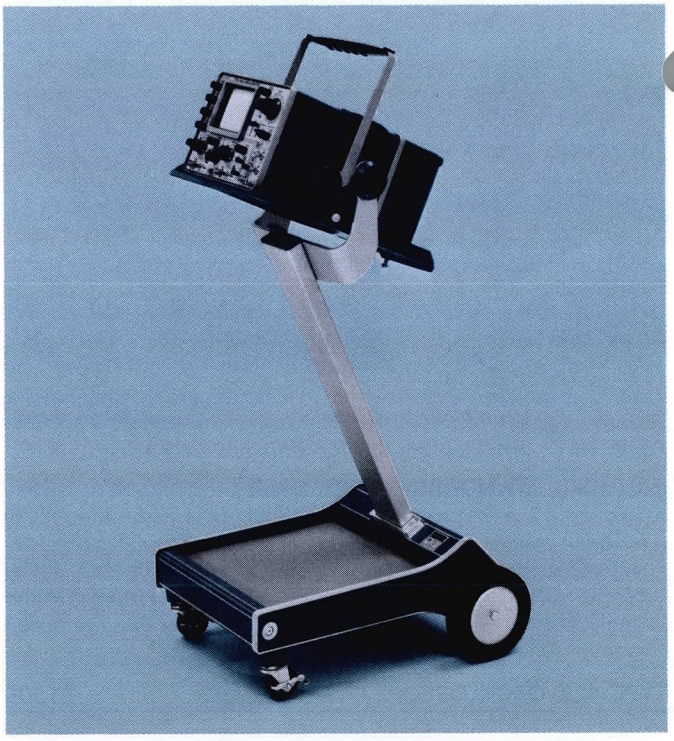
Domestic shipping weight 10¼ lbs.

Includes: power cord, 3-wire AC w/female connector and male plug (161-0015-01); power cord, 3-wire DC w/female connector (161-0016-01); instruction manual (070-0895-00).

Order 016-0073-00 ..... $660

FOLDING VIEWING HOOD

Permits viewing of trace under high ambient-light conditions, order 016-0082-00 ..... $9



SCOPE-MOBILE® CART

Type 200-2 occupies less than 18-inches aisle space, has storage space in base $95

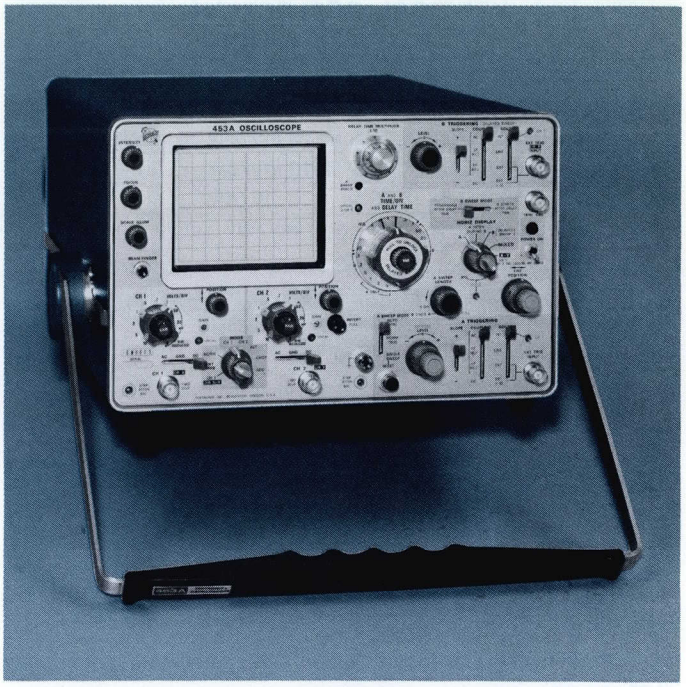
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

453A

60-MHz Dual-Trace Oscilloscope

NEW

- 5 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS
- 60-MHz BANDWIDTH at 20 mV/DIV
- 8 x 10 DIV CRT
- BRIGHT, HIGH RESOLUTION DISPLAYS
- CALIBRATED MIXED SWEEP
- CALIBRATED SWEEP DELAY
- FULL BANDWIDTH TRIGGERING
- 5 mV/DIV X-Y DISPLAYS
- ALL SOLID STATE
- DESIGNED FOR SEVERE ENVIRONMENTS



Increased bandwidth, larger, brighter displays, calibrated mixed sweep, color-coded front panel, and easy-to-use X-Y capabilities are some of the features of the 453A, the new version of the world's most widely used oscilloscope.

The CRT in the new 453A provides 33% more viewing area and the accelerating potential is 40% higher (14 kV).

Most laboratory measurements are solved by high gain dual-trace oscilloscopes. With the larger CRT and increased light output the 453A meets or exceeds the requirements of the vast majority of laboratory measurements. Many field problems involve measuring low frequency signals in high ambient light. The increased light output of the 453A makes it particularly suited for these applications. Other field and laboratory measurements involve resolving pulses with nanosecond periods, a problem which the 453A's larger CRT lets the user solve easily and quickly.

The rugged, field proven design of the 453 is retained in the 453A. So is laboratory accuracy, and ease of maintenance. The 453A is a complete measurement package, including new, smaller 10X probes, with space for all accessories inside the protective front panel cover. Complete weight is 30 pounds.

The electrically identical rack version, the R453A, requires only 7 inches or rack height. The portable and rack versions are also available for television applications, and to meet EMI requirements of MIL-I-6181D.

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 60 MHz (5.8 ns) from 20 mV/div to 10 V/div, DC to 50 MHz (7 ns) at 10 mV/div, DC to 40 MHz (8.75 ns) at 5 mV/div.

Calibrated Deflection Factor— 20 mV/div to 10 V/div at full bandwidth, 5 mV/div and 10 mV/div at reduced bandwidth.

Input R and C— 1 megohm paralleled by approx 20 pF.

HORIZONTAL

Calibrated Time Base— 0.1 μs/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div.

Calibrated X-Y Operation— 5 mV/div to 10 V/div in 11 steps.

Delay Range— 0.2 μs to 50 s.

External Input— 270 mV/div or 2.7 V/div dual trace, 5 mV/div to 10 V/div single trace.

CRT

Display Area— 8 x 10 divisions (0.8 cm/div)

Accelerating Voltage— 14 kV

Phosphor—P31

OTHER

Amplitude and Time Calibrator— 1 V or 0.1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 92 W at 115 VAC.

NEW

453A

60-MHz Dual-Trace Oscilloscope

VERTICAL DEFLECTION
(2 identical channels)

Bandwidth* and Risetime from 50-Ω terminated source, with† or without P6054 Probe‡
DC to at least 60 MHz, 5.8 ns at 20 mV/div to 10 V/div
DC to at least 50 MHz, 7.0 ns at 10 mV/div
DC to at least 40 MHz, 8.75 ns at 5 mV/div
DC to at least 25 MHz, 14 ns at 1 mV/div single trace, cascaded

*Measured at —3 dB down. Lower —3 dB point, AC coupled, is 1.6 Hz or less (0.16 Hz or less with included 10X probe).

†Stated deflection factors are without 10X probe.

‡With included 3 1/2-foot or optional 6-foot probe. The 9-foot version provides 57 MHz maximum bandwidth.

Deflection Factor— 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 25 V/div. Warning lights indicate uncalibrated settings.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 500-kHz rate); Added.

Input R and C— 1 megohm within 2% paralleled by approx 20 pF.

Maximum Input Voltage— 600 V (DC + peak AC), AC component to 1 kHz.

Signal Output—Channel 1 vertical signal is DC to at least 25 MHz, 14 ns, terminated in 50 Ω. At least 25 mV/div into 1 megohm.

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base A— 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 12.5 s/div. Warning light indicates uncalibrated setting. Sweep length continuously variable from 4 div or less to at least 10 div.

Time Base B— 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A & B Sweep Accuracy (center 8 div)

SWEEP RATE	0°C to +40°C	—15°C to +55°C
0.1 μs/div to 50 ms/div	± 3%	±4%
0.1 s/div to 5 s/div	± 3%	±5%

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div. Magnified display accurate within 1% in addition to specified time base sweep accuracy.

Horizontal Display Modes—A only, A intensified during B, B (delayed sweep), Mixed Sweep, and X-Y (Channel 1 drives X axis).

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal); Normal Trigger; Single Sweep. Light indicates when sweep is triggered.

Time Base B Sweep Modes—B Triggerable after delay time; B starts after delay time.

Calibrated Mixed Sweep—Displays A sweep for period determined by delay-time multiplier control, then displays B sweep for remainder of horizontal sweep. Mixed sweep displays are accurate within 2% plus specified A sweep accuracy for the A portion of the display; B portion of the display accuracy is the same as for Time Base B.

CALIBRATED SWEEP DELAY

Delay Range— 0.2 μs to 50 s after delaying sweep start.

Delay Accuracy (center 8 div)

DELAY TIME SETTING	0°C to +40°C	—15°C to +55°C
1 μs to 50 ms	Within 1.5%	Within 2.0%
0.1 s to 5 s	Within 2.5%	Within 3.5%
MULTIPLIER LINEARITY	Within 0.2% of full scale (2 minor dial divisions)	Within 0.3% of full scale (3 minor dial divisions)
DIFFERENTIAL TIME MEASUREMENT		
1 μs to 50 ms	Within 1.5% and 4 minor dial divisions	
0.1 s to 5 s	Within 2.5% and 4 minor dial divisions	

Jitter— 1 part or less in 20,000 of 10X the time/div setting.

TRIGGER

Modes—Automatic or Normal on Time Base A. Automatic operation useful between 20 Hz and 60 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates. Normal triggering only on Time Base B.

Time Base A & B Trigger Sensitivity

TRIGGER MODE	TO 10 MHz	AT 60 MHz
DC INTERNAL EXTERNAL	0.3 div deflection 50 mV	1.5 div deflection 200 mV
AC	Requirements increase below 30 Hz	
AC LF REJECT	Requirements increase below 30 kHz	
AC HF REJECT	Requirements increase below 30 Hz and above 50 kHz	

Sources—Internal, Line, External, External ÷ 10. Input R and C approx 1 megohm paralleled by approx 20 pF (except in AC LF Reject mode). 600 volts maximum input (DC + peak AC). Level adjustment through at least ±2 volts in External, through at least ±20 volts in External ÷ 10.

Jitter— 1 ns or less at 60 MHz and 10 ns/div.

X-Y OPERATION

Full-Sensitivity X-Y (CH 1 Horiz, CH 2 Vert)— 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 5% from 0°C to +40°C, within 8% from —15°C to +55°C; no variable on Ch 1. Bandwidth is DC to at least 5 MHz (—3 dB). Phase difference between amplifiers is 3° or less at 50 kHz at 20 mV/div.

453A
60-MHz Dual-Trace Oscilloscope

NEW

Horizontal Amplifier (External Input)—Approx 270 mV/div in External, approx 2.7 V/div in External ÷ 10. 600 V maximum input voltage (DC + peak AC), AC component to 1 kHz. Same bandwidth and phase difference as previously described.

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating: −15°C to +55°C. Storage: −55°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axis, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (453A Mod 163D and R453A Mod 163D only)—Meets interference requirements of MIL-1-6181D, power line conducted: 150 kHz to 25 MHz, radiated (with included mesh filter installed): 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

CRT

Tektronix CRT— 4-inch rectangular tube; 8 x 10 div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied. 14-kV accelerating potential. Z-axis input DC coupled to CRT cathode; noticeable modulation at normal intensity with 5-V or more peak-to-peak signal; DC to 50 MHz usable frequency range.

Graticule—Internal, no parallax; variable edge lighting.

Beam Finder—Compresses trace within graticule area for ease in determining the location or relative magnitude of an off-screen signal, regardless of settings of vertical and horizontal position controls.

OTHER CHARACTERISTICS

Amplitude and Time Calibrator— 1 V, 0.1 V and 5 mA at external jacks; accurate within 1% from 0°C to +40°C, and within 1.5% from −15°C to +55°C. 1-kHz repetition rate accurate within 0.5% from 0°C to +40°C, and within 1% from −15°C to +55°C.

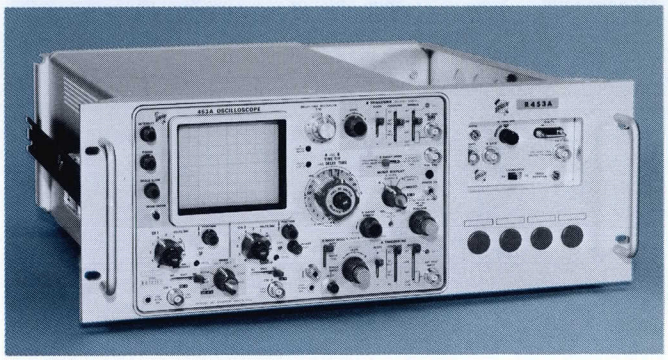
Signal Outputs—Positive gates from both time bases (approx 12 V).

Power Requirements—Quick-change line voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. 48 to 62 Hz, 92 watts maximum at 115 V and 60 Hz.

Cooling—Filtered, forced-air ventilation.

453A Dimensions and Weights

Height	7-1/8 in	18.2 cm
Width	12-1/2 in	30.8 cm
Depth (incl. panel cover)	20-1/2 in	52.0 cm
Depth (handle extended)	22-3/8 in	56.8 cm
Net weight (w/o panel cover)	29-1/4 lb	12.7 kg
Net weight (with panel cover and accessories)	31-1/4 lb	13.6 kg
Domestic shipping weight	≈43 lb	≈18.7 kg
Export-packed weight	≈57 lb	≈24.8 kg



R453A Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth (behind front panel)	18 in	45.7 cm
Net weight	33-1/2 lb	14.5 kg
Domestic shipping weight	≈65 lb	≈28.2 kg
Export-packed weight	≈86 lb	≈37.4 kg

Included Standard Accessories—Two P6054 Probes with accessories (010-6054-01); 50-Ω 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed; instruction manual (070-1089-00); operator's manual (070-1105-00); five fuses, assorted spares. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

453A OSCILLOSCOPE **$2050**

R453A OSCILLOSCOPE **$2135**

CONVERSION KIT

Portable to Rackmount—Includes hardware and instructions to convert the 453A Portable Oscilloscope for rackmount installation.

Order 040-0446-01 ..... $110

453A AND R453A MOD 163D

Includes the features of the standard 453A and R453A and in addition meets electromagnetic interference requirements of MIL-1-6181D; Power line conducted: 150 kHz to 25 MHz; Radiated (with included mesh filter installed): 150 kHz to 1 GHz.

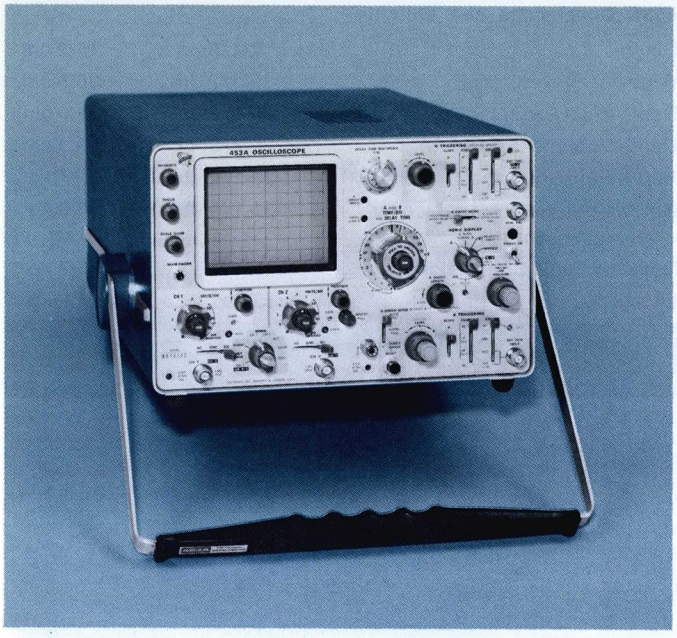
453A MOD 163D OSCILLOSCOPE **$2150**

R453A MOD 163D OSCILLOSCOPE **$2235**

NEW

453A MOD 127C

Television Oscilloscope



- ***DC-to-60 MHz BANDWIDTH***
- ***5 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***DUAL TRACE***
- ***COMPACT, LIGHT WEIGHT***
- ***CALIBRATED DELAYED SWEEP***

An internal TV Sync Separator circuit permits stable internal Line or Field-rate triggering from displayed composite video or composite sync waveforms. External ÷ 10 trigger sources are replaced by internal TV Sync positions providing Line (Horizontal) sync pulses to the B Sweep circuit and either Field (Vertical) or Line sync pulses to the A Sweep circuit.

Individual line selection of VIT (vertical interval test) signals is facilitated by the delayed sweep features in the 453A. The wide range of delayed sweeps permits accurate alternate-frame color-burst observations in the PAL color system.

Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. Other characteristics are the same as 453A and R453A. A parallax-free, 8 x 10 div, illuminated graticule is standard. Two additional snap-in TV graticules are supplied but may not be illuminated.

INCLUDED STANDARD ACCESSORIES

Same as 453A except as follows: delete two P6054 3.5-ft, 10X probe packages (010-6054-01); add two P6054 6-ft probe packages (010-6054-03); two 6-32 adapters (103-0051-01); snap-in light filter/TV graticule (NTSC) (378-0664-01); snap-in light filter/TV graticule (CCIR) (378-0664-02); 453A MOD 127C instruction manual insert.

453A MOD 127C **$2135**

R453A MOD 127C **$2220**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probes supplied with the 453A satisfy most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages.

C-31-R High Speed Camera—f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film,
order C-31-R $585

C-30A Compact Camera—f/1.9 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $480

Probes—
P6048 10X Probe Package, order 010-0215-00 ..... $61
P6045 1X FET Probe Package, order 010-0204-00 ..... $325

Scope-Mobile® Cart— 200-1 is compact for easy maneuvering $95

Mesh Filter—Improved display contrast and EMI filtering is obtained with this filter, which is easily inserted in place of the ornamental ring. One is supplied with MOD 163D.
Order 378-0648-00 ..... $15

Protective Cover—The protective cover for the 453A or 454A can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0074-01 ..... $10

*Registered Trademark Polaroid Corporation

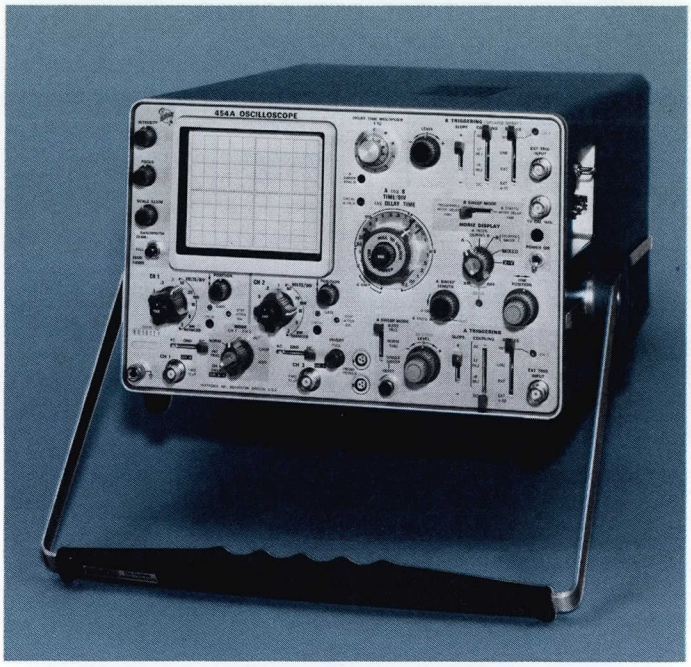
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

454A

150-MHz Dual-Trace Oscilloscope

NEW

- 2 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS
- 150-MHz BANDWIDTH at 10 mV/DIV
- 2 ns/DIV SWEEP RATE
- 8 x 10 DIV CRT
- BRIGHT, HIGH RESOLUTION DISPLAYS
- CALIBRATED MIXED SWEEP
- CALIBRATED SWEEP DELAY
- FULL BANDWIDTH TRIGGERING
- 2 mV/DIV X-Y DISPLAYS
- ALL SOLID STATE
- DESIGNED FOR SEVERE ENVIRONMENTS



The 454A offers convenient measurement of fast-rise pulses and high-frequency signals to at least 150 MHz. Risetime is 2.4 ns with or without probe.

Many laboratory and field measurements involve resolving pulses with nanosecond periods. With sweep rates to 2 ns/div, deflection factors to 2 mV/div and a 33% larger CRT, the user solves these problems quickly and easily. The time-base system has calibrated sweep delay and calibrated mixed sweep permitting highly-magnified displays of small portions of undelayed sweeps, accurate measurement of waveform time jitter and precise time measurements.

Two vertical channels provide sensitivities to 2 mV/div, cascaded single-trace displays at ≈400 μV/div and wide bandwidth X-Y displays to 2 mV/div. The dual-trace vertical system displays either channel separately, adds channels algebraically, alternates between channels, or chops between channels at a 1-MHz rate. A new 33% larger CRT complements the 2 mV/div deflection factor and 2 ns sweep rate.

The Type 454A is mechanically designed to withstand environmental extremes and rough handling in transit. Plug-in transistors provide ease of maintenance.

The R454A (the rackmount model) is electrically identical to the 454A, but is mechanically designed to mount on tilting slide-out tracks in a standard 19-inch rack.

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 150 MHz (2.4 ns) from 10 mV/div to 5 V/div, DC to 100 MHz (3.5 ns) at 5 mV/div, DC to 50 MHz (7.0 ns) at 2 mV/div.

Calibrated Deflection Factor— 10 mV/div to 5 V/div at full bandwidth, 2 mV/div and 5 mV/div at reduced bandwidth.

Input R and C— 1 megohm paralleled by approx 15 pF.

HORIZONTAL

Calibrated Time Base— 20 ns/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 2 ns/div.

Delay Range— 10 ns to 50 s.

Calibrated X-Y Operation— 2 mV/div to 5 V/div in 11 steps, DC to 2 MHz.

CRT

Display Area— 8 x 10 division (0.8 cm/div)

Accelerating Voltage— 14 kV

Phosphor—P31

OTHER

Amplitude and Time Calibrator— 1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 116 W at 115 VAC.

454A

150-MHz Dual-Trace Oscilloscope

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Risetime from 50 Ω terminated source, 0°C to +40°C.

With or without P6054 10X Probe**	With P6045 FET Probe	With P6048 10X Probe	Deflection Factor***
150 MHz, 2.4 ns	130 MHz, 2.7 ns	100 MHz, 3.5 ns	10 mV/div to 5 V/div
100 MHz, 3.5 ns	95 MHz, 3.7 ns	75 MHz, 4.7 ns	5 mV/div
50 MHz, 7.0 ns	45 MHz, 7.8 ns	45 MHz, 7.8 ns	2 mV/div
33 MHz, 11 ns	30 MHz, 12 ns	30 MHz, 12 ns	≈400 μV/div single trace, cascaded

*Measured at —3 dB down. Lower —3 dB point, AC coupled, is 10 Hz or less (1 Hz or less with included 10X probe). Bandwidth can be limited to approx 20 MHz.

**With included 3 1/2-foot or optional 6-foot probe. The 9-foot version provides 116-MHz maximum bandwidth.

***Stated deflection factors are without 10X probe.

Deflection factor— 2 mV/div to 5 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Warning lights indicate uncalibrated settings.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 1-MHz rate); Added.

Input R and C— 1 megohm within 2% paralleled by approx 15 pF.

Maximum Input Voltage— 500 V (DC + peak AC), AC component to 1 kHz.

Signal Output—Channel 1 vertical signal is DC to at least 50 MHz, terminated in 50 Ω, at least 10 mV/div into 1 megohm.

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

Probe Power—Connectors provide correct voltages for two optional P6045 FET Probes.

HORIZONTAL DEFLECTION

Time Base A— 20 ns/div to 5 s/div in 26 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 12.5 s/div. Warning light indicates uncalibrated setting. Sweep length continuously variable from 4 div or less to at least 10 div.

Time Base B— 20 ns/div to 0.5 s/div in 23 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A & B Sweep Accuracy (center 8 div)

SWEEP RATE	0°C to +40°C	—15°C to +55°C
20 ns/div to 0.5 s/div	±3%	±4%
1 s/div to 5 s/div	±3%	±5%

X10 Magnifier—Operates over full time base, increases fastest rate to 2 ns/div. Magnified display accurate within 1% in addition to specified time base sweep accuracy, except within 2% at —15°C to +55°C at the 5 fastest sweep rates.

Horizontal Display Modes—A only, A intensified during B; B (delayed sweep), Mixed Sweep, and X-Y (Channel 1 drives X axis).

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal); Normal Trigger; Single Sweep. Light indicates when sweep is triggered.

Time Base B Sweep Modes—B Triggerable after delay time; B starts after delay time.

Calibrated Mixed Sweep—Displays A sweep for period determined by delay-time multiplier control, then displays B sweep for remainder of horizontal sweep. Mixed sweep displays are accurate within 2% plus specified A sweep accuracy for the A portion of the display; B portion of the display accuracy is the same as for Time Base B.

CALIBRATED SWEEP DELAY

Delay Range— 0.01 μs to 50 s after delaying sweep start.

Delay Accuracy (center 8 div)

Delay Time Setting	0°C to +40°C	—15°C to +55°C
0.1 μs to 50 ms	within 1.5%	within 2.0%
0.1 s to 5 s	within 2.5%	within 3.5%
Multiplier Linearity	within 0.2% of full scale (2 minor dial divisions).	
Differential Time Measurement		
0.1 μs to 50 ms	within 1.5% and 4 minor dial divisions.	
0.1 s to 5 s	within 2.5% and 4 minor dial divisions.	

Jitter— 1 part or less in 20,000 of 10X the time/div setting.

TRIGGER

Modes—Automatic or Normal on Time Base A. Automatic operation useful between 20 Hz and 150 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates. Normal triggering only on Time Base B.

Time Base A & B Trigger Sensitivity

Trigger Mode	To 20 MHz	At 150 MHz
DC Internal External	0.3 div deflection 75 mV	1.5 div deflection 375 mV
AC	Requirements increase below 60 Hz	
AC LF Reject	Requirements increase below 50 kHz	
AC HF Reject	Requirements increase below 60 Hz and above 50 kHz	

Sources—Internal, Line, External, External ÷ 10. Input R and C approx 1 megohm paralleled by approx 15 pF. 500 volts maximum input (DC + peak AC). Level adjustment through at least ± 2 volts in External, through at least ± 20 volts in External ÷ 10.

Jitter— 0.4 ns or less at 150 MHz and 2 ns/div.

X-Y OPERATION

Full-Sensitivity X-Y (CH 1 Horiz, CH 2 Vert)— 2 mV/div to 5 V/div in 11 calibrated steps (1-2-5 sequence), accurate within 3%; no variable on CH 1. Bandwidth is DC to at least 2 MHz (—3 dB). Phase difference between amplifiers is 3° or less throughout bandwidth at 20 mV/div.

454A

150-MHz Dual-Trace Oscilloscope

NEW

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating: −15°C to +55°C. Storage: −55°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axis, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (454A Mod 163D and R454A Mod 163D only)—Meets interference requirements of MIL-1-6181D, power line conducted: 150 kHz to 25 MHz, radiated (with included mesh filter installed): 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

PHOTOGRAPHIC WRITING SPEED
(without Film Fogging Techniques)

Camera and Phosphor				Minimum Photographic Writing Speed
Camera Lens	Object-to-image ratio	Polaroid* film type	CRT Phosphor	
C-31-R f/1.2	1:0.5	410 (10,000 ASA)	P31	1600 div/μs (1280 cm/μs)
			P11	3200 div/μs (2560 cm/μs)
C-30A f/1.9	1:0.7	107 (3,000 ASA)	P31	182 div/μs (146 cm/μs)

CRT

Tektronix CRT— 4-inch rectangular tube; 8 x 10 div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P11 optional without extra charge. 14-kV accelerating potential. Z-axis input DC coupled to CRT cathode; noticeable modulation at normal intensity with 5-V or more peak-to-peak signal; DC to 50 MHz usable frequency range.

Graticule—Internal, no parallax; variable edge lighting.

Beam Finder—Compresses trace within graticule area for ease in determining the location or relative magnitude of an off-screen signal, regardless of settings of vertical and horizontal position controls.

OTHER CHARACTERISTICS

Amplitude and Time Calibrator— 1 V and 5 mA at external jacks; accurate within 1% from 0°C to +40°C, and within 1.5% from −15°C to +55°C. 1-kHz repetition rate accurate within 0.5% from 0°C to +40°C, and within 1% from −15°C to +55°C.

Signal Outputs—Positive gates from both time bases (approx 12.6 V) and a positive-going sawtooth from Time Base A (approx 10 V).

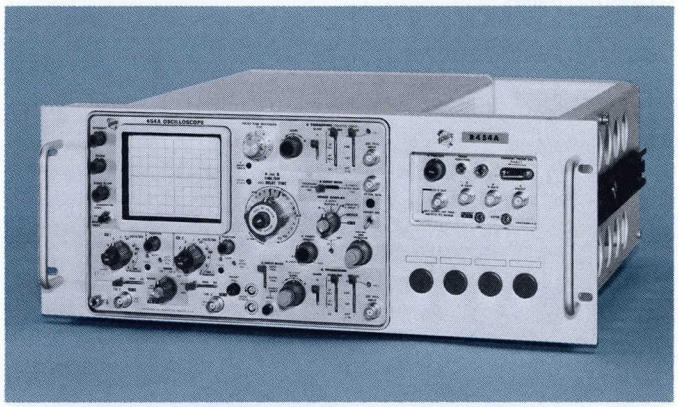
*Registered Trademark Polaroid Corporation

Power Requirements—Quick-change line voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. 48 to 62 Hz, 116 watts maximum at 115 and 60 Hz.

Cooling—Filtered, forced-air ventilation.

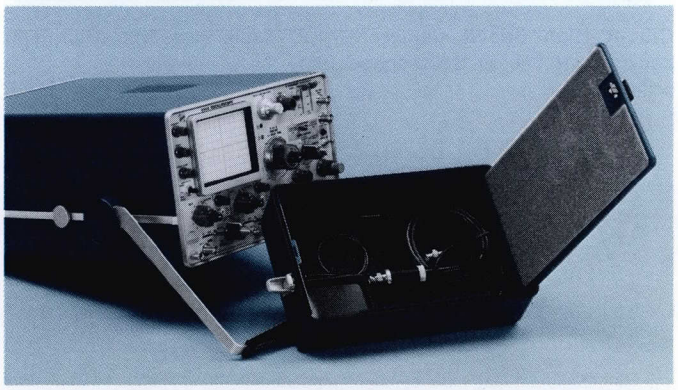
454A Dimensions and Weights

Height	7-1/8 in	18.2 cm
Width	12-1/2 in	30.8 cm
Depth (incl. panel cover)	20-1/2 in	52.0 cm
Depth (handle extended)	22-3/8 in	56.8 cm
Net weight (w/o panel cover)	29-1/4 lb	12.7 kg
Net weight (with panel cover and accessories)	31-1/4 lb	13.6 kg
Domestic shipping weight	≈43 lb	≈18.7 kg
Export-packed weight	≈57 lb	≈24.8 kg



R454A Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth (behind front panel)	18 in	45.7 cm
Net weight	33-1/2 lb	14.5 kg
Domestic shipping weight	≈65 lb	≈28.2 kg
Export-packed weight	≈86 lb	≈37.4 kg



Included Standard Accessories—Two P6054 Probes with accessories (010-6054-01); 50-Ω 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed; instruction manual (070-1074-00); operator's manual (070-1106-00); four fuses, assorted spares. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

454A OSCILLOSCOPE **$3050**

R454A OSCILLOSCOPE **$3135**

454A

150-MHz Dual-Trace Oscilloscope

454A AND R454A MOD 163D

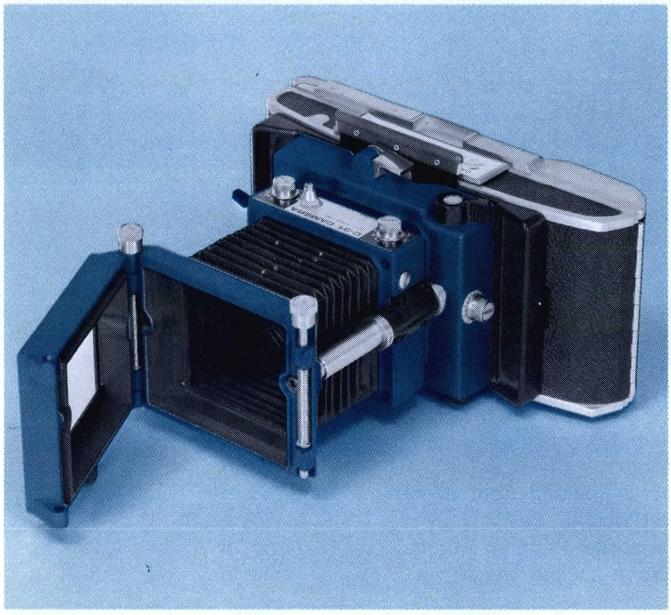
Includes the features of the standard 454A and R454A and in addition meets electromagnetic interference requirements of MIL-1-6181D; Power line conducted: 150 kHz to 25 MHz; Radiated (with included mesh filter installed): 150 kHz to 1 GHz.

454A MOD 163D OSCILLOSCOPE **$3150**

R454A MOD 163D OSCILLOSCOPE **$3235**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probes supplied with the 454A satisfy most measurement requirements; optional probes, including high-voltage and current-measuring probes, may be better suited for particular applications. See catalog accessory pages.



C-31-R High Speed Camera—f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film,
order C-31-R $585

C-30A Compact Camera—f/1.9 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land Pack-Film back for 3000-speed film, order C-30A-P $480

Probes—
P6048 10X Probe Package, order 010-0215-00 ..... $61
P6045 1X FET Probe Package, order 010-0204-00 ..... $325

Scope-Mobile® Cart— 200-1 is compact for easy maneuvering $95

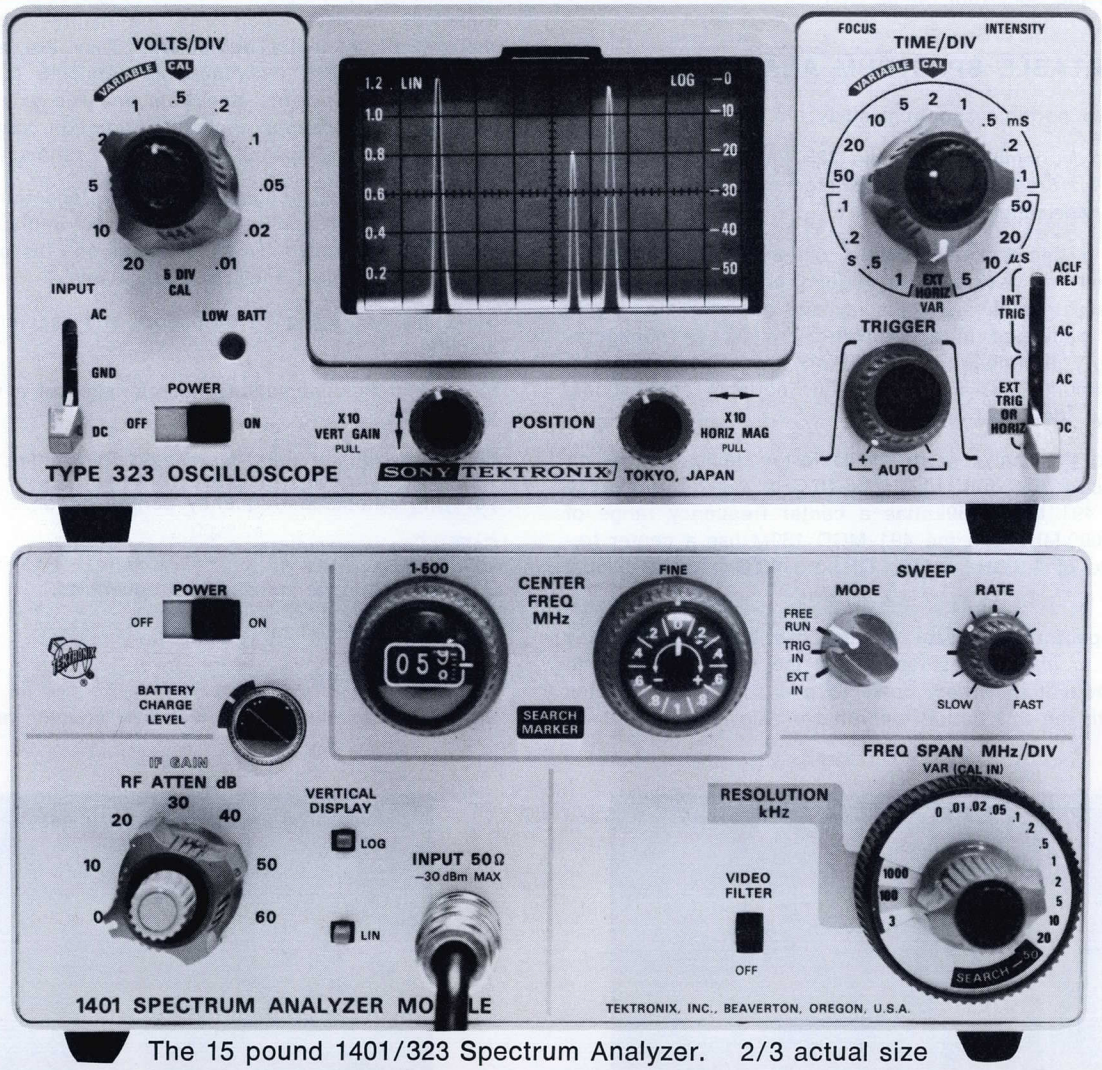
Conversion Kit, Portable to Rackmount—Includes hardware and instructions to convert the 454A Portable Oscilloscope for rackmount installation.
Order 040-0446-01 ..... $110

Mesh Filter—Improved display contrast and EMI filtering is obtained with this filter, which is easily inserted in place of the ornamental ring. One is supplied with MOD 163D.
Order 378-0648-00 ..... $15

Protective Cover—The protective cover for the 453A or 454A can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0074-01 ..... $10

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

INSTRUMENT	PAGE	CHARACTERISTICS			
		CENTER FREQUENCY	FREQUENCY SPAN (DISPERSION)	RESOLUTION	INCIDENTAL FM
1L5 3L5	208	50 Hz to 1 MHz	10 Hz to 100 kHz/div (100 Hz to 1 MHz full scale).	≤10 Hz to ≥500 Hz	≤3 Hz from 50 to 9900 Hz ≤10 kHz from 9.9 to 990 kHz
1L20	210	10 MHz to 4.2 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale—CF ≥275 MHz).	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock
1L40	210	1.5 GHz to 40 GHz			
491	202	10 MHz to 40 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale—CF ≥275 MHz).	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock
491 MOD 139L	202	10 MHz to 2.0 GHz			
491 MOD 139M	202	1.5 GHz to 40 GHz			
1401	206	1 MHz to 500 MHz	10 kHz/div to 50 MHz/div (100 kHz to 500 MHz full scale).	3 kHz, 100 kHz, 1 MHz	≤20 kHz at 1 MHz, ≤10 kHz at 500 MHz center frequency



The 15 pound 1401/323 Spectrum Analyzer. 2/3 actual size

Spectrum analysis can be defined as the study of the energy distribution of an electrical signal as a function of the frequencies within that signal. The information gained through spectrum analysis is frequently unobtainable by any other means. As a result, Spectrum Analyzers have developed into measurement tools which accurately provide information in an increasingly wide range of applications. Today, engineers and technicians are putting the spectrum analyzer into use in production, maintenance, in the laboratory, and in the field.

Spectrum analyzers may be grouped into two general categories:

1. Real Time—A spectrum analyzer that performs an analysis of the incoming signal simultaneously with the time of the event.

2. Non-Real Time—A spectrum analyzer that performs an analysis of a repetitive event by a sampling process.

Tektronix analyzers are non-real time instruments using swept intermediate frequency or swept front end techniques. A swept front end spectrum analyzer is a heterodyning device in which the first local oscillator is swept. A swept intermediate frequency spectrum analyzer is a heterodyning device in which a local oscillator other than the first is swept.

PLUG-IN SPECTRUM ANALYZERS

Users of Tektronix oscilloscopes can achieve high-quality spectrum analysis at a cost less than that of other analyzers. In addition to cost, convenience is another significant advantage which oscilloscopes with plug-in analyzers offer over ordinary spectrum analyzers. The oscilloscope's calibrated time base and versatile triggering allow direct measurement of pulse repetition rate and provide stable displays even in the presence of interference. The oscilloscope powers the analyzer and displays the spectrum on its CRT.

PORTABLE SPECTRUM ANALYZERS

There are two portable spectrum analyzers available:

The 1401 which combines with the 323 Portable Oscilloscope to make up a 15-pound, battery-operated system and the 491, a 38-pound, wide-range system.

The 491 is a compact, lightweight, self-contained, wideband spectrum analyzer designed for rugged environmental conditions and easy mobility. The display and analyzer circuitry is conveniently packaged in an easy-to-carry (38 lb) configuration. For very broadband analysis (up to 40 GHz), constant usage, rackmounting (7-inch height), or portable applications, the 491 is an ideal instrument.

Two modified 491 analyzers are available for applications which do not require the full 10 MHz-to-40 GHz center frequency range. The 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz and the 491 MOD 139M has a center frequency range of 1.5 GHz to 12.4 GHz (to 40 GHz with optional accessories).

The 1401 Spectrum Analyzer Module can be used with any oscilloscope to make measurements in the range of 1 MHz to 500 MHz. Since it is battery powered and small . . . it mates very well with the 323 battery operated oscilloscope to make a complete voltage-versus-time oscilloscope, as well as a spectrum analysis system, unexcelled in portability.

Tektronix Spectrum Analyzers select a portion of the electromagnetic spectrum—as wide as 500 MHz, for example—and display on the CRT all the signal activity by frequency that is occurring. Within the portion of the spectrum displayed, any signal, amplitude or frequency modulated, pulsed carrier, etc., is plotted as a series of "pips" on the CRT. Calibrated frequency span (dispersion) permits detailed study of the signal, with frequency difference read directly from the CRT.

The usefulness of Tektronix Spectrum Analyzers extends into many measurement areas. They are used by government agencies to check the sidebands of radio-transmitting devices. Telephone companies find transmission-line carrier measurements quick and accurate, often providing data not obtainable by other means. Spectrum Analyzers are finding increased use in missile projects and the exploration of outer space, especially in association with the maintenance and troubleshooting of telemetry equipment. They are indispensable to recently developed techniques of servicing radar, microwave, and CATV equipment. Spectrum analysis extends into lower-frequency applications including vibration studies, design of audio equipment, speech therapy, and others.

There are many recognized uses for spectrum analyzers. A complete list of applications would be impractical; therefore, the following limited list is intended only as an illustration of some of the typical analyzer applications:

Detecting squegging of oscillators and regeneration in power amplifiers.

Measuring the modulation characteristics of a video-modulated transmitter.

Troubleshooting a pulse-modulated transmitter.

Verifying automatic frequency control action.

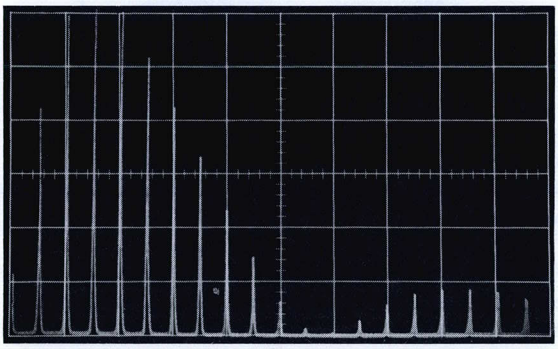
Calibrating wavemeters.

Detecting spurious transmitter frequencies.

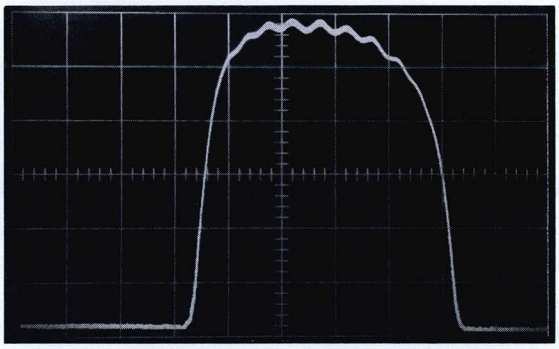
Adjusting balanced modulators.

Tuning oscillators.

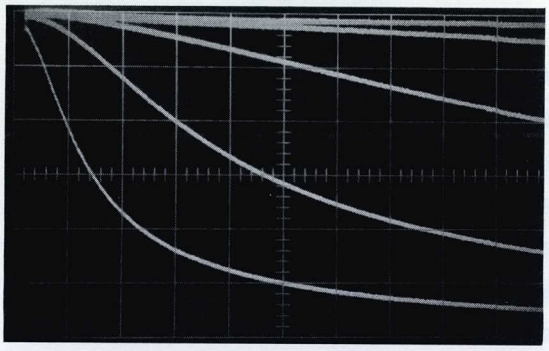
Spectrum surveillance in electronic counter measures.



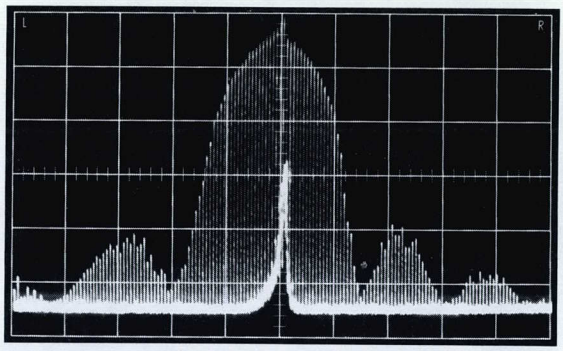
The spectrum of a pulse with 1 μs period and 90 ns duration displayed using a 1L20 Plug-In Spectrum Analyzer. The Frequency Span is from 0 MHz to 20 MHz.



A plot of the response of a 455 kHz filter made using a 1L5 Spectrum Analyzer and a Tektronix Swept Frequency Converter. Center Frequency is 450 kHz. Frequency Span is 10 kHz/div. Display is Log.



A plot of the responses of a variable-band pass amplifier with the 1L5 and Tektronix Swept Frequency Converter. Center Frequency is 50 Hz. Frequency Span is 10 kHz/div. Mode is Linear.



200-MHz pulsed RF displayed with a 1L20. Repetition-Rate lines are evident at 5 ms/cm (Note: CW Feedthrough).

GLOSSARY

In the description of spectrum analyzers many specialized technical terms are used. Many people are unfamiliar with the meaning of these terms, thus creating a communication problem. The problem is compounded by the different terms used by different manufacturers to describe the similar functions or concepts. The IEEE has established a committee whose purpose is to develop a unified set of terms and definitions. However, the task of this group is not yet finished. This glossary includes the terms and definitions presently used by Tektronix, Inc.

Center Frequency (radio frequency or intermediate frequency)—That frequency which corresponds to the center of the reference coordinate.

Center Frequency Range (radio frequency)—That range of frequency that can be displayed at the center of the reference coordinate. When referred to a control (e.g., Intermediate Frequency Center Frequency Range), the term indicates the amount of frequency change available with the control.

Deflection Factor—The ratio of the input signal amplitude to the resultant displacement of the indicating spot.

Dispersion—See Frequency Span.

Drift (frequency drift) (stability)—Long-term frequency changes or instabilities caused by frequency changes in the spectrum-analyzer local oscillators.

Display Flatness—Uniformity of amplitude response over the rated maximum dispersion (usually in dB).

Dynamic Range (on screen)—The maximum ratio of signal amplitude that can be simultaneously observed within the graticule (usually in dB).

Frequency Band—A range of frequencies that can be covered without switching.

Frequency Span—The frequency sweep excursion over the frequency axis of the display. Can be expressed as frequency/full frequency axis or frequency/div in a linear display.

Incidental Frequency Modulation (residual frequency modulation)—Short-term frequency jitter or undesired frequency deviation caused by instabilities in the spectrum-analyzer local oscillators. Incidental frequency modulation limits the usable resolution and dispersion.

Linearity (dispersion linearity)—A measure of the comparison of frequency across the frequency span to a straight-line frequency change.

Maximum Input Power—The upper level of input power that the spectrum analyzer can accommodate without degradation in performance (e.g., spurious responses and signal compression) (usually in units of dBm).

Minimum Usable Dispersion—The narrowest dispersion obtainable for meaningful analysis. Defined as ten times the incidental frequency modulation when limited by "incidental frequency modulation".

Resolution Bandwidth—Resolution is the ability of a spectrum analyzer to discretely display adjacent signals within a frequency span. It is measured, in frequency, as the separation or span between two discrete signals of equal amplitude when the notch or dip between them is 3 dB down. It is a function of analyzer bandwidth, sweep speed, frequency span, and incidental FM.

Resolution bandwidth depends on the most selective amplifier (usually the last IF) stage in the signal path. It is a measure of the bandwidth at approximately the −6 dB amplitude level (of an amplifier with Gaussian response) when the frequency span and sweep time are adjusted for minimum display bandwidth to a CW signal. Theoretically, resolution and resolution bandwidth become synonymous at very long sweep times.

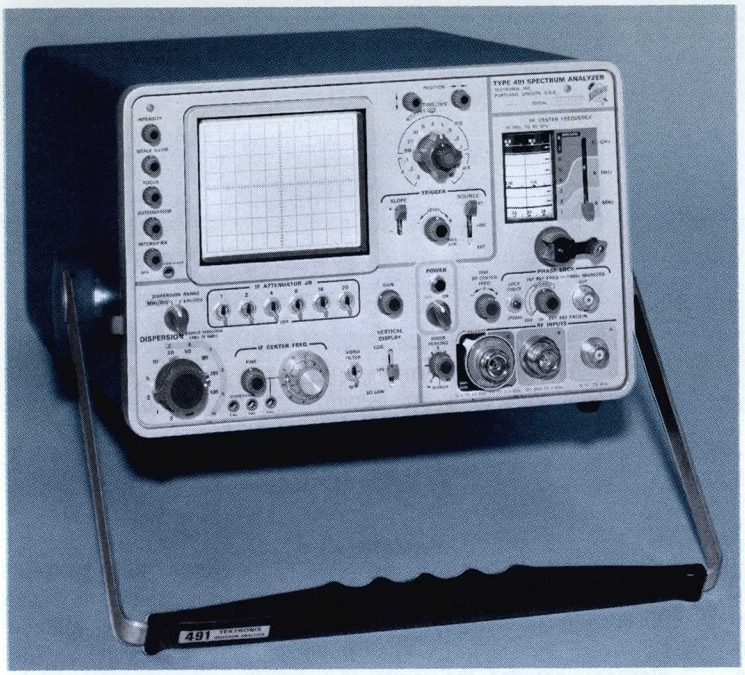
Sensitivity (CW)—Rating factor of spectrum analyzers ability to display weak signals.

1. Signal equals noise. That input signal level (usually in dBm) which results in a display where the signal level above the residual noise is equal to the residual noise level above the baseline; expressed as: signal + noise = twice the noise.
2. Minimum discernible signal. That input signal level (usually in dBm) which results in a display where the signal is just distinguishable from the noise.

Spurious Response—A characteristic of a spectrum analyzer wherein displays appear which do not conform to the calibration of the radio frequency dial.

491

10 MHz-to-40 GHz Spectrum Analyzer



- ***COMPACT, LIGHT WEIGHT***
- ***INTERNAL PHASE LOCK***
- ***CALIBRATED DISPERSION TO 100 MHz***
- ***COUPLED RESOLUTION***
- ***WIDE-RANGE TIME BASE***
- ***LOW POWER CONSUMPTION***
- ***ENVIRONMENTALIZED***
- ***ALL SOLID-STATE***

The Type 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is an easy-to-carry package weighing less than 40 pounds complete with accessories. The Type R491 is electrically identical, requires only 7 inches of rack height.

Operation is simple. Resolution and calibrated dispersion controls are coupled, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Since dispersion is calibrated, frequency differences can be read directly from the CRT. Internal phase lock provides stable displays even at 1 kHz/div dispersion.

Two modified instruments are available for applications which do not require the full center frequency range (10 MHz to 40 GHz) of the Type 491. These are the 491 MOD 139L (10 MHz to 2000 MHz) and the 491 MOD 139M (1.5 GHz to 40 GHz). Specifications for the MOD 139L and MOD 139M are the same as for the 491 except where noted.

Each instrument is completely self-contained, has oscilloscope-type time base and trigger circuits, 8 x 10-div CRT with P7 phosphor and internal graticule. They operate over a wide range of AC voltages, require only 55 W, maximum.

BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY*	
		1-kHz RESOLUTION	100-kHz RESOLUTION
1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
3	800 MHz to 2000 MHz	≥ —105 dBm	≥ —85 dBm
4	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
5	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
6	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
7	12.4 GHz to 18.0 GHz	≥ —90 dBm	≥ —70 dBm
8	18.0 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz ≥ —70 dBm to 40 GHz	≥ —60 dBm ≥ —50 dBm

*Signal + noise = 2 X noise

Bands 1-8 are covered in the Type 491.
Bands 1-3 only are available in 491 MOD 139L.
Bands 4-8 only are available in 491 MOD 139M, bands 4-6 directly, bands 7-8 using optional accessories.

CHARACTERISTICS

DIAL ACCURACY

± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION

1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div —MHz/div). Accuracy throughout full range of RF-center frequency control, within ±3% except at 2 MHz/div (±5%) and 1 MHz/div (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

COUPLED RESOLUTION

1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

10 MHz-to-40 GHz Spectrum Analyzer

DISPLAY FLATNESS
Maximum amplitude variation over 100-MHz dispersions up to 12.4 GHz is 3-dB or less, except over 50-MHz dispersion in Band 1. Above 12.4 GHz the maximum amplitude variation (100-MHz dispersion) is 6-dB or less.

INCIDENTAL FM
Less than 300 Hz at fundamental, with Phase Lock.

FREQUENCY STABILITY
kHz/div dispersion range—±10 kHz throughout line voltage range after 1 minute; ±5 kHz/°C. MHz/div dispersion range—±200 kHz throughout line voltage range after 1 minute; ±20 kHz/°C.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω for coaxial inputs.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz adjustment of center frequency from 5 MHz/div to 0.2 MHz/div dispersion positions, ±10-MHz adjustment at 10 MHz/div, ±2.5-MHz adjustment from 500 kHz/div to 1 kHz/div dispersion positions.

VERTICAL DISPLAY (8 DIVISIONS)
Log — ≥40-dB dynamic range.
Linear
Square Law — ≥13-dB dynamic range.

HORIZONTAL DEFLECTION

INTERNAL SAWTOOTH GENERATOR
10 μs/div to 0.5 s/div in 15 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to approx 1.25 s/div.

TRIGGER SOURCE
Internal, external, or line. 100-V maximum external input (DC + peak AC).

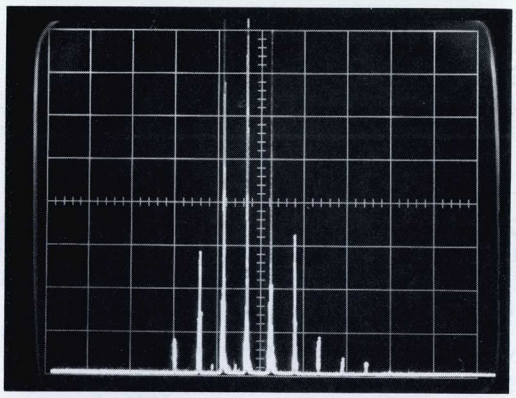
TRIGGER REQUIREMENTS
0.2-div deflection or 0.2-V external from 20 Hz to 100 kHz.

CRT AND DISPLAY FEATURES

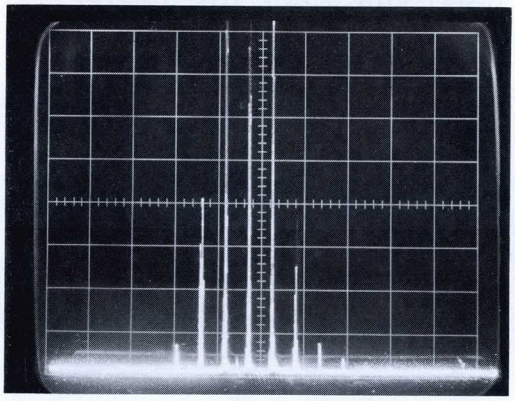
TEKTRONIX CRT
8 x 10-div display area (each div = 0.8 cm); P7 phosphor.

GRATICULE
Internal, no parallax, variable edge lighting.

DISPLAY FEATURES
Intensity, focus and astigmatism controls. Intensifier adjusts relative brightness of signal and baseline for convenient viewing and photography.



Quality of photographs is greatly enhanced when relative brightness of signal and baseline can be controlled, as in upper waveform. Lower waveform taken under same conditions shows normal results of slow sweep time/div settings. Improvement is even more pronounced in some applications. Waveforms photographed with C-30A Camera.



ENVIRONMENTAL CAPABILITIES

ELECTROMAGNETIC INTERFERENCE
Meets specifications of MIL-I-6181D over the following frequency ranges: Radiated (with included CRT mesh filter installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

TEMPERATURE
Operating: —15° C to +55° C.
Non-operating: —55° C to +75° C.

ALTITUDE
Operating: 15,000 feet.
Non-operating: 50,000 feet.

HUMIDITY
Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

VIBRATION
Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 1 shock per axis.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz; 55 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

REAR PANEL CONNECTORS

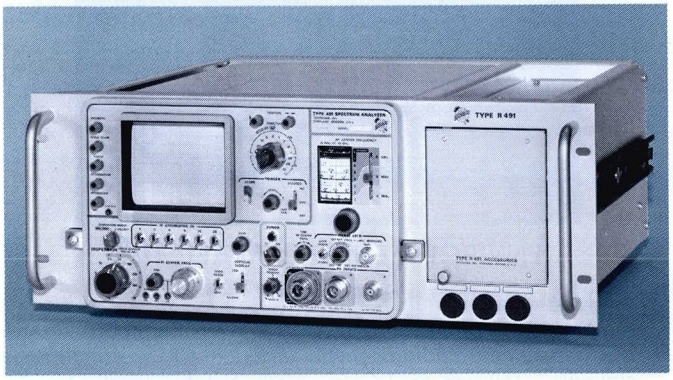
BNC connectors for external trigger input, sawtooth output (70 to 90 mV P to P) and recorder output ($\geq$4 mV/div of displayed signal in LIN mode, DC-coupled, approx 600-Ω source resistance).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$7\frac{3}{16}$ in	18.2 cm
Width	$12\frac{7}{16}$ in	31.6 cm
Depth (incl. panel cover)	$19\frac{11}{16}$ in	50.0 cm
Depth (with handle extended)	$21\frac{9}{16}$ in	54.7 cm
Net weight (w/o panel cover)	30 lb	13.6 kg
Weight (with panel cover and accessories)	38 lb	17.3 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈62 lb	≈28.2 kg

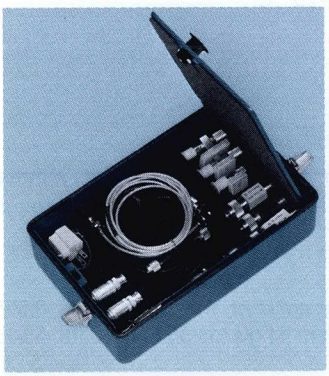
RACK MODEL DIMENSIONS AND WEIGHTS

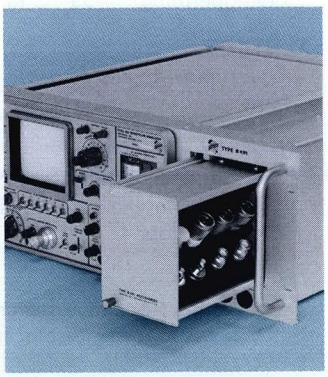
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	$17\frac{1}{2}$ in	44.4 cm
Net weight	41 lb	18.6 kg
Domestic shipping weight	≈72 lb	≈32.7 kg



RACKMOUNTING

Type R491 withdraws from rack on slide-out assembly, tilts for convenience. Further mounting information on catalog instrument dimension page.





ACCESSORY STORAGE

Included panel cover for Type 491 and drawer for Type R491 hold all standard accessories except manual and protective cover.

INCLUDED STANDARD ACCESSORIES

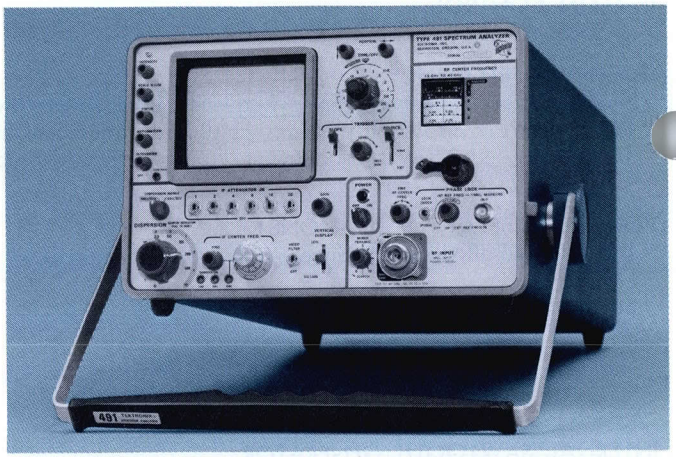
6 ft BNC cable, 50 Ω miniature coax (012-0113-00); 6 ft N cable, RG 223/U coax (012-0114-00); 2 ft TNC cable, RG 223/U coax (012-0115-00); wave guide mixer, 12.4 to 18 GHz (119-0097-00); wave guide mixer, 18 to 26.5 GHz (119-0098-00); wave guide mixer, 26.5 to 40 GHz (119-0099-00); 10-dB attenuator, Type N fittings (011-0085-00); 20-dB attenuator, Type N fittings (011-0086-00); 40-dB attenuator, Type N fittings (011-0087-00); two BNC male to N female adapters (103-0058-00); two BNC female to N male adapters (103-0045-00); wave guide mixer adapter (119-0104-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); clear CRT protector plate (386-0118-00); ornamental ring (354-0248-00); two one-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); instruction manual (070-0598-01). Type R491 includes all above accessories except the front cover and protective cover, also includes slide-out assembly and hardware.

TYPE 491 SPECTRUM ANALYZER **$4895**

TYPE R491 SPECTRUM ANALYZER **$4995**

TYPE 491 MOD 139L

10 MHz to 2000 MHz Spectrum Analyzer



The Type 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N) of the MOD 139L. The appearance is the same as that of the Type 491 with the following exceptions: the C-band input is removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139L ONLY)

6-ft BNC cable, 50-Ω miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and special instruction manual.

The R491 MOD 139L also includes slide-out assembly (35[illegible]0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

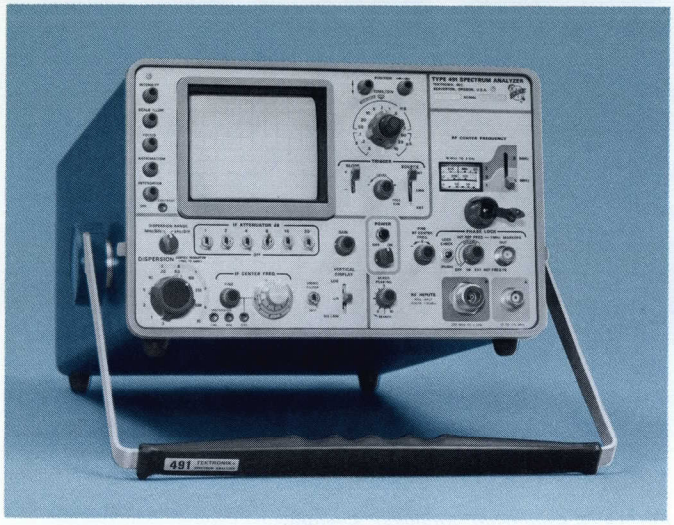
TYPE 491 MOD 139L **$3500**

TYPE R491 MOD 139L **$3600**

491
10 MHz-to-40 GHz Spectrum Analyzer

TYPE 491 MOD 139M

1.5 GHz to 12.4 GHz Spectrum Analyzer
(40 GHz with Optional Accessories)



The Type 491 MOD 139M has a center frequency range of 1.5 GHz to 40 GHz with optional accessories. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N). The appearance is the same as that of the Type 491 with the following exceptions: the A and B band inputs are removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139M ONLY)

6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and special instruction manual.

The R491 MOD 139M also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

TYPE 491 MOD 139M $3700
TYPE R491 MOD 139M $3800

OPTIONAL ACCESSORIES FOR THE 491 MOD 139M

NOTE: These accessories are required to extend the frequency range of the MOD 139M from 12.4 GHz to 40 GHz.

Cable, TNC, coaxial, 2 feet (012-0115-00) ..... $ 10.00
Waveguide mixer adapter (119-0104-00) ..... $ 44.00
Waveguide mixer 12.4-18.0 GHz (119-0097-00) ..... $ 77.00
Waveguide mixer 18.0-26.5 GHz (119-0098-00) ..... $ 88.00
Waveguide mixer 26.5-40.0 GHz (119-0099-00) $138.00

OPTIONAL ACCESSORIES FOR THE 491 MOD 139L AND 491 MOD 139M

BNC male to N female adapter (103-0058-00) ..... $ 2.75
BNC female to N male adapter (103-0045-00) ..... $ 2.40
10-dB attenuator, Type N fittings (011-0085-00) $45.00
20-dB attenuator, Type N fittings (011-0086-00) $45.00
40-dB attenuator, Type N fittings (011-0087-00) $55.00

CONVERSION KITS

PORTABLE TO RACK-MODEL

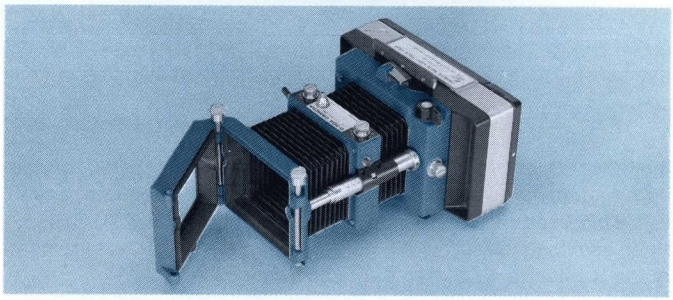
Kit includes hardware and instructions to convert Type 491 Analyzers for rack installations.
Order 040-0444-00 ..... $138

RACK MODEL TO PORTABLE

Kit includes cabinet, panel cover, oscilloscope cover, and instructions to convert Type R491 Analyzers for portable operation.
Order 040-0445-00 ..... $85

OPTIONAL ACCESSORIES

The following accessories are usable on the 491, 491 MOD 139L, 491 MOD 139M and their rackmount configurations. Cameras, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages.



C-30A COMPACT CAMERA

f/1.9 lens, magnification variable from 1:1.5 to 1:0.7, Polaroid Land* Pack-Film back, order C-30A-P $480

C-30A CAMERA CARRYING CASE

Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film.
Order 016-0126-00 ..... $ 38

FOLDING VIEWING HOOD

Permits viewing of trace under high ambient-light conditions.
Order 016-0082-00 ..... $9.00

SCOPE-MOBILE® CART

Model 200-1 friction lock holds Type 491 at 0° to 60° angle. Cart occupies <18 inches of aisle space, carries up and down stairs easily, has storage space in base. A more complete description with photographs is given in the General Accessories Section.
Order 200-1 ..... $95.00

FRONT COVER

Included as a part of Type 491, protects front panel and holds standard accessories. Available separately for use with Type R491, order 200-0633-03 ..... $22.00

BNC THRU-PANEL ADAPTER

Mounts in pre-punched holes in Type R491 panel, BNC connector on both sides, order 103-0070-00 ..... $3.00

BNC CABLE

Used in conjunction with above adapter, provides access to rear-panel connectors on Type R491. BNC-to-BNC 30-in cable, order 012-0117-00 ..... $6.90

*Registered Trademark, Polaroid Corporation

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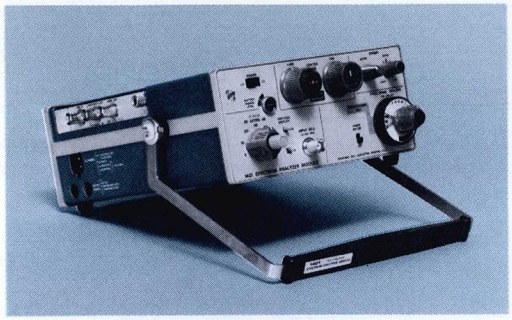
Please refer to General Information page

NEW

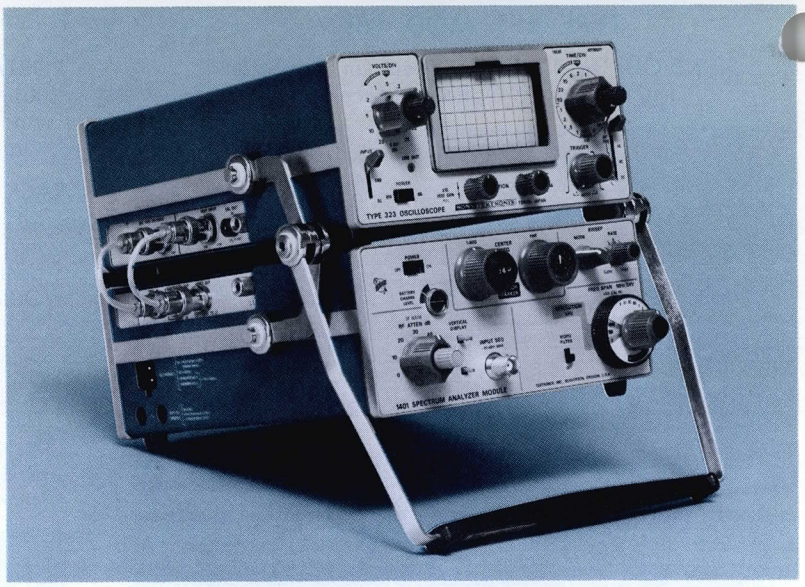
1401

1 MHz-to-500 MHz Spectrum Analyzer Module

- AC, DC or BATTERY POWERED
- EASY to CARRY, EASY to USE
- 1 MHz to 500 MHz in ONE DISPLAY
- UP TO 1-MHz RESOLUTION BANDWIDTH
- SWEPT FRONT END
- 60-dB LOG DYNAMIC RANGE
- DESIGNED FOR SEVERE ENVIRONMENTS



1401 Spectrum Analyzer Module



1401/323 Spectrum Analyzer System

The 1401 Spectrum Analyzer Module is an expansion of the plug-in concept of using an oscilloscope for spectrum analysis. This module, used with the Sony/Tektronix 323, 324, or other oscilloscope, provides complete facilities for measurement in the 1 MHz to 500 MHz frequency range.

It is compatible with any oscilloscope having 0.5 V/div horizontal deflection factor (adjustable ±10%) and 1.2 V full-screen vertical deflection. Compatible oscilloscopes include the Tektronix 453A, 454A and, with minor modification the 422.

Among its unique features is automatic center frequency positioning in the Search mode. At 50 MHz/div frequency span (Dispersion), the center frequency automatically becomes 250 MHz, preventing a possible erroneous display. In the Search mode, the center frequency control positions a negative marker to indicate that part of the spectrum which will appear at center screen when the frequency span is reduced to less than 50 MHz/div.

Design of the 1401/323 provides for easy carrying, multiple positions for convenient viewing and access. Power may be obtained from the normal AC line, 6 to 16 VDC, or internal rechargeable batteries.

ANALYZER CHARACTERISTICS

Center Frequency Range—1 MHz to 500 MHz, continuously variable with 10-turn digital readout control. Absolute accuracy within ± (5 MHz + 5% of dial reading). Fine control provides a calibrated variation of up to plus or minus 1 MHz, within 10%.

CW Sensitivity—At least −100 dBm at 3 kHz resolution, at least −85 dBm at 100 kHz resolution, at least −78 dBm at 1000 kHz resolution.

Frequency Span (dispersion)— 50 MHz/div to 10 kHz/div in 12 steps (1-2-5 sequence), accurate within 10% over a 10 div display, plus 0 Hz span. Frequency span is continuously variable, uncalibrated from the indicated span toward zero.

Resolution Bandwidth— 3, 100, and 1000 kHz.

Display Flatness—Amplitude variations are within 3 dB over entire frequency range.

Incidental FM—No more than 20 kHz at 1 MHz center frequency to 10 kHz or less at 500 MHz center frequency.

Intermodulation Distortion—At least −50 dB.

Frequency Stability—Within 50 kHz over any 5 minute interval after 20 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Input Power— +30 dBm maximum with RF attenuation, −30 dBm without RF attenuation.

RF Attenuator— 0 to 60 dB in 10 dB steps, accurate within ±(0.5 dB + 1% of dB reading).

IF Gain Control—At least 30-dB range.

Vertical Display—Linear and log.

Dynamic Range—At least 60-dB in Log Mode.

Video Output— 1.2 V for full-screen deflection.

SWEEP CHARACTERISTICS

Free Run—Sweep rate continuously variable between one sweep/second and 100 sweeps/second (approximate).

External Trigger—As above, but accepts an external positive pulse of 1 to 10 V, at least 100 ns width, 1 MHz or less.

External Horizontal—Input accepts signal of 0 to +5 V. 0 corresponds to approximately 0 frequency and +5 V corresponds to approximately 500 MHz in Search Mode. 10 V maximum input.

1401 1 MHz-to-500 MHz Spectrum Analyzer Module

NEW

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Non-operating: −55°C to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

OTHER CHARACTERISTICS

Power Sources—Battery operation: removable power pack contains 6 size "C" NiCd cells providing at least 3½ hours operation. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge position prevents battery self-discharge when not in use. Battery charge level is indicated on an expanded scale DC voltmeter. External DC source: operates from an external DC source of 6 V to 16 V, requires 4.8 W. External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 14 W maximum at 115 VAC.

Dimensions and Weights—

	1401		323		1401/323	
	in	cm	in	cm	in	cm
Height	3-1/2	8.9	3-1/2	8.9	7	17.8
Width w/handle	8-1/2	21.6	8-1/2	21.6	9-3/8	23.8
Depth w/panel cover	10-5/8	27.0	10-5/8	27.0	10-5/8	27.0
Depth w/handle	13	33.0	13	33.0	14-5/8	37.2
	lb	kg	lb	kg	lb	kg
Net weight w/o accessories	7-1/2	3.4	7	3.2	14-1/2	6.6
Domestic shipping weight	13	5.9	13	5.9	22	10.0
Export-packed weight	21	9.5	21	9.5	30	13.6

SPECTRUM ANALYZER SYSTEM

1401/323 Included Standard Accessories—Two 5½-inch BNC-to-BNC cables (012-0214-00); 6-ft BNC-to-BNC cable (012-0113-00); BNC-to-banana post patch cord (012-0089-00); two 8-ft power cords (161-0043-00); blue filter (378-0670-01); amber filter (378-0670-02); viewing hood (016-0247-01); two strap assemblies (346-0051-00); P6049 10X probe (010-0223-00); two panel covers (200-0812-00); accessory pouch (016-0113-00); screwdriver (003-0672-00); 1401 operator's hand book (070-1082-00); 1401 instruction manual (070-1071-00); 323 instruction manual (070-0750-00).

Order 1401/323 ..... **$2860**

1401/324 Included Standard Accessories—Same as above except instruction manual for 323 is replaced by 324 instruction manual (070-1032-00).

Order 1401/324 ..... **$3125**

SPECTRUM ANALYZER MODULE

1401 Included Standard Accessories—Two 5½-inch BNC-to-BNC cables (012-0214-00); 6-ft BNC-to-BNC cable (012-0113-00); 8-ft power cord (161-0043-00); blue filter (378-0670-01); amber filter (378-0670-02); strap assembly (346-0051-00); panel cover (200-0812-00); screwdriver (003-0672-00); 1401 operator's hand book (070-1082-00); 1401 instruction manual (070-1071-00).

Order 1401 ..... **$1900**

OSCILLOSCOPE SUMMARY

CHARACTERISTIC	TYPE 323	TYPE 324
Bandwidth	DC to 4 MHz	DC to 10 MHz
Risetime	90 ns	36 ns
Deflection Factor	10 mV/div to 20 mV/div at full bandwidth	
	1 mV/div at 2.75 MHz	2 mV/div at 8 MHz
Input R and C	1 megohm paralleled by approx 47 pF	
Time Base	5 μs/div to 1 s/div	1 μs/div to 0.2 s/div
Magnifier	X10	X5
CRT Display Area	6 x 10 divisions (1/4-inch divisions)	
Phosphor	P7 supplied when ordered with 1401	
Amplitude Calibrator	Internal, 0.5 V at external jack	
Power Sources	Internal batteries	Internal batteries
	External 6 to 16 VDC	External 6.5 to 16 VDC
	90 to 136 VAC	115 VAC ±10%
	180 to 272 VAC	230 VAC ±10%
	48 to 440 Hz	48 to 440 Hz
	14 W at 115 VAC	20 W at 126 VAC
Price with batteries	$960	$1225

The SONY®/TEKTRONIX® Type 323 and 324 are manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, they are available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 1401 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $10

Handle Conversion Kit—For customers who wish to combine an existing 323 or 324 Oscilloscope with the 1401 Analyzer Module, to form a System as shown on the preceding page. The existing separate handles are replaced by the larger combination handle. Hardware is included.
Order 040-0563-00 ..... $30

Power Pack—Extra power pack, in addition to the one supplied with the 1401 allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0119-02 ..... $98

Battery Set—Set of 6 NiCd cells,
order 146-0012-01 ..... $23

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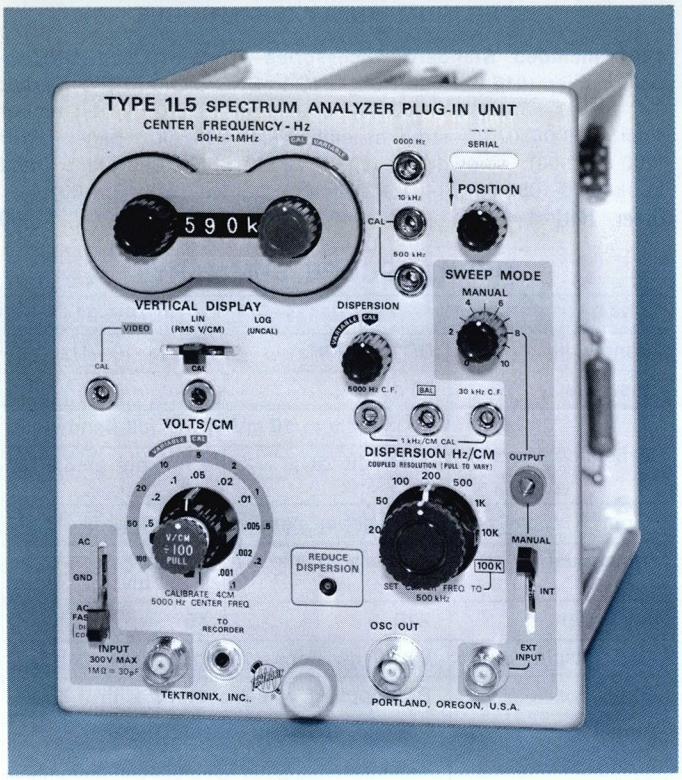
1L5 and 3L5

50 Hz-to-1 MHz Spectrum Analyzer



- ***CALIBRATED VERTICAL DEFLECTION***
- ***CALIBRATED DISPERSION***
- ***10 Hz to 1 MHz IN ONE DISPLAY***
- ***TIME-BASED OR FREQUENCY-BASED DISPLAYS***
- ***RECORDER OUTPUT***

The Type 1L5 and 3L5 operate over a center-frequency range of 50 Hz to 1 MHz, and provide accurate spectral and time-based displays from 10 Hz to 1 MHz. Calibrated volts/cm and Hz/cm controls make the Type 1L5 and 3L5 as easy to use as the oscilloscope in which each is operated. The 1L5 operates in the Type 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The Type 3L5 operates in the Type 561B or 564B (and the earlier 561A and 564) Oscilloscopes in combination with a Type 2B67, 3B3, 3B4, or 3B5 Time-Base Unit.*

Resolution bandwidth extends from 10 Hz to 500 Hz. High-resolution spectral displays can be viewed in their entirety (even at the very slow sweep rates required for maximum resolution) with the Type 549 or 564B Storage Oscilloscope. Stored displays can also be compared with subsequent displays, and can be easily photographed for permanent record.

Applications include vibration studies, waveform analysis, and noise measurements. Others are listed in the reference section.

*IMPORTANT: Time Base Units with serial numbers under those listed require a simple modification to provide a sweep signal to the Analyzer. Type 2B67: 15180, Type 3B3: 4270, Type 3B4: 740. Modification Kit part number 040-0413-00.

SPECTRAL DISPLAYS

CENTER FREQUENCY RANGE

50-Hz to 990-kHz, calibrated in 10-Hz, 100-Hz, 1-kHz and 10-kHz steps. Continuously variable to at least 1 MHz.

CENTER FREQUENCY	ACCURACY
50 Hz to 990 Hz	±(5% + 50 Hz + 50 Hz/°C change)
1000 Hz to 9900 Hz	±(5% + 100 Hz + 100 Hz/°C change)
10 kHz to 99 kHz	±(5% + 3 kHz + 200 Hz/°C change)
100 kHz to 990 kHz	±(5% + 10 kHz + 200 Hz/°C change)

STABILITY

50 Hz to 9900 Hz — 100 Hz/hour or less with stable ambient temperature (±1°C).

DEFLECTION FACTOR

10 μV/cm to 2 V/cm, calibrated in RMS volt/cm (1-2-5 sequence). Accurate within 3% from 1 mV/cm to 2 V/cm, within 6% from 10 μV/cm to 500 μV/cm (÷100 pulled), for linear displays at maximum resolution. The uncalibrated variable control is continuous between steps (≈3:1).

CALIBRATED DISPERSION

10 Hz/cm to 100 kHz/cm in 9 steps. Accuracy at center frequencies of:

a) 50 Hz to 9900 Hz — ≤±10% (20°C to 30°C)
— ≤±20% (0°C to 50°C)
b) 10 kHz to 990 kHz — ≤15% (0°C to 50°C)

Linearity is within 3%.

COUPLED RESOLUTION

≤10 Hz to ≥500 Hz (20°C to 30°C), coupled with the dispersion control but separately switchable.

DISPLAY FLATNESS

Amplitude variations are within 0.5 dB from 10 Hz to 1 MHz at most deflection factors; except within +0.5 dB, —3 dB at 1 mV/cm and 2 mV/cm (or 10 μV/cm and 20 μV/cm with ÷100 pulled).

NOISE
≤5 μV RMS.

DYNAMIC RANGE
≥60 dB in LOG (uncalibrated) mode.

INTERMODULATION DISTORTION AND SPURIOUS SIGNALS
(1L5) ≥50 dB below the 6-cm signal level.
(3L5) ≥50 dB below the 8-cm signal level.

RECORDER OUTPUT
5 to 15 mV for 6-cm linear display, into 600-Ω.

LOCAL OSCILLATOR OUTPUT
Must sweep ≥1 MHz from ≈3 MHz to ≈2 MHz; ≥1 V P-P.

1L5 SWEEP MODES
Manual, internal and external. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 549 Storage Oscilloscope and Type 556 Dual-Beam Oscilloscope provides an internally-coupled sweep to the Analyzer; external input is used with other oscilloscopes.

3L5 SWEEP MODES
Manual and internal. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 561B and 564B Oscilloscopes with time base unit provide an internally-coupled sweep to the Analyzer.

TIME-BASED DISPLAYS

BANDWIDTH
10 Hz to 1 MHz at most deflection factors; 10 Hz to 700 kHz at 0.1 V/cm and 0.2 V/cm (or 1 mV/cm and 2 mV/cm with ÷100 switch pulled).

DEFLECTION FACTOR
1 mV/cm to 100 V/cm in calibrated P-to-P steps (1-2-5 sequence), accurate within 3% (within 6% from 2 V/cm to 100 V/cm). Uncalibrated control provides continuous variation between steps, reduces gain by a factor of approx 3.

INPUT
1 megohm paralleled by approx 30 pF.
300 V DC + peak AC maximum input voltage.

OTHER CHARACTERISTICS

1L5 WEIGHTS

Net weight	8 lb	3.6 kg
Domestic shipping weight	≈13 lb	≈5.8 kg
Export-packed weight	≈21 lb	≈9.0 kg

3L5 WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	≈13 lb	≈5.8 kg
Export-packed weight	≈17 lb	≈7.7 kg

INCLUDED STANDARD ACCESSORIES
1X probe (010-0193-00), banana-to-banana cable (012-0031-00), BNC-to-banana cable (012-0091-00), plug (134-0052-00), plug protector (134-0076-00), instruction manual (070-0600-01 for Type 1L5 or 070-0630-01 for Type 3L5).

TYPE 1L5 SPECTRUM ANALYZER UNIT **$1025**
TYPE 3L5 SPECTRUM ANALYZER UNIT **$1125**

OPTIONAL ACCESSORIES

P6007 100X Probe Package, order 010-0150-00 ..... $29
P6012 10X Probe Package, order 010-0203-00 ..... $36
600-Ω Termination (BNC), order 011-0092-00 ..... $18

50 Hz-to-1 MHz Swept Frequency Source

- ***SLAVED SPECTRUM ANALYZER-SWEPT FREQUENCY DISPLAYS***
- ***50-Hz to 1-MHz CENTER FREQUENCY***
- ***1-MHz DISPERSION CAPABILITY***

The Swept Frequency Converter is an accessory unit to the Type 1L5 or Type 3L5 Spectrum Analyzer Plug-In Units. It accepts the local oscillator output from the analyzer and converts it to a signal source slaved to the center frequency and dispersion setting of the analyzer.

The result is a signal source with center frequency range of 50 Hz to 1 MHz, single frequency (analyzer in MANUAL SWEEP mode) or swept frequency with dispersion capability of 1 MHz max to 100 Hz min. It provides for variable amplitude control and regulation for constant output within 0.5 dB. Sweep rate is controlled by the horizontal time base.

CHARACTERISTICS

OUTPUT FREQUENCY—50 Hz to 1 MHz, selectable within the center frequency range of the Spectrum Analyzer.

OUTPUT VOLTAGE—4 V P-P to 8 V P-P max behind 600 Ω.

OUTPUT FREQUENCY FLATNESS—within 0.5 dB into 600 Ω.

OSCILLATOR INPUT VOLTAGE (from Spectrum Analyzer) 0.8 V P-P to 2 V P-P.

OUTPUT REGULATION
FAST—effective in preserving amplitude flatness when lowest frequency component is not less than 10 kHz and sweep rate is 10 ms/div or faster.
SLOW—used when frequency is less than 10 kHz and for sweep rates slower than 10 ms/div.

OUTPUT AMPLITUDE RECOVERY (output regulator FAST to SLOW)—10 s or less to recover to same amplitude as FAST.

OUTPUT RESISTANCE—600 Ω within 15%.

POWER REQUIREMENTS—90 VAC to 272 VAC, 50 to 400 Hz.

INCLUDED STANDARD ACCESSORIES
600-Ω termination (011-0092-00); two BNC cables (012-0075-00); BNC-to-dual banana adapter (103-0090-00); instruction manual (070-0762-00).

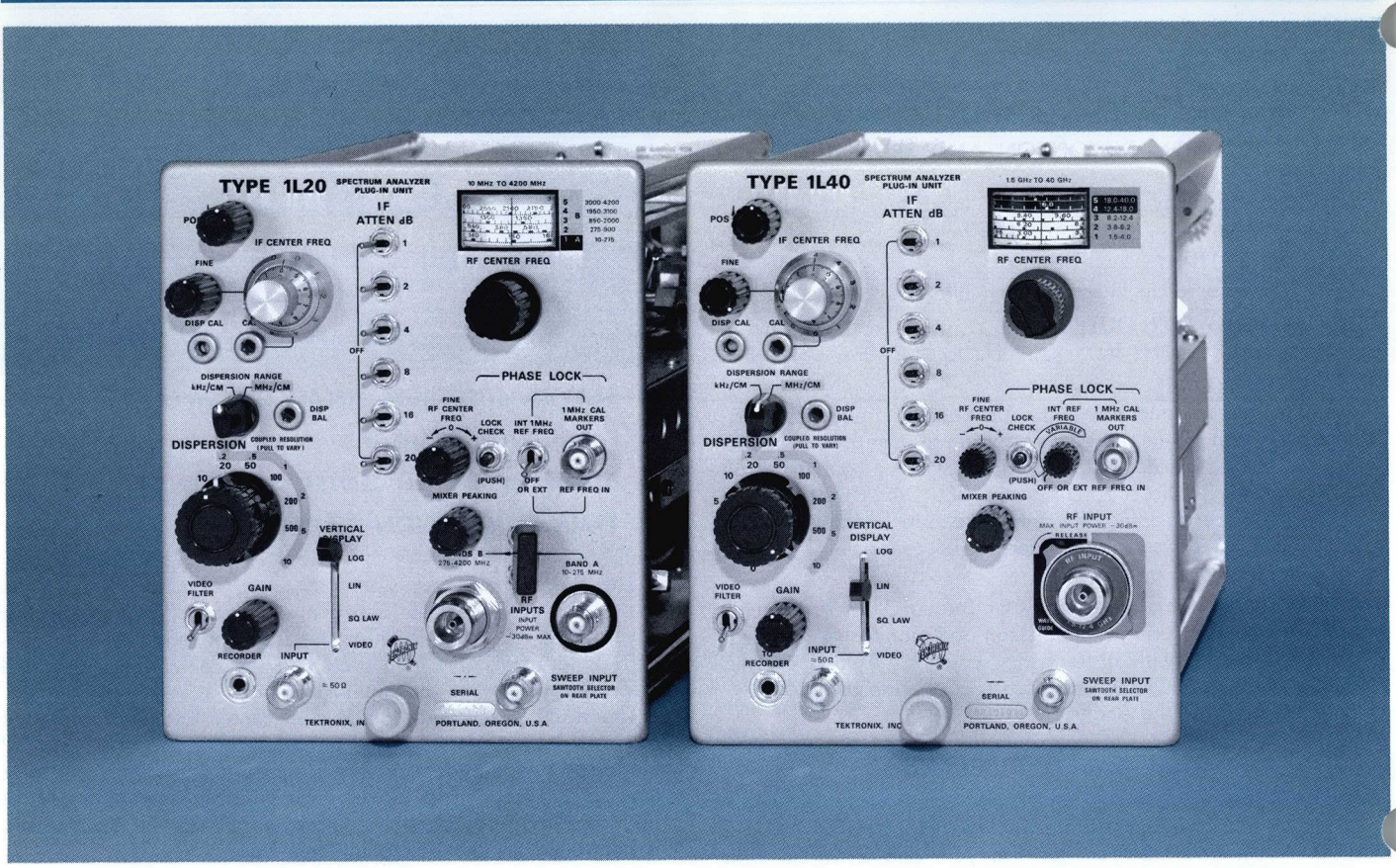
SWEPT FREQUENCY CONVERTER, order 015-0107-00 . . **$330**

600-Ω STEP ATTENUATOR
A 0 to 51 dB switch attenuator for use with the Type 1L5 or 3L5. The input resistance is 600 Ω (within 2%). The attenuation error is within 0.05 dB/dB. Power rating is 1/8 W max. Bandwidth is DC to 1 MHz, order 011-0093-00 ..... $83

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

1L20 and 1L40

Multi-Band Spectrum Analyzer



Type 1L20 covers 10 MHz to 4.2 GHz

- ***INTERNAL PHASE LOCK***
- ***CALIBRATED DISPERSION TO 100 MHz***
- ***COUPLED RESOLUTION***
- ***AMPLITUDE VARIATIONS WITHIN 3 dB OR LESS***
- ***CONVENIENT WAVEGUIDE MIXERS WITH TYPE 1L40***
- ***RECORDER OUTPUT***

*Type 1L40 covers 1.5 GHz to 40 GHz**

Operating convenience and performance is now offered in multi-band plug-in units for all present Tektronix Type 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The Type 549 Oscilloscope adds further convenience to spectrum analysis—allowing storage and simultaneous comparison of spectral displays.

BUILT-IN PHASE LOCK circuit synchronizes the analyzer local oscillator with a stable reference frequency (internal 1 MHz or external 1 to 5 MHz). When the local oscillator is locked in phase to the reference frequency, the local oscillator stability approaches that of the reference frequency. This allows very narrow dispersion at high frequencies where the analyzer would normally be limited by oscillator drift, microphonics, and other perturbations. Phase lock can be used to view any signal within the tuning range of the analyzer.

CALIBRATED DISPERSION from 1 kHz/cm to 10 MHz/cm makes frequency measurement as easy and accurate as time measurement. Frequency differences can be read directly from the CRT.

COUPLED RESOLUTION from 1 kHz to 100 kHz greatly simplifies operation, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Dispersion and resolution controls can be uncoupled and operated separately if desired, for optimized viewing of a particular signal.

*With optional accessories.

1L20 and 1L40
Multi-Band Spectrum Analyzer

TYPE	BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY* 1-kHz RESOLUTION	MINIMUM CW SENSITIVITY* 100-kHz RESOLUTION
1L20	1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
	2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
	3	850 MHz to 2 GHz	≥ —100 dBm	≥ —80 dBm
	4	1.95 GHz to 3.1 GHz	≥ —95 dBm	≥ —75 dBm
	5	3 GHz to 4.2 GHz	≥ —90 dBm	≥ —70 dBm
1L40	1	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
	2	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
	3	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
		OPTIONAL WAVEGUIDE MIXERS AND ADAPTER REQUIRED BEYOND 12.4 GHz		
	4	12.4 GHz to 18 GHz	≥ —90 dBm	≥ —70 dBm
	5	18 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz	≥ —60 dBm
			≥ —70 dBm to 40 GHz	≥ —50 dBm

*Signal + noise = 2X noise

DIAL ACCURACY
± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION
1 kHz/cm to 10 MHz/cm in 1-2-5 sequence, 2 ranges (kHz/cm—MHz/cm). Accuracy of 10-cm display, throughout full range of IF center frequency control, within ±3% except at 2 MHz/cm (±5%) and 1 MHz/cm (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

BANDWIDTH RESOLUTION
1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

DISPLAY FLATNESS
Amplitude variations are within 3 dB over the full 100-MHz dispersion range (or less) except:
a) over 50 MHz in Band 1 with Type 1L20.
b) within 6 dB from 12.4 GHz to 40 GHz with Type 1L40.

INCIDENTAL FM (LO + IF)
300 Hz or less at LO fundamental when phase locked.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz range from 5 MHz/cm to 0.2 MHz/cm, ±10 MHz at 10 MHz/cm. ±2.5-MHz range in all kHz/cm positions. FINE control has ±1-MHz and ±50-kHz range in MHz/cm and kHz/cm modes respectively.

VERTICAL DISPLAY (6 cm)
Log—≥40-dB dynamic range.
Linear
Square Law—≥13-dB total dynamic range.
Video— ≤16 Hz to ≥10 MHz, approx 50-Ω input resistance.

RECORDER OUTPUT
12 mV to 20 mV with 6-cm linear display.

WEIGHTS

Net weight	7½ lb	3.4 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES
Patch cord, BNC to banana (012-0091-00); plug protector (134-0076-00); tini-plug (134-0052-00); instruction manual (070-0519-01 for Type 1L20, 070-0904-00 for Type 1L40).

TYPE 1L20 SPECTRUM ANALYZER UNIT $1950

TYPE 1L40 SPECTRUM ANALYZER UNIT $2150

OPTIONAL ACCESSORIES

The following accessories extend the operational range of the 1L40 from 12.4 GHz to 40 GHz. The waveguide mixer adapter and cable are required for use with the waveguide mixers.

Waveguide Mixer Adapter (119-0104-00) $44
Cable Assembly (012-0115-00) $10
Waveguide Mixer 12.4—18.0 GHz (119-0097-00) $77
Waveguide Mixer 18.0—26.5 GHz (119-0098-00) $88
Waveguide Mixer 26.5—40.0 GHz (119-0099-00) $138

Attenuators are all supplied with Type N fittings. See accessory section for adapters for other series. Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300-W peak. Impedance is 50 Ω.

10-dB attenuator, order 011-0085-00 ..... $45
20-dB attenuator, order 011-0086-00 ..... $45
40-dB attenuator, order 011-0087-00 ..... $55

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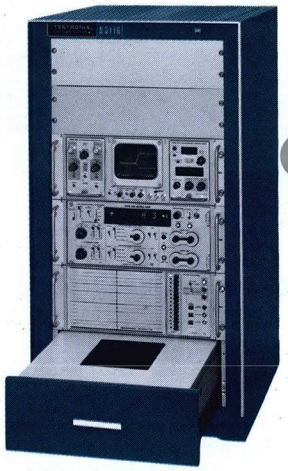
Please refer to General Information page

AUTOMATED MEASUREMENT SYSTEMS AND PROGRAMMABLE PRODUCTS

	Reference	212
568/R568	Readout Oscilloscope	217
3S5 and 3S6	Programmable Dual-Trace Sampling Units	219
3T5 and 3T6	Programmable Sampling Sweep Units	220
3A2 and 3B2	Analog/Digital Amplifier and Time Base	221
R1140	Programmable Power Supply	245
R1340	Data Coupler	246
230/R230	Digital Unit	222
240/R240	Program Control Unit	224
241/R241	Programmer	227
R250	Auxiliary Program Unit	228
	Programmable Pulse Generators	231
286, 287, R288	Sampling Head Multiplex Unit, Multiplex Control Unit, Multiplex Master Controller	232
S-3110 and S-3111	Automated Measurement Systems	235
S-3120, S-3121, S-3122	Automated Measurement Systems	237
S-3130, S-3131, S-3132	Automated Measurement Systems	238
S-3150	Automated Integrated Circuit Measurement System	241

Tektronix Automated Measurement Systems

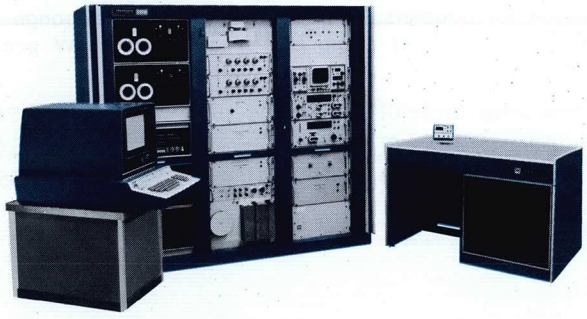
Tektronix Automated Measurement Systems use Tektronix Catalog products and add additional equipment such as programmable pulse generators, programmable power supplies, fixtures, equipment racks and other equipment. Tektronix does the systems engineering and supplies an automated measurement system ready to do your measurement job.



S-3110 Automated Measurement System includes the 568/230 with 241 Program Unit providing up to 15 automatic measurements.

S-3120 Automated Measurement System includes the 568/230 with the 240 Program Control Unit, a Disc Memory, and Punched Tape Reader. It includes a pulse generator and 2 power supplies.

S-3130 Automated Measurement System includes the 568/230/240, R250 Auxiliary Program Unit, Disc Memory, and Punched Tape Reader. It also includes a programmable pulse generator, 4 programmable power supplies, and test fixtures.



The S-3150 is a high-speed, disc-programmed, dynamic, functional and DC-test system for integrated circuits. The S-3150 includes a small computer (D.E.C. PDP-8L) for data acquisition and program writing.

The 1801 and 1802 Test Stations contain programmable fixturing and allow manual and automatic handling in ambient or controlled environmental conditions.

AUTOMATED MEASUREMENT AND TEST SYSTEMS

The process of determining the parameter values of a product, device, circuit, substance, etc. can be described as "making a measurement". The process of measuring, and then evaluating the determined values on the basis of expected results of predetermined limits can be described as "making a test". The accelerating need to measure and test has put a demand on industry to speed up the processes while maintaining or increasing accuracies.

Systems and system components in this section are designed so that the customer can choose just the right increment of automatic operation he requires to do his job. He can meet his requirements by choosing a completely-specified and assembled system, or he can choose individual system components and assemble a system, using his own engineering resources.

To evaluate and choose from the products and systems in this section, it is necessary to know the basic blocks that make up a Tektronix Automated System and the functions of each block.

The Measurement Technique

All Tektronix Automated Measurement Systems can measure DC voltages (and currents), as well as the dynamic parameters of complex waveforms in terms of amplitude and time. The basic process used in sampling. Sampling is the process used to convert and display fast information. The conversion of repetitive information by sampling not only provides the conversion technique for analog display, but forms the basis for further conversion of that information to digital form.

Digitizing of analog-display information, formed by the sampling process, can take place on a sample-by-sample basis in the R1340 Data Coupler for use directly by a computer or on a measurement-by-measurement basis in the 230 Digital Unit. This is illustrated in block form in Figure 1.

Most Tektronix Automated Measurement Systems utilize a common group of instruments consisting of the 568 Readout Oscilloscope and Sampling plug-ins, plus the 230 Digital Unit. The prime function of the 230 is to make digital measurements of sampled analog data. Results are then compared to programmed limit values for automatic indication of whether the measurements are above, within, or below the predetermined limits.

The use of a precise number of displayed samples per CRT horizontal division is fundamental to the digitizing process used for time measurements. Since the horizontal axis of the sampling scope is scaled in equivalent time per division, the time between successive samples (or dots) in the display represents

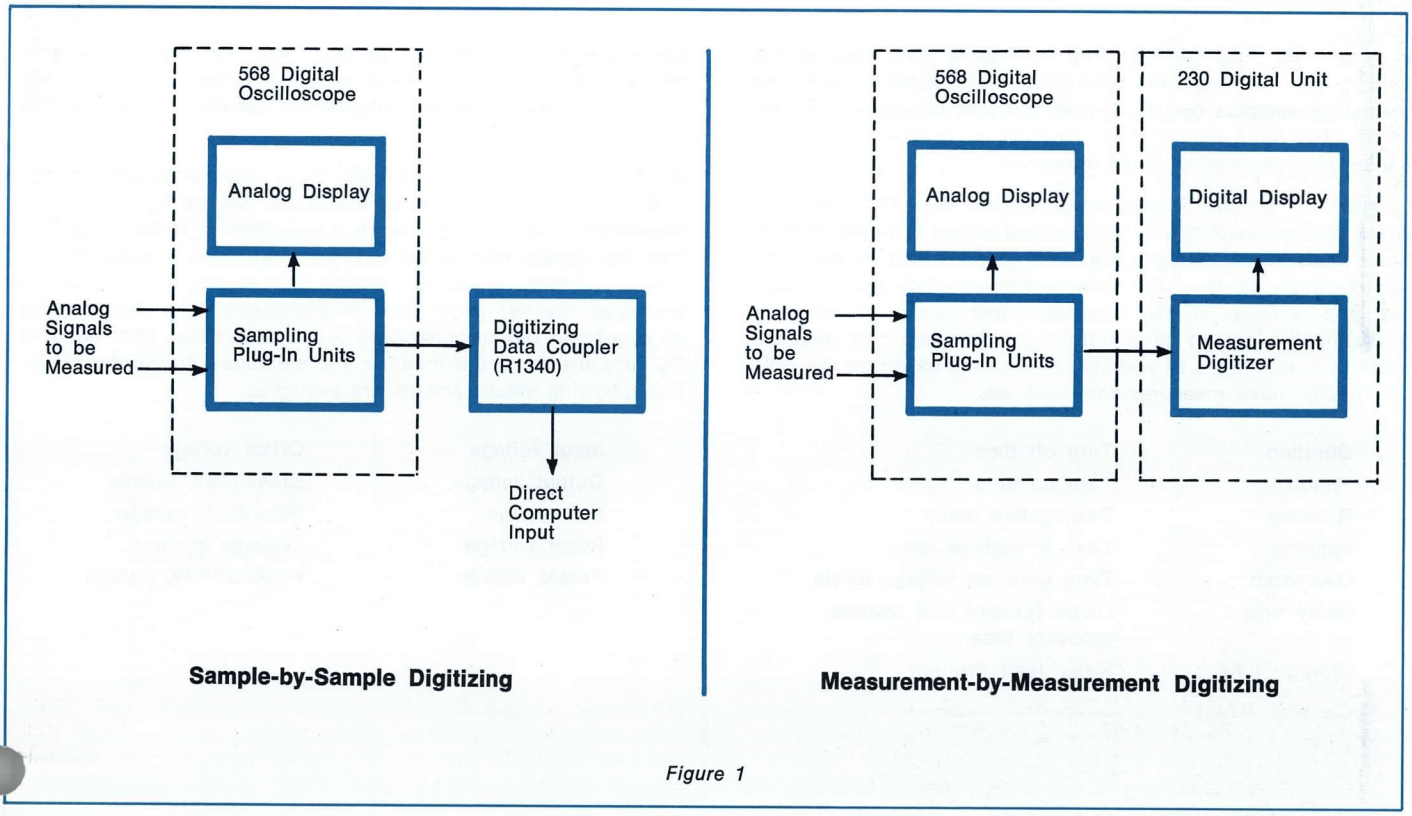
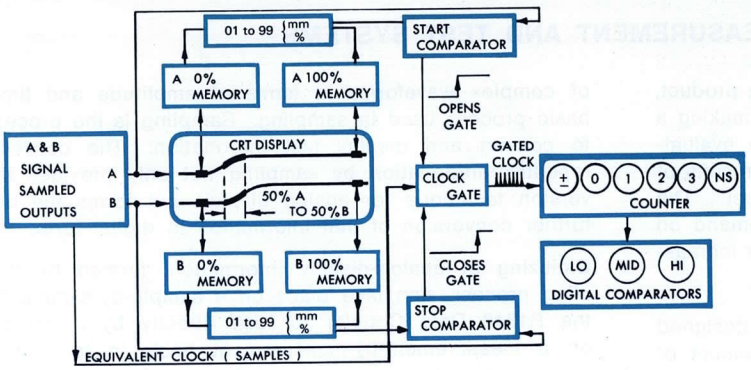
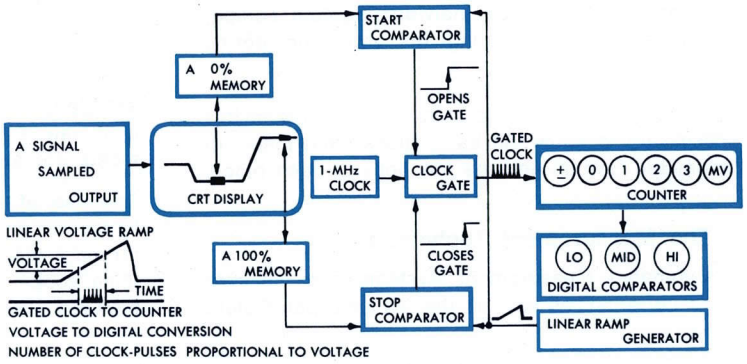


Figure 1



TYPE 230
Time Measurement



TYPE 230
Voltage Measurement

an equivalent time period. The equivalent time periods are used to form an equivalent time clock. For example: when the number of samples per division is 100 and the equivalent-time per division is 1 nanosecond, each successive sample in the display then represents 10 picoseconds.

To make an equivalent time measurement, the 230 Digital Unit stores voltages from two zones selected on the 568 CRT display. These memorized voltages are divided and used to set comparator-circuit ranges. The comparators are then used to start and stop a count of the equivalent-time clock. Since many measurements are of time differences between two absolute levels or percentages of amplitudes, systems based on the 568/230 readily make measurements such as:

Duration	Turn off time
Period	Turn on time
Risetime	Propagation delay
Falltime	Time to voltage level
Overshoot	Time between voltage levels
Delay time	Diode forward and reverse recovery time
Storage time	Noise feed through

Other time measurements can be made between points such as: percentages of amplitude, absolute voltages (or currents), divisions of horizontal CRT display, or between any two of the above on one or both CRT traces.

When a system is used to make amplitude measurements, the 568/230 measurement group measures the voltage difference between two selected points on a waveform or between ground and the voltage that exists at a selected point in time. Amplitude measurement requires storing two voltages in the 230, in the same manner as in time measurements, and then making an Analog to Digital conversion of the difference. Both AC and DC measurements are made in the amplitude measuring mode. The following measurements are examples:

Input voltage	Offset voltage
Output voltage	Breakdown voltage
Set voltage	Saturation voltage
Reset voltage	Leakage current
Preset voltage	Peak-to-Peak voltage

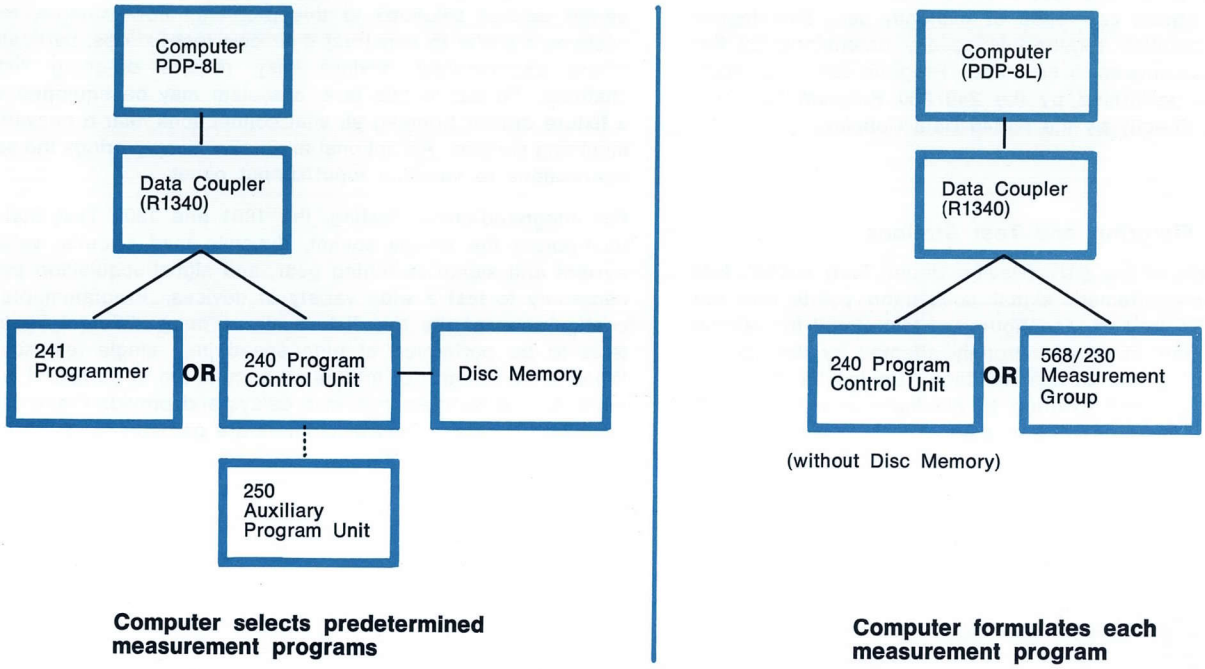


Figure 2

568/230 Voltage Measurement

Program Control

The 230 Digital Unit and the 568 Oscilloscope, with sampling plug-in units, can be manually operated or programmed to make measurements. In a system, manual operations are partly or completely replaced by some form of a programming. The programming format uses parallel lines to the basic measurement package. A measurement is made by "grounding" a selected group of these lines. The 241 Programmer is used to "ground" program lines through the insertion of diode logic in the program lines and up to 15 measurements are programmed with the 241 either by front-panel or remote control.

When a large number of measurements and tests are to be made rapidly, a tape, disc, or other programming medium is used. The 240 Program Control Unit is used to manage the flow of program data while programs are being written, debugged, or executed. Up to three R250 Auxiliary Program Units can be used with the 240 to increase programming capacity.

Program control by computer is provided through the R1340 Data Coupler. Two basic techniques are used. In the first, the computer is used to select predetermined measurement programs, stored within the 241 Programmer, or on a disc memory, used with the 240 Program Control Unit.

Measurement results are available to the computer and can be used to control the sequence of subsequent measurements. In the second approach, the computer may be used to formulate and control each measurement directly, thus serving to store and alter measurement programs according to the computer's own program. Basic combinations are shown in Figure 2.

568/230 Time Measurement

Programming

Measurement programs may be written directly in 4-bit characters through the 240 Program Control Unit, by installing diodes on removable circuit boards in the 241 Programmer, or by any means by which a punched-paper tape can be generated. An English-language Translator Program is supplied with the S-3150 which enables the programmer to assemble, review, and edit measurement programs at the keyboard of a teletypewriter or a Tektronix T4002 Graphic Display Terminal.

Programming a measurement routine can be done through the use of peripherals, with or without computer assistance. Among the system peripherals offered are a Graphic Computer Terminal, teletypewriter, low-speed tape punch, DEC PDP-8L.

Data Recording

Test results may be presented in the form of go, no-go indicators or used as "sort" commands to an automatic handler. When extensive measurement data must be collected, however, several choices are offered. For example, a line printer may be attached directly to the 230 Digital Unit to provide a hard copy of test measurement results. When it is desired to store measurement results for off-line computer analysis, the R1340 Data Coupler permits computer-compatible data recording on either magnetic or punched-paper tape. On-line computer analysis or recording through computer peripherals is also permitted by the R1340.

Stimulus

Stimulus sources, consisting of DC voltages and currents, pulse or computer words, are often used with systems. These sources

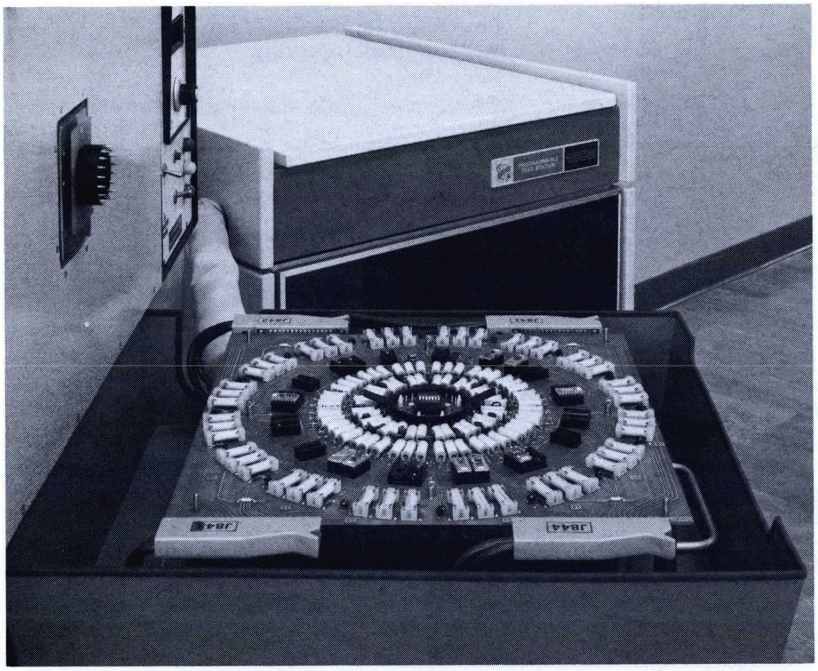
can be an addition to or an integral part of a system. The power supplies, pulse sources, and word generators in a system may be program controlled or manually set. The degree of automatic operation required is usually determined by the number of measurements to be made. Program control of stimulus sources is performed by the 240/250 Program Units or, in some cases, directly by the R1340 Data Coupler.

Fixturing and Test Stations

Fixturing consists of the DUT (Device Under Test) socket, test circuitry, and measurement signal acquisition points and the switching circuits used to reconfigure the test circuit for various tests. Measurement rates are strongly affected by the sophistication of fixturing and device handling. Device handlers are used with sophisticated fixturing to eliminate or minimize the delays of manual insertion of devices under test. Device handlers are particularly useful in any environmental test cycle.

Test-fixture requirements vary widely depending on the type of device being tested. Tektronix Automated Measurement Systems permit several solutions to this problem. For example, many customers prefer to construct their own test fixtures, particularly where experimental devices may require on-going fixture changes. To aid in this task, a system may be equipped with a fixture drawer bringing all vital connections near a convenient mounting surface. An optional alternative simply brings the same connections to versatile input/output panel.

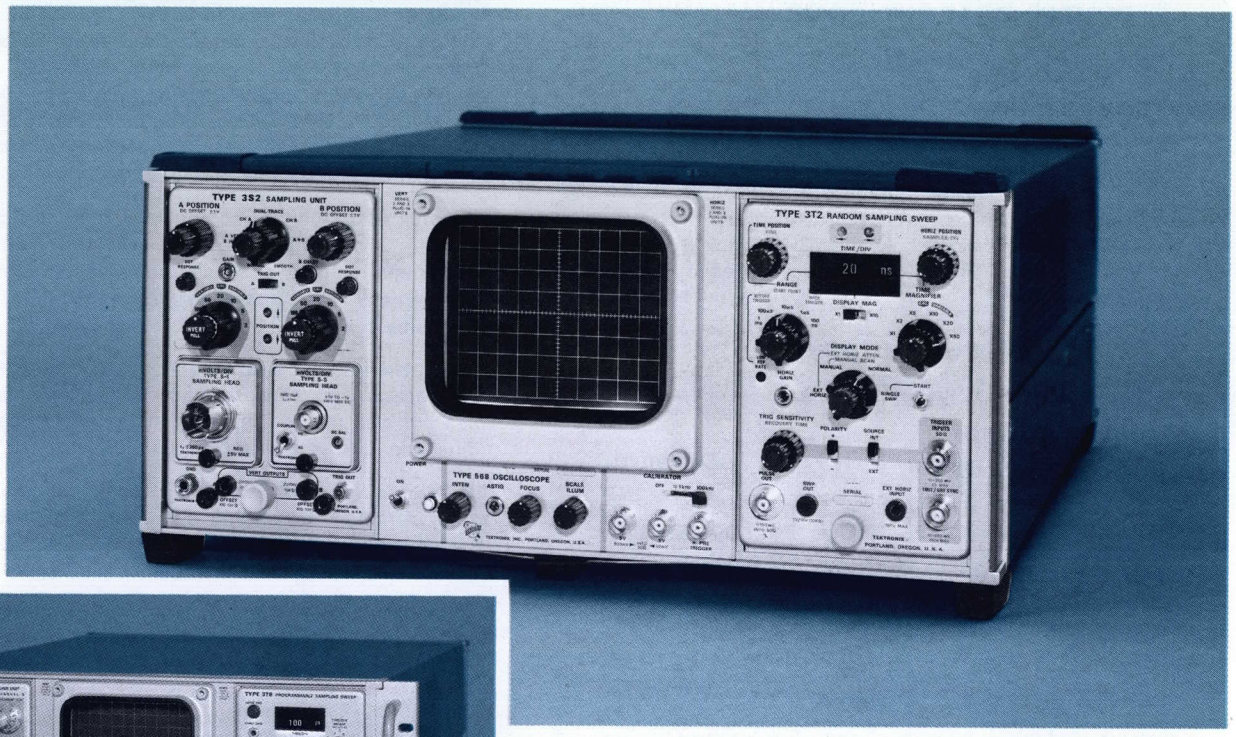
For integrated-circuit testing, the 1801 and 1802 Test Stations incorporate the device socket, dynamic load circuits, voltage, current and signal switching gear, and signal-acquisition points necessary to test a wide variety of devices. Programmable reconfiguration of the test fixture allows many different kinds of tests to be performed at high speed in a single test socket. When large volumes of integrated circuits are to be tested, automatic device handlers minimize delays and provide highest possible testing rates. Device handlers are particularly useful in an environmental test cycle.

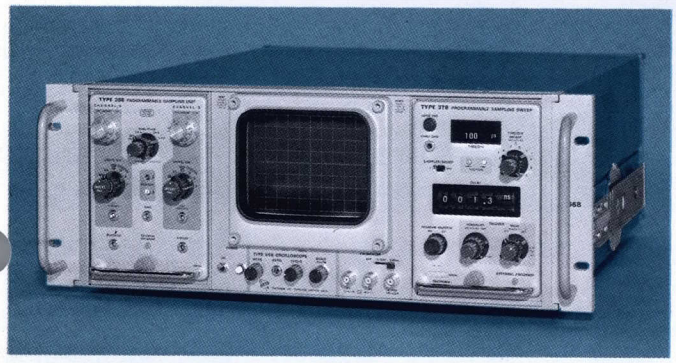


New 1802 Test Station—
pod hinges down for manual testing.

AUTOMATIC HANDLING AND ENVIRONMENTAL TESTING—The 1802 Test Station has been specially designed for the 8824 Mechanized Ambient Handler and the 8072 Supercharger manufactured by Delta Design Inc., La Mesa, California. Handling rates from 1000 to 4000 units per hour are limited by testing time and soak period desired, not by the handling mechanism. Environmental test limits are −55°C and +150°C, either hand, magazine, or bowl-feed options are available. Device outputs may be made into a magazine, a 3-bin sorter, or a 5-bin sorter. Contacter length and capacitance has been kept to a minimum to insure best possible transient response for dynamic measurements. Device switching speeds as fast as 4 ns are cleanly preserved in the Ambient Handler with a corresponding 4 ns for the Supercharger.

568
Readout Oscilloscope





- **ANALOG DISPLAYS OF ANALOG/DIGITAL MEASUREMENT SYSTEM**
- **PROVIDES MEASUREMENT INFORMATION FOR 230 DIGITAL UNIT**
- **ILLUMINATED NO-PARALLAX GRATICULE**
- **SOLID-STATE DESIGN**

568 and R568 Readout Oscilloscopes are designed for use with 2-Series and 3-Series Plug-In Units in both the vertical and horizontal deflection systems. When used together with the 230 Digital Unit, digital readout of measurements (in addition to the analog display on the CRT) makes the measurements faster, more convenient, and more accurate.

Connectors on the rear provide measurement information for the 230 Digital Unit, couple trace-brightening information from the 230 to the 568, and provide input and programming information for programmable plug-in units.

The 568/R568 are designed mainly for use in digital measurement systems, but through use of amplifier, spectrum analysis, and time-base plug-in units, they may be used in other applications that do not require digital readout.

Through use of solid-state components, the 568/R568 offer reliable operation with low-heat dissipation.

CHARACTERISTIC SUMMARY

VERTICAL

Vertical deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier Plug-In Units. See chart for plug-in units that provide digital readout when used with a 230 Digital Unit.

HORIZONTAL

Horizontal deflection characteristics are extremely flexible through use of 2-Series and 3-Series Amplifier and Time-Base Units. See chart for plug-in units that provide digital readout when used with a 230 Digital Unit.

CRT

Display Area— 8 x 10 div. (Each major div = 1 cm.)

Accelerating Voltage— 3.5 kV.

Phosphor—P2.

OTHER

Amplitude Calibrator— 5 V and 0.5 V into 100 kΩ or more or 500 mV and 50 mV into 50 Ω. Repetition rate is 100 kHz or 1 kHz.

Power Requirements—Quick-change, line-voltage taps permit operation from 90 to 110 V, 104 to 126 V, 112 to 136 V; or 180 to 220 V, 208 to 252 V, 224 to 272 V. Line frequency is 48 to 66 Hz. Power consumption is 210 watts maximum.

DIGITAL READOUT COMBINATIONS

Digital and analog displays are simultaneously presented on the Type 568 Readout Oscilloscope and Type 230 Digital Unit. A Digital Readout Combination consists of a Type 568, Type 230, and any of the following combinations of amplifier and time-base plug-in units. Units marked with asterisk are programmable in addition to providing digital readout. The Type 3A2 and 3B2 should be installed in pairs. Other 2-Series and 3-Series Plug-In Units can be used for normal analog CRT display, but do not provide digital readout. Refer to 560-Series pages for other plug-in units.

PLUG-IN UNITS

VERTICAL			
TYPE	MINIMUM DEFLECTION FACTOR	T_R	BANDWIDTH
3S1	2 mV/div	350 ps	DC to 1 GHz
3S2	2 mV/div	Use with S-Series Heads	
3S5*	2 mV/div	Use with S-Series Heads	
3S6*	2 mV/div	Use with S-Series Heads	
S-1	50-Ω Head	350 ps	DC to 1 GHz
S-2	50-Ω Head	75 ps	DC to 4.5 GHz
S-3A	100-kΩ Head	350 ps	DC to 1 GHz
S-4	50-Ω Head	25 ps	DC to 14 GHz
S-5	1 MΩ Head	1 ns	DC to 350 MHz
S-6	50-Ω Head	30 ps	DC to 12.5 MHz
3A2	10 mV/div	700 ns	DC to 500 kHz

TIME BASE	
TYPE	CALIBRATED SWEEP RANGE
3T2	200 ps/div to 100 μs/div plus X10 magnifier
3T5*	100 ps/div to 500 ms/div
3T6*	100 ps/div to 500 ms/div
3T77A	200 ps/div to 100 μs/div plus X10 magnifier
3B2	2 μs/div to 1 s/div

*Programmable in addition to providing digital readout.

Amplitude Calibrator—Front-panel selection of squarewave outputs of 100 kHz, crystal-controlled, with an accuracy of ±0.05% or approx 1 kHz, RC time-constant controlled. Output voltages are 5 V and 0.5 V into 100 kΩ or greater or 500 mV and 50 mV into 50 Ω. + PRETRIGGER output provides a positive-going pulse that occurs ≈1/4 cycle ahead of the rising portion of the calibrator signal. Connectors are BNC.

Tektronix CRT—5-inch rectangular CRT with 3.5-kV accelerating potential. A P2 phosphor is normally supplied; P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

Illuminated Internal Graticule—Edge lighted graticule is marked in 8 vertical and 10 horizontal divisions (centimeters). Centerlines are also marked in 2-mm increments. Scale illumination is adjustable with a front-panel control.

DC-Voltage Supplies—Electronically regulated to compensate for widely varying line conditions. Separate regulated heater supply is included. The Type 568 has an additional 25 watts of regulated power available at the rear connector for system use.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 210 watts maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights

	568		R568	
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16-13/16	42.7	19	48.3
Depth	21-7/8	55.5	21-1/4	54.1
	lb	kg	lb	kg
Net weight	35	15.9	67	30.4
Domestic shipping weight	53	24.0	75	34.0
Export-packed weight	76	34.4	99	44.9

INCLUDED STANDARD ACCESSORIES

Implosion shield (337-0539-00); 18-inch patch cord, BNC-to-BNC (012-0087-00); 18-inch patch cord, BNC-to-banana plug (012-0091-00); patch cord, post jack-to-BNC (012-0092-00); instruction manual (070-0596-00). R568 also includes slide-out assembly (351-0086-00) and mounting hardware.

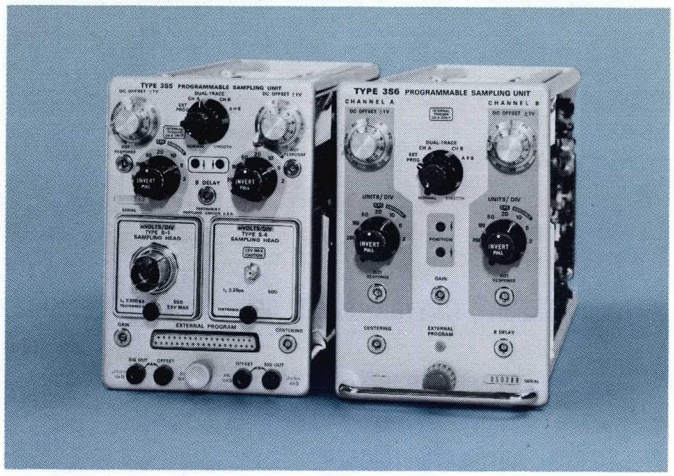
568 OSCILLOSCOPE, without plug-in units **$1250**
R568 OSCILLOSCOPE, without plug-in units **$1300**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3S5 and 3S6

Programmable Dual-Trace Sampling Units

- **PROGRAMMABLE VOLTS/DIV**
- **PROGRAMMABLE DC OFFSET**
- **CHOICE OF SAMPLING HEADS**



The 3S5 and 3S6 Dual-Trace Sampling Units extend the automated measurement capabilities of the 568/230 Oscilloscope Digital Readout System by allowing remote programming of deflection factor, DC offset, and smoothing.

External programming of the 3S5 can be accomplished by either a front- or rear-panel connector; signal inputs are on the front. The 3S6 has its program and signal inputs on the rear and can be used only in the 568 Oscilloscope.

Sampling heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for external delays.

CHARACTERISTICS

Deflection Factor— 2 mV/div to 200 mV/div in 7 calibrated steps 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Vertical outputs to the 230, each channel programmed with 3 program lines or by manual front-panel controls.

DC Offset Range— +1 V to −1 V. Allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls +1 V and −1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and −995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code, plus one program line per channel for + or − polarity.

B-Delay Range—Channel B display can be continuously positioned in time from +5 ns to −5 ns with respect to Channel A. Accommodates up to 3-foot difference in signal cables.

Programming—The 3S5 and 3S6 use negative logic with true being ground, or less than 2 V, and false being open, or more than 6 V. 27 program lines plus ground are required to externally program all measurement functions.

Display Modes—A only, B only, dual trace, and algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays.

Weights

Net weight	11 lb	5.0 kg
Domestic shipping weight	≈19 lb	≈8.6 kg
Export-packed weight	≈25 lb	≈11.3 kg

3S5 Included Standard Accessories—Connector (131-0422-00); connector cover (200-0660-00); circuit board connector (388-0805-00); instruction manual (070-0788-00).

3S5 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads $1875

3S6 Included Standard Accessories— 6-ft sampling-head extender (012-0130-00); two circuit board connectors (388-0805-00); instruction manual (070-0789-00).

3S6 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads $1875

3S5 OPTIONAL ACCESSORIES

3-ft sampling-head extender, order 012-0124-00 ..... $64
6-ft sampling-head extender, order 012-0125-00 ..... $66

SAMPLING HEADS

Sampling heads may be plugged into the 3S5 or located remotely on the optional 3-ft or 6-ft sampling-head extenders. The 3S6 uses sampling heads located remotely on included 6-ft sampling-head extender that connects to the rear of the 568 Oscilloscope. 568 Oscilloscopes below serial number B110000 require a modification. Consult your Field Engineer, Representative, or Distributor.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874*	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

For complete descriptions refer to Sampling Head pages.

*Registered Trademark General Radio Company

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

3T5 and 3T6

Programmable Sampling Sweeps

- **PROGRAMMABLE TIME/DIV, SWEEP DELAY AND SAMPLES/SWEEP**
- **100 ps/DIV to 500 ms/DIV CALIBRATED SWEEP RANGE**
- **EXTERNAL AUTOMATIC TRIGGER**

The 3T5 and 3T6 can be externally programmed to extend the automatic measurement capabilities when used with the 568/230 Oscilloscope Digital Readout System. The 3T5 can be externally programmed when used with the 561B or 564B Oscilloscopes. The 3T5 and 3T6 can also be used manually, using the front-panel controls.

Real-time sampling (1 ms/div to 500 ms/div) and digital delay are provided. An external automatic trigger mode eliminates the need for adjustments over a wide range of trigger signal characteristics.

Sweep Time/Div— 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep. Switch selected or programmed by BCD 2-bit and 4-bit code.

Samples/Sweep— 1 sample/sweep, externally programmed only. 100 or 1,000 samples/sweep, switch selected or programmed by BCD 2-bit code. Can be programmed to scan quickly (100 samples/sweep) when not making a measurement, then provide maximum resolution (1,000 samples/sweep) when making a measurement.

Delay Range— 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div. 0 to 9.999 μs in 1-ns increments from 1 ns/div to 1 μs/div. 0 to 999.9 μs in 100-ns increments from 2 μs/div to 500 μs/div. Switch selected or programmed by BCD 16-bit code.

Delay Jitter (all sweep speeds)— 0.1 division or less, independent of the amount of delay.

Triggering—SOURCES: Internal, if sampling unit contains a trigger pick-off; External, 50-Ω terminated input. JITTER: External automatic, pulse, 30 ps or less with 300-mV pulse, 2 ns or less wide; sinewave, 200 ps or less with 300 mV P-P signal at 30 MHz.

Pulse Triggering

SOURCE	FREQUENCY	AMPLITUDE
Internal	1 Hz to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

Sinewave Triggering

SOURCE	FREQUENCY	AMPLITUDE peak-to-peak
Internal	100 kHz to 100 MHz	100 mV to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

Weights

Net weight	7 lb	3.2 kg
Domestic shipping weight	10 lb	4.5 kg
Export-packed weight	14 lb	6.3 kg

3T5 Included Standard Accessories— 5-ns, 50-Ω RG58 cable with BNC connectors (012-0057-01); 10X 50-Ω BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); electrical connector (131-0422-00); electrical connector cover (200-0660-00); circuit board connector (388-0805-00); instruction manual (070-0760-01).

3T5 SAMPLING SWEEP UNIT **$1975**

3T6 Included Standard Accessories—Circuit board connector (388-0805-00); instruction manual (070-0761-01).

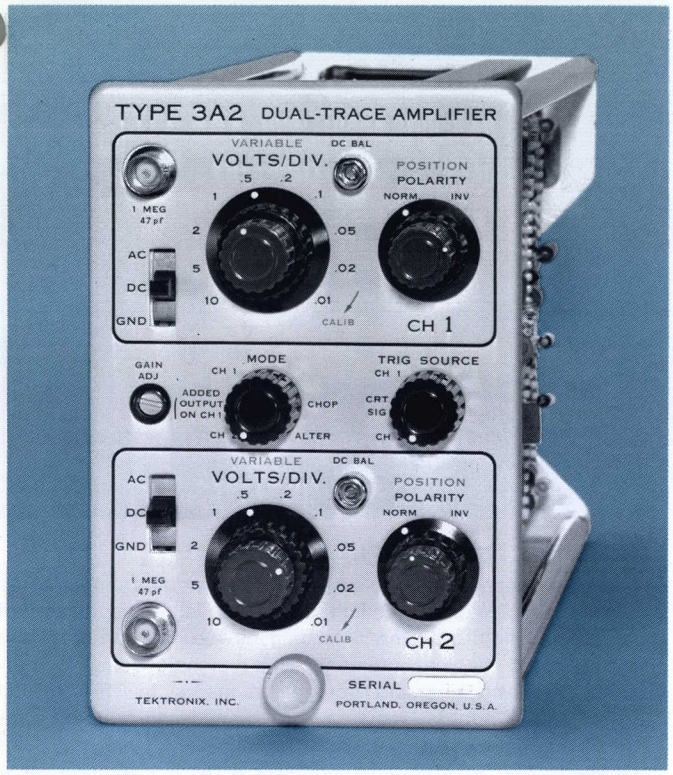
3T6 SAMPLING SWEEP UNIT **$1975**

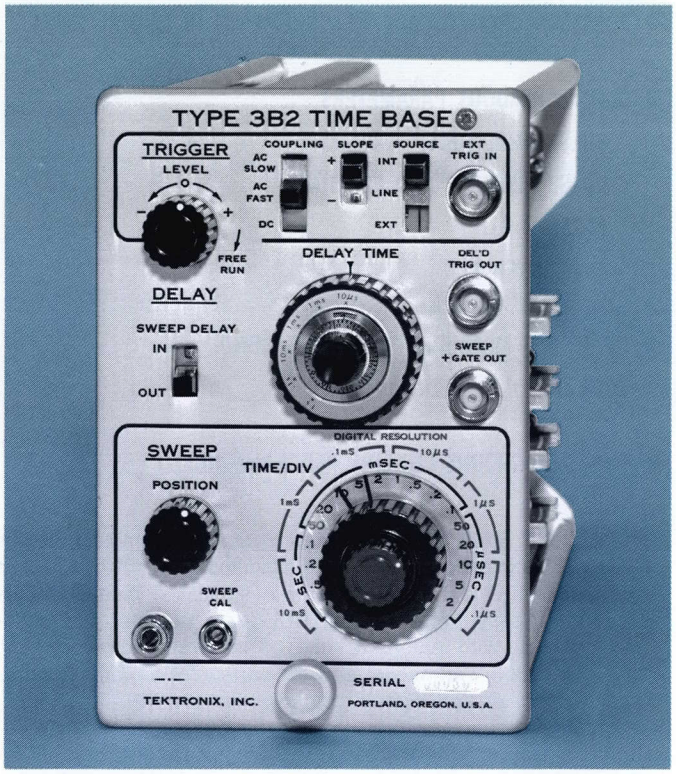
Field Modification Kit, order 040-0577-00.

For Computer-controlled External Sweep and Trigger. D/A and A/D converters permit computer scanning and digitizing of a waveform through the R1340 Data Coupler.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Analog/Digital Amplifier 3A2
Analog/Digital Time Base 3B2





- **DIGITAL READOUT WITH 568/230**
- **DC-to-500 kHz BANDWIDTH**

The 3A2 Dual-Trace Amplifier and 3B2 Time-Base Units enable digital readout and analog displays of low and medium-frequency information. Both types of displays are provided using the 568/230 Digital Readout Oscilloscope System. Analog displays (but not digital readout) are provided using 561B or 564B Oscilloscopes. The 3A2 also provides analog displays in the 565 Oscilloscope.

3A2 DUAL-TRACE AMPLIFIER UNIT

Bandwidth—DC to 500 kHz at 3-dB down. Low-frequency 3-dB point AC-coupled: 2 Hz.

Deflection Factor— 10 mV/div to 10 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Input RC— 1 megohm paralleled by approx 47 pF.

Maximum Input Voltage— 600 V (DC + peak AC).

Display Modes—Ch 1 only, Ch 2 only, added, alternate (channels switched at end of each sweep), chopped (successive 12-μs segments of each channel displayed).

Trigger Source—Channel 1, Channel 2, or displayed signal.

Weights

Net weight	6 lb	2.7 kg
Domestic shipping weight	9 lb	4.1 kg
Export-packed weight	13 lb	5.9 kg

Included Standard Accessories— 18-inch patch cord, BNC to BNC (012-0087-00); instruction manual (070-0354-00).

TYPE 3A2 DUAL-TRACE AMPLIFIER UNIT **$650**

3B2 TIME-BASE UNIT

Time Base— 2 μs/div to 1 s/div in 18 calibrated steps (1-2-5 sequence), accurate within 3%. Calibrated digital readout with 568/230 Digital Readout System.

Digital Resolution— 0.1 μs to 10 ms in 6 decade steps. Resolution can be selected independently of time/div. Clock accuracy is 0.1%.

Delay Time— 5 μs to 10.5 s, continuously variable and calibrated, accurate within 1%. Delay can be switched in or out.

Signal Outputs—Delayed trigger nominally +5 V, sweep gate nominally +15 V.

Trigger Coupling—AC Slow, AC Fast, or DC.

Trigger Sources—Internal, external, or line.

Trigger Requirements— 0.2-cm deflection or 0.4 V external. ±12-V trigger level selection.

Weights

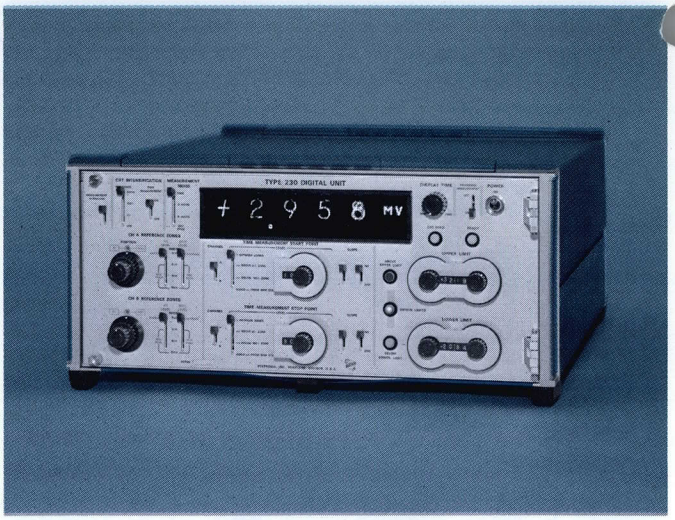
Net weight	6 lb	2.7 kg
Domestic shipping weight	8 lb	3.6 kg
Export-packed weight	13 lb	5.9 kg

TYPE 3B2 TIME-BASE UNIT **$795**
Includes instruction manual (070-0355-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

230
Digital Unit

- **PRESENTS OSCILLOSCOPE MEASUREMENTS IN DIGITAL FORM**
- **DIGITAL READOUT PARAMETERS**
  - **PULSE AMPLITUDE**
  - **PULSE RISETIME AND FALLTIME**
  - **PULSE WIDTH**
  - **TIME INTERVAL**
- **UP TO 100 MEASUREMENTS PER SECOND WITH OPTIONAL PROGRAMMERS**
- **PARALLEL GROUND-CLOSURE PROGRAMMING**



The 230 and R230 Digital Units provide digital measurements of signals displayed on the 568 Oscilloscope. The 230 has flexible measurement capabilities with up to 100 measurements per second, easy programming, BCD data outputs, and solid-state circuitry with extensive use of integrated circuits. The 230 Digital Unit can make a wide variety of repetitive pulse measurements on the signals displayed on the 568. The digital presentations can designate voltage measurements, time-difference measurements between similar pulses, and time-difference measurements between voltages or percentages of pulse amplitudes. The 230 can be externally programmed for use in high-speed, automatic measurement systems. Data output connectors provide measurement results in convenient BCD code. Programming is easily accomplished with the use of new Tektronix Program Units.

MEASUREMENT MODES

The 230 Digital Unit's four basic measurement functions (Channel A volts, Channel B volts, Time, and External Program) are selected by the Measurement Mode switch.

VOLTAGE measurements are made on either Channel A or Channel B between the 0% and the 100% reference zones. The signal polarity is determined and read out automatically on the digital readout.

TIME measurements are made on either Channel A, Channel B, or between the two channels. The time measurements are made from a predetermined start point to a predetermined stop point that can be referenced to the 0% and 100% reference zones or to the start of the sweep.

EXTERNAL PROGRAM—All of the front-panel functions required to make voltage and time measurements can be easily programmed externally. The variety and flexibility of measurements possible with external programming are even greater than those possible through use of the 230 front-panel controls, and measurements and limits can be changed more rapidly.

DIGITAL READOUT

The measurements made by the 230 are read out directly on six Nixie* tubes. Decimal point and unit of measure (ns, μs, ms, s, mV, V) are automatically presented. The polarity of the measurement (+ or —) is also read out automatically.

*Trademark Burroughs Corporation

DISPLAY TIME

The digital readout display time may be varied from ≈10 ms to 10 s. EXTERNAL HOLD light indicates when the measured data is being held until the recording device has had sufficient time to record the measurement. External hold does not prevent the next measurement from being made. In TRIGGERED MEASUREMENT operation, a measurement is started after receipt of a trigger (+ or —) and after DISPLAY TIME has been completed. The READY light indicates a ready condition for a trigger.

REFERENCE ZONES

The 0% and the 100% zones establish the reference points from which all measurements are made. The reference zones can be brightened on the oscilloscope by means of the CRT Intensification Reference Zone switch. The switch brightens both zones, 100% zone only, 0% zone only or disables the zone intensification.

The 0% POSITION and 100% POSITION controls determine the start position of the 0% and 100% zones to any 1/2-cm point from the start of the sweep by means of a 20-position switch. Five external program lines are required for each position control.

LEVEL WIDTH controls select the width of the reference zone and select the type of voltage reading, average or peak.

The AVERAGE 0.3-cm WIDTH position of the control is normally used for average voltage and most time measurements.

The three PEAK positions (2-cm, 4-cm, 10-cm WIDTH) are used for average-to-peak, or peak-to-peak voltage measurements. Two program lines are required for each 0% LEVEL or 100% LEVEL width controls.

TIME MEASUREMENT START POINT

The start of the time measurement is selected to start on either Channel A or Channel B and on the first or second positive-going or negative-going slope. The time measurement starts when the signal reaches one of the 99 predetermined levels. Four different modes of start point level selection are available: (1) % between 0% and 100% zones, (2) mm above 0% zone, (3) mm below 100% zone, and (4) Horizontal mm from sweep start. Eleven BCD program lines are required for externally programming the time measurement start point. There are 159 predetermined levels available in the external programming mode.

CRT intensification during the time measurement portion of the sweep is selected by means of the CRT Intensification Time Measurement On-Off switch.

TIME MEASUREMENT STOP POINT

All functions of the Time Measurement Stop Point controls are similar to the Time Measurement Start Point controls. The count is stopped on a selected point Ch A or Ch B. If the Stop Point occurs before the Start Point, a negative reading is indicated.

RESOLUTION

DOTS/MEASUREMENT Time measurements are performed by gating and counting clock-pulses during the measurement interval. If a measurement interval occupied 2.5 div and the sweep speed was 10 ns/div with 100 samples/div, then 250 samples would be registered in the digital readout counter and reading would be 25.0 ns.

The TIME MEASUREMENT START and STOP comparators have ±0.1 mm pick-off resolution capabilities. This gives the 230 the ability to scale a 1-cm display in 1% steps.

MEASUREMENT AVERAGING permits selection of measurements to be a statistical average of eight sweeps or to be a measurement of only one sweep. One program line is required for Measurement Averaging selection.

LIMIT CONTROLS

The Limit Controls select the UPPER and LOWER measurement Limits. Measurement limit results can be quickly determined, on the front panel, by means of three lights (ABOVE UPPER LIMIT, WITHIN LIMITS, BELOW LOWER LIMIT) and the information is available on the rear panel for stopping automatic measurement sequences or for automatic sorting. Fifteen BCD lines are required for programming each limit control.

EXTERNAL READOUT

Data outputs are available on the rear panel of the 230 that permit the recording of measurement polarity, displayed digits, units of measure, decimal point, and measurement limit results. The information is in BCD code.

The 230 can be synchronized to a data recorder. Regulated power is available for use in systems applications.

EXTERNAL PROGRAMMING

All of its measurement functions can be programmed by means of ground closures or logic levels. The programming is achieved with 105 program lines using negative logic with true being ground or 2 V or less and false being open or 6 V or more. Suitable programming devices include: The 241 Programmer, 240 Program Control Unit, card readers, block readers, computers, etc.

When using the 3T5 or 3T6 Programmable Sampling Sweep Units for the oscilloscope time base, the 230 Digital Unit can program the sweep to provide increased measurement speeds. The time base can be made to run fast (10 dots/div) during the non-measurement part of the sweep and then run at normal speeds (100 dots/div) for maximum resolution during the measurement. This function is obtained by externally programming the high-speed program line.

Measurement speed can be increased by externally programming the position of the 0% and/or 100% Reference Zones start point to 12 cm. This puts the reference zones into a memory hold position of up to 10 seconds and permits several different measurements to be made without a zone charging sweep. This gives an additional feature of permitting measurements referenced to reference zones that are not on the CRT display.

OTHER CHARACTERISTICS

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 130 watts maximum at 115 V and 60 Hz. Rear-panel selector provides rapid accommodations for six line-voltage ranges.

Dimensions and Weights

	230		R230	
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16-13/16	42.7	19	48.3
Depth	21-7/8	55.5	22-3/4	57.8
	lb	kg	lb	kg
Net weight	56	25.4	61	27.6
Domestic shipping weight	73	33.1	79	35.8
Export-packed weight	94	42.6	100	45.3

INCLUDED STANDARD ACCESSORIES

230 to 568 48-inch interconnection cable (012-0119-01); Automated Measurement Systems Concept Book (062-1106-00); instruction manual (070-0635-00). R230 also includes slide-out assembly (351-0086-00) and mounting hardware.

230 DIGITAL UNIT **$3900**
R230 DIGITAL UNIT **$3950**

Field Modification Kit, order 040-0489-00 ..... $84
Includes all hardware required to convert bench 230 to rack-mount R230.

SIGNAL CHOPPERS

With the signal choppers, the 230 Digital Unit can make DC and pulse voltage measurements with respect to ground.

Probe Chopper Quad (set of 4) for S-3A Probes, includes case and accessories, order 015-0155-01 ..... $375

Probe Chopper for two S-3A Probes, order 015-0128-01 .. $190
Includes: two 10X attenuators (010-0367-00)

Probe Chopper for two P6045 Probes, order 015-0129-01 . $110

50 Ω Quad Signal Chopper, order 015-0185-00 ..... $400

50 Ω Dual Signal Chopper, order 015-0184-00 ..... $250

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

240

Program Control Unit

- **PROGRAM BRANCHING FOR DIAGNOSTIC TESTING**
- **PROGRAM PREPARATION, MODIFICATION AND VERIFICATION**
- **PROGRAM STORAGE**
  - **Disc Memory Option**
  - **Punched Tape Reader Option**
- **EXPANDABLE WITH R250**
  - **192 or 384 Additional Program Lines**

The 240 and R240 Program Control Units are designed to provide automated measurements utilizing the 568 Oscilloscope with the 3T5 or 3T6 and 3S5 or 3S6 Programmable Plug-In Units and the 230 Digital Unit. The 240 accepts program data serial-by-bit from the optional Disc Memory, serial-by-character from an optional Punched Tape Reader or from an external source. Programs may be originated or modified manually from the front panel of the 240. If other equipment needs to be externally programmed, an R250 Auxiliary Program Unit may be added to the 240.

Measurement rates in excess of 100 measurements per second are achieved and sorting, classifying, and diagnostic test routines are performed using the Disc Memory. The Disc Memory also permits random access to a library of up to 1600 independent measurements. This feature permits a computer or other control device to have complete control over the test measurements, making calculations from the test data and using the Disc Memory for further measurements and sorting at the maximum test rates.

The Punched Tape Reader provides a maximum measurement-rate of 5 measurements per second. The Disc Memory can be added later. The Punched Tape Reader is also used for loading measurement programs into the Disc Memory. The 240 may be used without the Disc Memory or Punched Tape Reader by providing program data externally in a serial-by-character form, asynchronously at up to 600-kHz character rate. Data sources include paper or magnetic Tape Readers and computer data output.

The 240 has a fixed word length of 48 4-bit characters that normally are used to program the measurement address, 568 Oscilloscope with the 3T5 or 3T6 and 3S5 or 3S6 Programmable Plug-in Units, and the 230 Digital Unit. The 192 program lines use negative logic, with true being a saturated NPN transistor to ground and false being an open collector. The 240 can also be used to program other equipment.

The R250 Auxiliary Program Unit expands the programming capabilities of the 240, permitting programming of pulse generators, power supplies, test fixtures, automatic handlers, and other devices required for automated measurement systems. The R250 provides program buffering, digital-to-analog conversion, and patch panel capabilities. One R250 provides an additional 192 program lines; two R250's provide 384 program lines.

240
Program Control Unit

FUNCTIONS

The 240 has eight function modes selected by a front-panel switch. It performs any functions after receiving a start command from an external source or the front panel. The functions are as follows:

Transfer Test On Disc To Tape—Loads the 240 with program data from the Disc Memory, selected by test address. When the 240 register is full, the program data is shifted to the Tape Punch. When the Tape Punch has punched a complete program, the 240 is returned to a ready condition.

Locate Next Disc Address—Locates the next disc address after a measurement has been made. Programs on the disc are spaced to achieve fast access time. Measurement rates are in excess of 100 per second.

Read Test From Disc—Loads a register with program data from the selected disc sector and commands the 568/230 to make a measurement. After measurement, the 240 returns to the ready condition.

Read Test Sequence From Disc—Loads a register with program data from the selected disc sector and commands the 568/230 to make a measurement. After measurement, a command from the 230 loads the register with data from the disc sector selected by the next test address. The automatic sequencing continues until the 240 completes all measurements. In this mode the 240 can be programmed to branch to a new measurement sequence and stop the sequence on out-of-limits measurements. For example, when making a risetime measurement, an above-limit risetime can stop the sequence and a below-limit risetime can branch to a new measurement sequence for reclassifying the component. Out-of-limit measurements are normally programmed to repeat, to check for measurement error.

Read Test Sequence From Tape—Loads a register with program data from the Punched Tape Reader and commands the 230 to make a measurement, and continue making measurements until the 240 receives a stop signal. The Punched Tape Reader can program the 240 to stop the sequence on out-of-limit measurements. Out-of-limit measurements are normally programmed to repeat, to check for measurement error.

Examine Or Modify Characters In Register—Displays on character data lights the data that is in a selected shift register. Characters are selected by character address switches. Characters can be modified with the use of the new-data switch and the modify push button.

Write Test In Register On Disc—Permits new or modified program data in the register to be written on a selected disc sector. A write inter-lock prevents accidental writing and changing of data written on the Disc Memory.

Transfer Tape Sequence To Disc—Loads the register with new program data from the Punched Tape Reader and writes the program data on a selected disc sector. The write inter-lock key prevents accidental writing on the Disc Memory.

PROGRAM INPUTS

The 240 program inputs are in one of two forms: serial by 4-bit character plus parity at up to 600-kHz character rate, or the Disc Memory input is serial by bit (4 bits plus parity per character) at a 3-MHz bit rate. The optional Disc Memory and Punched Tape Reader are designed specifically for use with the 240. The Disc Memory has a storage capacity of 1600 measurements for a 240/250 System; 1080 measurements for a 240/250/250 System. Program access time for the Disc Memory averages 17 ms, but can be optimized to approximately 1 ms by minimum access-time programming. The optional Punched Tape Reader has a maximum speed of 300 characters per second and is used in low-speed measurement systems and for loading programs into Disc Memory. Magnetic tape readers, computers, and other data sources can be used with the 240.

DISC TEST ADDRESS

The disc test address can be selected manually or externally by computer or other control device. This permits random access to the Disc Memory. For external control of the disc test address, 12 program lines are required with negative logic (true = 0 V to +2 V, false = +6 V to +12 V) plus one external enable-line.

PROGRAM LINE OUTPUTS

The 240 has 192 lines that are normally used to program the 568 Oscilloscope with the 3T5, 3T6, 3S5, or 3S6 Programmable Plug-In Units, and the 230 Digital Unit. These lines can program other equipment when the 568 and 230 are in use. Program lines use negative logic, with true being a saturated NPN transistor to ground and false being an open collector. Space is available on program boards for special circuitry such as logic level conversion, logical inversion, gating, etc.

OTHER CHARACTERISTICS

Power Requirements—90 V to 136 V or 180 V to 272 V, 48 to 66 Hz, 194 watts at 115 V and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Dimensions and Weights

	240		R240	
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16-3/4	42.7	19	48.3
Depth	21-7/8	55.5	22-3/4	57.8
	lb	kg	lb	kg
Net weight	37-1/2	17.0	38-1/2	17.4
Domestic shipping weight	49	24.2	54	24.4
Export-packed weight	69	31.3	74	33.6

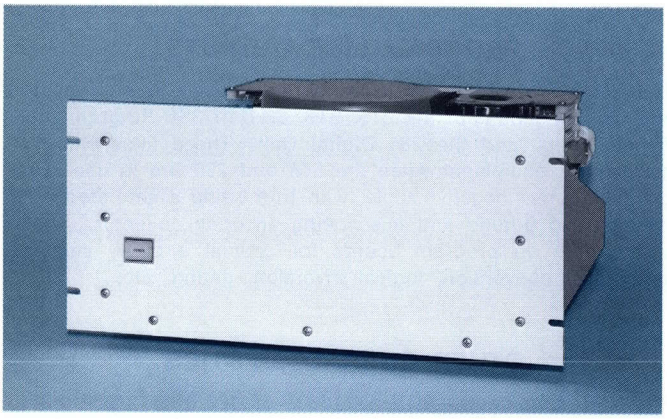
INCLUDED STANDARD ACCESSORIES

240 only adapter (013-0095-00); Punched Tape Reader only adapter (013-0096-00); 36-pin cable J202 (012-0131-03); 36-pin cable J203 (012-0131-04); 36-pin cable J214 (012-0131-05); 36-pin cable J224 (012-0131-06); 36-pin cable J201 (012-0131-07); 36-pin cable J204 (012-0131-01); 240 program format table tablet (070-0884-01); instruction manual (070-0749-00).
R240 also includes mounting tracks (351-0086-00) and mounting hardware.

240 PROGRAM CONTROL UNIT **$4850**
R240 PROGRAM CONTROL UNIT **$4900**

OPTIONAL ACCESSORIES

Disc Memory—An 8-track rotation Disc Memory capable of storing 200 measurements per track or a total of 1600 measurements with the 240 or 240/250 Program Units; 1080 measurements with the 240/250/250. The Disc Memory is 8-3/4 inches high, 19 inches wide, 19-3/4 inches deep, weighs 62 lb. The instrument is wired for 108-V to 132-V operation, 190 watts, 60 Hz. The Disc Memory is made by Data Disc, Inc.



Disc Memory, 60 Hz power, order 020-0024-00 ..... $7200

Disc Memory, 50 Hz power, order 020-0028-00 ..... $7200

Disc Memory for 240/250/250, 60 Hz power, order 020-0025-00 ..... $7200

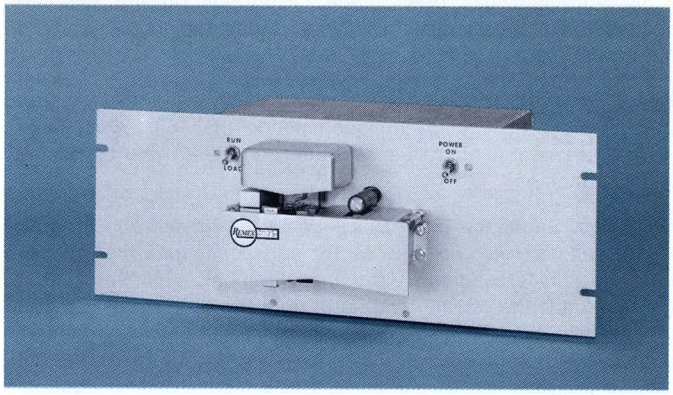
Disc Memory for 240/250/250, 50 Hz power, order 020-0029-00 ..... $7200
Includes: extender card (012-0151-00); 240 to Disc Memory cable (012-0133-00).

Line Selector Transformer—Designed for use with the above optional accessories, where line voltages are encountered outside the accessories' limitations. The transformer will deliver 0.85 kVA, within the voltage ranges of 90 V to 136 V or 180 V to 272 V, 48 to 66 Hz (50 or 60 Hz with above accessories).

Three outlets are available; one wired for 120 V nominal, two are wired for 115 V nominal.

Line Selector Transformer, order 120-0598-00 ..... $193

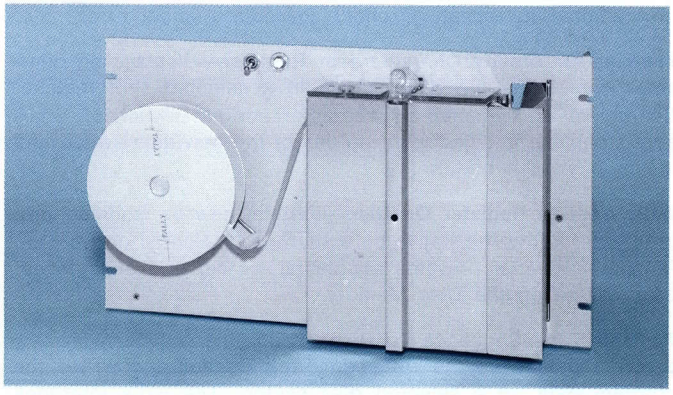
Punched Tape Reader—Designed for use with the 240 for programming the 568/230 Digital Oscilloscope System or for loading programs into the Disc Memory. Programs may be generated on the Tape Punch or any standard ASCII tape punch. The Punched Tape Reader has a maximum speed of 300 characters per second. Measurement programs are fixed word length and require 48 4-bit characters plus parity when using the 240, 96 4-bit characters plus parity when using a 240/250, and 144 4-bit characters plus parity when using a 240/250/250 Measurement System. The Punched Tape Reader is 7 inches high, 19 inches wide, 7-3/4 inches deep, and weighs 26 lb. Power requirements are 95 V to 130 V, 150 watts, 60 Hz. The Punched Tape Reader is made by Remex Electronics, Inc.



Punched Tape Reader, 60 Hz power, order 020-0026-00 . $1375

Punched Tape Reader, 50 Hz power, order 020-0030-00 . $1375
Includes: 240 to Punched Tape Reader cable (012-0147-00).

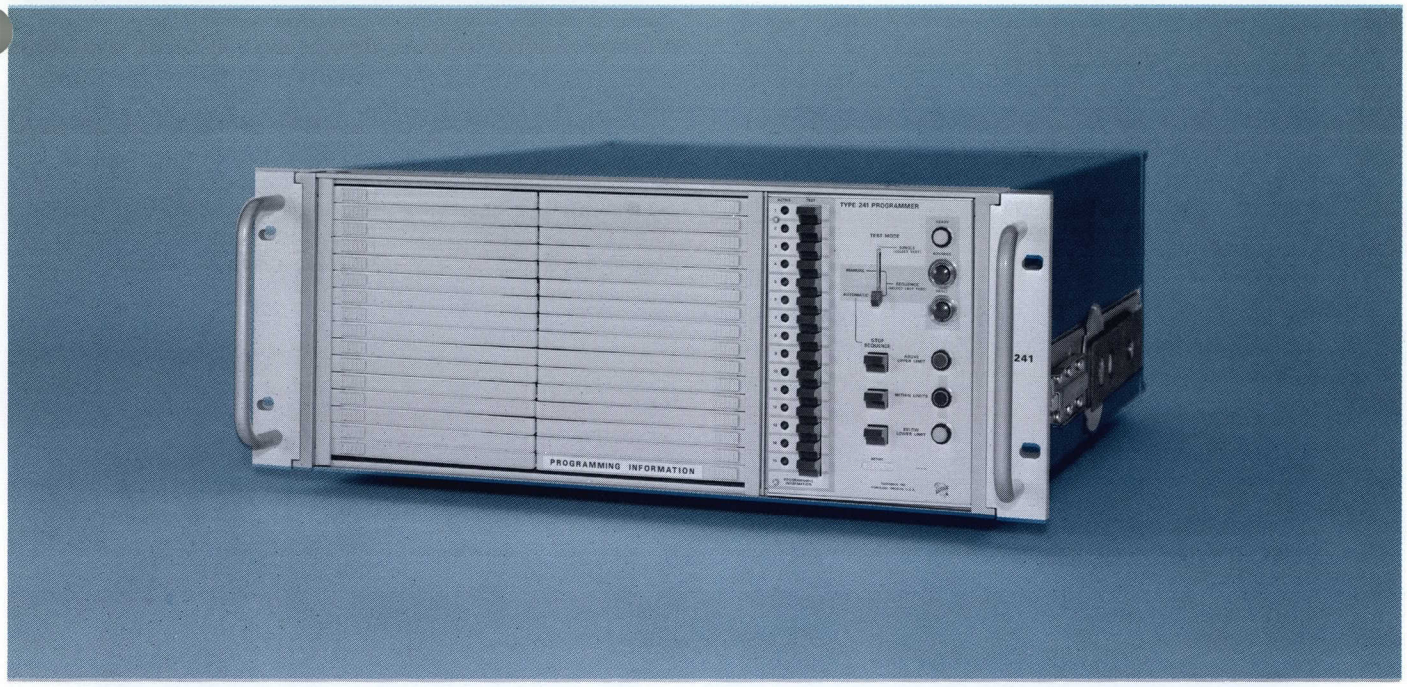
Tape Punch—Used for generating new program tapes from the 240. Programs stored in the Disc Memory may be transferred via the 240 to the Tape Punch for permanent storage. The Tape Punch has a maximum speed of 60 characters per second. It is 10-1/2 inches high, 19 inches wide, 12-3/4 inches deep, and weighs 38 lb. The Tape Punch is factory wired for 105-V to 125-V operation, 320 watts, 50 Hz to 60 Hz. The perforator mechanism is made by Tally, Inc.



Tape Punch, order 020-0027-00 ..... $2800
Includes: 240 to Punched Tape Reader/Tape Punch cable (012-0146-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

241
Programmer



- **PROGRAMS UP TO 15 MEASUREMENTS**
- **AUTOMATIC OR MANUAL MEASUREMENT SEQUENCE**
- **AUTOMATIC TEST LIMITS STOP**
- **14 ADDITIONAL PROGRAM LINES**

The 241 Program Unit is designed for use with the 568 Oscilloscope; 3T5, 3T6, 3S5, or 3S6 Programmable Plug-In Units; and the 230 Digital Unit. The 241 has 14 lines available for programming other equipment.

15 programmed measurements can be selected by front panel push buttons or external control lines and automatic or manual sequencing is provided. In the automatic sequence mode, out-of-limit conditions can stop the measurement sequence.

Each measurement is programmed with quick-insertion diode logic. Changing programs is a simple, plug-in operation.

OPERATING MODES

Single Test—Any one measurement can be selected, in any order, by push button or by grounding external control lines.

Manual Sequence—Up to 15 measurements are sequenced, one each time the ADVANCE button is pushed or external line is grounded.

Automatic Sequence—All programmed measurements (1 thru 15 are sequenced once on command from the ADVANCE button. Measurements outside of programmed limits stop sequencing. The ADVANCE button resumes sequence. The RESET button readies the sequence to restart the first measurement. ADVANCE and RESET command external control-lines are activated by ground closure.

OTHER CHARACTERISTICS

Power Requirements—Supplied by the 230 Digital Unit.

Dimensions and Weights

	241		R241	
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16 3/4	42.7	19	48.3
Depth	21 7/8	55.5	22 3/4	57.8
	lb	kg	lb	kg
Net weight	33	14.9	35 1/2	16.1
Domestic shipping weight	52	23.5	51	23.1
Export-packed weight	72	32.6	71	32.2

INCLUDED STANDARD ACCESSORIES

36-pin cable J202 (012-0131-03); 36-pin cable J203 (012-0131-04); 36-pin cable J214 (012-0131-05); 36-pin cable J224 (012-0131-06); 36-pin cable J201 (012-0131-07); interconnecting cable, 6 feet long (012-0131-01); 15 program circuit cards (670-0285-00); 30 blank labels (334-1337-00); 3 diode packages with 150 diodes each (016-0254-00); 3 diode insertion tools (003-0611-00); test format tablet (070-0908-00); instruction manual (070-0809-00). R241 also includes slide-out assembly (351-0086-00) and mounting hardware.

241 PROGRAMMER **$2540**
R241 PROGRAMMER **$2590**

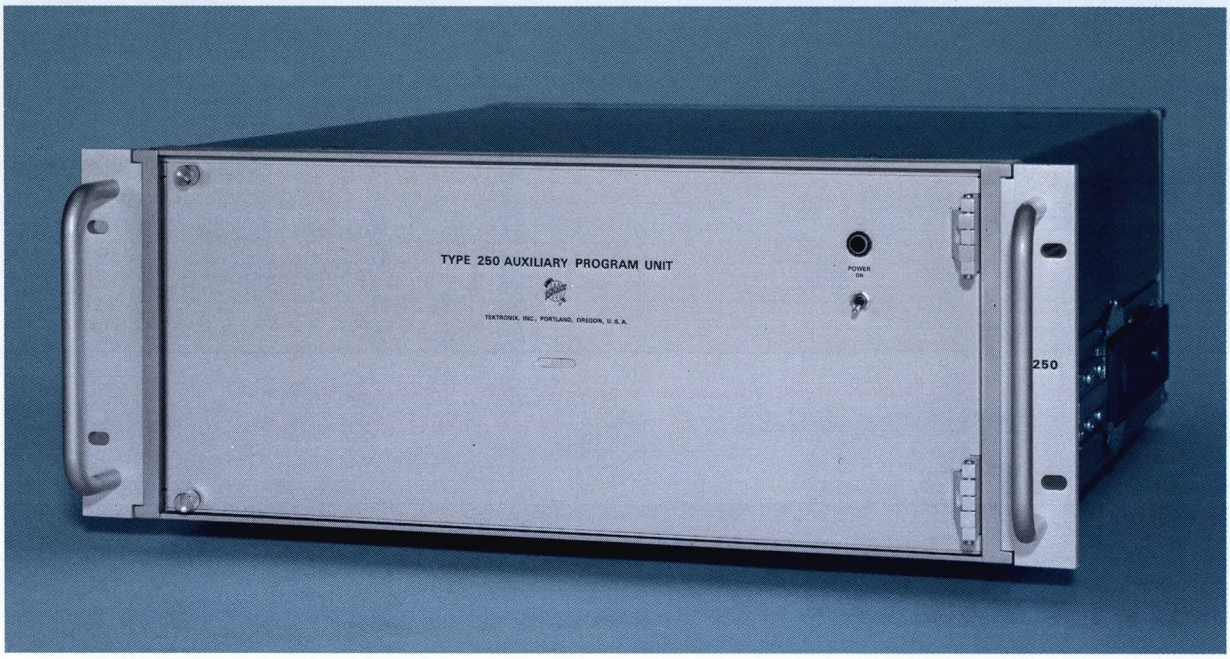
OPTIONAL ACCESSORIES

Program Card— 15 additional program cards can be stored in the 241. Cards are easily rearranged for different tests, order 670-0285-00 ..... $44

Diode Package— 150 diodes, order 016-0254-00 ..... $60

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

250
Auxiliary Program Unit



- **PROGRAMS**
  - R116 PULSE GENERATOR
  - R293 PULSE GENERATOR
  - POWER SUPPLIES
  - FIXTURES
  - OTHER EQUIPMENT
- **192 PROGRAM LINES**
  - 48 4-BIT CHARACTERS
- **PROGRAM BUFFERING**
  - LEVEL CONVERSION
  - LEVEL INVERSION
  - DIGITAL-TO-ANALOG CONVERSION
- **PATCH-PANEL CAPABILITIES**

The R250 Auxiliary Program Unit is designed for use with the 240 Program Control Unit to permit external programming of additional equipment such as: power supplies, pulse generators, and fixtures. Internal power supplies are available for external programming requirements: +20 V at 300 mA, +10 V at 4 A, +3.6 V at 7 A, and −10 V at 2 A. The R250 requires 12 program assembly cards and cables for operation. Program assembly cards consist of one shift register card and two program (standard, resistance, conductance) cards in any combination.

Systems engineering is required with the shift register cards and the program boards. The customer must determine the proper interface required from the R250 to the auxiliary equipment to be programmed. Then two program boards are selected and wired to each shift register card to obtain the necessary program functions. Three program boards are available offering the following functions: standard program boards with negative logic programming, resistance program boards, and conductance program boards.

Up to two R250's may be used with the 240, providing an additional 192 program lines per R250. The R250 has 48 4-bit characters with 192 program lines. It features program buffering, digital-to-analog conversion and patch panel capabilities.

Two Tektronix programmable pulse generators are available and listed under optional equipment. They come complete with the program assembly cards and cables necessary for use with the R250.

Power Requirements— 90 V to 136 V or 180 V to 272 V, 48 to 66 Hz, 194 watts at 115 V and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22 3/4 in	57.8 cm
Net weight	37 1/2 lb	17.0 kg
Domestic shipping weight	≈52 lb	≈23.5 kg
Export-packed weight	≈72 lb	≈32.6 kg

INCLUDED STANDARD ACCESSORIES

240 to R250 interconnecting cable (012-0134-00); program format table (070-0886-00); mounting tracks (351-0086-00) and mounting hardware; instruction manual (070-0748-00).

R250 AUXILIARY PROGRAM UNIT **$1800**
(requires 12 Program Assembly Cards for operation)

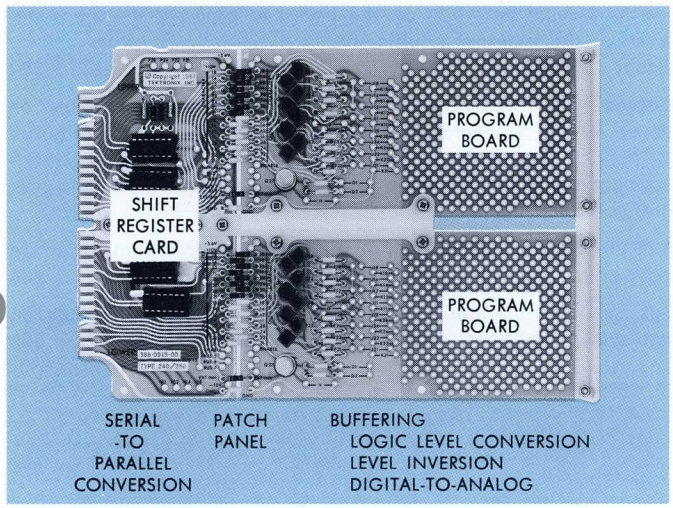
R250 MOD 29

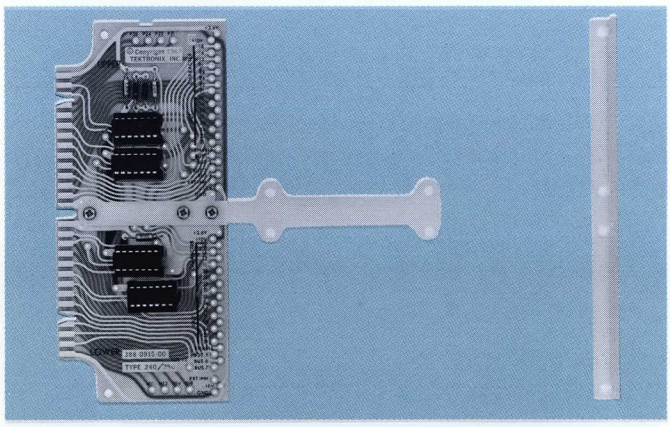
If a second R250 is to be used in a system, please indicate on your order, R250 MOD 29.

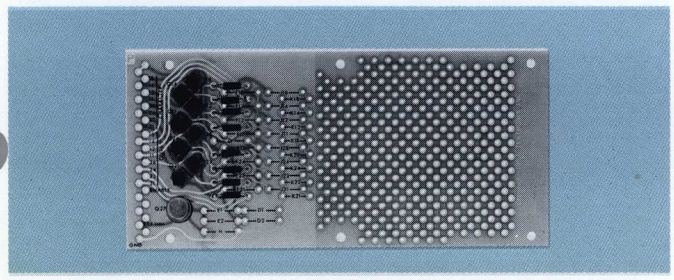
INCLUDED STANDARD ACCESSORIES

240 to R250/250 interconnecting cable (012-0135-00); performance check program tape (016-0134-00); program format table (070-0887-00); mounting tracks (351-0086-00) and mounting hardware; instruction manual (070-0748-00).

R250 MOD 29 AUXILIARY PROGRAM UNIT **$1800**
(requires 12 Program Assembly Cards for operation)







REQUIRED PROGRAM ACCESSORIES

Program Assembly Cards—Twelve program assembly cards are required for operation of the R250. Each program assembly card consists of one shift register card that does the serial-to-parallel conversion, and two program boards that provide program buffering. Wiring between the shift register card and the program boards is required. Interwiring connections provide patch-panel capabilities. Two Tektronix Programmable Pulse Generators are available with program assembly cards necessary for programming their functions.

Shift Register Card— 12 shift register cards are required for the operation of the R250. Each card contains a 4-character, 4-bit shift register providing a total of 16 bits for programming. The normal connection from the shift register is 8 bits to the upper program board and 8 bits to the lower program board. Two program boards are required with each shift register card. The program boards may be of the same or different types. The shift register card provides the following connections: 16 program lines to an associated rear-panel connector, 8 lines to an adjacent program board on the right, and 8 lines to an adjacent program board on the left.
Order 020-0020-00 ..... $77.00

Standard Program Board—The standard program board contains separate buffer amplifiers for 8 program lines and has provisions for adding isolation diodes and RC delay networks for each program line. The standard program board must be mounted on the shift register card, and inter-wiring connections must be made. The board provides negative logic with true being a saturated NPN transistor to ground, and false being an open collector. Space is available on the board for special circuitry, such as logic level conversion, logical inversion gating, etc.
Order 020-0021-00 ..... $27.50

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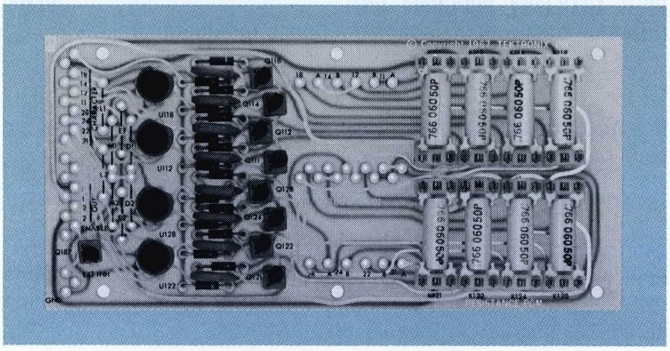
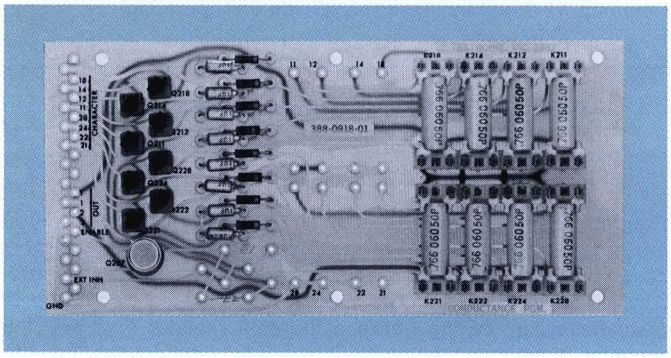
Please refer to General Information page





Resistance Program Board—The resistance program board includes buffer drivers, amplifiers, and reed relay switches and coils for switching 8 resistors in a series of resistive networks. Eight program bits from the shift register provide 2 decades of resistance changes (1% increments) for programming analog functions. The resistance program board provides digital-to-analog conversion necessary for programming analog equipment. The resistance program board must be mounted on the shift register card, and inter-wiring connections must be made. Proper resistors must be wired on the board to program the steps desired in the external equipment.

Order 020-0023-00 ..... $88

Conductance Program Board—The conductance program board is similar to the resistance board, except that 8 resistors are switched in a parallel resistance network. This gives 100 increments of conductance change for programming analog conversions which require linear change of conductance. The conductance program board must be mounted on the shift register card, and inter-wiring connections must be made. Proper resistors must be wired on the board to program the steps desired in the external equipment.

Order 020-0022-00 ..... $94

Cables—The 192 program lines of the R250 are available on seven 36-pin connectors on the rear panel. Cables are required to connect the R250 to the programmable instruments. Interconnecting cables are included with the optional Tektronix programmable equipment.

6-ft shielded interconnecting cable with 36-pin connector on both ends, order 012-0131-00 ..... $44

8-ft shielded interconnecting cable with 36-pin connector on one end, no connector on other end, order 012-0132-00 .. $28

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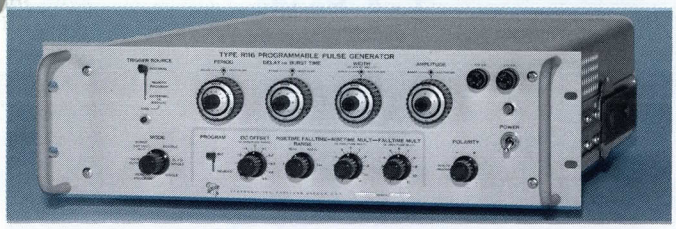
OPTIONAL PROGRAMMABLE PULSE GENERATORS



R116 MOD 703L PROGRAMMABLE PULSE GENERATOR

The R116 MOD 703L Programmable Pulse Generator is a modified R116 Programmable Pulse Generator furnished with 5 Program Assembly Cards and interconnecting cables necessary for use with the R250. Program assembly cards program the R116 and are calibrated. The input and output connectors of the R116 MOD 703L are on the rear panel.

75 programming bits are required for all range and incremental programming plus mode and polarity programming. If all functions do not require programming, one or more of the programming assembly boards need not be used. Front panel controls are accurate within the indicated tolerances plus an additional 2%.

Pulse Period—Programmed in 5 decade ranges (100 ns, 1 μs, 10 μs, 100 μs, 1 ms). Each range can be programmed from X1.0 to X10.0 in 0.1 incremental steps. Accurate within 5% on 100-ns range, within 3% on all other ranges.

Pulse Delay/Burst—Programmed in 4 decade ranges (10 ns, 100 ns, 1 μs, 10 μs) with each range programmed from X5.0 to X54.5 in 0.5 incremental steps. Accurate within 3% + 10 ns.

Pulse Risetime and Pulse Falltime—Programmed from 10 ns to 109 μs. The risetime and falltime is the result of (t_r/t_f range) x (t_r or t_f multiplier) x (amplitude multiplier). Range is programmed in 4 decade steps (1 ns, 10 ns, 100 ns, 1 μs). Risetime and falltime multipliers are separately programmable, but share a comon range program. Multiplier ranges are from X1.0 to X10.9 in 0.1 incremental steps. Accurate within 10% above 10 ns on the 1-ns and 10-ns range, within 5% on the 100-ns and 1-μs range. When (t_r/t_f range) x (t_r of t_f multiplier) x (amplitude multiplier) is less than 10 ns, the output risetime or falltime is less than 11 ns, uncalibrated.

Pulse Amplitude—Programmed in 3 ranges (0.2 V, 0.5 V, 1 V) with multipliers from X2.0 to X9.9 in 0.1 incremental steps. Amplitude into 50 Ω is accurate within 3% + 15 mV on 0.2-V range; within 3% + 25 mV on 0.5-V range; within 3% + 50 mV on 1-V range.

Pulse Width—Programmed in 4 decade ranges (10 ns, 100 ns, 1 μs, 10 μs) with each range programmed from X5.0 to X54.5 in 0.5 incremental steps. Accurate within 5% on 10-ns range, within 3% on all other ranges.

Pulse DC Offset Range—Programmed in 80 increments in 0.1 incremental steps, from 0.0 to 4.9 times the pulse amplitude range. Accurate within 5% ±200 mV.

R116 MOD 703L **$3365**

Includes: 5 program assemblies for the R250; card P7, pulse delay (672-0207-01); card P8, pulse period, mode (672-0208-01); card P9, pulse width, amplitude, t_r/t_f decade, offset (672-0208-02); card P10, pulse width multiplier, amplitude multiplier (672-0209-01); card P11, pulse risetime multiplier, falltime multiplier (672-0209-02); R116 MOD 703L to R250 interconnecting cable (012-0141-00); test format tables; standard accessories of R116; instruction manual.

R293 MOD 703M PROGRAMMABLE PULSE GENERATOR

The R293 MOD 703M is a modified Tektronix R293 Programmable Pulse Generator and Power Supply Unit furnished with a program assembly (1 shift register card with 2 program boards installed and wired) for the R250, designed to program the pulse amplitude and pulse width of the R293. Input and output connectors of the R293 are on the rear panel. The following performance characteristics apply to the R293 MOD 703M programmed by the Tektronix R250 Auxiliary Program Unit and using the program assembly card furnished with the R293.

PROGRAMMABLE CHARACTERISTICS

Pulse Amplitude—Programmed with 4 bits in 0.5-V increments over a range of 6 V to 12 V, accurate within 3% of programmed value.

Pulse Width—Programmed with 10 bits in 1-ns increments over a range from 2 ns to 250 ns, accurate within 3% + 3 ns.

NON-PROGRAMMABLE CHARACTERISTICS

Risetime— 1 ns or less at maximum amplitude.

Falltime— 1 ns or less at 20 ns or more width, 2 ns or less at 3 to 20 ns width at maximum amplitude.

Repetition Rate— 10 kHz or less to 90-100 kHz, continuously variable, uncalibrated.

Polarity—Selectable, positive or negative.

POWER SUPPLY

Regulated Current Supply— 300 μA to 300 mA (continuously variable) at up to 20 V, positive or negative polarity. Accuracy within ± (3% of dial reading) +50 μA, or ± (3% of programmed value) +50 μA. ±1% maximum change with line change from 93.5 V to 135 V. Ripple is 0.5% or less or 50 μA, whichever is greater. Overshoot is 0.5% or less of change in programmed current.

Regulated Voltage Supply— 0 to ±50 V (continuously variable) at up to 200 mA. Accuracy within ± (2% of dial reading) +25 mV, or ± (3% of programmed value) +25 mV. ±1% maximum change with line change from 93.5 V to 135 V. Ripple is 0.05% or less or 5 mV, whichever is greater. Overshoot if 5% or less of change in programmed voltage.

OTHER CHARACTERISTICS

Pretrigger Pulse— +1/2 V or more into 50 Ω and +2 V or more into open circuit, occurs approximately 200 ns before leading edge of main pulse. 100-ps maximum jitter between pretrigger and leading edge of main pulse.

External Trigger Requirement— 2 V or more; DC to 100 kHz; 1-μs or less risetime; 200 V DC maximum.

Power Requirements— 93.5 V to 135 V or 187 V to 270 V, low or high range selected by rear-panel switch. 50 to 400 Hz, 65 watts maximum.

R293 MOD 703M **$1675**

Includes: Program assembly card for R250 (672-0210-01); R293 MOD 703M to R250 interconnecting cable (012-0142-00); measurement format table; instruction manual with MOD 703M additions; plus included standard accessories of the R293.

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Please refer to General Information page

286 Multiplexer Unit
287 Multiplexer Control Unit
R288 Multiplex Master Controller

SAMPLING-HEAD MULTIPLEXING

A Sampling-Head Multiplexer system allows the signals from up to 64 test points to be measured by a two-input sampling unit. The measurements are made from a sampling head coupled to each test point. The signals sensed by these sampling heads are then electronically switched (multiplexed) into the sampling unit, two signals at a time.

SAMPLING HEAD MULTIPLEXER

The 286 Sampling Head Multiplexer is the basic unit of a sampling-head multiplexer system. The 286 can operate four sampling heads. When operated singly, a 286 receives head selection commands directly from the external programmer and signal data directly from the selected sampling head. Head selection commands are digital information that determine which sampling heads are operated with the sampling unit. Signal data is analog information consisting of strobe driver pulses, offset and feedback voltages, signal samples (from the sampling heads) and reference voltages.

A 286 may be installed in a 287 or R288. In this case, the 286 receives its head selection and signal data from the R288 and/or the 287.

MULTIPLEX CONTROL UNIT

The 287 controls up to four 286's, thus allowing the multiplexing of up to 16 sampling heads. The 286's are installed in compartments in the 287. If only one 287 is being operated, it receives head selection commands directly from the external programmer and signal data directly from the sampling unit.

A 287 may be controlled by an R288. In this case, the 287 receives head selection and signal data from the R288. A rack-mount version of the 287, called an R287, is also available.

MULTIPLEX MASTER CONTROLLER

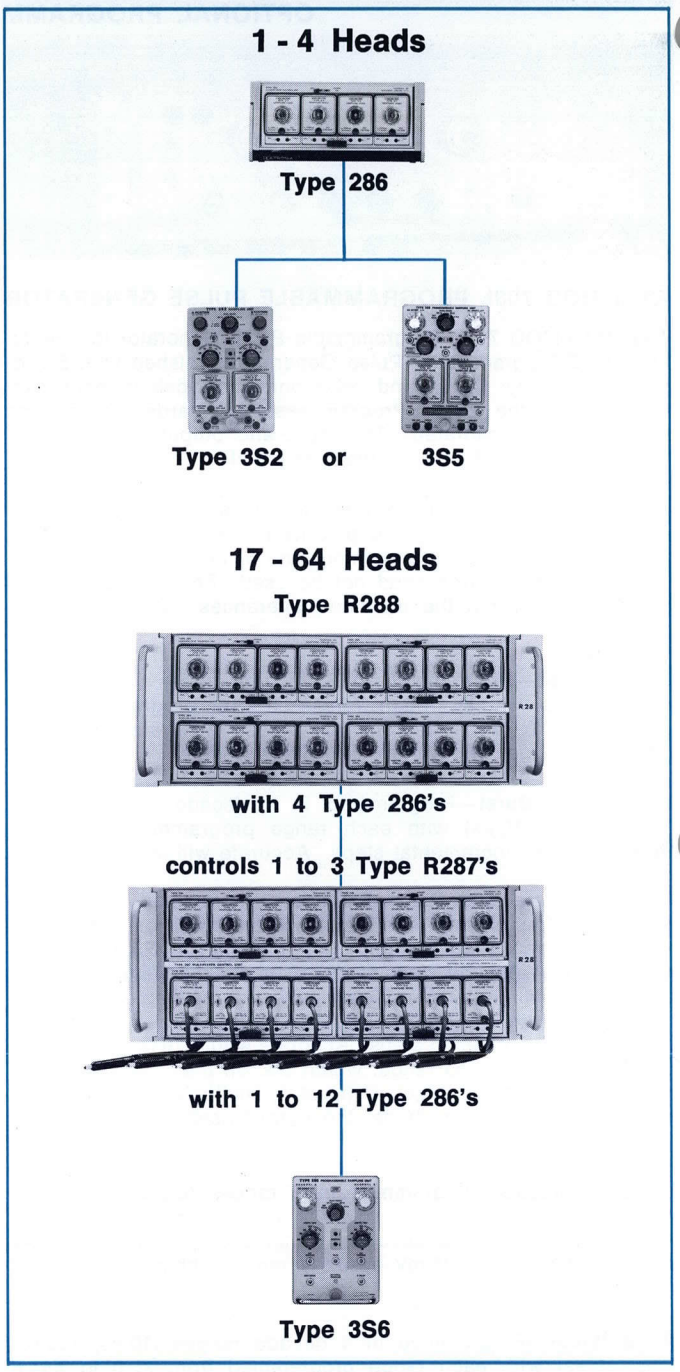
The R288 controls up to four 287's, thus allowing the multiplexing of up to 64 sampling heads. To conserve space, the circuitry of one 287 is built into each R288. The R288 controls the 287 circuitry within its own physical unit and up to three other 287's. The R288 receives head selection commands from the external programmer, and signal data from the sampling unit. This data is then distributed to the 287's and 286's.

SAMPLING SYSTEMS WHICH CAN USE SAMPLING-HEAD MULTIPLEXING

Oscilloscope	Sampling Unit	Sampling Sweep
568/R568	3S2	3T2
	3S5	3T5
	3S6	3T6
561B/R561B	3S2	3T2
	3S5	3T5
564B/R564B	3S2	3T2
	3S5	3T5
7000 Series	7S11 (2 each)	7T11

The following Sampling Heads can be used with the 286, 287, R288 Multiplex Systems: S-1, S-2, S-3A, S-4, S-5, S-6, S-50, S-51, S-52, S-53, and S-54.

Three Tektronix programmers may be used to program sampling head multiplexer systems: the 241 Programmer, the 240 Program Control Unit, or the R250 Auxiliary Control Unit. The programmer provides head selection commands to control the operation of the 286's, 287's, and R288. If an R250 is chosen to program the multiplexer system, a special R250 program assembly is necessary.



TEKTRONIX PROGRAMMERS WHICH CAN BE USED TO PROGRAM A SAMPLING-HEAD MULTIPLEXER SYSTEM

Programmer	Number of Heads It Can Program	Type of Memory
241/R241	Up to 16	Program Cards
240/R240	Up to 16	Magnetic Disc, Perforated Tape, Computer
240 and R250	Up to 64	

Multiplexer Unit 286
Multiplexer Control Unit 287
Multiplex Master Controller R288

286 SAMPLING-HEAD MULTIPLEX UNIT

Indicator lamps for each head indicate which of the dual-trace sampling unit channels has been selected for display. Front-panel delay and balance adjustments are provided for each head.

Displayed Noise—(Introduced by 286) Less than 1.2X noise specified for selected head.

Deflection Factor Change—(Introduced by 286) Within 1%.

Power Requirements—Quick-change, line-voltage selection permits operation from any of the following voltages: 90 V to 110 V, 104 V to 126 V, 112 V to 136 V, 180 V to 220 V, 208 V to 252 V, 224 V to 272 V. The 286 will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of approximately 25 watts at 115 VAC.

Dimensions and Weights

Height	2 1/2 in	6.4 cm
Width	8 in	20.4 cm
Depth	12 in	30.5 cm
Net weight	6 lb	2.7 kg
Domestic shipping weight	9 lb	4.1 kg
Export-packed weight	17 lb	8.0 kg

286 SAMPLING HEAD MULTIPLEX UNIT **$825**
Does not include manual.

OPTIONAL CABINET

Cabinet for 286, order 437-0110-00 ..... $38.50

OPTIONAL ACCESSORIES

Rack Adapter—Adapts the 286 for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 286 occupies half-rack width. Two 286's can be mounted side by side, or alongside other half-rack width instruments such as the 106 Square-wave Generator, 114, 115, or 2101 Pulse Generators, 191 Constant Amplitude Generator, or 2901 Time-Mark Generator. The 286 can also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

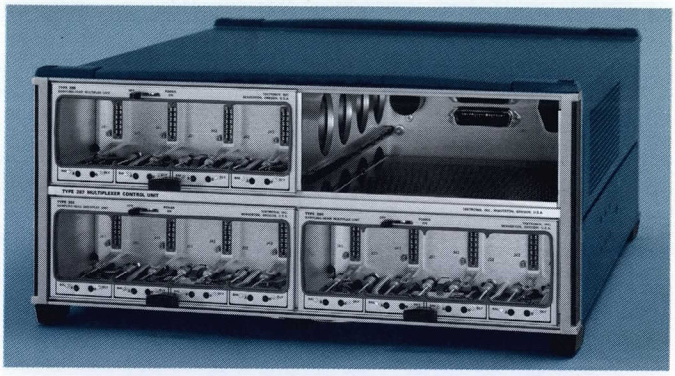
Rack Adapter, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

286 Mounting Kit, order 016-0190-00 ..... $10

Power Cord, order 161-0010-03 ..... $3.10

Instruction Manual, (286, 287, R288), order 070-1007-00 .. $5.00

Cable labels for 286, to identify cable connectors, order 334-1526-00 ..... $.50



287 MULTIPLEX CONTROL UNIT WITH THREE OPTIONAL 286'S INSTALLED

The 287 Multiplex Control Unit is designed for use with Tektronix 286 Sampling-Head Multiplex Units. The 287 accepts up to four 286's, allowing any two of 16 heads to be selected for display. Connectors on the rear of the instrument provide for driving signal choppers simultaneously with the head selected for display.

Display Noise—(Introduced by 286 and 287) Less than 1.2X noise specified for selected heads.

Deflection Factor Change—(Introduced by 286 and 287) Within 1%.

Power Requirements—The 287 acts as a convenience outlet for each of the four 286's mounted within. DC power for operating the 287 is supplied by the sampling unit with which it is used.

Dimensions and Weights

Height	8 in	20.4 cm
Width	16 13/16 in	42.7 cm
Depth	21 7/8 in	55.6 cm
Net weight	19 lb	8.6 kg
Domestic shipping weight	30 lb	13.6 kg
Export-packed weight	50 lb	22.8 kg

INCLUDED STANDARD ACCESSORIES

Cable labels for 287 (334-1527-00); instruction manual (070-1007-00).

287 MULTIPLEX CONTROL UNIT **$700**

R287 Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22 3/4 in	57.8 cm
Net weight	19 lb	8.6 kg
Domestic shipping weight	30 lb	13.6 kg
Export-packed weight	50 lb	22.8 kg

INCLUDED STANDARD ACCESSORIES

Cable labels for 287 (334-1527-00); mounting tracks (351-0086-00); instruction manual (070-1007-00).

R287 MULTIPLEX CONTROL UNIT **$750**

OPTIONAL ACCESSORIES

Drawer, mounts in unused compartments. Provides storage for accessories, order 014-0034-00 ..... $25

R287 recess mounting kit, recesses R287 front panel 4 inches into rack and covers with blank-panel door. Provides space to route sampling head signal cables to rear of rack. R287 recess mount occupies 8 3/4 inches of vertical rack space, order 016-0158-00 ..... $60

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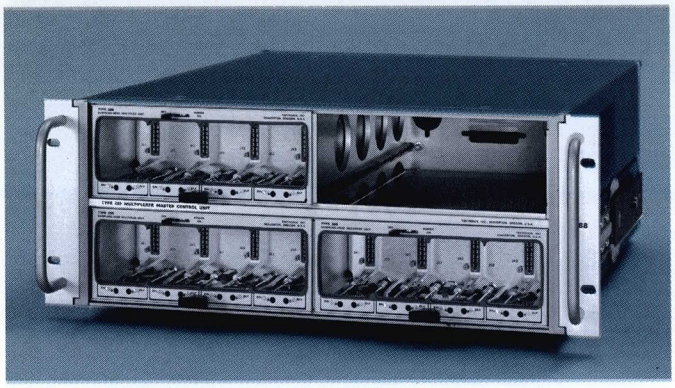
Please refer to General Information page

286 Multiplexer Unit
287 Multiplexer Control Unit
R288 Multiplex Master Controller



R288 MULTIPLEX MASTER CONTROLLER WITH THREE OPTIONAL 286's INSTALLED

The R288 Multiplex Master Controller is designed for use in multiplexing sampling head systems where the selection of more than 16 sampling heads is required. The R288 acts as a controller for up to four 286 Sampling Head Multiplex Units with the 286's installed in the R288 as plug-in units. In addition, the R288 will operate up to three companion R287 Multiplex Controllers. Through the use of six binary-coded lines for each sampling unit display channel, the programmer can select any one of up to 64 heads for display on Channel A and any one of the 63 remaining heads for display on Channel B. Connectors on the rear panel of the instrument provide the output for driving signal choppers corresponding to the heads selected for display.

Displayed Noise—(Introduced by 286, 287, and R288) Less than 1.2X noise specified for selected head.

Deflection Factor Change—(Introduced by 286, 287, and R288) Within 1%.

Power Requirements—Receptacles mounted at the rear of each R288 plug-in compartment supply AC power for operating the 286's via a sampler controlled relay. DC power for operating the R288 is supplied by the sampling unit used.

Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth	22-3/4 in	57.8 cm
Net Weight	19 lb	8.6 kg
Domestic shipping weight	≈30 lb	≈13.6 kg
Export-packed weight	≈50 lb	≈22.8 kg

INCLUDED STANDARD ACCESSORIES

Cable labels for the R288 (334-1528-00); mounting tracks (351-0086-00).

R288 MULTIPLEX MASTER CONTROLLER $900

OPTIONAL ACCESSORIES

Drawer, mounts in unused compartments. Provides storage area for accessories, order 014-0034-00 ..... $25

R288 recess mounting kit, recesses R288 front panel 4 inches into rack and covers with blank-panel door. Provides space to route sampling head signal cables to rear of rack. R288 recess mount occupies 8 3/4 inches of rack space vertically, order 016-0158-01 ..... $60

Sampling Unit to Multiplexer Cables

Type 3S6 to Multiplexer, order 012-0177-00 ..... $ 65
Type 3S5 or 3S2 to Multiplexer, order 012-0178-00 ..... $125

MUX*-System Configuration	Number of S. Heads	R288-to-287/ R287 Interconn. Cables	Signal Chopper** Cables
286 Rack-mounted plug-in	1 to 4	---	012-0186-00
1-287/R287 (1 to 4-286's)	5 to 16	---	012-0131-02
1-287/R287, 1-R288 (5 to 8-286's)	17 to 32	1 ea., 012-0177-00 012-0131-00	012-0131-02
2-287/R287, 1-R288 (9 to 12-286's)	33 to 48	2 ea., 012-0177-00 012-0131-00	012-0131-02
3-287/R287, 1-R288 (13 to 16-286's)	49 to 64	3 ea., 012-0177-00 012-0131-00	012-0131-02

* MUX - Abbreviation for multiplexer; complies with Mil Std 12 C.
** Order choppers separately.

MUX-System Configuration	Number of S. Heads	Programmer-to-MUX Cables 241/R241	240/R240	R250
286 (Rack-mounted plug-in)	1 to 4	012-0176-00	012-0131-00	012-0131-00
1-287/R287 (1 to 4-286's)	5 to 16	012-0176-00	012-0131-00	012-0131-00
1-287/R287, 1-R288 (5 to 8-286's)	17 to 32	---	---	012-0131-00
3-287/R287, 1-R288 (9 to 12-286's)	33 to 48	---	---	012-0131-00
3-287/R287, 1 R288 (13 to 16-286's)	49 to 64	---	---	012-0131-00

User Built Programmer to Multiplexer Cable, order 012-0132-00 ..... $28
012-0132-00 is an 8-ft cable with a single 36-pin connector suitable for use with any multiplexing system configuration. If only the connector is desired, order 131-0293-00.

Interconnection Accessory Description

Name, Part Number	Price	Description
Cable (012-0131-00)	$44	Interconnecting cable, 6-ft, 36-pin to 36-pin.
Cable (012-0132-00)	$28	Program cable, 8-ft, 36-pin connector on one end, no connector on other end.
Cable (012-0176-00)	$40	Program cable to interconnect 286 or 287 with 241, 6-ft, 36-pin to 36-pin.
Cable (012-0177-00)	$65	Signal cable to connect 286, 287 or R288 with 568. 6-ft, 36-pin to 36-pin.
Cable (012-0178-00)	$125	Signal cable to interconnect 286, 287, or R288 with 3S2 or 3S5, 6-ft, 36-pin to two sampling head connectors.
Cable (012-0186-00)	$65	Chopper adapter cable. Permits chopper quad to be driven directly from a 230. Required for use with 286, not required with 287 or R288.
Chopper Quad (015-0155-01)	$375	Set of four probe choppers including attenuators for use with S-3A Sampling Heads to provide ground reference for DC and pulse displays.
Chopper Quad (015-0185-00)	$400	Set of four choppers for use with 50 Ω lines to provide ground reference for DC and pulse displays.
Connector (131-0293-00)	$6	36-pin program connector.

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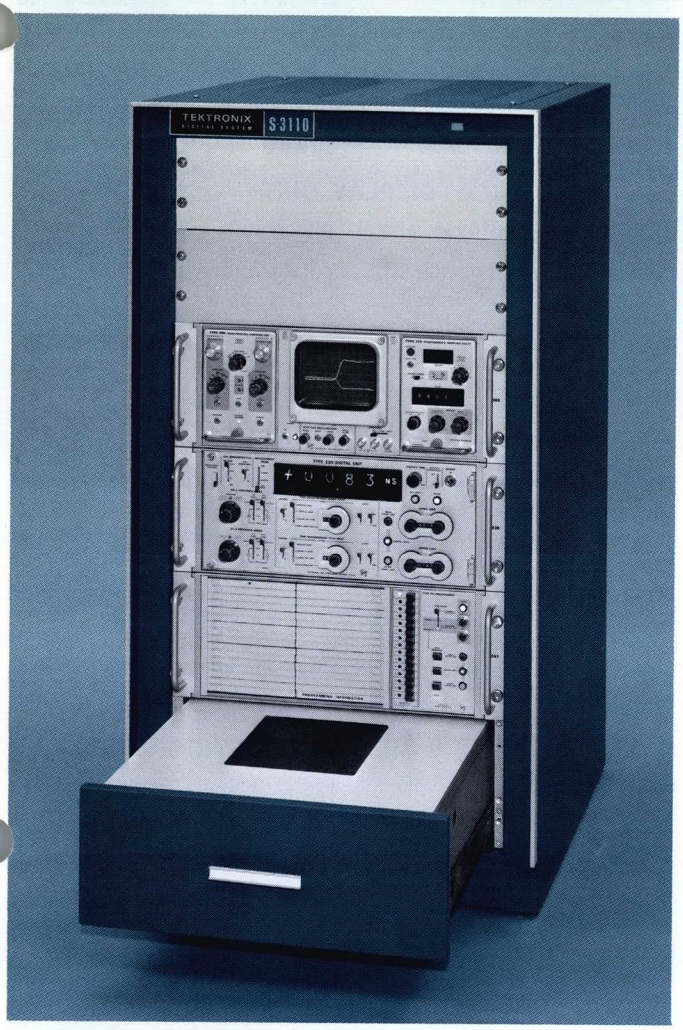
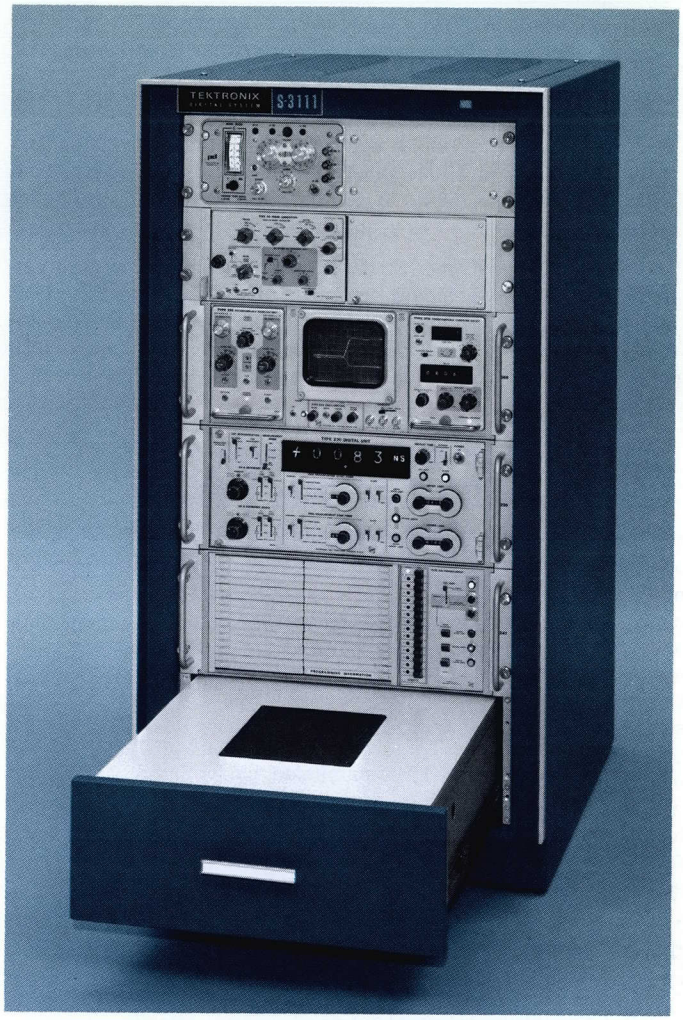
S-3110 and S-3111

Automated Measurement Systems





- **DYNAMIC MEASUREMENTS**
  - PULSE RISETIME AND FALLTIME
  - PULSE WIDTH AND PERIOD
  - PROPAGATION DELAY AND STORAGE TIME
  - PULSE AMPLITUDE AND SATURATION VOLTAGE
  - MANY OTHER SPECIFIC MEASUREMENTS
- **AUTOMATIC MEASUREMENT SEQUENCE**
  - UP TO 15 MEASUREMENTS
  - AUTOMATIC STOP SEQUENCE
- **GO/NO-GO TESTING**
- **400-ps RISETIME**
- **100 ps/DIV-to-500 ms/DIV**
  - CALIBRATED SWEEP RANGE
- **20 mV/DIV-to-2 V/DIV**
  - CALIBRATED VOLTAGE RANGE

The S-3110 and S-3111 Model 651A Automated Measurement Systems are dynamic measurement systems intended for measuring the performance of active devices under simulated operating conditions. They are designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards, and subassemblies in all segments of the electronic industry. These systems can sequence through up to 15 measurements at a rate of 100 measurements per second. High and low measurement limits may be programmed and the system will stop on any combination of limits. A foot switch permits remote operation of the advance and reset program functions.

These systems feature up to 15 measurement programs. Each measurement program has a card that is easily programmed by inserting diodes between the proper clips. Typically, 15 to 20 diodes will provide the necessary program conditions. They are inserted with an easy-to-use tool.

The following instruments comprise the S-3110 Model 651A: R568 Oscilloscope with the 3T6 Programmable Sampling Sweep and 3S6 Programmable Sampling Unit, two S-3A Sampling Heads, R230 Digital Unit, R241 Programmer, 44-inch high equipment rack, two blank panels, a fixture drawer, two probe choppers, and a foot switch.

The fixture drawer contains mounting for the S-3A Sampling Head Probes, pulse generator inputs through 50-Ω coax, DC power supply inputs, and 14 buffered fixture lines through a 56-pin circuit board connector. An unwired test fixture card (670-1016-00) and a performance check-out card are included as standard accessories.

The S-3111 Model 651A is identical to the S-3110 Model 651A with the exception that a pulse generator and power supply are added in place of the two blank panels. The pulse generator is a Tektronix 115 MOD 814R, mounted in a rack adapter that permits adding another pulse generator at a later date. The

power supply is a Power Designs, Inc. Model 2005A mounted in a rack adapter that permits adding another supply at a later date.

The Tektronix 115 MOD 814R features output connectors on the rear panel, 10-ns to 100-μs separate and variable risetimes and falltimes, 100-ns to 10-ms pulse periods, 50-ns to 500-μs pulse delay or burst time, 50-ns to 500-μs pulse width, +5 V to −5 V DC offset and up to ±10 V amplitude into 50 Ω.

The Power Designs, Inc. Model 2005A Precision Power Source features a digitally-selected operating range from 0 to 20 V, 0 to 500 mA; accuracy is within 0.1% ±1 mV; load and line regulation is better than 0.0005% or 100 μV; noise and ripple is less than 100 μV, P-P; and stability is less than 100 μV drift per 8 hours.

CHARACTERISTICS

DUAL-TRACE VERTICAL AMPLIFIER

The included 10X probe attenuators must be used with the included probe choppers. Vertical characteristics are stated with the 10X attenuator.

Voltage Measurements—From 20 mV/div to 2 V/div (8 div full scale) accurate within 3%.

Bandwidth—Equivalent to DC to 875 MHz.

Risetime—400 ps or less.

Input Characteristics—1 MΩ paralleled by 2 pF.

Programmable DC Offset—From +9.95 V to −9.95 V in 50-mV steps.

Refer to 3S6 page for further description.

TIME BASE

Programmable Sweep Time/Div—From 100 ps/div to 0.5 s/div in 30 calibrated steps, accurate within 3% (within 5% from 100 ps to 500 ps).

Programmable Digital Delay Range—From 0 to 999.9 μs in increments of 100 ps, 1 ns, or 100 ns, depending on the sweep time/div.

Automatic Triggering—Eliminates the need for trigger adjustments over a wide range of trigger amplitudes, shapes, and repetition rates. Automatically triggers on signals of 100 mV to 500 mV amplitude over a frequency range from DC to 100 MHz.

Refer to 3T6 page for further description.

PROGRAMMER

Programs up to 15 measurements. Test modes include automatic sequence of up to 15 measurements, manual or external program sequence through 15 measurements or single measurement operation. Out-of-limits measurements can stop the automatic sequence if desired. Each program has one program card with 159-bit capacity that are selected by inserting diodes between the proper clips. Typically, 15 to 20 diodes will provide the necessary program conditions. A foot switch provides remote operation of the Programmers advance and reset functions.

Refer to 241 page for further description.

DIGITAL UNIT

Units of Measure—Readout in V, mV, ns, μs, ms, s.

Numerical Readout—From −3999 to +3999.

Programmable Measurement Limits—From −3999 to +3999.

Data Output—In parallel BCD code, 29 lines, (1, 2, 4, 8; true = ground, false = +12 V).

Refer to 230 page for further description.

DISPLAY UNIT

CRT Display—8 x 10 cm with P2 phosphor.

Calibrator—Provides 100 kHz accurate within 0.05%, and approximately 1-kHz signals; amplitudes of 0.5 V and 5 V P-P within 2% into 100-kΩ or greater load, or 50 mV and 500 mV P-P within 2% into a 1% 50-Ω load.

Refer to 568 page for further description.

FIXTURE DRAWER

The fixture drawer provides in one convenient location the input and output facilities of the system. The drawer is 7 inches deep and provides the following facilities: mountings for 2 sampling heads, 2 probe power connections for FET probes (probe power supplies are mounted inside main cabinet), 2 sets of pulse generator trigger and output connectors, 3 sets of power supply output connectors, 2 signal lines, a 36-pin connector which provides probe chopper drive lines, an unwired fixture card, and a connector for the foot switch.

OTHER CHARACTERISTICS

Power Requirements—105 V to 125 V or 180 V to 272 V, 48 Hz to 66 Hz, ≈340 watts (S-3110 Model 651A) ≈500 watts (S-3111 Model 651A) at 115 V and 60 Hz. Rear-panel selector on each instrument provides rapid accommodations for six line-voltage ranges.

Dimensions and Weights

	S-3110		S-3111	
	in	cm	in	cm
Height	44	111.9	44	111.9
Width	23	58.5	23	58.5
Depth	27-1/2	69.9	27-1/2	69.9
	lb	kg	lb	kg
Net Weight	375	170.9	392	178.6
Domestic shipping weight	463	209.8	480	217.5

S-3110 MODEL 651A AUTOMATED MEASUREMENT SYSTEM . $16,350
S-3111 MODEL 651A AUTOMATED MEASUREMENT SYSTEM . $18,350

INPUT/OUTPUT PANEL

In the S-3110 and S-3111 Automated Measurement Systems the fixture drawer is replaced by an input/output panel and empty drawer. The input/output panel provides mounting for the S-3A Sampling Heads, a trigger input connector, power supply output connectors, pulse generator output and trigger input connectors, and a program connector that has 14 program lines available for programming peripheral equipment plus the necessary lines for operating the probe choppers.

S-3110 AUTOMATED MEASUREMENT SYSTEM $15,500
S-3111 AUTOMATED MEASUREMENT SYSTEM $17,500

Automated Measurement Systems are available with different Sampling Heads featuring up to 25-ps risetimes, and data recording options. Consult your Field Engineer, Representative, or Distributor for further information.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-3120

Automated Measurement System

- **DYNAMIC MEASUREMENTS**
- **DIAGNOSTIC TESTING**
- **100 MEASUREMENTS PER SECOND AUTOMATICALLY**
- **1600-MEASUREMENT MEMORY**
- **400-ps RISETIME**

The S-3120 Automated Measurement System is a dynamic measurement system intended for measuring the performance of active devices under simulated operating conditions. It is designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards, and sub-assemblies in all segments of the electronic industry. Typical areas of application are found in production testing, QC, incoming inspection and preproduction testing.

The S-3120 is intended for use in measurement areas where the power supply voltages and pulse parameters do not require programming. It is not necessary to program pulse generators and power supplies when testing large quantities of devices of a single family that require the same input pulse characteristics, power supplies, and logic voltages.

The S-3120 can sequence through measurements at a rate of more than 100 measurements per second. The Disc Memory stores a library of up to 1600 independent measurements and permits sorting and classifying devices with diagnostic test routines. The Disc Memory also permits random access to a library of 1600 measurements, permitting a computer or other control device to have complete control over the test measurement. The computer can make calculations from the test data and use the Disc Memory for further measurements and sorting at the maximum test rate.

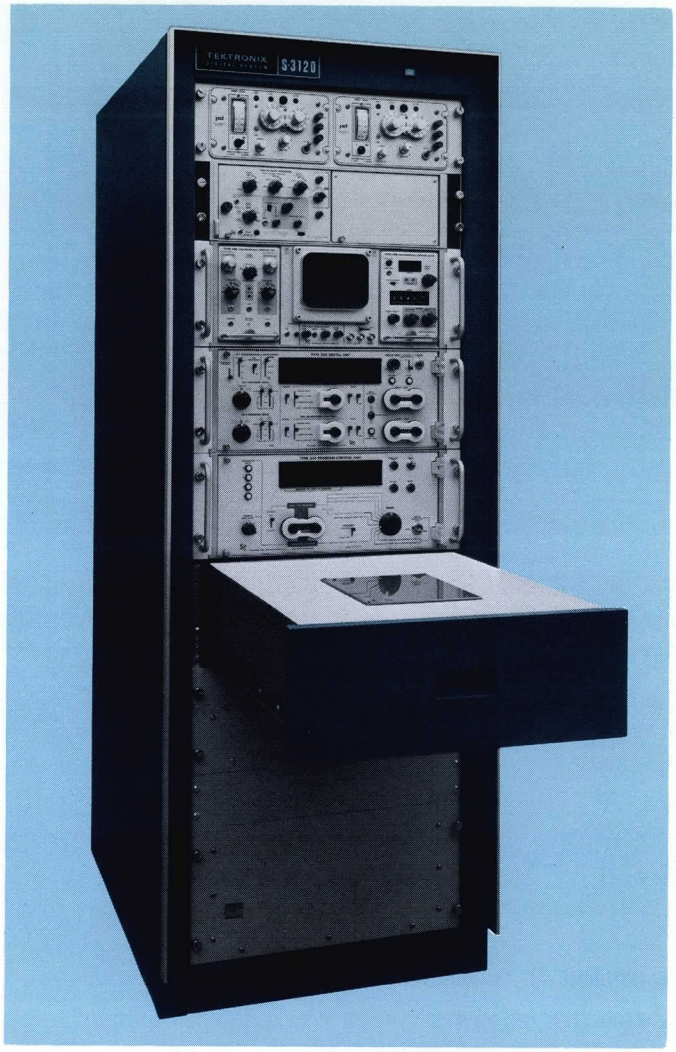
The following instruments comprise the S-3120: R568 Oscilloscope with the 3T6 Programmable Sampling Sweep and the 3S6 Programmable Sampling Unit, two S-3A Sampling Heads, R230 Digital Unit, R240 Program Control Unit, a Disc Memory, Punched Tape Reader, R115 MOD 814R Pulse Generator, two Power Supplies, two Probe Choppers; enclosed in a single-bay cabinet with a pull-out drawer that is used as a test station.

CHARACTERISTICS

The dual-trace vertical amplifier, time base, digital unit, display unit, pulse generator, and power supplies are the same as described for the S-3111 (except that the S-3120 features two power supplies instead of one).

Test Station—A pull-out drawer that provides the interface between the S-3120 and the device under test. All of the inputs and outputs of the S-3120 are available on a 56-pin connector and through 50-Ω connectors located in the Test Station. A test fixture containing a socket for the device under test, and the appropriate test circuitry for input and output signals can quickly and easily be inserted into the 56-pin connector and the 50-Ω connectors. This feature permits the test fixture to be easily changed when new devices are to be checked. Two unwired test fixture cards are included with the S-3120. They require circuit design and wiring to obtain a proper interface to the device under test. A system performance check-out test fixture card is also included. Consult your Field Engineer, Representative, or Distributor for quotations on wired test fixture cards for specific devices and tests.

Power Requirements— 105 V to 125 V, 60 Hz, approx 700 watts at 115 V and 60 Hz. Rear-panel selector on each instrument provides rapid accommodations for line-voltage ranges.



Dimensions and Weights—The S-3120 is 60 inches high, 26 inches wide, and 30 inches deep. Shipping weight is ≈500 lb. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted, and locked in any one of seven positions for convenient access.

Installation—A Tektronix System Specialist installs the S-3120.

S-3120 AUTOMATED MEASUREMENT SYSTEM $36,850

PUNCHED TAPE PROGRAMMING ONLY

The S-3121 is identical to the standard S-3120 with the Disc Memory deleted.

S-3121 AUTOMATED MEASUREMENT SYSTEM $28,850

DISC MEMORY PROGRAMMING ONLY

The S-3122 deletes the Punched Tape Reader from the standard S-3120.

S-3122 AUTOMATED MEASUREMENT SYSTEM $35,500

OPTIONS

Tape Punch—Can be ordered installed, when ordering an S-3120.
Tape Punch installed $2800

Consult your Field Engineer, Representative, or Distributor for additional information.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-3130
Automated Measurement System

*Optional Dual-Test Station with Optional Printer Installed

- **DYNAMIC MEASUREMENT**
- **1600 MEASUREMENTS**
- **100 MEASUREMENTS PER SECOND**
- **500-ps RISETIME**
- **PROGRAM BRANCHING FOR DIAGNOSTIC TESTING**

The S-3130 Digital Automated Measurement System is a dynamic measurement system intended for measuring the performance of active devices under simulated operating conditions. It is designed to test integrated circuits, transistors, diodes, circuit modules, circuit boards, and sub-assemblies. Typical applications are production testing, QC, incoming inspection, and preproduction testing.

The S-3130 can sequence through measurements at a rate of more than 100 measurements per second. The Disc Memory provides access to 1600 independent measurements, and permits sorting and classifying. Diagnostic test routines may also be performed. Provisions are made for a computer control of the measurement or measurement routine. The computer can make calculations, based on test data, and employ the Disc Memory for further measurements.

The following instruments are included in the S-3130: R568 Oscilloscope with the 3T6 Programmable Sampling Sweep and 3S6 Programmable Sampling Amplifier, two S-3A Sampling Heads, R230 Digital Unit, R240 Program Control Unit, R250 Auxiliary Program Unit, R116 MOD 703L Programmable Pulse Generator, four Programmable Power Supplies, a Disc Memory, Punched Tape Reader, Interface Unit, Probe Choppers, and a dual-bay enclosed cabinet with an operator table containing a Test Station. Several options are available to satisfy specific measurement requirements.

PROGRAMMABLE SAMPLING AMPLIFIER

Vertical Characteristics—Stated with the S-3A Sampling Head, signal chopper, and 10X attenuator.

Voltage Ranges—From 20 mV/div to 2 V/div (8 div full scale) accurate within 3%.

Risetime—500 ps or less.

Dual-Trace Input Characteristics—1 MΩ within 1% paralleled by 2.4 pF within 10%.

Programmable DC Offset—From +9.95 V to −9.95 V in 50-mV steps, accurate within 2% of the programmed value or 50 mV, whichever is greater.

Refer to 3S5/3S6 page for further description.

TIME BASE

Programmable Sweep Time/Div—From 100 ps/div to 0.5 s/div in 30 calibrated steps. 1 ns/div to 0.5 s/div, accurate within 3%. 100 ps/div to 500 ps/div, accurate within 5%.

Programmable Digital Delay Range—From 0 to 999.9 μs in increments of 100 ps, 1 ns, or 100 ns, depending on the sweep time/div, accurate within 3%.

S-3130

Automated Measurement System

Automatic Triggering—Eliminates the need for trigger adjustments over a wide range of trigger amplitudes, shapes, and repetition rates. Automatically triggers on signals of 100-mV to 500-mV amplitude over a frequency range from DC to 100 MHz.

Refer to 3T5/3T6 page for further description.

DIGITAL UNIT

Units of Measure—Read out in V, mV, ns, μs, ms, s.

Numerical Readout—From −3999 to +3999.

Programmable Measurement Limits—From −3999 to +3999.

Data Output—In parallel BCD code, 29 lines; 1, 2, 4, 8; true = ground, false = +12 V.

Refer to 230 page for further description.

MEMORY AND PROGRAMMING

Memory Capacity— 1600 measurements.

Programming Format—A fixed word length of 96 4-bit characters.

Parity Check—Made on each character read into the 240 Program Control Unit.

Access Time— 17 ms average; approx 1 ms with minimum-access time programming.

Program Lines— 360 parallel program lines are available to various system instruments.

THREE 40-VOLT PROGRAMMABLE POWER SUPPLIES

Operating Ranges—From 0 to ±40 V; 500 mA, programmed in 10-mV steps, repeatable within 0.5%, ±3 mV.

Output Slewing Rate— 200 V/ms.

Load Regulation—Within 0.25% or 1 mV, whichever is greater.

Line Regulation—Within 0.02% or 0.5 mV, whichever is greater.

Ripple—Less than 3 mV RMS.

80-VOLT PROGRAMMABLE POWER SUPPLY

Operating Range—From 0 V to ±79.9 V; 200 mA, programmed in 10-mV steps, repeatable within 0.5%, ±3 mV.

Output Slewing Rate— 200 V/ms.

Load Regulation—Within 0.25% or 1 mV, whichever is greater.

Line Regulation—Within 0.02% or 0.5 mV, whichever is greater.

Ripple—Less than 3 mV RMS.

PROGRAMMABLE PULSE GENERATOR

The R116 Programmable Pulse Generator is modified (MOD 703L) to include 5 program assembly cards that provide digital-to-analog conversion of program data. The R116 is calibrated with the program assembly cards that are mounted in the R250. The input and output connectors of the R116 are on the rear panel.

All functions of the R116 MOD 703L are programmed in the S-3130. These functions include: pulse period from 100 ns to 10.9 ms; pulse delay/period from 50 ns to 545 μs; pulse width from 50 ns to 545 μs; pulse amplitude from 0.4 V to 9.9 V; pulse risetime and falltime from 10 ns to 109 μs; pulse DC offset from −4.9 V to +4.9 V.

*Optional Equipment

DISPLAY UNIT

CRT Display— 8 x 10 cm.

Refer to 568 page for further description.

TEST STATION

The Test Station is in the operator table and provides the interface between the S-3130 and the device under test. Test inputs and outputs of the S-3130, including 32 program lines, are available on a 56-pin connector and through 50-Ω connectors. A test fixture card that contains a socket for the device under test, and the appropriate test circuitry for input and output signals, can quickly and easily be inserted into the Test Station. This feature permits the test fixture to be easily changed. Two unwired test fixture cards are included. They require circuit design and wiring to obtain a proper interface to the device under test.

DIMENSIONS AND WEIGHTS

The S-3130 2-bay cabinet is 66 inches high, 60 inches wide, and 34 inches deep, excluding the operator table. Shipping weight is approx 1700 lb.

POWER REQUIREMENTS

105 V to 125 V, 60 Hz, approx 100 watts at 115 V and 60 Hz.

For other Power Frequencies and Voltages consult your Field Engineer, Representative, or Distributor.

INSTALLATION

A Tektronix System Specialist installs the S-3130. He checks the complete system for proper operation.

FACTORY TRAINING

Tektronix provides an intensive System Training course. Theory of operation, programming, calibration, and troubleshooting are discussed for each System instrument, as well as the complete System.

S-3130 AUTOMATED MEASUREMENT SYSTEM $53,500

S-3130

Automated Measurement System

PUNCHED TAPE PROGRAMMING ONLY

The S-3131 is identical to the standard S-3130 with the exception that the Disc Memory is deleted and programming is accomplished with the Punched Tape Reader. The maximum measurement rate with the Punched Tape Reader is 3 measurements per second.

S-3131 AUTOMATED MEASUREMENT SYSTEM $45,150

DISC MEMORY PROGRAMMING ONLY

The S-3132 deletes the Punched Tape Reader from the standard S-3130 and maintains the maximum measurement rate of 100 measurements per second.

S-3132 AUTOMATED MEASUREMENT SYSTEM $51,750

OPTIONS

Multiple Test Stations—Up to four test stations are available for the S-3130. The S-3130 can scan two, three, or four stations, making measurements from any station on command. If the S-3130 is making a measurement at one station and receives a start command from another station, it finishes the first measurement sequence before switching stations.

Each station has separate test fixture cards that permit checking different devices at each station. The station selects its own measurement sequence, indicates the measurement limit results (high, low, go), has a start and reset button, and indicates the station's condition of test (in process or waiting).

Automatic Calibration—The automatic-calibration option checks and adjusts, when necessary, the vertical deflection factor (20 mV/div to 2 V/div) and the horizontal sweep rates (1 ns/div to 0.2 ms/div) to within 1%*.

*Accuracy on 20-mV/div and 50-mV/div positions is within 3%.

Tape Punch—The Tape Punch provides punched tape copies of program data stored in the Disc Memory. The Tape Punch can be ordered installed, when ordering the S-3130.

Tape Punch, installed $2800

Printer—A printer can be ordered installed, when ordering an S-3130. The printer typically supplied has a print format from left to right as follows:

4 columns, test number; next 5 columns, R230 numerical readout; next 2 columns, decimal location; next 2 columns, units of measure; and last column, Go, No/Go results.

Test Fixture Cards—Additional, unwired, test-fixture cards can be added at any time. They require circuit design and wiring to obtain a proper interface to the device under test. The fixture card mates to the 56-pin connector in the S-3130 and has a coaxial connector for the pulse generator input and has two probe connectors mounted on the card.

Additional Program Unit/Pulse Generators—An additional R250 adds 192 program lines used to program additional pulse generators, power supplies, fixtures, or other equipment.

The following is a list of common combinations of auxiliary program units and pulse generators. Price includes program unit/pulse generators, installation, programming, and checkout.

R250 MOD 650A with R116 MOD 703L $7,650

R250 MOD 650A with R293 MOD 703M $5,775

R250 MOD 650A with R116 MOD 703L/R293 MOD 703M $9,275

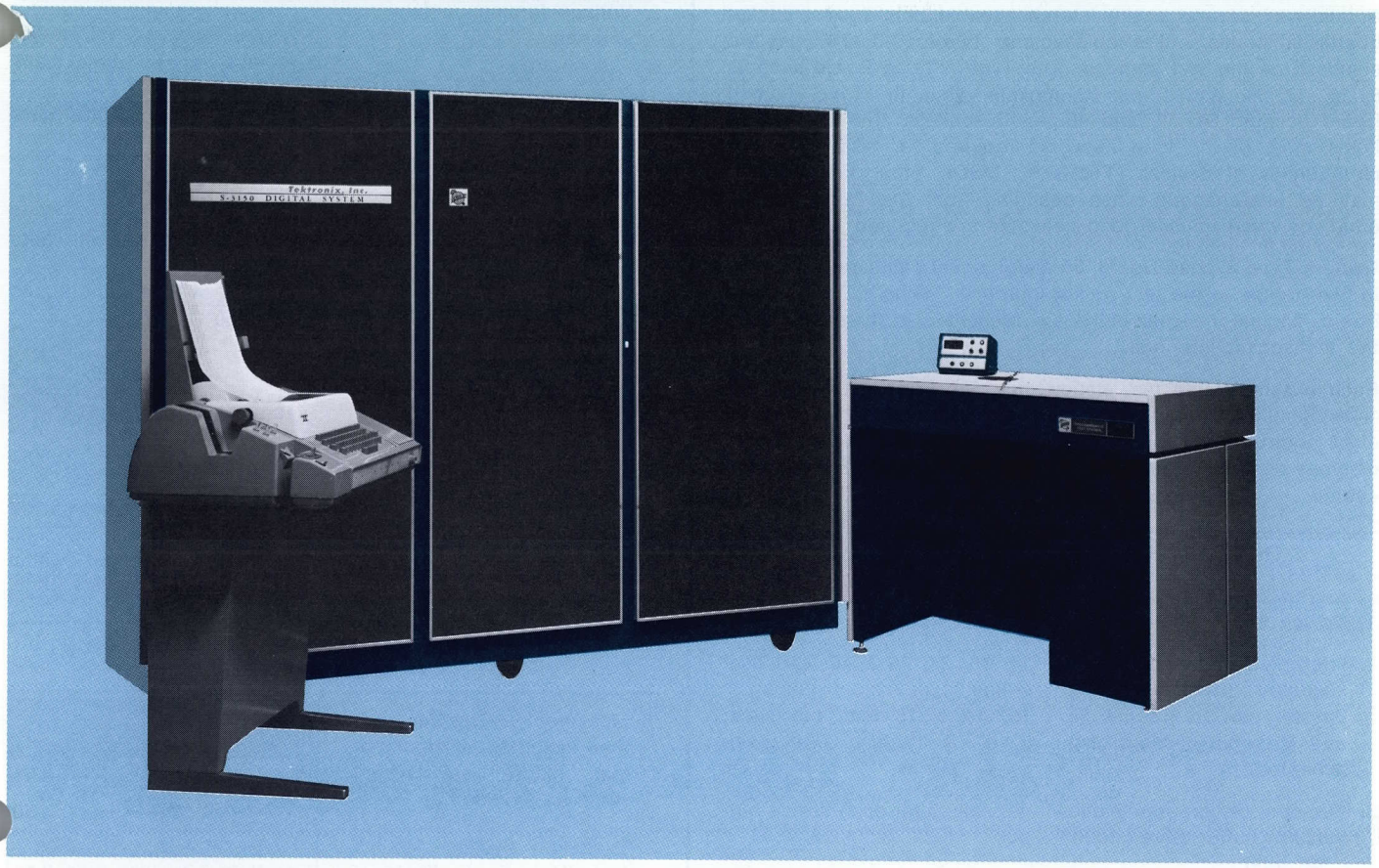
See catalog pages on R250 for detailed specifications of R250, R116 MOD 703L, and R293 MOD 703M.

The S-3130 is also available with different Sampling Heads featuring up to 25-ps risetime capabilities, and data recording options. Consult your Field Engineer, Representative, or Distributor for additional information on options.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

S-3150

Automated IC Measurement System



- **TWO PROGRAMMABLE TEST STATIONS AVAILABLE**
- **AT LEAST 40 LEAD TEST CAPACITY**
- **AUTO HANDLER OPTIONS**
- **ENVIRONMENTAL TESTS**
- **TWO LOAD BOARDS**
- **OPTIONAL 50 kHz FUNCTIONAL TESTS, 4 ϕ CLOCK**
- **COMPUTER**
  - **PROGRAM WRITING**
  - **DATA ACQUISITION AND REDUCTION**
- **CONTROL OF TEST SEQUENCE**

The S-3150 is a high-speed, disc-programmed, dynamic and DC tester for integrated circuits. The measurement system is self-contained and once programmed, will perform tests on a go/no-go basis or on a diagnostic basis at rates to 100 measurements per second. A Digital Equipment Corporation PDP-8/L Computer is utilized for on-line data acquisition, off-line data reduction and in writing programs using the interactive software supplied with the S-3150. The S-3150 system provides: (1) Fixture flexibility—only a single load board need be changed to accommodate most logic families, most changes within a family are under program control (loads, power supplies, and stimuli). (2) DC capability—DC currents and voltages may be measured to within 1% in the same socket as used for the dynamic measurements. (3) Computer-controlled data acquisition . . . no loss in test rate. (4) A special interactive computer program . . . generates measurement system programs from the keyboard. It is a plain English program that interacts with the programmer at the keyboard. (5) Use of a disc memory . . . measurement system may be used for go/no-go and diagnostic testing while the computer is used for batch data reduction or interactive program compilation.

The S-3150 consists of the following: R568 Oscilloscope with 3T6 Programmable Sampling Sweep and 3S6 Programmable Sampling Unit; Auto Cal Unit; R230 Digital Unit; R240 Program Control Unit; two R250 Auxiliary Program Units, two R116 MOD 703L Programmable Pulse Generators; R293 MOD 703M Programmable Pulse Generator; R1140 Programmable Power Supply (4 voltage, 1 current supply); Disc Memory; Punched Tape Photo Reader; Tape Punch Interface Unit; R1340 Data Coupler; DEC PDP-8/L (4k memory—ASR33); two DEC Tape Transports; DEC KD-8L Data Break; DEC DW08 A I/O Conversion Panel; DEC TC01 Tape Auto Control Unit; all mounted in a 3-bay, enclosed cabinet with the Programmable Test Station at one side; Teletype ASR33 free standing at other side.

TEST STATION

Identical testing capability is available in two test stations; the 1801 for manual testing, the 1802 for ambient and environmental automatic handlers and manual testing. The programmable test station is a console containing a programmable test fixture designed to test digital integrated circuits with up to 40 leads. It is controlled by the measurement system during the test sequence. Each lead of the integrated circuit under test can be independently connected to power supplies, signal sources, load networks, buffer drive circuits, and measurement probes.

S-3150

Automated IC Measurement System

A family of several easily interchangeable plug-on test socket boards facilitates socket replacement. Two load-board types are standard on the test stations. The Type A Load Board accepts 8, 10, 12, 14, and 16-pin IC sockets, while the Type B Load Board accepts 24, 36, and 40-pin IC sockets. The load board holds most of the load networks required for testing a complete family of devices (TTL, DTL, MECL, etc.). Load boards may be interchanged when changing from one family to another, or when unusual load networks are required.

Using a Type A Load Board, 35 major signal paths are presented in two groups to the test-socket interface. Using a Type B Load Board, 51 major signal paths are presented in three groups to the test-socket interface.

Each programmable test station includes: R287; four 286's; 16 S-3A Sampling Heads; 50-Ω switching matrix; DC subsystem; eight control logic boards; two load boards; ten socket boards of types desired; probe board, including choppers and required cables.

GENERAL CHARACTERISTICS OF THE TEST STATION

1. Device lead capacity	at least 40
2. Integrated circuit packages accepted (directly or in Barnes carriers; some TI and Motorola carriers also accepted)	14, 16, 24, 36 & 40 lead dual in-line 10, 14 & 16 lead flat pack; 8, 10, & 12 lead TO-5 pack
3. Number of programmable loads or buffer drive circuits 48 total	normally 3 for each device output
4. Number of programmable voltage supplies 4 total	3 directly programmable to any device output 1 programmable through load networks
5. Number of programmable current supplies	1 programmable to any lead
6. Measurement probes with programmable 1X and 10X attenuators	16 S-3A Sampling Heads
7. Pulse generator inputs 2	each one programmable directly to any lead or to buffer drive circuits
8. Number of leads selected for each measurement	2

DC MEASUREMENT CHARACTERISTICS OF TEST STATION

1. Voltage measurement	
range	±10 mV to ±160 V
accuracy	±10 mV to ±16 V range: within 1% plus 5 mV with auto calibration, within 3% plus 5 mV without auto calibration ±10 V to ±160 V range: within 1% plus 100 mV with auto calibration, within 3% plus 100 mV without auto calibration
2. Voltage forcing	
range	0 V to ±100 V
accuracy	0 to 40 V range: within 0.2% plus 2 mV 0 to 100 V range: within 0.2% plus 5 mV
3. Current measurement	
range	±5 nA to ±100 mA
accuracy	within 1% or 2 nA with auto calibration within 3% or 2 nA without auto calibration
voltage range over which current measurements can be made	−100 V to +100 V
4. Current forcing	
range	±1 μA to ±200 mA
accuracy	0 to 2 mA range: within 0.2% plus 0.1 μA 0 to 200 mA range: within 0.2% plus 10 μA

DYNAMIC MEASUREMENT CHARACTERISTICS OF TEST STATION

	Type A Load Board	Type B Load Board
1. Measurement system risetime including all effects of test fixture environment (from a 25 Ω source)	less than 1 ns	less than 2 ns
2. Excitation System risetime including all of effects of test fixture environment, but not including pulse generator risetime	less than 1 ns	less than 2 ns
3. Distributed capacitance at each lead	12.5 pF	15 pF

4. Voltage measurements	
range	3 mV to 16 V
accuracy	within 1% or 1 mV with auto calibration within 3% or 1 mV without auto calibration
DC offset range	−20 V to +20 V
safe overload voltage	100 V peak
5. Time measurements	
Sweep time/div	
range	100 ps to 500 ms in 10 ranges (1-2-5 sequence)
accuracy	within 1% with auto calibration within 3% without auto calibration
Delay ranges	
Time/div	
100, 200, 500 ps	0 to 1 μs in 100 ps increments
1 ns to 1 μs	0 to 10 μs in 1 ns increments
2 μs to 500 μs	0 to 1 ms in 100 ns increments
1 ms to 500 ms	no delay available
High-speed programming	system equipped with speed-up circuitry which eliminates unnecessary sweeps and samples

S-3150
Automated IC Measurement System

DISC MEMORY

1. Storage capacity	1080 measurements
2. Measurement word format	144 characters of four bits each (576 bits) plus parity
3. Test sequences	any length from 1 to 1080 measurements. Sequence may be altered by test results
4. Parity	each character checked for even parity compliance
5. Program access time	17 ms (average). Can be optimized to approx 1 ms
6. Operating modes	a. transfer test on disc to tape
	b. locate next disc address
	c. read test from disc
	d. read test sequence from disc
	e. read test sequence from tape
	f. examine or modify characters in register
	g. write test in register on disc
	h. transfer tape sequence to disc

568 ANALOG DISPLAY UNIT

1. CRT display area	8 x 10 centimeters

R1140 PROGRAMMABLE POWER SUPPLIES

40 V Power Supplies (3 each)	
operating range	0 V to ±39.99 V programmed in 10 mV steps at up to 400 mA source, 100 mA sink
accuracy	within 0.2% plus 2 mV
100 V Power Supply (1 each)	
operating range	0 V to ±100 V programmed in 100 mV steps at up to 100 mA source or sink
accuracy	within 0.2% plus 5 mV
Current Supply (1 each)	
operating range	0 mA to ±199.9 mA programmed in 100 μA steps, or 0 mA to ±19.99 mA programmed in 10 μA steps, or 0 mA to ±1.999 mA programmed in 1 μA steps (programmed range selection)
accuracy	within 0.2% ±20 μA for 0 to ±199.9 mA range, within 0.2% ±2 μA for 0 to ±19.99 mA range, within 0.2% ±0.2 μA for 0 to ±1.999 mA range
Compliance Voltage	
plus current	—40 V to positive programmed voltage limit
minus current	+40 V to negative programmed voltage limit

PROGRAMMABLE PULSE GENERATORS

R116 MOD 703L (2 each)
Includes 5 program assembly cards that provide digital-to-analog conversion of program data. All functions of the R116 MOD 703L are programmed in the S-3150.

Amplitude	±0.4 V to ±10 V in three ranges
Offset (of pulse baseline)	—4.9 to +4.9 V
Rise and Falltime	10 ns to 109 μs in four ranges
Period	100 ns to 10.9 ms in five ranges
Width	50 ns to 545 μs in four ranges

R293 MOD 703M—Furnished assembly to program pulse amplitude and pulse width.

Risetime	1 ns
Falltime	2.5 ns
Repetition Rate	100 kHz to 10 kHz (not programmed)
Pulse Width	2 ns to 250 ns programmed in 1 ns steps
Pulse Amplitude	6 V to 12 V programmed in 0.5 V steps
Polarity	± (not programmed)
Offset	none

AUTOMATIC CALIBRATION

The automatic calibration checks and adjusts, when necessary, the vertical deflection factor (20 mV/div to 2 V/div) and the horizontal sweep rates (1 ns/div to 0.2 ms/div) to within 1%.

DATA COUPLER

The R1340 Data Coupler is an interface between the measurement system and the PDP-8/L Computer. The data coupler:

1. Provides the capability of data logging at a rate compatible with measurement speed of the system without data recording.

2. Allows the computer to generate, store and screen the test patterns used for functional device testing.

3. Provides control or direction to a test sequence directly as a result of each measurement.

4. Provides for the Tape Reader to be used by the Type 240 or the computer.

5. Allows the computer to share the Tape Punch.

6. Allows the programmer to examine, modify, and replace measurement programs in conjunction with the interactive computer program. The computer and the measurement system can be used as stand-alone units or can be coupled together when it is desired.

DIGITAL COMPUTER

Tektronix S-3150 is currently supplied with a PDP-8/L Programmed Data Processor manufactured by the Digital Equipment Corporation of Maynard, Massachusetts. A basic software package is supplied with the S-3150. Although not required in the operation of Tektronix systems, support software furnished by the computer manufacturer including diagnostic programs and instructions is supplied with the computer.

SOFTWARE

The software packages supplied with the S-3150 allow test-program writing in plain English, test-result logging, and test-data reduction for several interpretive displays.

Test-Program Writing—Test sequences may be written in plain English at the teletypewriter (or optional computer terminal) keyboard. A basic understanding of test instrument terminology and device test requirements are the only prerequisites. Test writing proceeds with operator commands being validated and programming errors questioned as they occur. On-line test-program writing permits immediate debugging and test verification. Off-line writing allows the measurement system to proceed with device testing while new test programs are being written.

Functional test sequences are written at the keyboard in a similar, interactive fashion when the S-3150 functional-test option has been elected. Test patterns for input exercising and output comparison may be tabulated directly or the output pattern may be "learned" from a device known to be good.

Test sequences, once written, may be punched out on paper tape for permanent record. Contents of these tapes may be listed and modified as required.

Test-Result Logging—Test results may be collected for display, permanent storage, or further analysis when desired. Results are logged either on the teletypewriter or on paper tape for further data reduction.

Test-Data Reduction—Test data may be sorted and listed, showing the results of a particular test performed on many different devices. The results thus sorted may then be graphed or presented as a histogram.

DIMENSIONS AND WEIGHTS

The S-3150 is 66 inches high, 84 inches wide, and 34 inches deep, excluding the operator table. Instruments are mounted on slide-out tracks and individually can be pulled out, tilted, and locked in any one of seven positions for convenient access. Approx shipping weight is 2,500 pounds.

POWER REQUIREMENTS

105 V to 125 V, 60 Hz, approx 2,500 watts at 115 V and 60 Hz. 50-Hz models are available.

INSTALLATION

A Tektronix system specialist installs the S-3150. He checks the complete system for proper operation and assures that it meets or exceeds published specifications. Performance checkout software is included as part of the installation.

FACTORY TRAINING

Tektronix provides an intensive training course on the Tektronix Systems including: Theory of operation, programming, calibration, and troubleshooting.

S-3150 AUTOMATED IC MEASUREMENT SYSTEM **$140,000**

S-3150 MODEL 651B AUTOMATED IC MEASUREMENT SYSTEM **$100,000**

Includes Tape Punch, but deletes computer and data coupler.

OPTIONS

Unwired and TTL Load Boards, plus 27 types of socket boards are available.

Functional Test Option— 50 kHz functional testing may be added to the 1801 or 1802 at any time. The computer is required for this option to generate, store, and screen the test patterns used for input exercising and output comparison. Binary, gray-code, pseudo-random, or specifically-tabulated truth tables may be called for input exercising. Resulting output sequences from a device known to be good may then be stored to serve as a comparison table for subsequently tested devices. Tests are written with an interactive English-language translator.

Automatic Handling and Environmental Testing—The 1802 Test Station has been specially designed for the 8824 Mechanized Ambient Handler and the 8072 Supercharger manufactured by Delta Design Inc., La Mesa, California. Handling rates from 1000 to 4000 units per hour are determined by testing time and soak period desired. Environmental test limits are —70°C and +150°C, either hand, magazine, or bowl-feed options are available. Device outputs may be made into a magazine, a 3-bin sorter, or a 5-bin sorter.

Contactor length and capacitance has been kept to a minimum to insure best possible transient response for dynamic measurements. Device switching speeds as fast as 4 ns are cleanly preserved in the Ambient Handler with a corresponding 4 ns for the Supercharger.

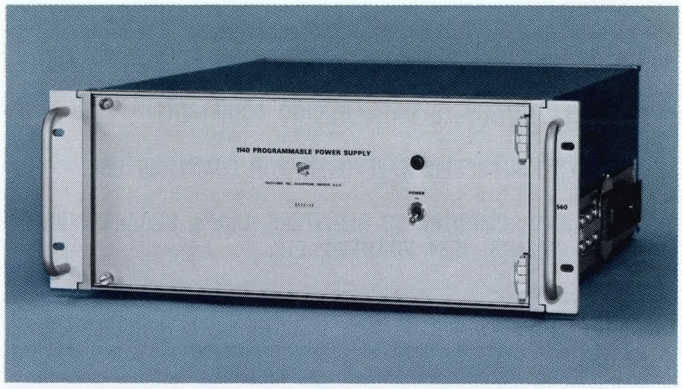
Consult your Tektronix Field Engineer, Representative, or Distributor for information on the options or requirements for special requirements such as handlers, digital voltmeters, incremental tape recorders, etc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

R1140
Programmable Power Supply

NEW

- FOUR INDEPENDENT VOLTAGES; ONE CURRENT
- DIGITAL PROGRAMMING
  LATCHING INPUTS
  TTL COMPATIBLE
- SAFE, CONTROLLED TRANSITIONS
- REMOTE SENSING



The R1140 Programmable Power Supply is intended to provide current and multiple-voltage outputs for use in high-speed automated measurement and test systems. BCD-programming format is completely digital (TTL levels) and no external programming resistance is required. Separate strobes and latching data inputs allow any of the five supplies to be reprogrammed independently, without disturbing the others. Independent safety logic for each supply prevents over-voltage condition during program transitions, including polarity switching. Programmable voltage limits on the current supply guard against unexpected changes in external load conditions.

Four-wire voltage supply outputs allow remote sensing at the load.

POWER SUPPLY CHARACTERISTICS
40-V SUPPLIES (3)

Range— +39.99 V to −39.99 V, programmable in steps as small as 10 mV.

Accuracy—Within 0.2% of programmed voltages, ±2 mV.

Programming—Requires 15 bits, plus strobe for each of the 40-V supplies.

Current—Sourcing, 400 mA or less; Sinking, 100 mA or less.

Regulation—Load, within 0.01% or 1.5 mV, whichever is greater. Line, within 0.001% or 100 μV, whichever is greater, over specified operating line-voltage range. Line frequency ripple and noise, 3 mV RMS or less.

Settling Time—(Time from positive edge of data strobe for output to change to within 1% of new programmed value.) Level change, 2.1 ms or less; Polarity change, 3.7 ms or less.

CURRENT SUPPLY

High Range	Medium Range	Low Range
+199.9 mA to −199.9 mA, programmable in steps as small as 100 μA.	+19.99 mA to −19.99 mA, programmable in steps as small as 10 μA.	+1.999 mA to −1.999 mA, programmable in steps as small as 1 μA.
Accuracy		
Within 0.2% of programmed current, ±20 μA	Within 0.2% of programmed current, ±2 μA	Within 0.2% of programmed current, ±0.2 μA

Programming—Requires 20 bits, plus strobe to program the current supply.

Compliance Voltage—Programming plus current (sourcing), −40 V to positive programmed voltage limit. Programming minus current (sinking), +40 V to negative programmed voltage limit.

Programmed Compliance Voltage Limit Range—Plus current, 0 to +70 V in 5 V increments. All 4 bits programmed gives +100 V. Minus current, 0 to −70 V in 5 V increments. All 4 bits programmed gives −100 V.

Regulation—Load, within 0.005% or 1 μA. Line, within 0.001% or 0.5 μA. Ripple and noise, 5 μA RMS or less.

Settling Time— 100 μs or less to settle to within 0.2% of programmed current or within 2% of programmed voltage.

100 V SUPPLY

Range— +100 V to −100 V, programmable in steps as small as 100 mV.

Accuracy—Within 0.2% of programmed voltage, ±5 mV.

Programming—Requires 13 bits plus strobe to program the 100 V supply.

Current—Sourcing or sinking, 100 mA or less.

Regulation—Same as 40-V supplies.

Settling Time—Same as 40-V supplies.

OTHER CHARACTERISTICS

Power Requirements— 105 to 125 V AC or 210 to 250 V AC, 48 to 66 Hz, 250 W maximum.

Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack Depth	20.5 in	52.2 cm
Net Weight	≈50 lb	≈22.7 kg
Domestic shipping weight	≈65 lb	≈29.5 kg
Export-packed weight	≈95 lb	≈43.1 kg

INCLUDED STANDARD ACCESSORIES

Three cables with 36-pin connectors (012-0131-12, -13, -14); three 36-pin connectors (131-0294-06); 20-ft cable with one 41-pin connector (012-0291-00); slide-out assembly (351-0086-00); rackmounting rear support kit (016-0097-00); rackmounting hardware (016-0099-00); instruction manual (070-3035-00).

R1140 PROGRAMMABLE POWER SUPPLY **$5000**
For use in systems with other than R250 Auxiliary Program Unit.

R1140 MOD 950A PROGRAMMABLE POWER SUPPLY **$6125**
For use in systems with R250 Auxiliary Program Unit. Accessories include five R250 programming assemblies (672-0211-00, -01, -02, -03, and -04).

NEW

R1340
Data Coupler

- **ALLOWS ON-LINE COMPUTER CONTROL**
- **COUPLES SYSTEMS TO DATA-LOGGING EQUIPMENT**
- **DIGITIZES HIGH-SPEED WAVEFORMS FOR COMPUTER USE**
- **INTERFACES COMPUTER TO REGISTERS, DVM's, PROGRAMMABLE INSTRUMENTS, TEST FIXTURES, ETC.**

The R1340 Data Coupler is a multi-purpose instrument intended to interface a wide variety of digital measurement, processing and recording equipment. The eight interface options presently available provide computer control, data logging and dot-by-dot waveform digitizing for the standard instruments normally used in Tektronix Automated Measurement Systems as well as for other instruments having digital inputs and outputs.

The R1340 consists of a rackmount cabinet with power supply, space for 12 plug-in cards and wired connectors for 18 interconnecting cables.

DATA LOGGING

Data logging from a measurement system using the 230 Digital Unit and 240 Program Control Unit can proceed without requiring a computer. Measurement results from the 230, measurement address number from the 240, and device type and serial information from the test station or other source may be logged on computer-compatible magnetic or paper tape. Duplication of paper tapes is allowed without computer control by the combined tape reader/punch interface.

COMPUTER CONTROL

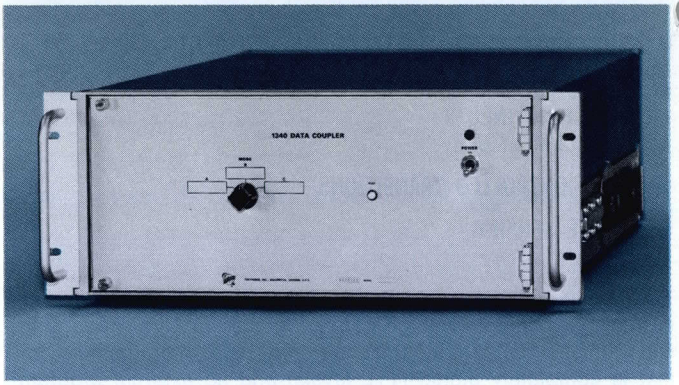
A Tektronix Automated Measurement System may be computer controlled through the R1340 in two different ways: (1) the computer can select predetermined measurement programs stored on individual program cards in the 241 Programmer or stored in magnetic-disc memory used with the 240 Program Control Unit, or (2) the computer can store and manipulate the measurement program directly through the 240 without disc memory. No computer software is supplied with the R1340.

WAVEFORM DIGITIZING

The R1340 operates with any 3-Series Sampling Unit, such as the 3S1, 3S2, 3S5 or 3S6, and the 3T5 or 3T6, to digitize waveforms for computer use. Waveform scanning is digitally controlled from the computer by a 10-bit horizontal address which may be incremented for sequential scanning or directly set to a predetermined location. Samples from both channels of the sampling unit are digitized by independent, 10-bit, analog-to-digital converters. Trigger-gating and signal-chopper operation can also be computer-directed. While the R1340 is intended for repetitive signal conditions, one sample of a single event, such as the response of an integrated circuit under functional test, can be digitized.

INTERFACING

Interface cards within the R1340 perform such functions as input/output level conversion, serial-to-parallel and parallel-to-serial format conversions, and temporary data storage in latching registers. A common TTL bus within the R1340 makes all data and control information available to each card where it is interfaced to a computer, other data source or data logger.



Standard "handshaking" logic is provided for data transfer. Flexible input and output circuits allow several choices for logic levels to be hard-wire-selected before interface boards are installed. See Figure 1.

INPUTS	Choice 1	Choice 2	Choice 3
High State	+5.0 V to +2.4 V	+32 V to +5.5 V	+28 V to −1.8 V
Low State	+0.8 V to 0 V	+3.3 V to −2.5 V	−3.7 V to −9.1 V
OUTPUTS supplied with open-collector NPN transistors. Space provided for collector load resistors to +5 or +14.3 V. BV_{CEO} = 40 V. V_{SAT} < +0.4 V at 10 mA. For negative-going outputs, output transistors may be changed to PNP's. Space provided for collector load resistors to −14.3 V.			

FIGURE 1

Three of the interface options provide different combinations of 32-bit data flow to and from other digital instruments such as counters, DVM's realtime clocks, test fixtures, programmable generators, etc.

OTHER CHARACTERISTICS

Rear Panel—Eighteen 36-pin connectors provide interface between the R1340 and peripherals via control cards in the R1340.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 102 W max. Rear-panel selector provides rapid accommodations for six line-voltage ranges.

Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack Depth	20 1/2 in	52.2 cm
Net Weight	32 lb	14.5 kg
Domestic shipping weight	≈47 lb	≈21.3 kg
Export-packed weight	≈67 lb	≈30.4 kg

INCLUDED STANDARD ACCESSORIES

Rackmounting kit (016-0097-00); hardware kit (016-0099-00); slide-out tracks (351-0086-00); extender card (670-1263-00); instruction manual (070-3034-00).

R1340 DATA COUPLER **$3000**
Without interface cards or interconnecting cables.

R1340 MOD 950A DATA COUPLER **$4800**
Front panel marked for use with R230/R240 Measurement Systems. Also includes R230/R240 Interface Package (021-0007-00).

R1340
Data Coupler

NEW

OPTIONS

The interface options require from 1 to 5 of the 12 card slots and some cards must be used in specified slots (see Figure 2). Therefore, no combination of options can be installed that require use of the same slot.

	Slot Number											
Interface	**J1**	**J2**	**J3**	**J4**	**J5**	**J6**	**J7**	**J8**	**J9**	**J10**	**J11**	**J12**
R230/R240 021-0007-00					X	X	X	X		X		
PDP-8/L Computer 021-0008-00	X	X	X									
Tape Reader/Pnch 021-0009-00				X								
Data-logging 021-0011-00	X	X										
568 or R568 021-0029-00						X	X					
32-bit Output 021-0013-00	Can be used in slots 2 through 12											
16-bit Input/ 16-bit Output 021-0014-00	Can be used in slots 2 through 12											
32-bit Input 021-0028-00	Can be used in slots 2 through 12											

FIGURE 2

R1340 to R230/R240 Interface package, order 021-0007-00 ..... $1800
For use with R230/R240 Systems. Performs the following functions:

1. Permits directing the Tape Reader data to the Type 240, external data receiver (e.g., a computer), or the Tape Punch.
2. Permits data flow from the computer (or other data source) or 240 to the Tape Punch.
3. Permits data flow between the 240 and any connected data source or receiver.
4. Permits data flow from the 230 readout to a data receiver.
5. Permits data flow from a data source to a data receiver.

This package may be installed in the R1340 for use with a Tektronix S-3120, S-3130, or S-3150 Automated Measurement System. Includes: 5 interface cards (test number - 670-1260-00, test address - 670-1265-00, 230 data - 670-1267-00, header - 670-1268-00, 240 test I/O - 670-1269-00); 4 interconnecting cables (012-0131-08, 012-0131-09, 012-0131-10, 012-0131-11); instruction manual (070-3050-00).

R1340 to Paper Tape Reader/Punch Interface Package, order 021-0008-00 ..... $900
For use with Digital Equipment Corp. PDP-8/L. This package permits computer-controlled data exchange among installed assemblies. It may be installed in the R1340 for use with all Tektronix Automated Measurement Systems. Includes: 3 interface cards (device selector PDP-8/L - 670-1261-00, data in from PDP-8/L - 670-1271-00, data out from PDP-8/L - 670-1272-00); 3 interconnecting cables (012-0260-00, 012-0261-00, 012-0262-00); instruction manual (070-3049-00).

R1340 to Paper Tape Reader/Punch Interface Package, order 021-0009-00 ..... $400
For use with Remex Tape Readers (60 Hz - 020-0026-00, 50 Hz - 020-0030-00) and Tally, Inc. Tape Punch (020-0027-00). This package must be used with package 021-0007-00, 021-0008-00, or both. It performs the following:

1. Paper-tape duplication (when used with 021-0007-00).
2. Data flow between R240, Tape Reader, and Tape Punch (when used with 021-0007-00).
3. Data flow between PDP-8/L, Tape Reader, and Tape Punch (when used with 021-0008-00).

This package may be installed in the R1340 for use with a Tektronix S-3120, S-3130, or S-3150 Automated Measurement System. Includes: interconnecting cable (012-0263-00); tape punch/reader interface card (670-1270-00); instruction manual (070-3051-00).

Data-logging Interface Package, order 021-0011-00 ..... $325
For data logging with either Peripheral Equipment Corp. Model 1807-9 Incremental Write Tape Transport or Tally Inc. Tape Punch. For Mag-tape data-logging, also order interconnecting cable 012-0308-00. For Paper-tape data-logging, also order 021-0009-00. This package permits internally multiplexed data flow from installed interface assemblies to the data-logger. It can be used with 021-0007-00, 021-0013-00, 021-0014-00, 021-0028-00, or others. It cannot be used with 021-0008-00. It may be installed in the R1340 for use with all Tektronix Automated Measurement Systems. Includes: 2 interface cards (data formatter - 670-1335-00; data multiplexer - 670-1336-00); instruction manual (070-3053-00). For mag-tape data-logging, also order interconnecting cable 012-0308-00.

R1340 to 16-bit Input/16-bit Output Interface Package, order 021-0014-00 ..... $350
Permits two-way, data flow. Flexible interface voltage levels (See Fig. 1). This package may be installed in the R1340 for use with all Tektronix Automated Systems and all other interface packages. Includes: 16-bit I/O buffer interface card (670-1333-00); instruction manual (070-3056-00).

R1340 32-bit Input Interface Package, order 021-0028-00 ..... $350
For use with counters, registers, DVM's, etc. Flexible interface voltage levels (See Fig. 1). This package may be installed in the R1340 for use with all Tektronix Automated Measurement Systems and all other interface packages. Includes: 32-bit input buffer interface card (670-1419-00); instruction manual (070-3054-00).

R1340 32-bit Output Interface Package, order 021-0013-00 ..... $350
For computer control of programmable instruments, test fixtures, systems, etc. Flexible interface voltage levels (See Fig. 1). This package may be installed in the R1340 for use with all Tektronix Automated Measurement Systems and all other interface packages. Includes: 32-bit output buffer interface card (670-1334-00); instruction manual (070-3055-00).

R568 to R1340 Digitizing Interface Package, order 021-0029-00 ..... $2600
For use with the 3S5 or 3S6 and 3T5 or 3T6. D-A and A-D converters permit computer scanning and digitizing of a waveform. 3T5 or 3T6 requires Field Modification Kit 040-0577-00 (see 3T5/3T6 page). Must be used with 021-0008-00 or equivalent. Cannot be used with 021-0007-00. Includes: interconnecting cable (012-0309-00); 2 interface cards (10-bit D-A converter - 670-1420-00, dual 10-bit A-D converter - 670-1421-00); instruction manual (070-3057-00).

OPTIONAL ACCESSORIES

Blank prototyping interface card (670-1266-00); interconnecting cable with 36-pin connectors (012-0131-00); interconnecting cable, 36-pin connector on one end only (012-0132-00); interconnecting cable for magnetic tape reader (012-0308-00).

TELEVISION INSTRUMENTS

PRODUCT	DESCRIPTION	PAGE	NTSC 525/60	PAL 625/50	PAL 525/60	CATV
140	Signal Generator	272	Yes			
141A	Signal Generator	273		Yes		
142	Signal Generator	273			Yes	
144	Signal Generator	271	Yes			Yes
146	Signal Generator	266	Yes			Yes
520	Vectorscope	250	Yes			Yes
521	Vectorscope	254		Yes		
522	Vectorscope	254			Yes	
528	Waveform Monitor	258	Yes	Yes with MOD 188G	Yes	Yes
529	Waveform Monitor	262	Yes	Yes with MOD 188D*	Yes	Yes
453A MOD 127C	Oscilloscope	277	Yes	Yes	Yes	Yes
4501	Scan Converter	355	Yes	Yes	Yes	Yes
1401	Spectrum Analyzer	206	Yes	Yes	Yes	Yes

*Other modified Type 529 Waveform Monitors are available for 625-line, 50-field television standards. Please confer with your Tektronix Field Engineer, Representative or Distributor.

VECTORSCOPES

The vectorscope has emerged as an essential instrument to those making measurements in color television systems. Vectorscopes are capable of a wide variety of specialized measurements. Differential phase and differential gain are measurable directly, whether the test signal is a full field signal as in out-of-service and proof of performance testing, or a single line per frame vertical interval test signal for in-service testing.

The vectorscope may be thought of as an oscilloscope having a circular time base which has extreme stability (it is determined by the frequency of the color subcarrier). Time delay between two signals can be checked, because the phase difference at any particular frequency can be related to time difference. An example of this is the setup of two color cameras some distance apart. The two signals can be viewed together on a time-shared basis. Any time-delay difference between the two camera links will appear as a phase difference in the vectorial display. This time-delay difference can be determined by noting that 360° on the graticule equals 280 nanoseconds of time in the Type 520 and 522 (225 nanoseconds in the Type 521). The difference can be minimized by adjusting the connecting cable lengths so that there will be no hue or phase difference from one camera to the other.

The chromaticity of any televised material can be measured. Here the measurements are not expressed directly in the customary units in which colorimetry deals, but in terms of the phase angle of the color subcarrier.

WAVEFORM MONITORS

In the field of waveform monitors, Tektronix offers the Type 529 in full rack width and half rack width versions for a variety of mounting arrangements with picture monitors. The Type 529 finds wide acceptance as a transmission test instrument because of its digital line selector and bright, sharp trace which makes it suitable for monitoring vertical interval test signals. For analyzing individual lines per frame of the picture, a variable line selector and line strobe are provided so that the line being examined may be identified on the associated picture monitor.

For a large number of applications, single line viewing is not required, as in camera control and routine monitoring. For these applications, the Type 528 is finding widespread acceptance due to its simplicity and compactness. Two Type 528 instruments occupy only 5¼ inches of rack space, yet the screen size is 8 x 10 cm.

TELEVISION SIGNAL GENERATORS

Tektronix Signal Generators are available for both NTSC and PAL color TV systems. The instruments are all solid-state utilizing digital integrated circuits to achieve the stability, accuracy and reliability expected of instruments which generate test, sync and subcarrier signals. They provide operating capabilities usually found in much higher priced generators.

RETURN LOSS BRIDGE

The 75-ohm Return Loss Bridge was developed to assess the performance of television transmission lines and their terminal equipments in carrying television signals without picture impairment. The Return Loss Bridge measures quantitatively the energy reflected in a transmission system due to impedance mismatching at or before the termination. Unlike fast pulse systems, the return loss technique uses standard TV test signals so that energy reflections at frequencies above those of interest are not measured. In this way, results are obtained which are meaningful in assessing transmission quality for television. Fast pulse techniques on the other hand locate impedance discontinuities when the return loss technique has determined that there are relevant reflections at video frequencies.

The Tektronix Return Loss Bridge is used in conjunction with the Type 1A5 or 7A13 Differential Plug-In Units. The Return Loss System is specified at —54 dB over the full 10 MHz bandwidth of the system. Since —46 dB is equivalent to an impedance discontinuity of less than 0.5%, the bridge provides more resolution than is usually required.

GLOSSARY OF TERMS

APL: Average picture level. The average luminance level of the unblanked portion of a television line.

BRUCH SEQUENCE: An arrangement of color burst signals which assures that the starting polarity of the burst signal is the same at the start of each field for improved stability of color synchronization.

CATV: Community Antenna Television.

CHROMINANCE: This term is used to indicate both hue and saturation of a color.

CHROMINANCE SIGNAL: In television, the sidebands of the modulated chrominance subcarrier which are added to the monochrome signal to convey color information. The chrominance signal components transmit the qualities of hue and saturation but do not include luminance or brightness.

COLOR BAR: A test signal, typically containing six basic colors—yellow, cyan, green, magenta, red and blue, which is used to check chrominance functions of color TV systems.

COLOR BURST: Refers to a burst of 8 to 10 cycles of subcarrier on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

COLOR SUBCARRIER: The carrier signal whose modulation sidebands are added to the monochrome signals to convey color information.

COMPOSITE VIDEO SIGNAL: The complete video signal. For monochrome, it consists of the picture signal and the blanking and synchronizing signals. For color, additional color synchronizing signals and color picture information are added.

DIFFERENTIAL GAIN: The amplitude change, usually of the color subcarrier, introduced by the overall circuit, measured in dB or per cent, as the picture signal on which it rides is varied from blanking to white level.

DIFFERENTIAL PHASE: The phase change of the color subcarrier introduced by the overall circuit, measured in degrees, as the picture signal on which it rides is varied from blanking to white level.

GEN-LOCK: A system of regenerating subcarrier and sync from a composite video source.

H RATE: The time for scanning one complete line, including trace and retrace, NTSC equals 1/15734 sec (color) or 63.5 μs.

HUE: The attribute of color perception that determines whether an object is red, yellow, green, blue, purple, or the like. White, black, and gray are not considered as being hues.

IRE UNIT: 7.14 mV.

LUMINANCE: This indicates the amount of light intensity which is perceived by the eye as brightness.

NTSC: National Television Standards Committee.

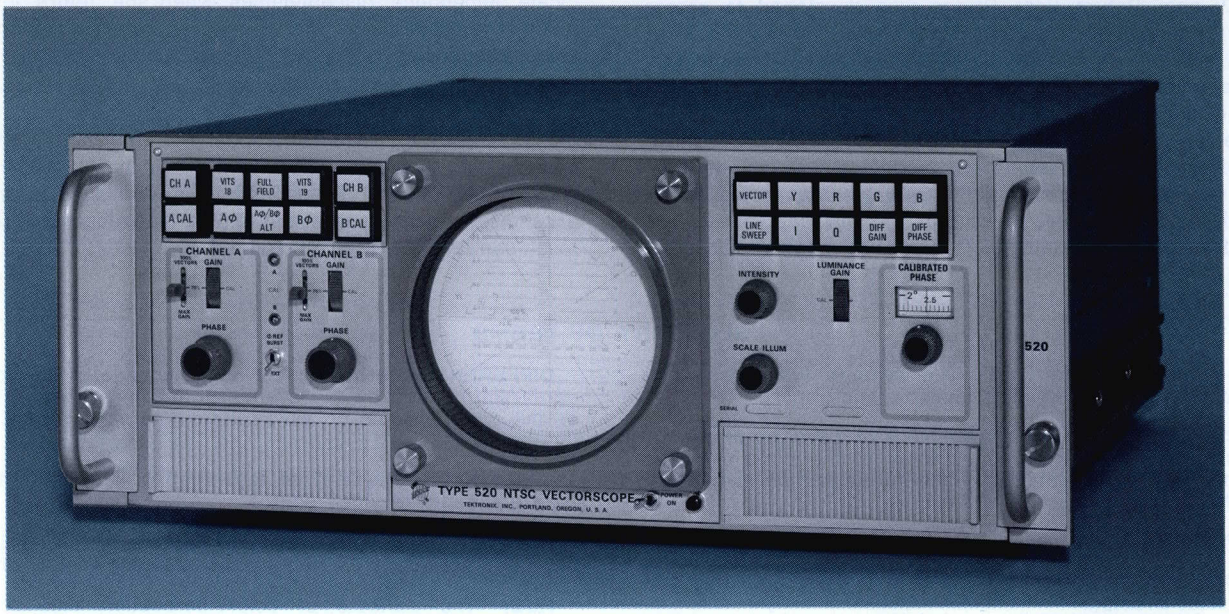
PAL: Phase alternation line. A system in which the subcarrier derived from the burst signal is switched 180° in phase from one line to the next. This system helps to minimize hue errors which may occur in a color transmission.

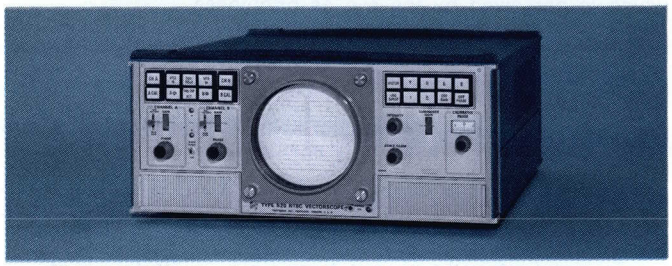
SATURATION: The degree to which a color is pure and undiluted by white light, distinguished between vivid and weak shades of the same hue. The less white light in a given color, the greater is its saturation.

STAIRCASE: A video test signal containing several steps at increasing luminance levels. The staircase signal is usually amplitude modulated by the subcarrier frequency and is useful for checking amplitude and phase linearities in video systems.

VITS: Vertical interval test signal (NTSC), vertical insertion test signal (PAL). A signal which may be included during the vertical blanking interval to permit on-the-air testing of video circuitry functions and adjustments.

520
NTSC Vectorscope





- ***PUSH-BUTTON OPERATING CONVENIENCE***
- ***AMPLITUDE CALIBRATED DISPLAYS***
- ***LUMINANCE AMPLITUDE, CHROMINANCE PHASE AND AMPLITUDE, DIFFERENTAL PHASE AND DIFFERENTIAL GAIN MEASUREMENTS***
- ***THE LUMINANCE CHANNEL AND THE LINE-RATE TIME BASE PERMIT DECODED R, G, B and Y DISPLAYS***
- ***ALL SOLID-STATE, COOL, QUIET OPERATION***

The Tektronix Type 520 NTSC Vectorscope is designed to measure luminance amplitude, and chrominance amplitude and phase of the NTSC composite color television signal. Self-canceling pushbutton switches permit rapid selection of displays for quick analysis of television signal characteristics, and to check Vectorscope calibration. All solid-state circuitry provides low power consumption and cool, quiet operation.

Dual inputs provide time-shared displays for comparison of input-output signal phase and gain distortion. A chrominance channel is provided which demodulates the chrominance signal to obtain color information from the composite video signal for use in VECTOR, LINE SWEEP, R, G, B, I, Q, Differential Gain (dA) and Differential Phase (dϕ) displays. A luminance channel separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B displays at a line rate.

A digital line selector permits the display of a single line Vertical Interval Test Signal from a selected line of either field 1 or field 2.

VECTOR PRESENTATION

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary and complementary colors: R (Red), B (Blue), G (Green); Cy (Cyan), Y_L (Yellow) and M_G (Magenta).

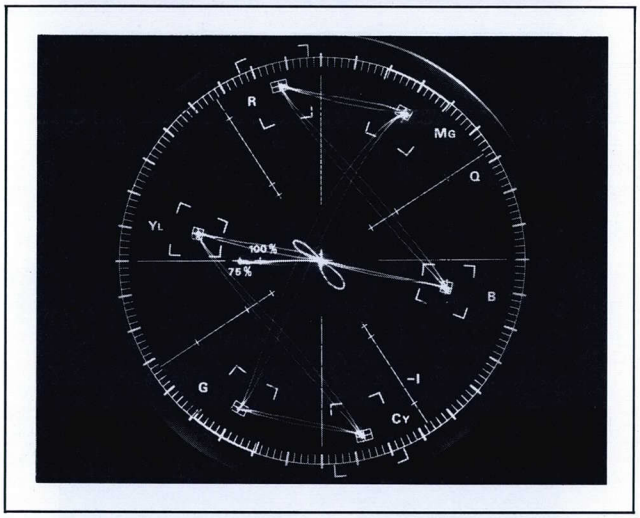


Fig 1—Vector display—full field color bars, 75% amplitude, 100% white reference, 10% set-up. Conforms to EIA standard RS189. Type 140 NTSC Test Signal Generator used as a signal source.

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on the Type 520 CRT has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits per FCC requirements (±10°, ±20%). The inner boxes indicate ±2.5° and 2.5 IRE units and correspond to phase and amplitude error limits per EIA specification RS-189, amended for 7.5% setup.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color signals are demodulated along any desired axis, I, Q, R-Y, B-Y, etc. and displayed at the line rate on a linear time base.

DUAL DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ and Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on the

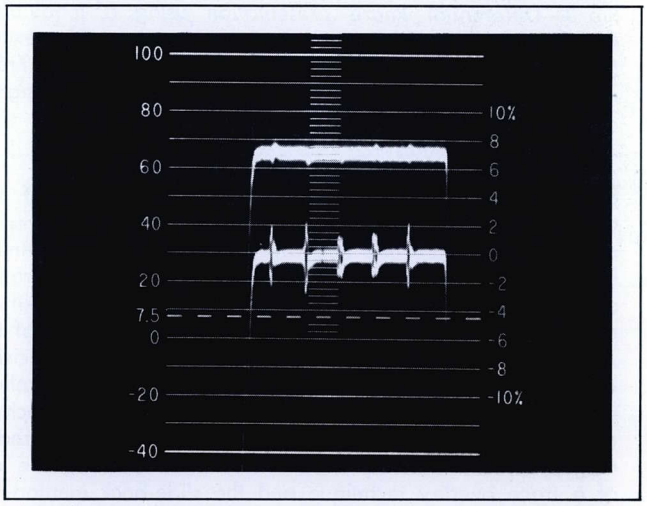


Fig 2—Differential Gain display from the Type 520 using the Type 140 NTSC Test Signal Generator. Lower trace, luminance is on. Upper trace, luminance is off. Minor divisions of graticule indicate .5% Differential Gain. Double exposure.

Type 520 Vectorscope. Differential gain (fig 2) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The IRE graticule major divisions represent % of voltage gain or loss when making a differential gain measurement. The 520 permits differential gain measurements with accuracy to better than 1%.

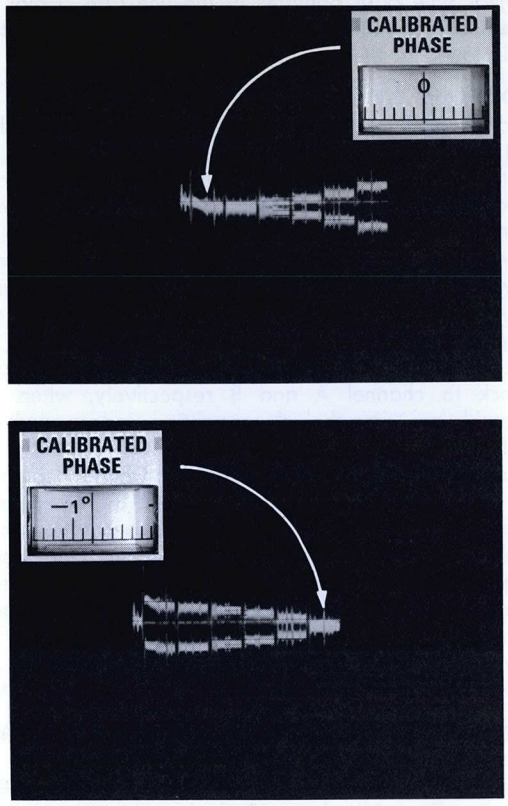
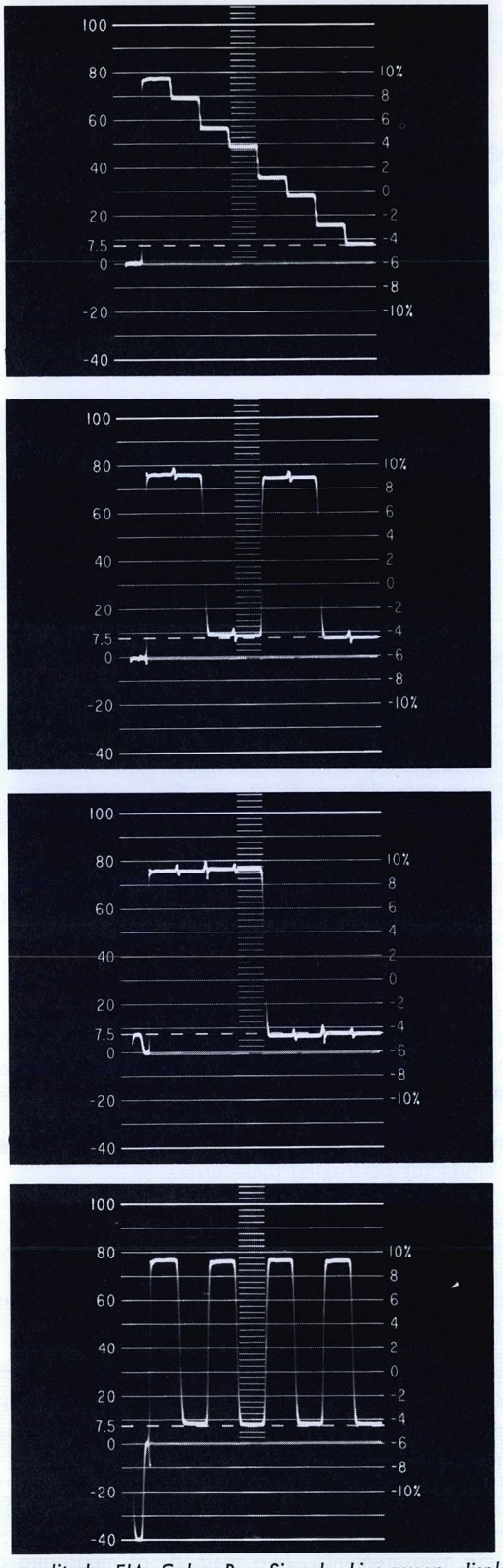


Fig 3—Differential Phase presentation using a modulated staircase signal. A trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (1st step of staircase signal overlayed) to point of measure in bottom photo (6th step overlayed) represents 1.2° differential phase distortion.

Differential phase (fig 3) is a phase modulation of the chrominance signal by the luminance signal. In the reproduced color picture, the hue will vary with scene brightness. Differential gain and differential phase may occur separately or together. The causes of these distortions are amplitude non-linearity and time delay that are not independent of the signal level. Differential phase is read from the precision calibrated phase shift control. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference burst is selectable, internal or external.

RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y) OBSERVATIONS

The Type 520 provides a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 4). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 5, 6, 7). Amplitude measurements of color signal components can be made with an accuracy of 3%.



75% amplitude EIA Color Bar Signal. Line-sweep displays of Luminance (fig 4), decoded Red (fig 5), decoded Green (fig 6), and decoded Blue (fig 7). Displays photographed with a Tektronix C-27-549 Camera, using a Tektronix Type 140 NTSC Test Signal Generator as a source.

VERTICAL INTERVAL TEST SIGNAL OBSERVATION

Vertical Interval Test Signals from preselected lines of either field 1 or field 2 can be displayed on the Type 520 Vectorscope.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

Normally, lines 18 and 19 in either field 1 or field 2 are selected by means of the VITS 18 and VITS 19 push buttons in conjunction with the FIELD switch. Internal quick-disconnect jumper wires permit selecting any line from 7 through 21 of either field. Intensity and focus are automatically adjusted for optimum viewing of VITS.

GRATICULE

Two separate graticules provide references for vector and line sweep displays. The parallax-free vector graticule, or the IRE graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z AXIS INPUT

The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

VIDEO INPUTS

Dual input BNC connectors (fig 8) for each channel permit 75-Ω loop-through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

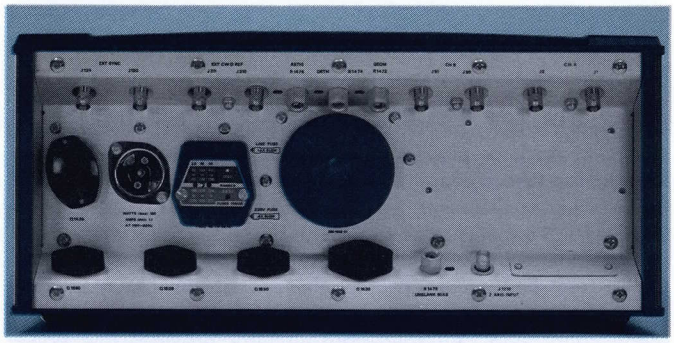


Fig 8—Rear view of 520 Vectorscope. The mounting angle of the coax connectors permit connecting cables to leave the instrument without protruding excessively and with a minimum of clearance space required.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95-watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

ENVIRONMENTAL CAPABILITIES

Ruggedly designed to withstand temperature and altitude variations, vibration, shock, and transportation. Listed instrument characteristics are valid over a temperature range of 0° C to +50° C ambient.

MECHANICAL CHARACTERISTICS

The Type 520 Vectorscope is available in two mechanical configurations. A cabinet model and a rackmount model (Type R520). Both instruments are electrically identical. The R520 mounts in a 19-inch rack and is provided with a slide-out assembly for convenient access to internal components.

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

DIMENSIONS AND WEIGHTS

TYPE 520	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
TYPE R520	Height	7 in	17.8 cm
	Width	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net weight	33 lb	15 kg
Domestic shipping weight		≈61 lb	≈27.7 kg
Export-packed weight		≈82 lb	≈37.3 kg

INCLUDED STANDARD ACCESSORIES

TYPE 520: Smoke-gray filter, installed (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); instruction manual (070-0639-01).

TYPE R520. Same as Type 520 but includes rackmounting hardware, and slide-out assembly (351-0195-00).

ORDERING INFORMATION

Cabinet model, order TYPE 520 NTSC VECTORSCOPE $2500

Rackmount model, order TYPE R520 NTSC VECTORSCOPE $2550

UHF connectors are optional and may be specified without extra cost.

OPTIONAL ACCESSORIES

75-Ω VOLTAGE STEP-UP TERMINATION

The 75-Ω Voltage Step-Up Termination provides a X5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a Tektronix Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the Vectorscope.

For use with Type 520 Vectorscope

UHF connectors, order 011-0100-00 . . . . . $27.50

BNC connectors, order 011-0100-01 . . . . . $27.50

SINGLE SIDEBAND CHROMA AMPLITUDE CORRECTOR

The Single Sideband Chroma Amplitude Corrector is designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a X2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

For use with Type 520 Vectorscope

UHF connectors, order 011-0107-00 . . . . . $27.50

BNC connectors, order 011-0107-01 . . . . . $27.50

C-27 TRACE RECORDING CAMERA

f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.

Order C-27-549 . . . . . $500

Type 520 to C-27 Camera Adapter, order 016-0225-02 . . $16

R520 CRADLE ASSEMBLY

For mounting the Type R520 in a WECO backless rack.

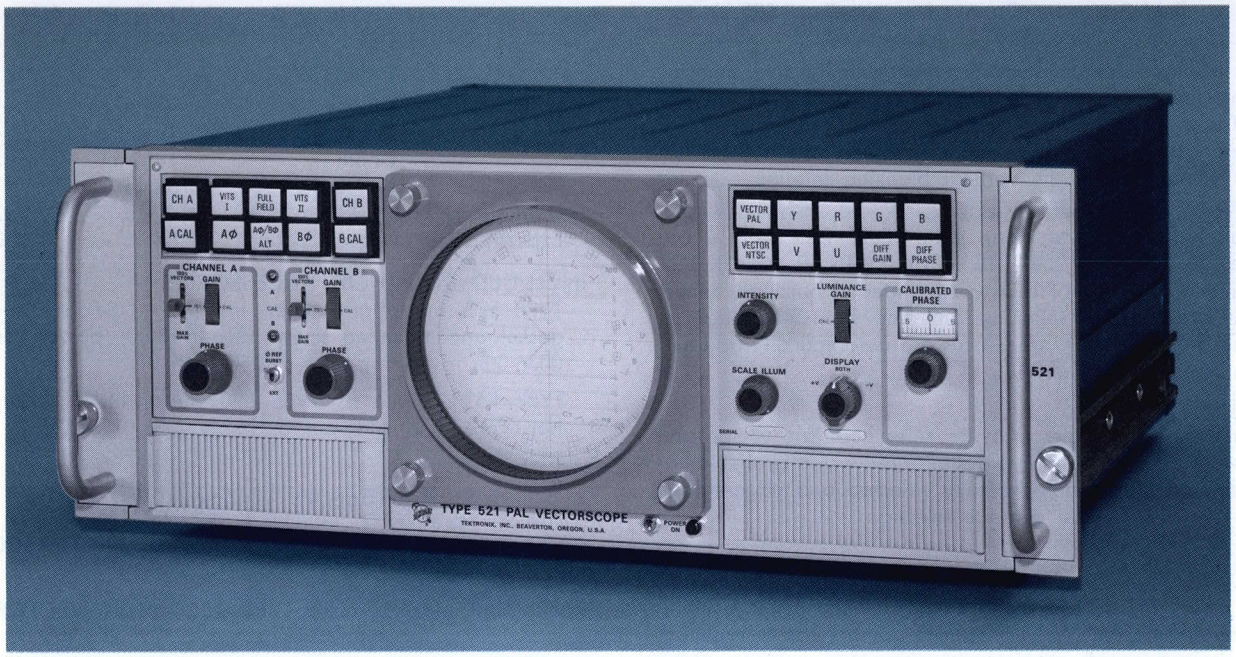
Order 426-0667-00 . . . . . $8.50

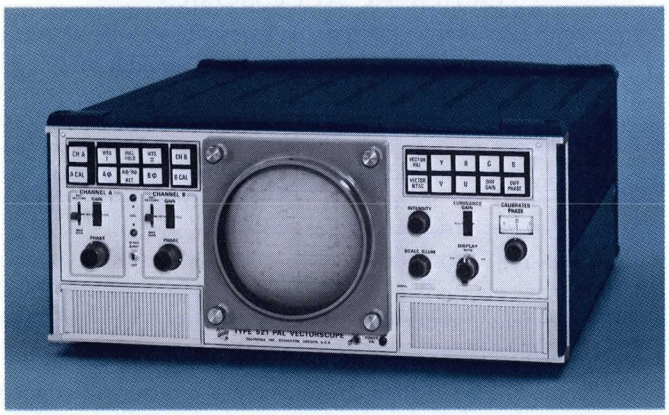
[1]Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

521 and 522*

PAL Vectorscopes





- ***PUSH-BUTTON OPERATING CONVENIENCE***
- ***AMPLITUDE CALIBRATED DISPLAYS***
- ***LUMINANCE AMPLITUDE, CHROMINANCE PHASE AND AMPLITUDE, DIFFERENTIAL PHASE AND DIFFERENTIAL GAIN MEASUREMENTS***
- ***THE LUMINANCE CHANNEL AND THE LINE-RATE TIME BASE PERMIT DECODED R, G, B and Y DISPLAYS***
- ***ALL SOLID-STATE, COOL, QUIET OPERATION***

The Tektronix Type 521 PAL Vectorscope is designed to measure luminance amplitude, and chrominance phase and amplitude of the PAL composite color television signal. It is designed for 625 line 50 field PAL Color TV signals utilizing a color subcarrier frequency of 4.43361875 MHz and is calibrated to observe video signals with 0 set-up level. Self-canceling push-button switches permit rapid selection of displays for quick analysis of television signal characteristics, and to check Vectorscope calibration. All solid-state circuitry provides low power consumption and cool, quiet operation.

Dual inputs are provided permitting time-shared displays for comparison of input-output signal phase and gain distortion. A chrominance channel is provided which demodulates the chrominance signal to obtain color information from the composite video signal for use in VECTOR PAL, VECTOR NTSC, R, G, B, U, V, Differential Gain and Differential Phase displays. A luminance channel separates and displays the luminance (Y) component of the composite color signal. The Y component is combined with the output of the chrominance demodulators for R, G and B displays at a line rate.

A digital line selector permits the display of a single line Vertical Insertion Test Signal from a selected line of either field 1 or field 2.

*For 525-line 60-cycle field, 3.575611 MHz subcarrier (Brazilian system)

VECTOR PRESENTATION

The vector presentation graphically displays the relative phase and amplitude of the chrominance signal on polar coordinates. To identify these coordinates the graticule (see fig 1) has points which correspond to the proper phase and amplitude of the primary, complementary and conjugate chrominance vectors: Red (R) (r), Green (G) (g), Blue (B) (b), Cyan (Cy) (cy), Magenta (Mg) (mg) and Yellow (Yl) (yl).

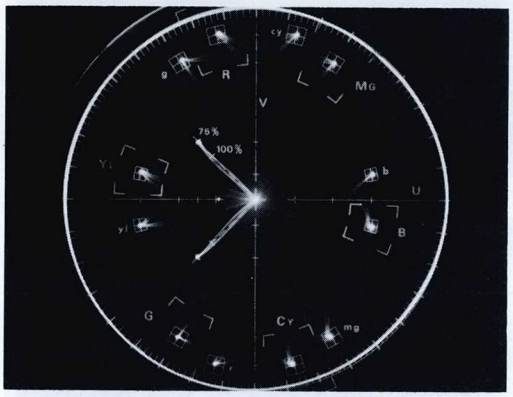


Fig 1A—Vector PAL presentation of PAL color bar signal.

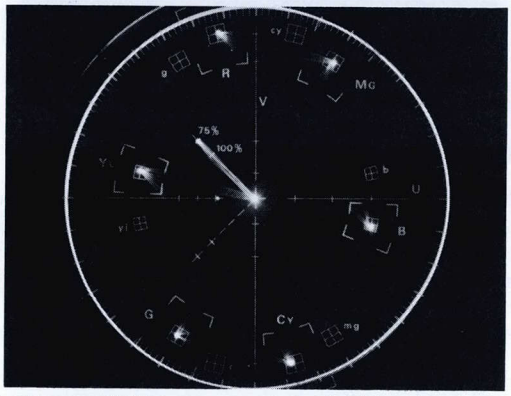


Fig 1B—Vector NTSC presentation of PAL color bar signal.

Any errors in the color encoding, video tape recording or transmission processes which change these phase and/or amplitude relationships cause color errors in the television receiver picture. The polar coordinate type of display such as that obtained on a vectorscope has proved to be the best method for portraying these errors.

The polar display permits measurement of hue in terms of relative phase of the chrominance signal with respect to the color burst. Saturation is expressed in terms of the displacement from center (radial length) toward the color point which corresponds to 75% (or 100%) saturation of the particular color being measured.

The outer boxes around the color points correspond to phase and amplitude error limits (±10°, ±20%). The inner boxes indicate ±3° phase angle and ±5% amplitude.

(+V), (+V and −V) and (−V) vector displays are provided, permitting observation of the 135° and 235° burst-related color information, individually or combined.

An internally generated test circle matched with the vector graticule verifies quadrature accuracy, horizontal to vertical gain balance and gain calibration for chrominance signal amplitude measurements. Two methods of measuring phase-shift are provided. Large phase-shifts can be accurately read from the parallax-free vector graticule. A precision calibrated phase shifter with a range of 30°, spread over 30 inches of dial length, is provided for measuring small phase-shifts.

LINEAR-SWEEP PRESENTATION

The linear time base operates at the line rate. Color signals are demodulated along any desired axis, U, V, etc. and displayed at the line rate on a linear time base.

DUAL DISPLAY

In dual-channel operation, successive samples of channels A and B are displayed on a time-shared basis. The switching rate is locked to horizontal sync and switching transients are blanked. Input-output signals from video equipment can be conveniently compared on channel A and B for phase and/or amplitude distortion. The subcarrier processing channel contains two uncalibrated 0° to 360° phase-shifters and one 30° CALIBRATED PHASE shifter. While viewing channel A or B, either of the uncalibrated phase-shifters, Aϕ or Bϕ, can be switched into the subcarrier processing channel. Aϕ or Bϕ will lock to channel A and B respectively, when A and B channel are time-shared, permitting independent phase control of channel A and B displays. Phase shifts caused by unequal signal paths are easily cancelled, leaving only phase and amplitude distortion caused by equipment deficiencies. Video cable lengths can be accurately matched for time delay at color subcarrier frequency to less than 0.5° phase difference. Accurate amplitude measurements of chrominance and luminance are provided from the CRT. An internal 1-V luminance amplitude calibration test signal is provided to check the gain accuracy of channel A and B amplifiers and the luminance channel.

DIFFERENTIAL GAIN AND DIFFERENTIAL PHASE MEASUREMENTS

The two main chrominance-signal distortions are differential gain and differential phase. Both can be measured on the Type 521 PAL Vectorscope. Differential gain (fig 2) is a change in color subcarrier amplitude as a function of luminance. In the reproduced color picture, the saturation will be distorted in the areas between the light and dark portions of the scene. The luminance graticule major divisions represent percent of voltage gain or loss when making a differential gain measurement. The 521 PAL Vectorscope permits differential gain measurements with accuracy to better than 1%.

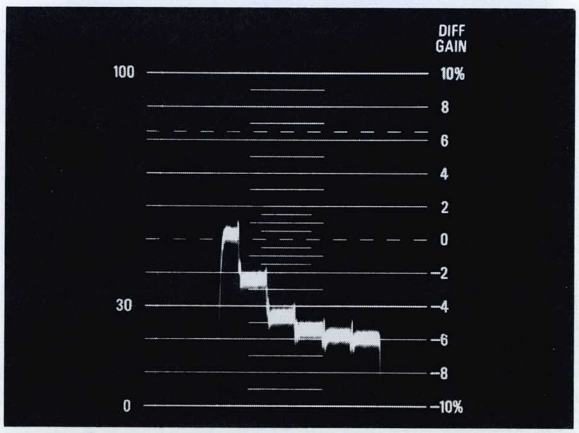
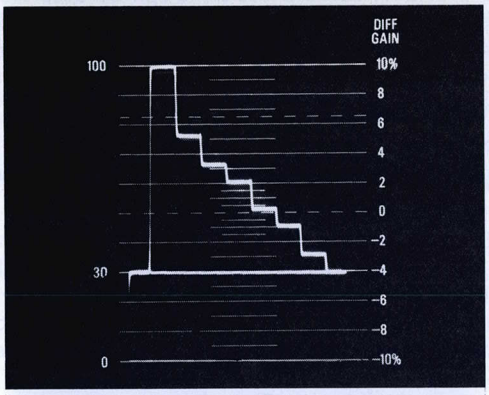


Fig 2—Type 521 PAL and Type 141A system being used to measure differential gain of a typical cascade of video amplifiers. Indicated differential gain is 6½%.



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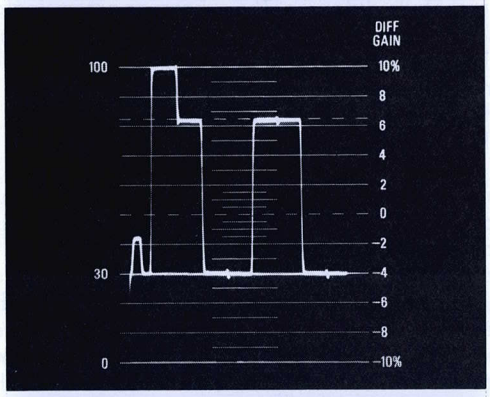

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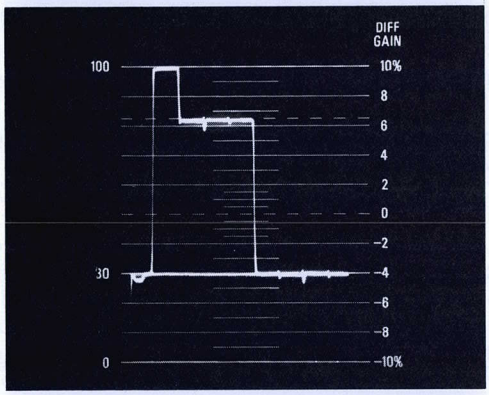

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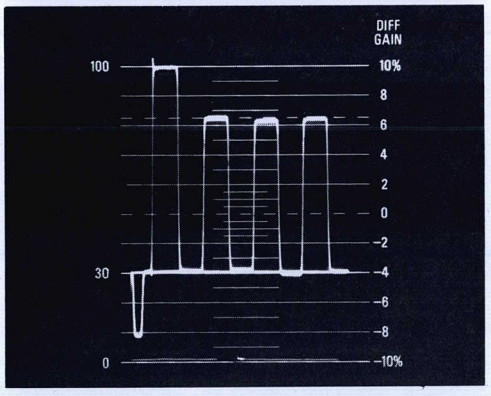


6

Line sweep presentations of Luminance (signal sequence; white, yellow, cyan, green, magenta, red, blue, and black, fig 3), decoded Red (fig 4), decoded Green (fig 5), and decoded Blue (fig 6), components of the PAL color bar signal. Photos were taken using a Type 141A PAL Television Test Signal Generator, a Type 521 PAL Vectorscope, and a C-27-549 Camera.

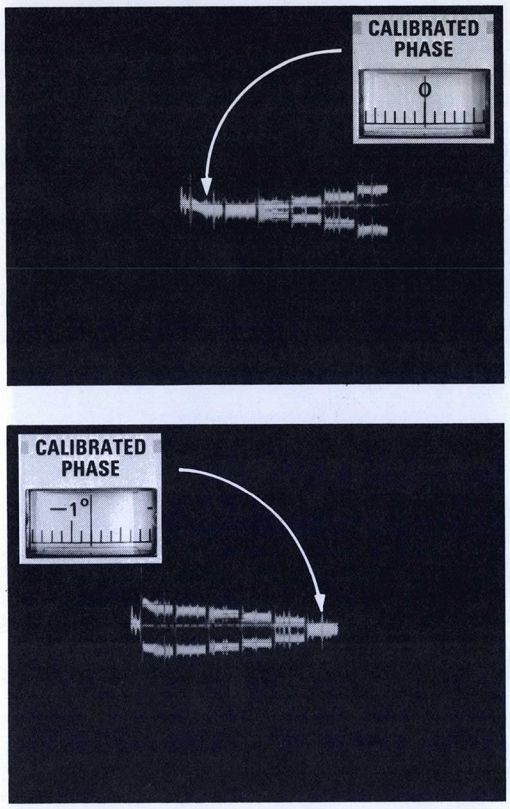


Fig 8—Differential Phase presentation using a modulated staircase signal. A trace overlay technique provides excellent resolution for measuring small phase changes. From reference point in top photo (1st step of staircase signal overlayed) to point of measure in bottom photo (6th step overlayed) represents 1.2° differential phase distortion.

Differential phase (fig 8) is a phase modulation of the chrominance signal by the luminance signal. Differential phase may result in picture impairment.

Differential gain and differential phase may occur separately or together. The causes of these distortions are amplitude non-linearity and time delay that are not independent of the signal level. Differential phase is read from the precision calibrated phase shift control. Dial resolution is excellent with 1° phase shift represented by approximately 1 inch of dial movement. The vertical deflection of the display is greatly magnified and inverted on alternate lines allowing the use of a trace overlay technique and the slide-back method for measuring small phase changes. The CALIBRATED PHASE control provides direct readout of differential phase. Using the standard linearity test signal, differential phase of 0.2° can be measured. Reference phase is selectable, from an internal subcarrier regenerator or an external CW source.

RED (R), GREEN (G), BLUE (B) AND LUMINANCE (Y) OBSERVATIONS

The Type 521 PAL Vectorscope provides a luminance channel which permits the separation and display of the luminance (Y) component from the composite color signal (fig 3). The Y component can also be combined with the output of the chrominance demodulators for R, G and B displays at a line rate (fig 4, 5, 6). Amplitude measurements of color signal components can be made with an accuracy of 3%.

521 and 522
PAL Vectorscopes

VERTICAL INSERTION TEST SIGNAL OBSERVATION

Vertical Insertion Test Signal from preselected lines of either field 1 and 3 or field 2 and 4 can be displayed.

Binary counters operate in conjunction with the field selector to select lines in either field that may carry suitable test signals. These circuits enable the Vectorscope to be used for measuring differential gain and differential phase from test signals transmitted in the vertical blanking interval of color broadcasts.

Specific lines are selected by means of the VITS I and VITS II push buttons. Vectorscopes normally are shipped from the factory with the following lines selected by these switches:

	(VITS I) FIELDS 1 and 3	(VITS II) FIELDS 2 and 4
Type 521/R521	lines 17 and 18	lines 330 and 331

Internal quick-disconnect jumper wires permit selecting any line from 4 through 22 or 316 through 335. Intensity and focus are automatically adjusted for optimum viewing of VITS.

GRATICULE

Two separate graticules provide references for vector and line sweep displays. The parallax-free PAL vector graticule, or the luminance graticule, is automatically selected and edge-lighted concurrent with operating mode selection.

Z AXIS INPUT

The Z-AXIS INPUT connector accepts external trace-brightening pulses for intensifying a portion of the display during the time of interest. A 1-V negative-going pulse is required.

VIDEO INPUTS

Dual BNC input connectors (fig 9) for each channel permit 75-Ω loop through operation with a return loss greater than 46 dB* to 5 MHz. Amplitude range is 0.7 V to 1.4 V VIDEO (sync tip to peak white).

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 47 to 63 Hz, 95 watts maximum at 115 V and 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

ENVIRONMENTAL CAPABILITIES

Listed instrument characteristics are valid over a temperature range of 0°C to +50°C ambient.

MECHANICAL CHARACTERISTICS

The Type 521 PAL Vectorscope is available in two mechanical configurations, a cabinet model and a rackmount model. Both instruments are electrically identical. The Type R521 mounts in a 19-inch rack and is provided with a slide-out assembly for convenient access to internal components.

DIMENSIONS AND WEIGHTS

Type 521	Height	7 in	17.8 cm
	Width	16⅞ in	42.9 cm
	Depth	19⅛ in	48.7 cm
	Net weight	33 lb	15 kg
Type R521	Height	7 in	17.8 cm
	Width	19 in	48.3 cm
	Depth	19¾ in	50.2 cm
	Net weight	33 lb	15 kg

*Exceeds CCIR recommendation 451-2, paragraph 3.1 and 3.2

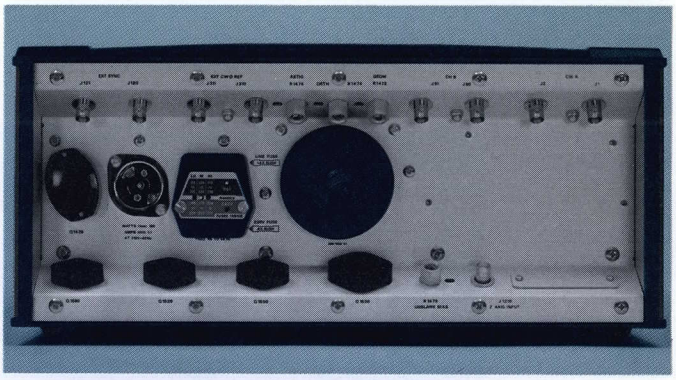


Fig 9—Rear view of Type 521 PAL Vectorscope.

INCLUDED STANDARD ACCESSORIES

Smoke-gray filter (378-0581-00); camera gasket and mounting screws (016-0114-00); power cord (161-0036-00); instruction manual 521/R521 (070-1027-00).

Type R521 same as Type 521 but includes rackmounting hardware, and slide-out assembly (351-0195-00).

ORDERING INFORMATION

Cabinet model, order

TYPE 521 PAL VECTORSCOPE **$2500**

Rackmount model, order

TYPE R521 PAL VECTORSCOPE **$2550**

For 525-line, 60-cycle field, 3.575611 MHz subcarrier (Brazilian system):

TYPE 522 PAL VECTORSCOPE **$2750**

TYPE R522 PAL VECTORSCOPE **$2800**

UHF connectors are optional and may be specified without additional cost.

OPTIONAL ACCESSORIES

R521 CRADLE ASSEMBLY

For mounting the Type R521 in a WECO backless rack.
Order 426-0667-00 ..... $8.50

C-27 TRACE RECORDING CAMERA

f/1.9, 1:0.5 lens; Polaroid Land* Pack-Film back.
Order C-27-549 ..... $500
Type 521 to C-27 Camera Adapter.
Order 016-0225-02 ..... $16

75-Ω VOLTAGE STEP-UP TERMINATION

The 75-Ω Voltage Step-Up Termination provides a ×5 increase in chrominance amplitude and permits Differential Gain and Differential Phase measurements to be made to a higher degree of accuracy when used with a Tektronix Vectorscope. Input impedance to the termination is a constant 75 Ω. Use of the termination requires a source of external sync to the vectorscope.

FOR USE WITH TYPE 521 VECTORSCOPE
BNC connectors, order 011-0109-00 ..... $27.50

SINGLE SIDEBAND CHROMA AMPLITUDE CORRECTOR

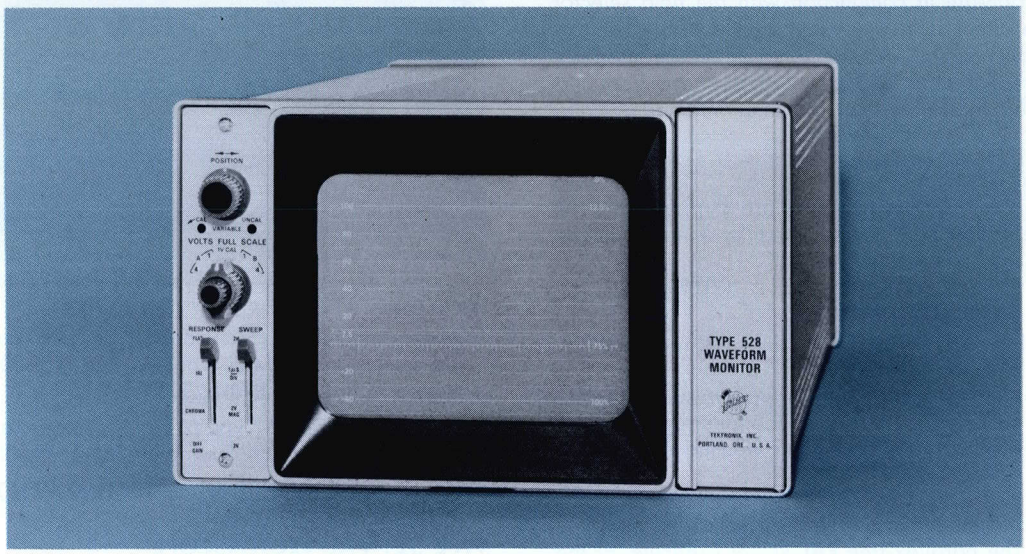
The Single Sideband Chroma Amplitude Corrector is designed for use with a Tektronix Vectorscope in transmitter applications where a vestigial sideband signal is being demodulated with a detecting diode. The corrector provides a ×2 increase in chrominance amplitude and passes luminance components with little or no attenuation. Input impedance is 75 Ω.

FOR USE WITH TYPE 521 VECTORSCOPE
UHF connectors, order 011-0108-00 ..... $27.50
BNC connectors, order 011-0108-01 ..... $27.50

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

528
Waveform Monitor



- ***LARGE 8 x 10-cm DISPLAY AREA***
- ***1/2 RACK SIZE***
- ***TWO VIDEO INPUTS***
- ***PICTURE MONITOR OUTPUT***
- ***SELECTABLE 1-VOLT AND 4-VOLT FULL SCALE DEFLECTION FACTORS***
- ***YRGB AND RGB INPUTS***
- ***ALL SOLID-STATE—LOW POWER CONSUMPTION***

The solid-state Type 528 Television Waveform Monitor provides bright, easy-to-read video waveform displays on a 5-inch CRT, yet requires only 5-1/4-inch vertical height and 1/2-rack width mounting space. This compact instrument is especially well suited for monitoring signals from camera outputs, video system output lines, transmitter video input lines, closed-circuit TV systems and educational TV systems.

Either of two video inputs, selectable from the front panel, may be displayed. The displayed video signal is also provided at a video output jack for viewing on a picture monitor. Calibrated, 1-volt and 4-volt full scale (140 IRE unit) sensitivities are provided for displaying common video and sync signal levels. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale. The built-in 1-volt calibration signal may be switched on to check vertical sensitivity calibration. Flat, IRE, Chroma, and Diff Gain frequency response positions permit observation of various signal characteristics.

Horizontal Sweep selection provides 2 H (two line), 1 μs/div (expanded two line), 2 V (two field) and 2 V MAG (expanded two field). Displays of RGB and YRGB waveforms from color processing amplifiers are provided for with interconnection through a rear-panel 9-pin receptacle.

A DC Restorer maintains the back porch at an essentially constant level despite changes in signal amplitude, APL and color burst. May be turned off when not needed.

All solid-state circuitry provides low power consumption, and long-term reliability.

VIDEO FEATURES

INPUTS

Rear-panel BNC connectors provide two unbalanced inputs (A & B) which may be used with either 75-Ω loop-through or bridging connection. Maximum return loss for A and B video inputs, terminated in 75 Ω, operating or non-operating is 46 dB or greater to 5 MHz. Normally AC coupled but may be easily modified by user for DC coupling.

Rear panel of Type 528 Waveform Monitor.

DEFLECTION FACTOR

Calibrated 1-volt and 4-volt (for 140 IRE unit deflection) positions are provided for video inputs A or B with accuracy within 1% for the 1-volt positions and 3% for the 4-volt positions. A variable sensitivity control permits uncalibrated displays from 0.25-volt to 4.0-volt full scale.

FREQUENCY RESPONSE

4 response positions are provided: FLAT—25 Hz to 3.6 MHz within 1% of response at 50 kHz, 3.6 MHz to 5 MHz +1%, —3% of response at 50 kHz, and +1%, —3% of response at 3.58 MHz; IRE—per IEEE Standard IEEE 205. Response at 4.43 MHz attenuated at least 22 dB; CHROMA—30% down between 3.1 MHz and 3.4 MHz, 30% down between 3.8 MHz and 4.1 MHz. Response at 3.58 MHz does not vary between FLAT and CHROMA by more than 1%. DIFF GAIN—same as CHROMA response with additional gain for displaying 100 IRE units of 90 mV to 143 mV subcarrier levels.

DIFFERENTIAL GAIN

1% or less with 10 to 90% APL changes using DIFF GAIN operating mode with modulated staircase signal, baseline adjusted to 50 IRE units position, and signal adjusted to 100 IRE units P-P.

TRANSIENT RESPONSE

1-volt or 4-volt calibrated deflection factor, FLAT response position, using 125-ns HAD $\sin^2$ pulse and bar test signal: preshoot is not more than 1 IRE unit, overshoot not more than 2 IRE units, ringing not more than 2 IRE units and pulse to bar ratio within 0.99:1 to 1.01:1.

LOW FREQUENCY TILT

1% or less tilt on the vertical window or 60 Hz squarewave (DC Restorer off).

MAXIMUM INPUT LEVEL

MAXIMUM DC INPUT

5 volts‡ for all response positions using AC coupling.

MAXIMUM AC INPUT

Flat and IRE response—Signal levels should be limited to produce displays not exceeding 200 IRE units.

CHROMA response—Chroma levels up to 140 IRE units may be displayed, provided the chroma plus luminance level does not exceed 200 IRE units when viewed in the FLAT response mode.

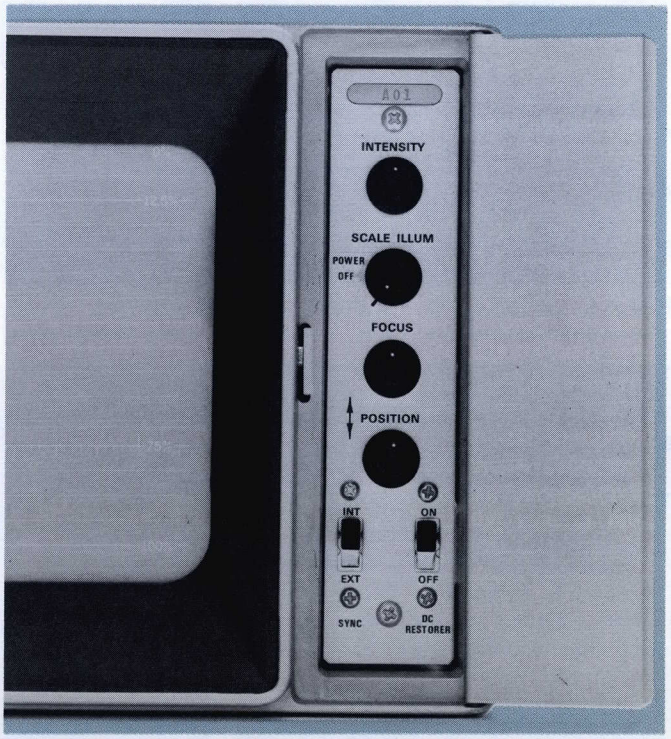
DIFF GAIN—Subcarrier signal levels of 90 mV to 143 mV peak to peak may be expanded, using the variable gain control, to 100 IRE units for measurement of differential gain with 10 to 90% APL.

DC RESTORER

Slow acting back porch DC restoration. Blanking level shift due to presence or absence of burst or changes in APL from 10% to 90% will not exceed 2 IRE units. May be disabled when desired.

VIDEO OUTPUT

The displayed signal is provided at a rear-panel BNC connector. Frequency response is 25 Hz to 5 MHz within 3%. Output signal amplitude is 1 volt within 15% for 140 IRE unit display using the FLAT response mode. DC level is 2 volts‡ or less into 75-Ω load. Nominal output impedance is 75 Ω.



Infrequently used operating controls are conveniently located behind a front-panel hinged door.

‡Exceeds CCIR recommendation 451-2 paragraph 3.2.

TIME BASE FEATURES

SYNCHRONIZATION

Internal or external sync is provided and is selectable by a switch behind the front panel hinged door. Internal sync is derived from composite video input. External sync is via a rear panel BNC loop-through connector and requires 1.5-volts to 4.5-volts composite sync input. The unterminated sync input impedance is approximately 15 kΩ paralleled by approximately 5 pF and maximum input voltage is 20 volts.‡

SWEEP MODES

4 sweep modes are provided: 2-V SWEEP—repetition rate equal to frame rate of applied video or external sync; 2-V MAG SWEEP—expands the vertical blanking interval (approximately 20X magnification of 2 V); 2-H SWEEP—repetition rate equal to half-line rate of applied video or external sync; 1-μs/div SWEEP—calibrated sweep with accuracy within 3% for center 10 div of 12-div sweep, and linearity within 3% throughout horizontal POSITION range, excluding first and last div.

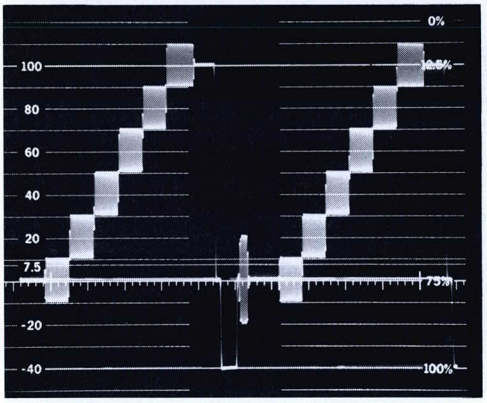


Fig 1. Modulated staircase signal. 2 H SWEEP, FLAT response.

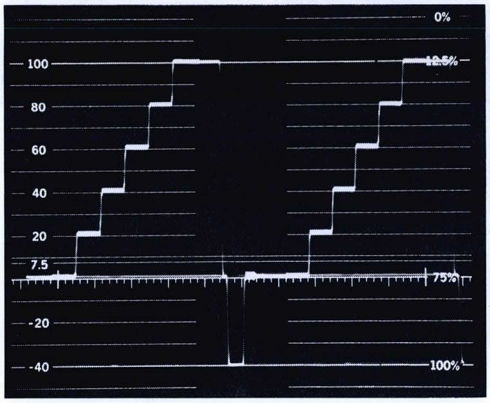


Fig 2. Modulated staircase signal. 2 H SWEEP, IRE response.

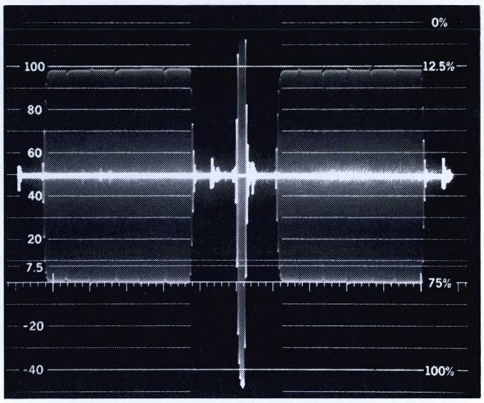


Fig 3. Modulated staircase signal. 2 H SWEEP, DIFF GAIN response.

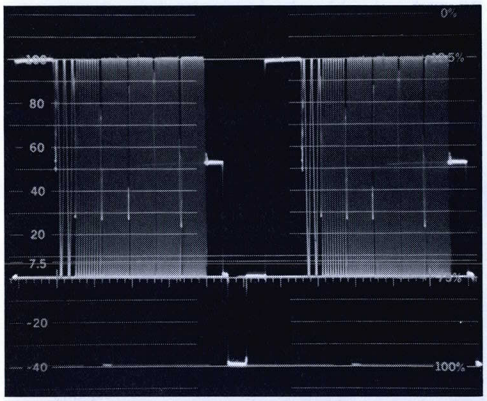


Fig 4. Multiburst signal. 2-H SWEEP, FLAT response.

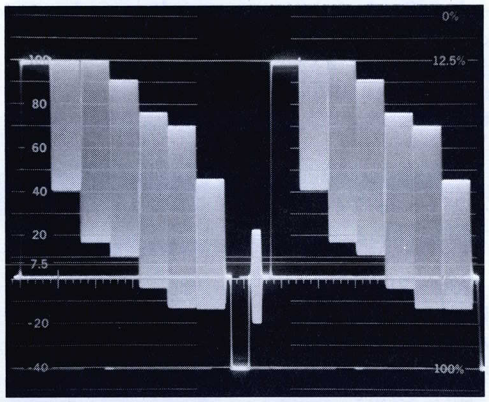


Fig 5. 75% saturated color bar signal. 2-H SWEEP, FLAT response.

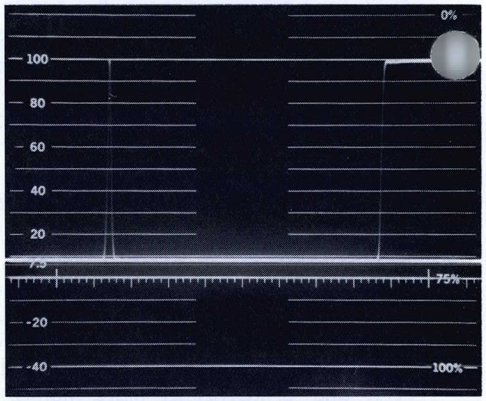


Fig. 6. .125 μs HAD Sin² Pulse and Bar. 1-μs/div calibrated sweep, FLAT response.

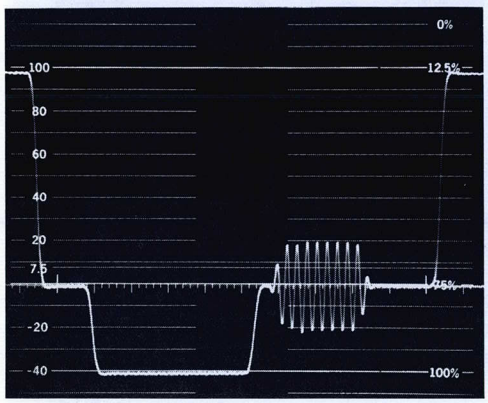


Fig. 7. Horizontal Blanking Interval. 1-μs/div calibrated sweep.

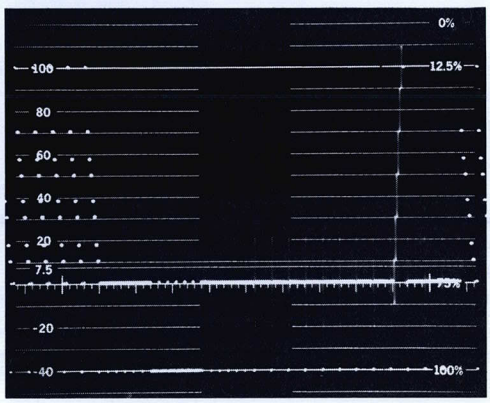


Fig 8. Vertical Blanking Interval. 2-V MAG SWEEP. 20X magnification permits convenient vertical blanking interval observation.

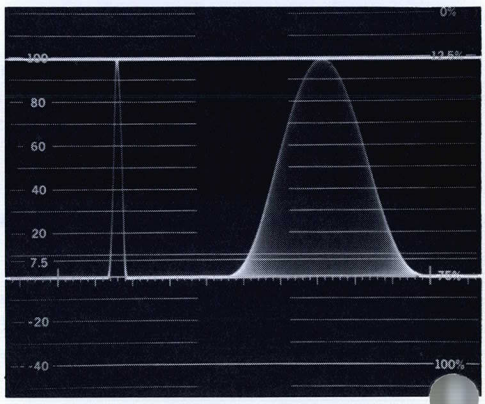


Fig 9. .250 μs HAD Sin² Pulse (left) and Modulated 20 T Sin² Pulse (right) with superimposed Bar Signal (top).

‡Exceeds CCIR recommendation 451-2, paragraph 3.2

YRGB AND RGB DISPLAYS

The Type 528 can be used with color camera processing amplifiers which provide the necessary sequential signal switching and staircase signals. A rear panel 9-pin receptacle provides the necessary interconnections. Factory wired for RGB (3 step) input.

STAIRSTEP AMPLITUDE

A 10-volt amplitude stairstep signal will produce a 9-div display length within 15%.

STAIRSTEP DC LEVEL

Peak AC plus DC signal levels shall not exceed limits of −12 to +12 volts. Maximum AC signal level is 12-volts peak-to-peak.

CONTROL SIGNALS

The RGB or YRGB modes may be initiated through the use of external voltage (12 volts to 15 volts) or ground connection at the rear panel 9-pin receptacle. A 9-pin plug is supplied with the included standard accessories.

OTHER FEATURES

REGULATED POWER SUPPLY

Operates on 99 volts AC to 132 volts AC and 198 volts AC to 264 volts AC, 48 Hz to 66 Hz line frequency. Operates on 115 volts ±10% or 230 volts ±10% at line frequencies from 66 Hz to 440 Hz. POWER CONSUMPTION: approx 48 watts at 115 volts AC, 60 Hz.

TEKTRONIX CATHODE-RAY TUBE

Flat-faced 5-inch rectangular CRT providing an 8 x 10-cm display area. P31 phosphor supplied. External graticule with variable illumination.

CALIBRATOR

An internal calibration signal provides a convenient reference for verifying deflection factor. Amplitude is 1.0 volt within 1%.

AMBIENT TEMPERATURE

Performance characteristics are valid over an ambient temperature range of 0° C to +50° C.

DIMENSIONS AND WEIGHTS

Type 528:	Height	5¼ in	13.3 cm
	Width	8½ in	21.6 cm
	Depth	18½ in	47.0 cm
	Net weight	15 lb	6.8 kg

INCLUDED STANDARD ACCESSORIES

9-pin connector (136-0099-00), connector cover (200-0249-00), instruction manual (070-0800-00).

ORDERING INFORMATION

ORDER TYPE 528 FOR 525-LINE, 30-FRAME TELEVISION STANDARDS

TYPE 528 WAVEFORM MONITOR **$1,000**

TYPE 528 MOD 146B WAVEFORM MONITOR **$975**

As above, but less cover, for mounting in Tektronix rack adapter (016-0115-02).

ORDER TYPE 528 MOD 188G FOR 625-LINE, 25-FRAME TELEVISION STANDARDS, CALIBRATED WITH CCIR SIGNALS WITH CHROMA RESPONSE CENTERED AT 4.43 MHz.

TYPE 528 MOD 188G WAVEFORM MONITOR **$1,000**

TYPE 528 WITH PROTECTIVE CABINET

The Type 528 MOD 147B is a standard Type 528 provided with a protective cabinet for table-top use or portable applications. Cabinet is aluminum construction, blue vinyl finish.

TYPE 528 MOD 147B WAVEFORM MONITOR **$1,030**

OPTIONAL ACCESSORIES

MOUNTING CRADLES

Two different cradle assemblies, with associated bezels and mounting brackets, allow the Type 528 Waveform Monitor to be mounted alongside an 8-inch or 9-inch Conrac† Picture Monitor, in a standard 19-inch rack.

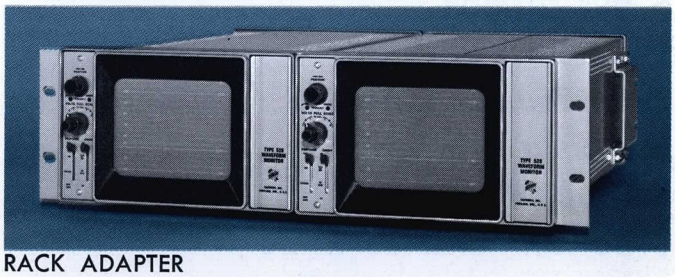
FOR MOUNTING 8-INCH CNB-8 PICTURE MONITOR (REQUIRES 10½-INCHES RACK SPACE)

Description	Part Number	Price
Cradle Assembly	014-0021-00	$35
Bezel and brackets for mounting Type 528 on operator's left	014-0035-00	40
Bezel and brackets for mounting Type 528 on operator's right	014-0036-00	40

FOR MOUNTING 9-INCH RND-9 PICTURE MONITOR (REQUIRES 8¾-INCHES RACK SPACE)

Cradle Assembly	014-0020-00	$35
Bezel and brackets for mounting Type 528 on operator's left	014-0038-00	40
Bezel and brackets for mounting Type 528 on operator's right	014-0037-00	40

TEKTRONIX 14-INCH MONOCHROME AND COLOR PICTURE MONITORS ARE AVAILABLE



RACK ADAPTER

For mounting two Type 528's side-by-side in a standard 19-inch rack. Included are rim clamps which allow fastening or removing of instruments from the front, order 016-0115-02 . . . . . $95.00

PANEL ASSEMBLY

For covering ½ of rack adapter when only one Type 528 is rackmounted, order 016-0116-00 . . . . . $8.00

C-27 CAMERA

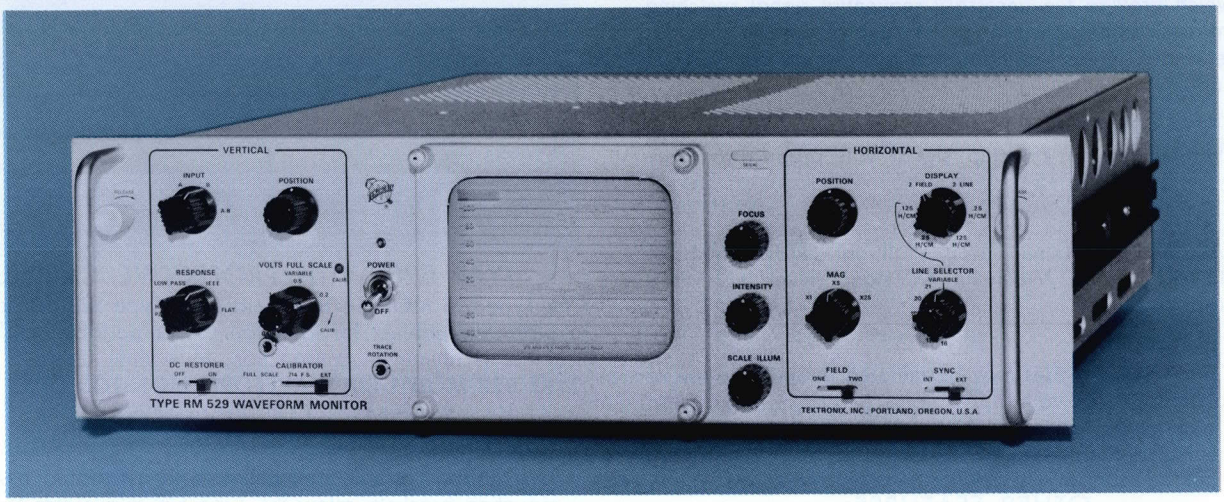
f/1.9, 1:85 lens, Polaroid Land* Pack-Film back, order C-27 . . . . . $460.00

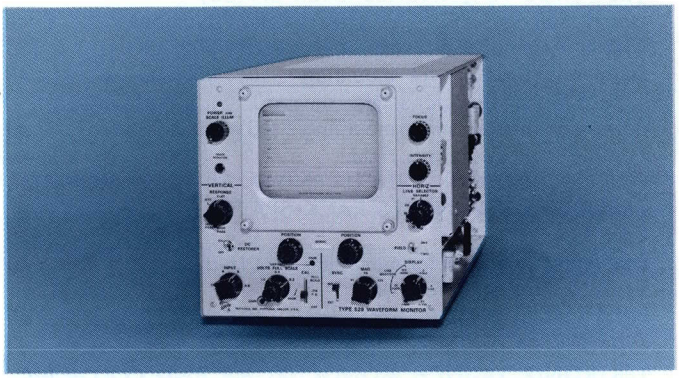
Type 528 to C-27 camera adapter 016-0249-03 . . . . . $16.00

†Registered Trademark Conrac Corporation, Conrac Division
*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

529
Waveform Monitor





- ***LINE SELECTOR***
- ***FLAT TO 8 MHz***
- ***4 FREQUENCY RESPONSES***
- ***POSITIVE FIELD SELECTOR***
- ***COOL—QUIET—CLEAN***
- ***NO FAN—ONLY 80 WATTS***
- ***AVAILABLE FOR USE WITH SEVERAL TV STANDARDS***

The Type 529 and RM529 bring to the Industry a flexibility in waveform monitoring: signal-level monitoring, bandwidth and differential gain measurements, $\sin^2$-pulse and bar testing, monitoring Vertical Interval Test Signals, transmitter percent-of-modulation measurements, YRGB displays (in conjunction with color-processing amplifiers) and others. Included are four video response characteristics, HIGH-PASS, LOW-PASS, IEEE, and FLAT. Both instruments feature FLAT RESPONSE to 8 MHz, assuring excellent waveform fidelity for sine squared testing with 2T, T and $\frac{1}{2}$T pulses.

DC RESTORATION maintains the back porch at an essentially constant level despite changes in signal amplitude, APL, and color burst, and may be turned off for viewing other than video signals. The circuit can easily be modified for sync-tip restoration.

Sensitivity range is 0.12 volts to 1.5 volts for full-scale deflection. Full-scale calibration at 0.714 V or 1.00 V is provided.

BRIGHT WAVEFORM DISPLAYS in line selector operation are obtained with a highly-efficient 5-inch aluminized CRT. The instrument uses the best of both solid-state and vacuum-tube circuitry resulting in improved stability and reliability. These instruments do not require a fan, resulting in cleaner operation and complete freedom from noise.

HORIZONTAL SELECTION provides 2-field or 2-line displays, plus calibrated sweep rates of 0.125 H/cm or 0.25 H/cm. Either calibrated rate may be delayed for line selection. SWEEP MAGNIFICATION extends the sweep rate by X5 or X25, offering calibrated sweep rates from 0.250 H/cm to 0.005 H/cm. POSITIVE FIELD SELECTION assures stable displays in the presence of random noise bursts and video switching. The LINE SELECTOR permits detailed study of any portion of any desired line(s), and a front panel switch selects lines 16 through 21 for viewing VIT signals. A VIDEO-OUTPUT AMPLIFIER supplies video and a brightening pulse to the associated picture monitor, intensifying the same line, or lines, displayed on the instrument when using the LINE SELECTOR.

VIDEO FEATURES

INPUTS
Two unbalanced inputs through rear-panel BNC connectors may be used with either 75-Ω loop-through or bridging connection (input R & C is 1 MΩ and 24 pF). Return loss is greater than 46 dB to 5 MHz using 75-Ω loop-through. Alternatively, one balanced, differential input may be used.

DEFLECTION FACTOR
120 mV to 1.5 V full scale. Continuously variable between ranges. Calibrated full-scale: 1.0, 0.50 and 0.20 V.

FREQUENCY RESPONSE
4 response characteristics provide: FLAT: +0.0 — 1% to 6 MHz; +0.0 — 3% to 8 MHz. IEEE: IEEE Standard IEEE 205. HIGHPASS: 3.58 MHz plus and minus 400 kHz at 15% to 30% down. LOW PASS: At least 80% down at 500 kHz.

DC RESTORER
Keyed back porch* type eliminates drift in DC-coupled vertical amplifier. Does not distort color burst. Waveform will remain on screen if there is a loss of sync pulses for DC restorer keying. DC restorer may be disabled by front-panel switch.

VERTICAL AMPLIFIER
May be DC-coupled to diode demodulator as in % Video Modulation Monitoring. Details are available in manual.

VIDEO OUTPUT
Signal is provided for driving a picture or line monitor with amplitude into 75 ohms approx equal to input signal to 529/RM529.

TIME-BASE FEATURES

CALIBRATED TIME BASE
0.125 H/cm. Magnifier extends calibrated time base to 0.025 H/cm and 0.005 H/cm within 3%. Rep rate is ½ of the TV line rate. The time base can be calibrated using TV signals. Color burst is displayed without phase interlace.

UNCALIBRATED TIME BASE
2 LINE: Triggered time base with rep rate of ⅓ TV line frequency. Provides complete 2-line display with horizontal blanking centered on the screen.

2 FIELD: Synchronized time base with rep rate the same as the TV frame rate. Entire frame of video is displayed with the vertical blanking centered on the screen. Time base will free-run in the absence of signal, indicating loss of incoming signal.

TIME-BASE MAGNIFIER
X5 and X25. Accuracy is within 3%. Magnifier expands the center of the display, convenient for monitoring equalizing or serrated pulses.

*Sync tip restoration available by simple modification.

COLOR CAMERA YRGB DISPLAYS
Can be used with color camera processing amplifiers providing these sequential signals and the staircase signal. To provide YRGB display directly, switching is done in the color processing amplifier. Receptacle to interconnect color processing amplifier (relay control, staircase signal input, and ground) is provided on rear panel.

VIT SELECTOR
Front-panel switch selects lines 16 through 21. Knob position indicates line selected for viewing.

LINE SELECTOR
Variable delay allows any line of either field to be viewed.

FIELD SELECTOR
Positive-acting field selection.

TRIGGER SELECTION
Stable triggering on composite video signals. INTERNAL: 200 mV to 1 V or more, peak to peak. EXTERNAL: 400 mV to 1 V or more, peak to peak.

OTHER FEATURES

REGULATED POWER SUPPLY
Operates on 115 V or 230 V line ± 10% RMS. LINE FREQUENCY: 48-66 Hz. POWER CONSUMPTION: Approx 80 W at 115 V, 60 Hz.

TEKTRONIX CATHODE-RAY TUBE
Flat-faced, 5-inch rectangular CRT, operating at 6.4 kV accelerating potential. Calibrated viewing area, 7 x 10 cm. Electrical beam rotator provides trace alignment. P31 phosphor is normally supplied. External graticule, variable illumination.

CALIBRATOR
Two internal calibration voltages of 0.714 V and 1.00 V on 1-volt full-scale range of VERTICAL GAIN switch. An external calibration signal may be used. Internal calibration pulse amplitude ±1% over ambient temperature range and line-voltage range. Reference is a Zener diode.

VENTILATION
Convection air-cooled. Operating Temperature Range: 0° C to +50° C.

DIMENSIONS AND WEIGHTS

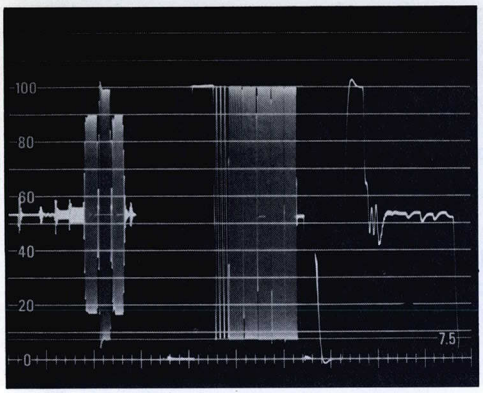
TYPE 529:	Height	8¼ in	21 cm
	Width	8½ in	21.6 cm
	Depth	19½ in	49.7 cm
	Net weight	27 lb	12.2 kg
	Domestic shipping weight	≈34 lb	≈15.5 kg
	Export-packed weight	≈47 lb	≈21.4 kg

Two Type 529 Waveform Monitors can be mounted side-by-side, or one mounted alongside an associated picture monitor in a standard 19-inch rack or console.

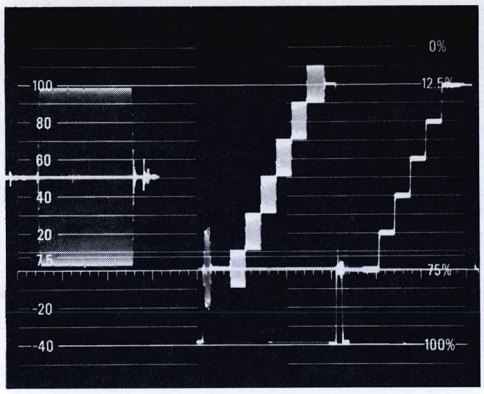
TYPE RM529:	Height	5¼ in	13.3 cm
	Width	19 in	48.2 cm
	Rack depth	18¼ in	46.4 cm
	Net weight	30½ lb	13.9 kg
	Domestic shipping weight	≈59 lb	≈26.8 kg
	Export-packed weight	≈81 lb	≈36.8 kg

Instrument fits standard 19-inch rack, can be tilted 90°.

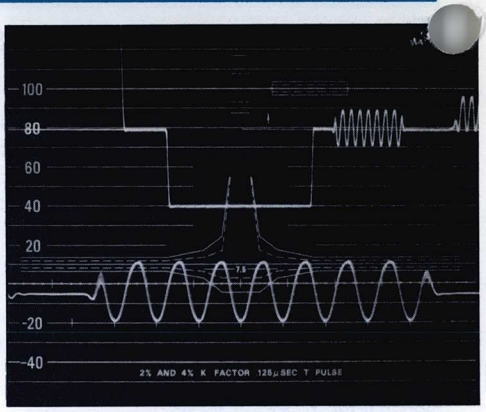
529
Waveform Monitor



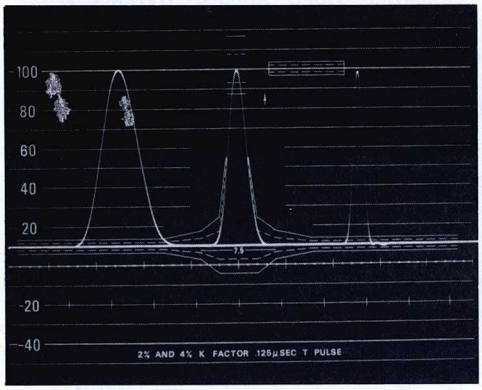
Multiburst Signal. Multiple exposure showing High-pass, Flat, and Low-pass response.



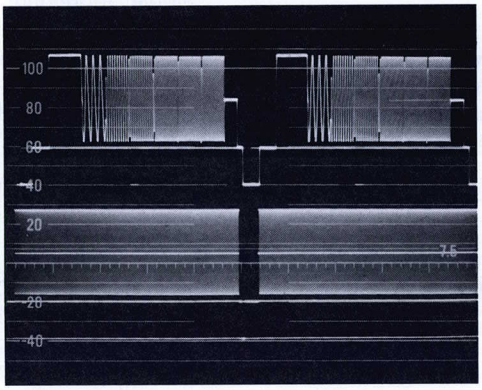
Modulated Staircase Signal. Multiple exposure left to right. High-pass position for measuring differential gain, Flat-response position, IEEE response position.



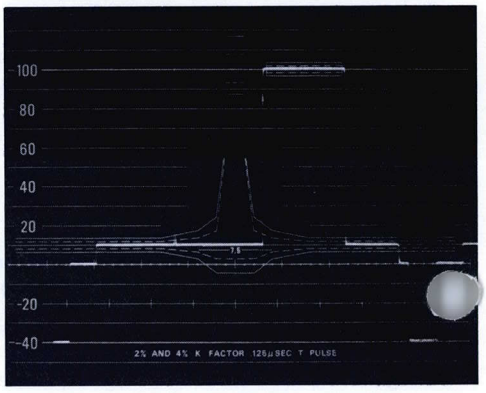
Color-Burst Signal. Double exposure. Top: X5 magnification. Horizontal display: 0.125 H/cm. Bottom: X25 magnification. Horizontal display: 0.125 H/cm.



Multiple exposure. Left: 2T. Center: T. Right: ½ T Sin², 0.25, 0.125, 0.0625 μs HAD.



Double exposure showing complete two-field displays and two-line displays.



Sin² Pulse and Bar Signal. 0.125 μs HAD T-Pulse and Bar.

INCLUDED STANDARD ACCESSORIES

TYPE 529: Smoke-gray light filter (378-0560-00); composite graticule, shown lower center (331-0156-01); noncomposite graticule, shown top left (331-0077-01); dual scale graticule, shown top center (331-0157-00); sin², K factor, and IRE graticule, shown top right, lower left, lower right (331-0161-02); 75-ohm termination resistor (011-0102-00); instruction manual (070-0509-01); graticule light insert (377-0064-00). Type RM529: same as Type 529 but includes four retainer bars (381-0187-00); one pr tracks (351-0040-02); instruction manual (070-0466-01).

TYPE 529 WAVEFORM MONITOR $1400

TYPE 529 MOD 147B WAVEFORM MONITOR $1430

Type 529 installed in a field case.

TYPE RM529 WAVEFORM MONITOR $1475

TYPE 529 MOUNTING CRADLES

Two different cradle assemblies, with associated bezels, allow the Type 529 Waveform Monitor to be mounted alongside an 8-inch or 9-inch Conrac* Picture Monitor, in a standard 19-inch rack. A cradle and bezel are also available for mounting two Type 529's side-by-side.

FOR MOUNTING 8-INCH CNB-8 PICTURE MONITOR (REQUIRES 10½-INCHES RACK SPACE)

Description	Part Number	Price
Cradle Assembly	014-0021-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0027-00	50.00
Bezel, for mounting Type 529 on operator's right	014-0028-00	50.00

FOR MOUNTING 8-INCH CZB-8 PICTURE MONITOR (REQUIRES 10½-INCHES RACK SPACE)

Description	Part Number	Price
Cradle Assembly	014-0021-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0025-00	50.00
Bezel, for mounting Type 529 on operator's right	014-0026-00	50.00

FOR MOUNTING 9-INCH RNB-9 PICTURE MONITOR (REQUIRES 8¾-INCHES RACK SPACE)

Cradle Assembly	014-0020-00	$35.00
Bezel, for mounting Type 529 on operator's left	014-0023-00	40.00
Bezel, for mounting Type 529 on operator's right	014-0024-00	40.00

FOR MOUNTING TWO TYPE 529 WAVEFORM MONITORS SIDE-BY-SIDE (REQUIRES 8¾-INCHES RACK SPACE)

Cradle Assembly	014-0020-00	$35.00
Bezel	014-0022-00	40.00

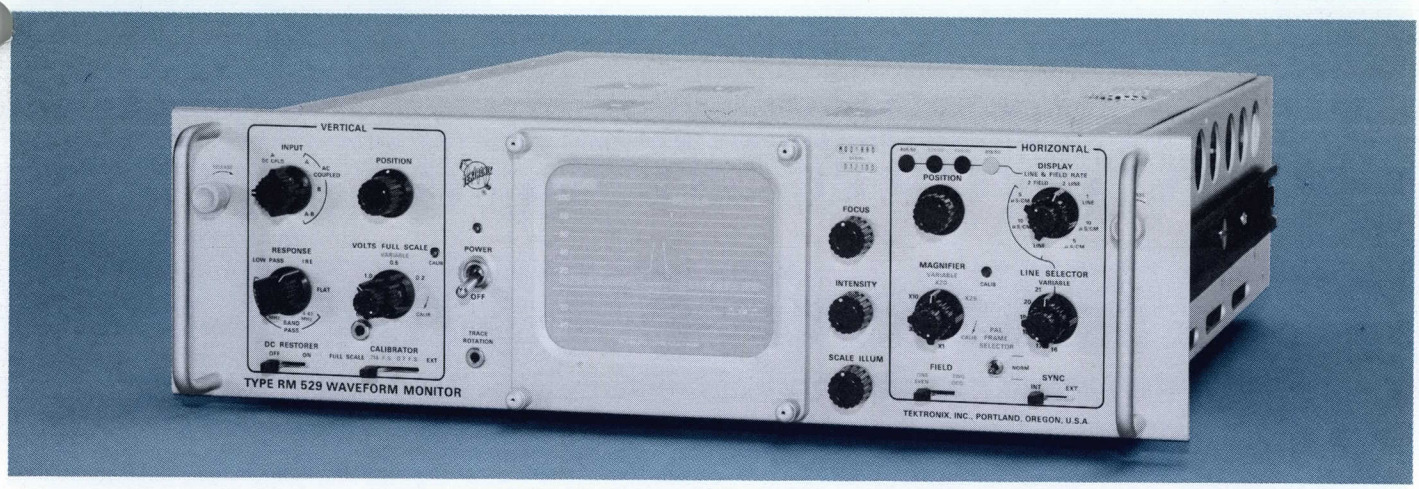
RM529 CRADLE ASSEMBLY

For mounting the Type RM529 in a WECO backless rack, order 426-0309-00 . . . . . $ 9.50

TEKTRONIX 14-inch monochrome and color picture monitors are available.

*Registered Trademark Conrac Corporation, Conrac Division

529
Multi-Standard Waveform Monitor



Type 529 or RM529 MOD 188D

The Type 529 Mod 188D and Type RM529 Mod 188D Waveform Monitors are adapted for use with 405-line 50-Hz field rate, 525-line 60-Hz field, 625-line 50-Hz field, and 819-line 50-Hz field standard television systems. Added Vertical RESPONSE switch positions, added MAGNIFIER steps and VARIABLE control, 5 and 10 μs/cm sweep rates in addition to line and field rates, and a PAL FRAME SELECTOR permit quick setup for use on any of four systems without internal adjustments. Panel marking, color-coordinated with Line/Field indicator light colors, identifies control positions associated with the selected system.

The added PAL FRAME SELECTOR permits normal display from all frames or selection of either frame of the four-field PAL color system cycle.

The Vertical system features selectable DC coupling for Video Input A, and added 1.1 MHz and 4.43 MHz Bandpass positions of the RESPONSE switch. The CALIBRATOR switch has an added 0.70 F.S. position for proper calibration for systems based on a 30-unit (of 100) blanking level. Sweep rates based on line and field intervals are supplemented by fixed 5 μs/cm and 10 μs/cm rates. Extra X10 and X20 MAGNIFIER positions and a VARIABLE MAGNIFIER provide maximum flexibility of adjustment for various test signals.

VERTICAL SYSTEM:

Response Switch: Added positions of 1.1-MHz Bandpass (—18 dB at 0.2 MHz) and 4.43-MHz Bandpass (—3 dB bandwidth ≥800 kHz) at double sensitivity.

Calibrator: 0.70 F.S. position added for CCIR standards.

Input Switch: Added DC-coupled position for Input A.

HORIZONTAL SYSTEM:

Line/Field Rate Selection: 405/50, 525/60, 625/50, 819/50.

Sweep Rates: 2 Field, 2 Line, 1 Line, 5 μs/cm, and 10 μs/cm.

Line Selector Sweep Rates: 1 Line, 5 μs/cm, 10 μs/cm. Discrete line selection provided for 525/60 and 625/50 systems; for 405/50 and 819/50 systems, continuously-variable line selection only.

Accuracy: All sweep rates (except 2 Field, an uncalibrated rate) are accurate within 3% (MAG X1).

Magnifier: X1, X5, X10, X20, X25, plus VARIABLE (±20% from selected step).

Field Switch: Added Even/Odd marking for PAL standards. Positive field selection provided except for CCIR System E (change-of-field only).

Pal Frame Selector: 3-position switch for viewing all frames or selecting alternate frames.

GENERAL:

Line Voltage: +10%, —8% accommodation range at 105, 110, 115, 120, 210, 220, 230, or 240-V center voltage, 48 to 66 Hz. Normally wired and fused for 240 V. Multi-tap transformer can be changed for use with any of the listed nominal line voltages.

Accessories: The following graticules are furnished in addition to the standard 529/RM529 complement: 0-100 unit composite CCIR Video, 30-unit blanking level, PN 331-0184-00. 0-100 unit composite CCIR Video, with $\sin^2$ & K factor ruling for 0.1 μs T and 0.2 μs 2T pulses, 2% and 4% K factor, timing line for 4.43 MHz, PN 331-0185-00 (installed).

TYPE 529 MOD 188D **$1565**

TYPE RM529 MOD 188D (Rackmount) **$1630**

OPTIONAL ACCESSORIES

TYPE 529 FIELD CASE

Provides cabinet protection for the Type 529 when used for applications outside of the rack. Aluminum construction, blue vinyl finish; order 016-0084-00 ..... $35

C-27 CAMERA

f/1.9-1:0.85 lens; Polaroid Land* Pack-Film back, order C-27 ..... $460

Type 529 or RM529 to C-27 Camera Adapter, order 016-0224-00 ..... $16

*Registered Trademark Polaroid Corporation

MESH FILTER

For improving display contrast when viewing under high-ambient light conditions; includes special graticule cover. Order 378-0575-00 ..... $18

9-PIN CONNECTOR

Used with color processing amplifiers for RBG, etc. displays. Order 134-0049-00 ..... $6

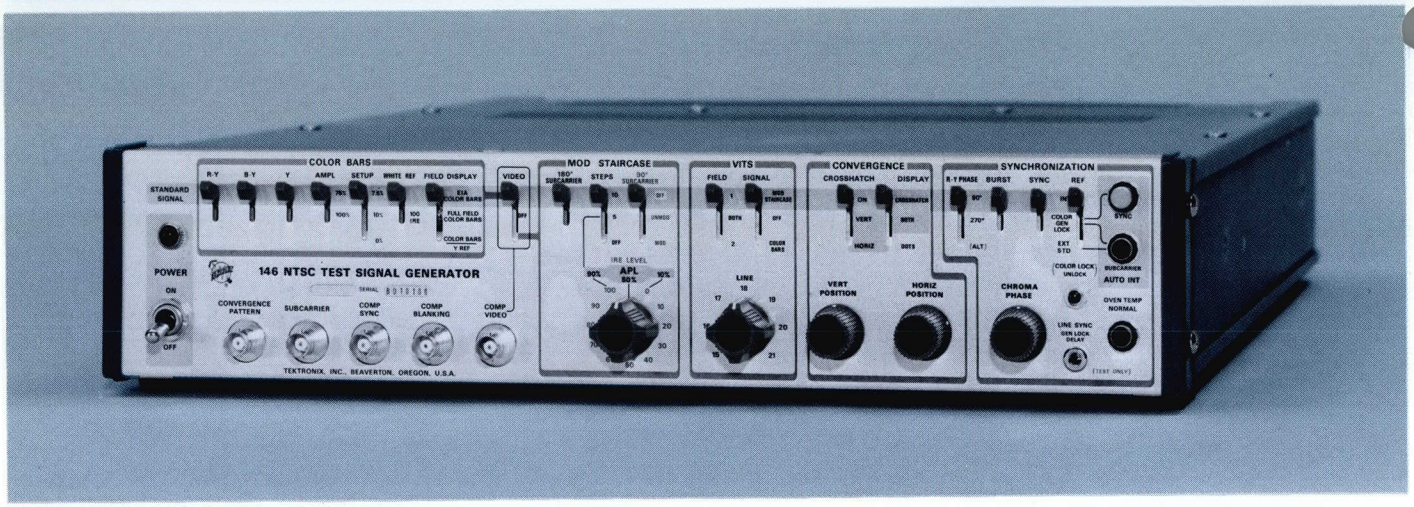
See the catalog accessory pages for additional information on other accessory items not listed.

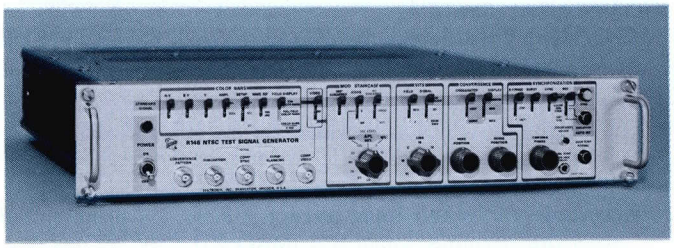
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

146

NTSC Signal Generator





- MASTER SYNC GENERATOR AND COLOR STANDARD
  CONFORMS WITH EIA STANDARD RS 170
- GEN-LOCK
  200 ms LOCK-IN
- TIMING JITTER LESS THAN 4 ns
- NTSC ENCODED COLOR BARS
  CONFORMS TO EIA STANDARD RS 189
  FULL-FIELD OR SPLIT-FIELD BARS
  75% OR 100% AMPLITUDE
  7½%, 10%, or 0% SETUP
- MODULATED STAIRCASE
  CONFORMS TO IEEE STANDARD IEEE 206
  VARIABLE APL, 10% to 90%—FIXED
  APL, 50%
  5 OR 10 STEPS
  SUBCARRIER PHASE-LOCKED TO BURST
- CONVERGENCE CROSSHATCH
- VERTICAL INTERVAL TEST SIGNALS
  MODULATED PEDESTAL, STAIRCASE OR COLOR BARS
  LINES 15 THROUGH 21, EITHER OR BOTH FIELDS

The 146 NTSC Signal Generator is a compact, solid-state source of high-quality television test, sync, and color sync burst signals for 525-line, 60-Hz field standard NTSC color TV systems. Combined in one compact unit are the test signals needed to accurately test, evaluate, and adjust laboratory and standard broadcast color video equipment. Each test signal conforms with industry standards, and provides additional refinements to enhance both the accuracy and range of measurements which can be made. The 146 offers a sync generator with a proportional control constant-temperature oscillator that has excellent short term frequency stability.

NTSC COLOR BARS

NTSC color bars are provided. The composition of these signals is in accord with EIA color bar signal specifications RS 189. In addition to basic signal requirements, these 100% saturated color bars are provided in either 75% or 100% amplitude with a choice of 0%, 7 1/2%, or 10% setup. The white bar amplitude may be independently selected at 75% or 100% for 75% amplitude bars. The 100% white bar amplitude level permits a convenient check of relative chrominance/luminance gain by comparing the peak amplitudes of the yellow and cyan, to the white bar. An additional refinement to the full field color bar is a black reference bar following the blue bar.

A new, split-field signal, COLOR BARS/Y REF, provides a picture monitor display and a waveform suitable for detecting the effects of rectified subcarrier on luminance (luminance cross-modulation). Standard color bars and the luminance component only of standard color bars are combined in a split-field, a combination that can clearly reveal the effects of luminance/chrominance time delay.

Luminance and Chrominance Component Amplitude Accuracies Amplitudes comply with the NTSC signal requirements as defined by the FCC. Absolute amplitudes of luminance signal, setup, and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chroma and burst) are within 3%. Relative amplitudes of all subcarrier frequency components (chroma and burst) are within 1% or 1.5 mV whichever is greater.

146 NTSC Signal Generator

NEW

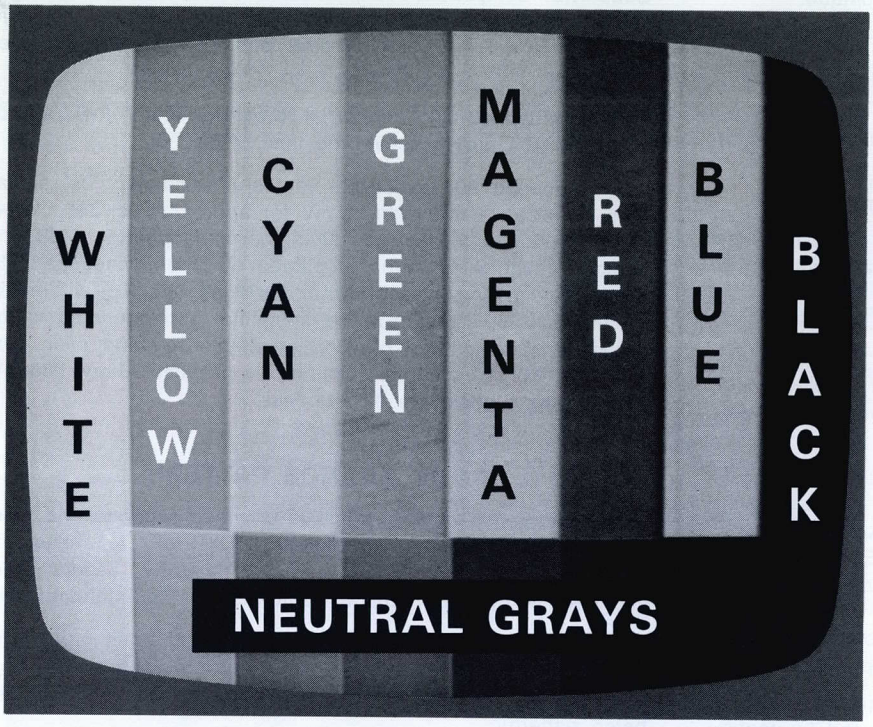


Fig 1. New, split-field signal on color picture monitor. Color bars 100% and 0% saturation. Useful to show gray-scale tracking.

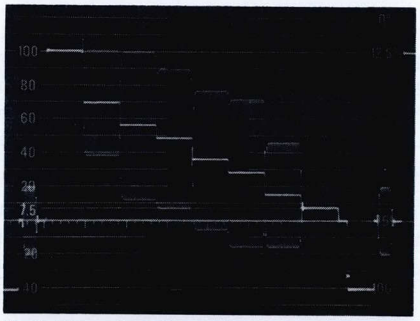


Fig 2. New split field display on waveform monitor. Color bars occupy ¾ field; corresponding luminance signal only completes field. Useful to check picture monitor gray scale rendition.

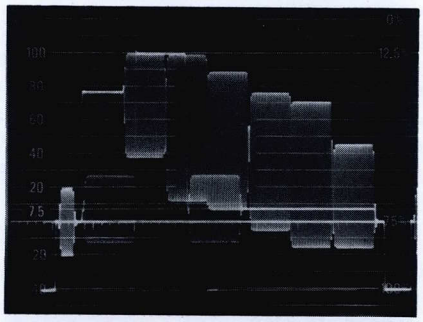


Fig 3. Standard EIA Color Bar Signal defined in RS-189. Setup can be conveniently changed to 10% or 0.

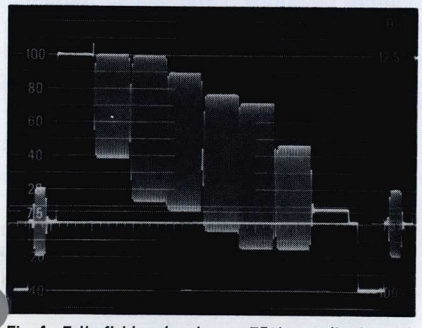


Fig 4. Full field color bars. 75% amplitude with 100% or 75% white bar amplitude.

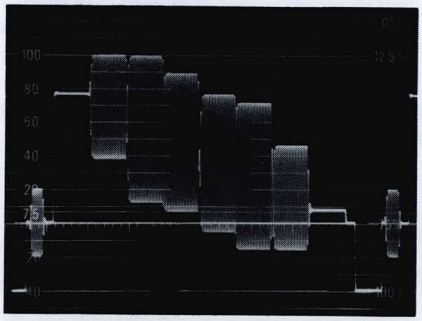


Fig 5. Full field color bars. 75% or 100% selectable. Black bar follows blue bar.

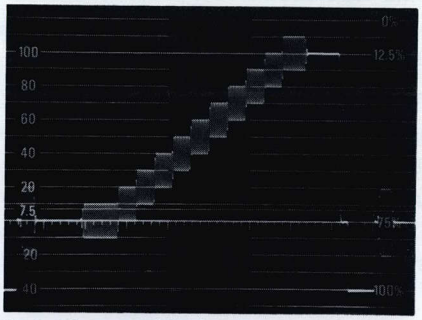


Fig 6. 10-step modulated staircase. Subcarrier is precisely in phase with burst.

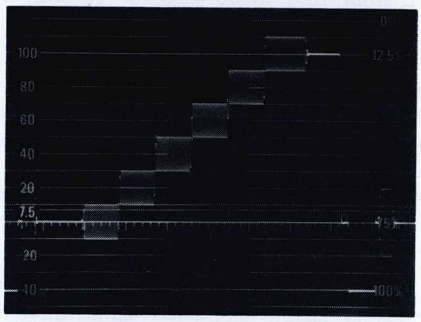


Fig 7. 5-step modulated staircase. Subcarrier amplitude may be increased to 40 IRE by internal adjustment.

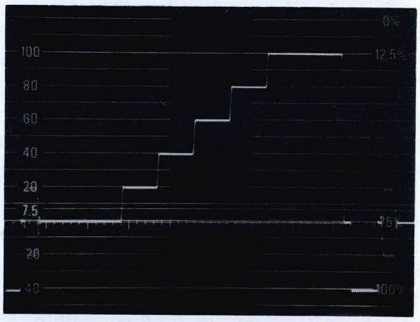


Fig 8. 5-step unmodulated staircase.

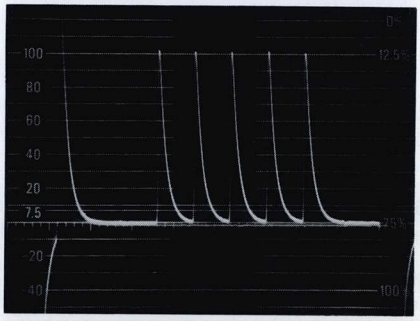


Fig 9. Differentiated 5-step staircase using the Video Staircase Differentiator (015-0075-00) to measure line time nonlinearity. Subcarrier modulation is off.

White Reference— 75% amplitude or 100% amplitude.

Chrominance Envelope Risetime and Falltime— 375 ns within 15%.

Setup— 10%, 7 1/2% or 0%.

Blanking to Peak White Amplitude— 714 mV (independent of setup).

Luminance Risetime and Falltime— 115 ns within 15%.

—**I and Q Chrominance Signal Width**— 9.4 μs on the same lines as black and white references, amplitude of each within 1% of burst amplitude.

MODULATED STAIRCASE

The modulated staircase signal is provided with a selection of APL from 10% to 90% (0 to 100 IRE) in eleven equal levels, or at a fixed APL of 50%.

The staircase luminance component is either 10 equal, 10 IRE Unit; 5 equal, 20 IRE Unit; or OFF selected by front-panel switch. The subcarrier component is phase locked to color burst. The signal is in strict conformity with IEEE 206 and the definition of APL is rigorously observed. Applications include measurements of differential gain and phase, dynamic gain, luminance signal linearity, luminance signal distortion caused by chrominance signal non-linearity, and burst phase errors.

A unique, Tektronix-developed, chroma-step signal provides a means to check luminance signal distortion caused by rectification of the subcarrier signal. When a variable APL mode is selected, subcarrier, phased to lead burst by 90°, may be added to the pedestal lines either as a constant 30-mV signal or amplitude modulated to produce 30-mV, 286-mV (40 IRE), and 572-mV (80 IRE) amplitudes. The amplitude modulated subcarrier is used to determine the effects of subcarrier rectification upon luminance signals at all APL's through the entire TV system. The constant 30-mV subcarrier signal is used to eliminate unnecessary portions of the display when making differential phase measurements. The chroma-step signal is also useful when checking video tape recorders for "chroma banding".

Luminance Component—Peak amplitude with 5 or 10 step, 714 mV within 1%. Each step is 143 mV within 1% in 5 step and 71.5 mV in 10 step. Step risetime is 260 ns within 15% and aberrations are within 2%. Step duration at blanking level and at white level is 13.2 μs within 5%. Intermediate step durations are 6.6 μs within 5%.

Chrominance Component—Amplitude is 143 mV P-P within 3% and in phase with burst.

Differential Phase— 0.1° or less.

Differential Gain— 0.5% or less.

Subcarrier Envelope—Risetime is 375 ns within 15% and duration is 40 μs within 5%. Envelope delay from horizontal sync is 16.1 μs within 5%.

50% Fixed APL—Each active line carries the modulated staircase signal. APL is 50% per IEEE standard, IEEE 206.

Variable APL—Staircase signal is on every 5th line and on the same lines each frame. The variable amplitude pedestal signal is on the remaining 4 out of 5 lines. APL range is 10% to 90% with lines without staircase having eleven selectable pedestal levels from 0 IRE to 100 IRE. 0 IRE position provides 10% APL, 50 IRE position provides 50% APL, and 100 IRE position provides 90% APL.

Subcarrier Component—A three-position switch controls the insertion of subcarrier on the pedestal lines. Pedestal positions are: subcarrier off, unmodulated subcarrier, and modulated subcarrier.

The unmodulated 90° subcarrier provides 30 mV P-P (approx 5 IRE at 90°) during active line time of 52.3 μs.

The modulated 90° subcarrier is the chorma-step test signal. This signal is 30 mV within 5 mV for approx 13 μs, 286 mV (40 IRE) within 3% for approx 20 μs (corresponding to 6-dB amplitude reduction from the amplitude of chrominance on 75% amplitude red and cyan bars), and 572 mV (80 IRE) within 3% for the last 20 μs of the active line time (corresponding to the chrominance amplitude of 75% amplitude red and cyan bars phased at 90°). Incidental phase errors between 30-mV, 286-mV, and 572-mV signals are 0.5° or less.

CONVERGENCE PATTERN

The convergence pattern signal is provided separate and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio, and geometeric distortion. It conforms to IEEE standard 202.

Display Available—White crosshatch, vertical lines only, horizontal lines only, white dots only, and crosshatch plus dots (dots appear centered in the rectangles formed by the crosshatch pattern).

Convergence Pattern Signal Characteristics—The P-P amplitude is 1 V within 5%. Pulse amplitude is 77 IRE. Sync amplitude is 40 IRE. Setup is 7 1/2%.

VERTICAL INTERVAL TEST SIGNALS

The modulated staircase or the color bar can be added on any line from 15 through 21 of either or both fields. The phase of the burst together with all other subcarrier frequency components of the test signal outputs may be varied 360° with respect to an external subcarrier frequency source.

It is possible to test an entire video system during programming, including transmitters, with the 75% amplitude, full-field color bar signal or the modulated staircase signal inserted on line 18 or 19.

SYNC GENERATOR AND COLOR STANDARD

The EIA sync generator circuitry is largely digital, using integrated circuitry for counting functions. The usual frequency multiplier circuits and their attendant problems have been avoided resulting in exceptional time stability. Internal adjustments permit some variation of widths, including burst flag timing. These adjustments are preset to conform to FCC standards.

Color Gen-Lock, External Subcarrier, and Internal Subcarrier can be selected for color standard reference. The 146 NTSC Signal Generator can synchronize the time of occurrence of field, frame, line, and subcarrier from composite video input. Front-panel lamps indicate loss of gen-lock H sync and/or subcarrier due to excessive noise and/or low amplitude.

The color standard has a proportional control oven for the quartz crystal and the entire oscillator circuit. The frequency stability achieved is well within FCC specifications. A front-panel lamp indicates proper operation of the oven. When the

146 NTSC Signal Generator

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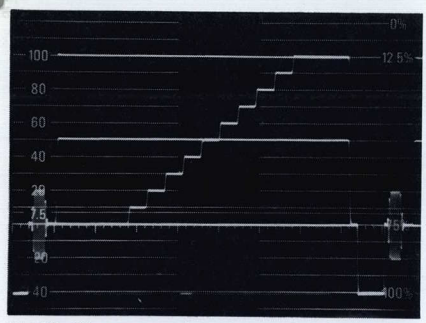


Fig 10. 10-step unmodulated staircase with 10%, 50%, and 90% APL (triple exposure).

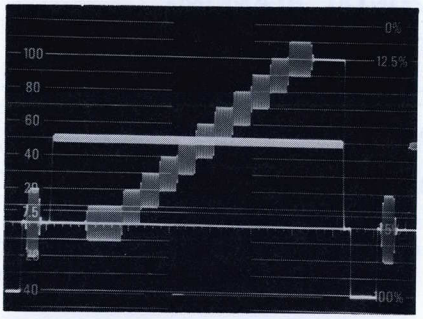


Fig 11. 10-step modulated staircase with APL pedestal at 50 IRE. Pedestal carries unmodulated (5 IRE) subcarrier at 90°. Subcarrier component provides phase markers when measuring differential phase, ±12° for 20 IRE modulation.

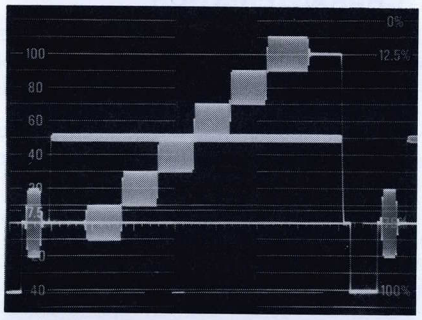


Fig 12. 5-step modulated staircase with APL pedestal at 50 IRE. Subcarrier component on pedestal provides phase markers when measuring differential phase, ±12° for 20 IRE modulation.

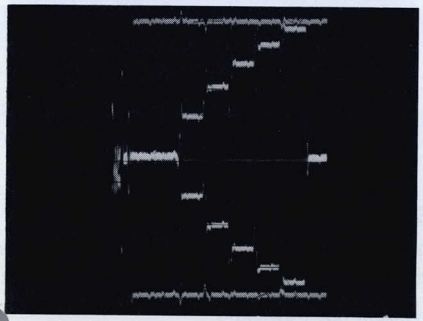


Fig. 13. Using a 146, 144, or 140 as a signal source, 90° unmodulated subcarrier on APL pedestal lines provides 12° phase markers in measuring phase difference. Using 40 IRE subcarrier on staircase, phase markers are ±6°. While this method is only approximate, it proves highly useful.

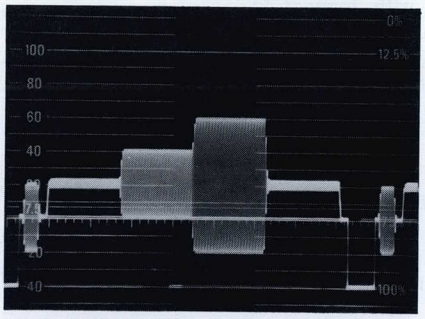


Fig 14. Modulated 90° subcarrier test signal, luminance of 20 IRE shown, variable 0 to 100 IRE in 11 equal steps.

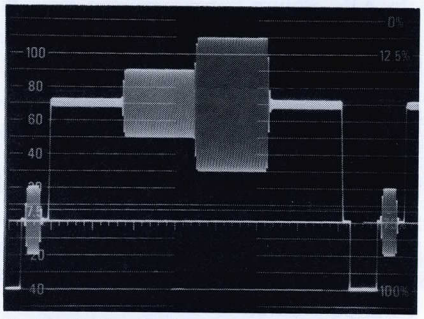


Fig 15. Modulated 90° subcarrier test signal at 70 IRE luminance level. Available as full field or as a VIT signal.

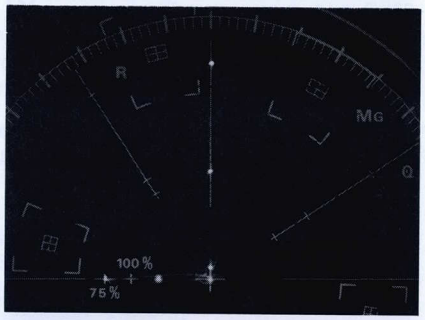


Fig 16. A portion of vectorscope display of 90° modulated subcarrier, 5, 40, 80 IRE. Color sync burst 40 IRE. Staircase subcarrier 20 IRE in phase with color sync burst.

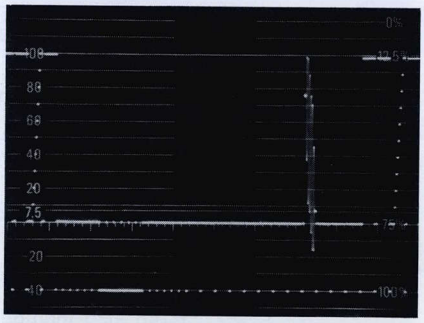


Fig 17. Vertical interval test signal. Color bars or staircase signal may be added to program signals. VITS is inhibited if gen-lock failure should occur, providing fail-safe operation.

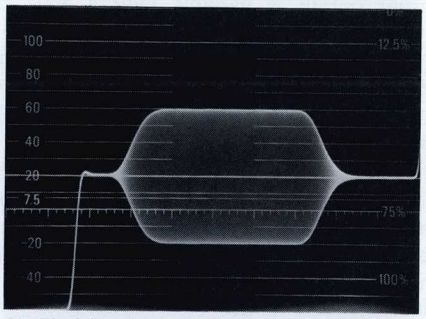


Fig 18. Color sync burst displayed in temporary unlock mode at 0.5 μs/cm to facilitate breezeway measurement. Burst width is measured between half-amplitude points.

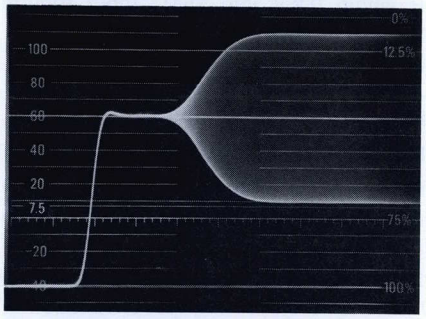


Fig 19. Burst breezeway color lock temporarily unlocked to facilitate breezeway measurement. Sweep speed is 0.25 μs/cm.

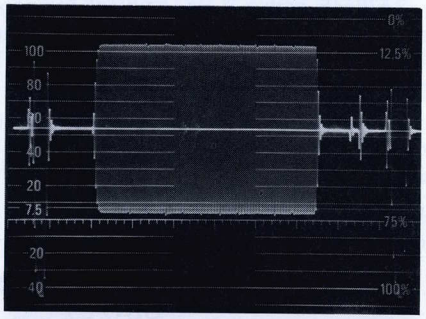


Fig 20. Differential gain measurement on waveform monitor using 10-step staircase. Note absence of luminance transients.

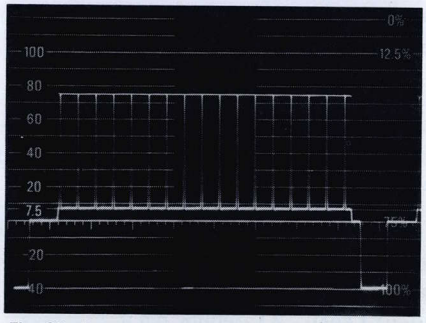


Fig. 21. Convergence pattern signal. Picture level is 77 IRE with 7½% setup. Pattern is electronically positionable in both axes.

internal color standard is used, the phase of the color subcarrier output is variable over a 360° range with respect to the phase of the burst contained in the video output. When an external color standard is used the phase of the burst (and all other subcarrier frequency components of the test signal outputs) may be varied 360° with respect to the external subcarrier source.

Phase-lock between the color subcarrier and the master sync clock can be interrupted by front-panel push button. The subcarrier frequency remains within specifications, but chroma appears as an "envelope" because of phase-lock interruption. This envelope facilitates measuring chroma to luminance delay and other measurements.

Subcarrier—Frequency is 3.579545 MHz within 5 Hz. Outputs are provided on the front and rear panels. Output impedance is 75 Ω within 5%. Isolation is at least 30 dB. Output level is 2 V P-P within 0.2 V into 75 Ω. Input requires 1 V to 4 V. Return loss is at least 46 dB at 3.58 MHz.

GEN-LOCK

Input—Can be composite video or black burst, sync negative.

Input Level Range— 0.5 V to 3 V (1 V nominal).

Input Return Loss— 46 dB to 5 MHz when terminated in 75 Ω.

Phase Accuracy—Within 1° input burst variations + or —10 Hz of 3.579545 MHz.

Within 5° with ambient temperature variation from 0°C to 50°C; within 1° for any 10°C variation within 0° to 50°. Burst must be 3.579545 MHz within 1 Hz and oven temperature normal.

Within 1° with input signal + or —3 dB from 1 V. Within 3° with burst/sync ratio variation —6 dB to +10 dB. Burst must be 3.579545 within 1 Hz, ambient temperature 20°C and oven temperature normal. Dynamic burst phase stability is within 0.1° with APL variation 10% to 90%; within 1° with —24 dB white noise.

Delay Range—Adjustable between 3 μs before input sync to 1 μs after. Delay is stable within 70 ns. Factory-set to coincidence.

Pull-In Time— 200 ms maximum.

Field/Frame Sync—Direct acting within one field.

COMPOSITE SYNC OUTPUT

Independent, front- and rear-panel outputs are provided with the two outputs isolated by at least 40 dB.

Output Level— 4 V within 0.2 V.

Return Loss—At least 30 dB to 5 MHz.

Risetime— 115 ns within 10%.

INPUT*

Required Amplitude— 2 V to 8 V, negative-going.

Return Loss—At least 46 dB using loop-through input on rear panel.

COMPOSITE BLANKING

Independent, front- and rear-panel outputs are provided with the two outputs isolated by at least 40 dB.

Output Level— 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss—At least 30 dB.

*Inputs are optional and only required for synchronizing with another NTSC sync generator.

VERTICAL DRIVE

One rear-panel output provides 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss— At least 30 dB.

HORIZONTAL DRIVE

One rear-panel output provides 4 V within 0.2 V.

Risetime— 115 ns.

Return Loss—At least 30 dB.

BURST FLAG

One rear-panel output provides 4 V within 0.2 V.

HORIZONTAL BLANKING

11.1 μs (digitally determined from 3.579545 MHz).

VERTICAL BLANKING

21 lines (digitally determined from 3.579545 MHz).

COMPOSITE VIDEO OUTPUT

Composite video consists of composite sync and video test signals as selected by front-panel controls. Independent front- and rear-panel outputs are provided with the two inputs isolated by at least 40 dB.

Output Level— 1 V P-P.

Return Loss— 30 dB from DC to 5 MHz.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 55 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0° to +50°C (except as noted).

Dimensions and Weights

	146		R146	
	in	cm	in	cm
Height	3 1/2	8.9	3 1/2	8.9
Width	16 3/4	42.6	19	48.3
Depth	18 1/2	47.1	18 1/2	47.1
	lb	kg	lb	kg
Net weight	17 3/4	8.0	18 1/2	8.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈54	≈24.4	≈55	≈25

INCLUDED STANDARD ACCESSORIES

75-Ω, through-line termination (011-0103-02); 3-conductor power cord (161-0036-00); instruction manual (070-1111-00).

R146 also includes rackmounting hardware.

146 NTSC TEST SIGNAL GENERATOR **$2,500**

R146 NTSC TEST SIGNAL GENERATOR (rackmount) **$2,500**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

144
NTSC Signal Generator

NEW

The 144 NTSC Signal Generator is a compact, solid-state source of high-quality color television test, sync, and burst signals for 525-line, 60-Hz field, cable, and broadcast TV systems. Combined in one compact unit are the signals needed to accurately test, evaluate, and adjust CATV, laboratory, and standard broadcast color video equipment.

The 144 is similar to the 146 NTSC Signal Generator with a Composite Color Test Pattern Signal Generator in place of Gen-Lock. For Gen-Lock applications, the 146 will be required. The 144 has an —I, W, Q, B signal in place of the Color Bar/Y REF split-field signal of the 146.

The 144 provides: NTSC encoded color bars (full-field or split-field), modulated staircase, convergence crosshatch or a composite color test pattern designed for use in CATV systems. The composite test pattern combines, in both fields, convergence, color bars, luminance only, and an insert area for displaying two external video inputs. The uses for this pattern are almost limitless. By locating the gray scale above the color bars, registry of the chrominance luminance signals can be easily checked. Luminance cross-modulation is also easily detected on picture monitors by comparing the brightness of the yellow color bar with the light gray directly above it, when the chrominance control is set to lowest possible gain. The lower insert area does not normally carry test signals. It is intended for message service: time and temperature, local news or commercial mesages, stock market ticker tape displays, etc. The crosshatch lines and/or dots are available for picture monitor linearity evaluation and convergence adjustment. Vertical interval test signals are provided by the 144.

The 144 can be used as the master sync generator for local program origination. The self-contained sync generator includes a temperature-controlled color standard with excellent frequency stability.

The 144 is available in rackmount (R144) and cabinet (144) styles.

COMPOSITE COLOR TEST PATTERN

This operating mode provides a convergence pattern (crosshatch lines and/or dots) with two inserts areas. Each insert is digitally controlled from the sync generator. The user may select the lines to be included in each insert area by proper placement of insulated color-coded jumpers within the instrument.

The first insert consists of either the staircase test signal or color bar signal. When the color bar is selected, the luminance portion of the color bars, is located directly above the first insert. The second insert can be controlled by the operator in the same manner as the first. Generally, the second insert will be below the center of the screen, as the center should carry the convergence pattern to permit proper converging of color receivers. This insert does not normally carry test signals since it is intended for message service.

Two video inputs are provided at the rear panel. Video input signals may be derived from TV cameras which are driven by the sync generator in the 144. A horizontal wipe control provides for smooth transition between the two signals, or allows them to be displayed simultaneously, sharing the selected insert area.

External Video Input—Two AC-coupled, 75-Ω, loop-through input connections are provided on the rear panel. Input requires 1.0 V P-P of composite video or 0.714 V P-P of non-composite video. Return loss is at least 30 dB to 5 MHz. External sync is stripped and sync from the 144 is inserted.

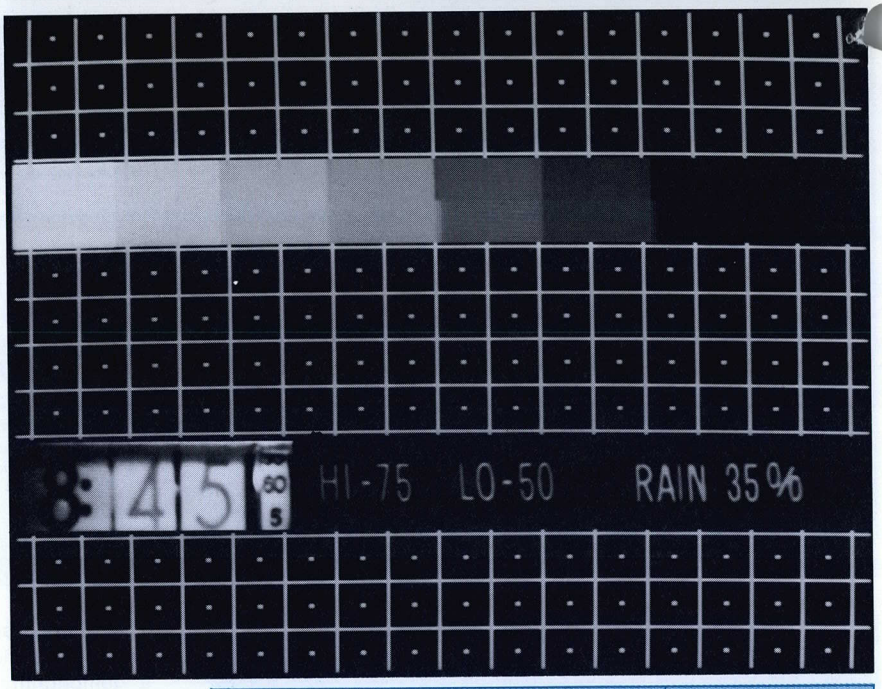
Composite Video Ouput—Composite video consists of composite sync and video test signals as selected by front-panel controls. Independent front- and rear-panel outputs are provided with the two inputs isolated by at least 40 dB. Output level is 140 IRE units with the exception of the crosshatch lines and dots which are set for 75 IRE units.

NEW

144
NTSC Signal Generator

COMPOSITE COLOR TEST PATTERN

Convergence pattern with full color bars and color bar luminance in upper insert and two video inputs displayed in lower insert.



Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 55 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

INCLUDED STANDARD ACCESSORIES

Two 75-Ω, through-line terminations (011-0103-02); set of insulated jumpers, assorted colors (013-0117-00); power cord (161-0036-00); instruction manual (070-1084-00).
R144 also includes rackmounting hardware.

Dimensions and Weights	144		R144	
	in	cm	in	cm
Height	3 1/2	8.9	3 1/2	8.9
Width	16 3/4	42.6	19	48.3
Depth	18 1/2	47.1	18 1/2	47.1
	lb	kg	lb	kg
Net weight	17 3/4	8.0	18 1/2	8.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈54	≈24.4	≈55	≈25.0

144 NTSC TEST SIGNAL GENERATOR **$2500**
R144 NTSC TEST SIGNAL GENERATOR (rackmount) **$2500**

140 NTSC Signal Generator

The 140 NTSC Signal Generator is substantially similar to the 146 NTSC Signal Generator. The 140 has minor control differences in the color bar and modulated staircase sections. Applications for Color Gen-Lock will require use of the 146. CATV applications for Composite Color Test Pattern will require use of the 144.

The 140 has a —I, W, Q, B signal in place of the Color Bar/Y REF split-field signal of the 146.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz, 55 watts maximum at 115 VAC and 60 Hz. Rear-panel selector provides rapid accommodation for 6 line-voltage ranges.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

Dimensions and Weights	140		R140	
	in	cm	in	cm
Height	3 1/2	8.9	3 1/2	8.9
Width	16 3/4	42.6	19	48.3
Depth	18 1/2	47.1	18 1/2	47.1
	lb	kg	lb	kg
Net weight	17 3/4	8.0	18 1/2	8.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈54	≈24.4	≈55	≈25.0

INCLUDED STANDARD ACCESSORIES

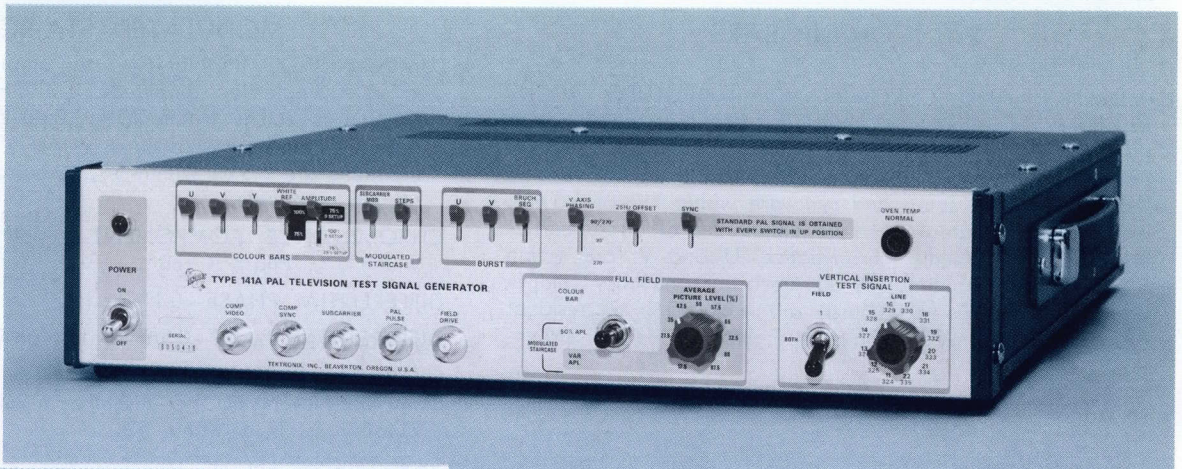
75-Ω, through-line termination (011-0103-02); power cord (161-0036-00); instruction manual (070-0944-00).
R140 also includes rackmounting hardware.

140 NTSC TEST SIGNAL GENERATOR **$2150**
R140 NTSC TEST SIGNAL GENERATOR (rackmount) **$2150**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

141A and 142*

PAL Signal Generators



- ***625-LINE, 50-CYCLE FIELD 4.433618 MHz SUBCARRIER***
- ***PAL COLOUR BARS***

  EBU bars—75% amplitude, 100% saturated, 0% setup, 100% white reference (75% white reference also selectable)

  BBC 95% bars—75% amplitude, 100% saturated, 25% setup, 100% white reference

  100% bars—100% amplitude, 100% saturated, 0% setup, 100% white reference
- ***MODULATED 5-STEP STAIRCASE***

  Fixed or variable APL
- ***VERTICAL INSERTION TEST SIGNAL***

  Modulated staircase

  Field 1, Field 2, or both
- ***PAL SYNC GENERATOR***

The Type 141A PAL Television Test Signal Generator is a source of high-quality television test signals for 625-line, 50-cycle field standard PAL colour TV Systems. The all solid-state Type 141A utilizes Digital Integrated Circuits to achieve stability, accuracy and reliability.

Three operating modes provide PAL Colour Bars, a 5-Step Staircase with fixed Average Picture Level (APL), and the same Staircase with variable APL. The colour bar output is a full-field test signal appearing on every active line and consists of 75% amplitude colour bars in descending luminance order with 0% setup. The white reference can be set at 75% or at 100% (for standard EBU bars). Two other versions of colour bar signal can be selected: 75% amplitude, 100% white reference with 25% setup (BBC 95% bars) and 100% amplitude, 100% white reference, 0% setup (100% bars). Any component of the composite video colour signal may be turned off. This includes Y, U, V, the entire colour bar signal, sync, burst (either U or V component only or both), and the 25-Hz offset of colour subcarrier which drives the sync generator.

The staircase signal is particularly useful with a Tektronix Type 521 PAL Vectorscope to measure differential phase and differential gain. Luminance channel linearity may also be measured using the Tektronix video staircase differentiator part #015-0154-00 (the transient response of the staircase signal component is determined by a $\sin^2$ filter whose cut-off frequency limits the energy content in the region of the colour subcarrier frequency).

The PAL subcarrier (140 mV P-P) is accurately phased at 180° (it lies along the —U PAL axis and is at the same phase on alternate lines). Subcarrier may be switched off when desired.

To provide VITS (Vertical Insertion Test Signal) the staircase signal is keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-335 on Field 2).

Normal PAL colour burst is provided on the staircase and colour bar signals. The complex four-field Bruch blanking sequence during vertical interval is provided and may be switched off if desired.

A 1-MHz reference signal which is frequency "locked" to the 4.43361875-MHz PAL subcarrier oscillator is provided at the rear of the instrument. The accuracy of the internal subcarrier oscillator may be conveniently verified by comparing the 1-MHz reference with known frequencies, such as the Droitwich 200-kHz radio transmissions in Europe.

The Type 141A is available in either rackmount (R141A) or cabinet (141A) styles.

**For 525-line, 60-cycle field, 3.575611 MHz subcarrier (Brazilian system).*

PAL COLOUR BARS

LUMINANCE AND CHROMINANCE AMPLITUDE ACCURACIES (25°C reference) Component amplitudes comply with the CCIR signal requirements as defined by CCIR, 11th Plenary Assembly, 1966, Vol. 5, p. 281. Absolute amplitudes of luminance signal, setup and sync are within 1% or 1.5 mV, whichever is greater. Absolute amplitudes of all subcarrier frequency components (chrominance, U and V) are within 3%. Relative amplitudes of all subcarrier frequency components (chrominance and burst) are within 1% or residual subcarrier plus 1 mV whichever is greater, of the red chrominance bar.

BAR WIDTH—6.5 μs within 5%.

WHITE REFERENCE—100% amplitude (normal); or 75% amplitude.

CHROMINANCE—Time difference between luminance and chrominance channels is 20 ns or less. Risetime is 260 ns within 10%. U, V quadrature error is 0.5° or less, V axis phase-switcher error is 0.5° or less.

RESIDUAL SUBCARRIER—At least 52 dB below 1 V except 30 dB at end of H blanking.

ABERRATIONS—Within 4% of 1 V P-P.

SPURIOUS SUBCARRIER—At least 52 dB below 1 V when viewed on a Type 529 Waveform Monitor. Other spurious outputs are at least 52 dB below 1 V also.

MODULATED STAIRCASE

LUMINANCE COMPONENT—5-step amplitude is 700 mV within 1%. Single-step amplitude is 140 mV within 1%. Step risetime is 260 ns within 15%. Step duration at blanking level and white level is 13 μs within 5%. Intermediate step durations are 6.5 μs within 5%. Aberrations are within 2% of step amplitude.

CHROMINANCE COMPONENT—Amplitude is 140 mV P-P within 3%. Phase is 180°.

DIFFERENTIAL PHASE—0.1° or less.

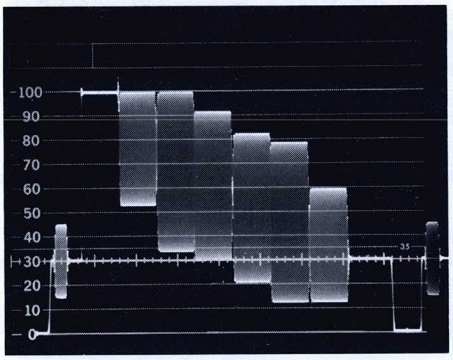
DIFFERENTIAL GAIN—0.5% or less at 0%, 50% and 100% APL.

SUBCARRIER ENVELOPE—Risetime is 260 ns within 15% and duration is 39 μs within 5%.

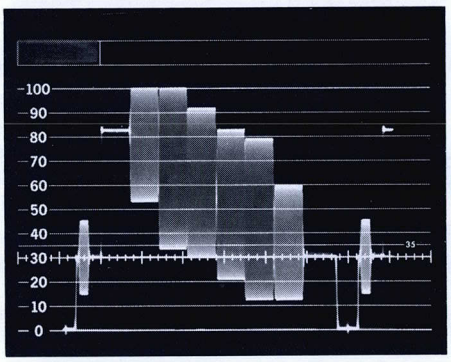
50% FIXED APL—Each active line carries the modulated staircase signal. APL is 50%.

VARIABLE APL—Staircase signal is on every 4th line and the same line every frame. Luminance level range is 700 mV in 10 equal increments, within 2%. The 90°/270° subcarrier modulation on the variable APL lines is 30 mV within 20%.

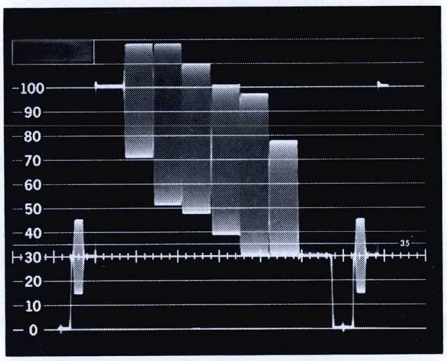
CONVERGENCE PATTERN—The Type 141A MOD 703Z provides a convergence pattern signal separate and independent from the other test signals. It is useful for measuring picture monitor or camera scanning linearity, aspect ratio, and geometric distortion. Displays available are: cross hatch, vertical lines only, horizontal lines only, and cross hatch plus dots (dots appear centered in the rectangles formed by the cross-hatch pattern). The Type 141A MOD 703Z retains all the features of the standard Type 141A.



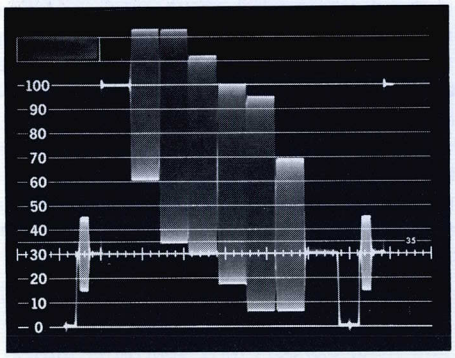
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 100% white reference.



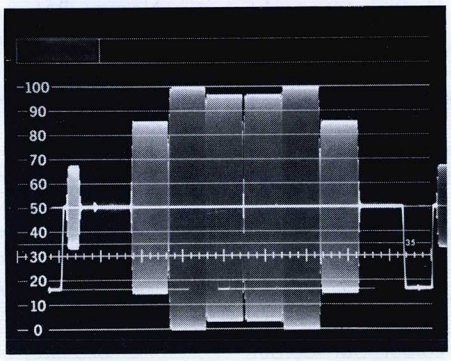
EBU colour bars—75% amplitude, 100% saturation, 0% setup and 75% white reference.



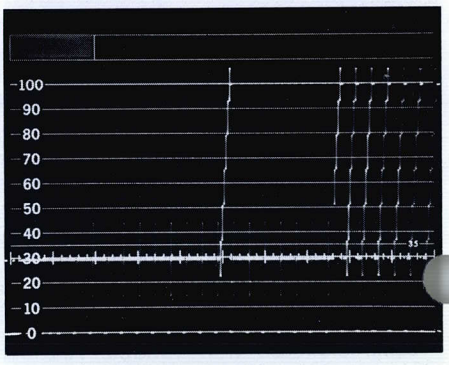
BBC 95% colour bars—75% amplitude, 100% saturation, 25% setup and 100% white reference.



100% colour bars—100% amplitude, 100% saturation, 0% setup, 100% white reference.

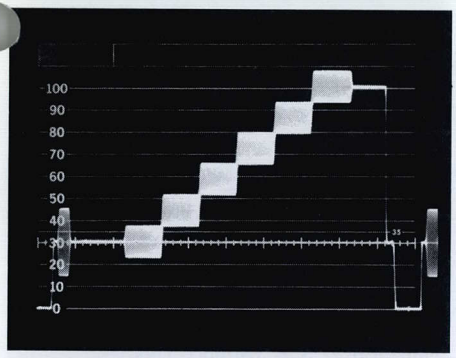


PAL colour bars, luminance component switched off (vertical gain of waveform monitor increased).

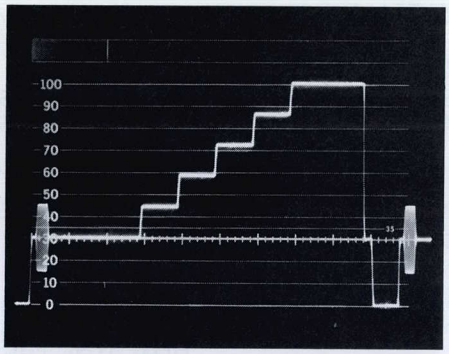


Vertical Insertion Test Signal, 5-step staircase with PAL subcarrier on line 16, field 1.

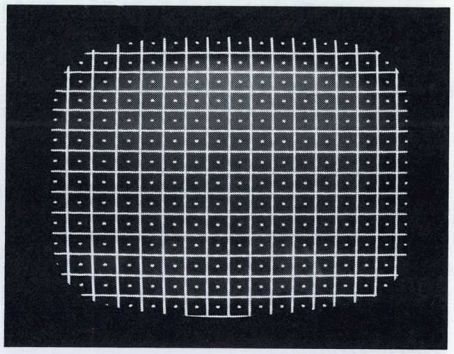
141A and 142
PAL Signal Generators



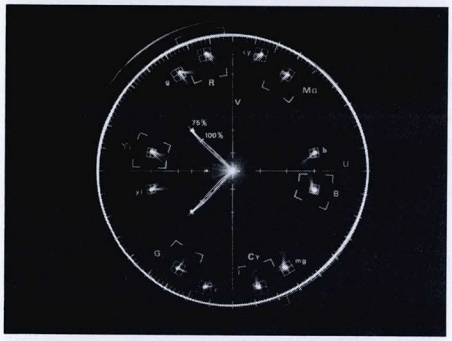
5-step staircase waveform with PAL subcarrier along -U axis. PAL burst is provided. Note white reference level following the modulation.



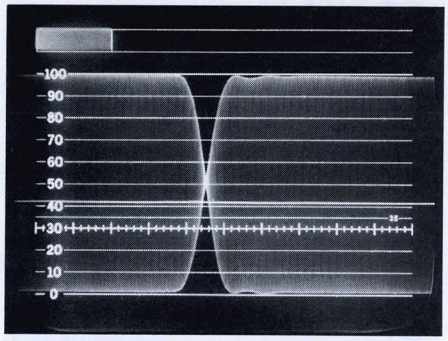
5-step staircase waveform, luminance only. Note double width black and white steps. Luminance transitions are $\sin^2$ shaped of approx 260-ns risetime.



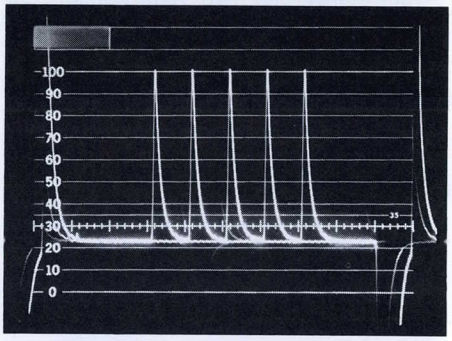
Convergence pattern, suitable for convergence, scanning linearity, and aspect ratio adjustments of monitors. Available with the Type 141A MOD 703Z and Type 142.



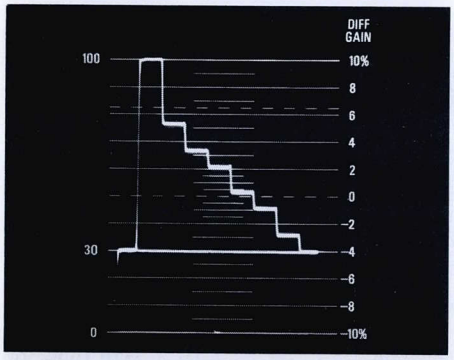
Vector PAL presentation of PAL colour bar.



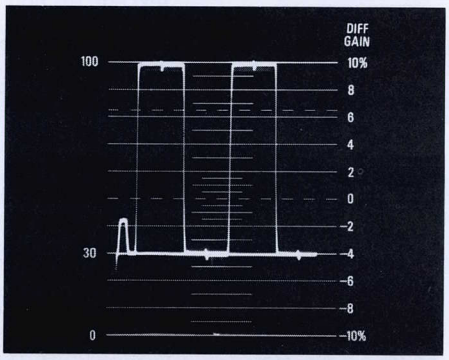
Chrominance signal, green-magenta transition, 250 ns/cm time base.



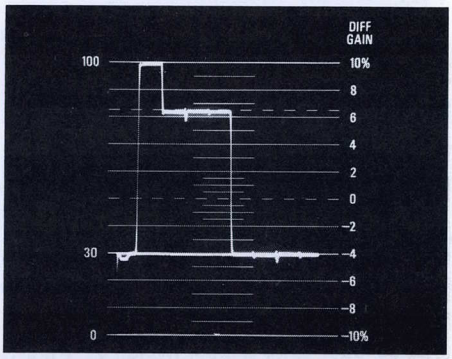
Stairstep luminance signal showing exact equality of individual transitions when differentiated by Tektronix Video Staircase Differentiator (part number 015-0075-00).



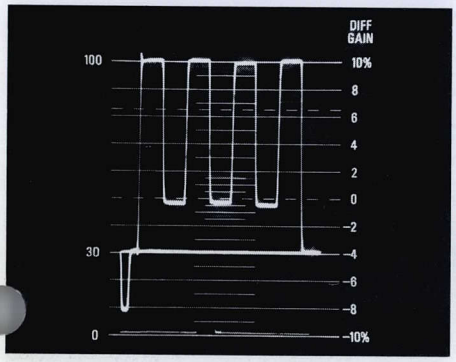
PAL colour bars, luminance signal only, 75% amplitude with 100% white reference.



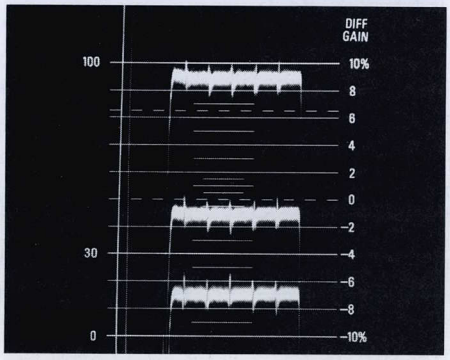
PAL colour bars, 100% amplitude, 100% white reference, demodulated to recover the RED signal.



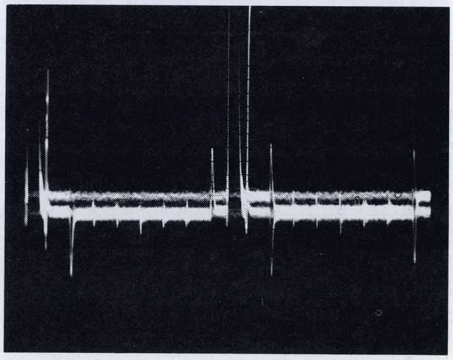
PAL colour bars, 75% amplitude, 100% white reference, demodulated to recover the GREEN signal.



PAL colour bars, 75% amplitude, 100% white reference, 25% setup, demodulated to recover the BLUE signal.



Combined differential gain of PAL Vectorscope and Type 141A Generator. Each minor scale division equals ½% differential gain. Top trace 87½% APL, middle trace 50% APL, bottom trace 12½% APL.



Combined differential phase of PAL Vectorscope and Type 141A Generator. Left trace 12½% APL, right trace 87½% APL.

VERTICAL INSERTION TEST SIGNAL

The staircase signal may be keyed on during a selected line of the vertical blanking interval, either or both fields (line 11-22 on Field 1 and line 324-335 on Field 2).

SYNC GENERATOR

ALL AMPLITUDES ARE SPECIFIED WITH 75-Ω LOAD IMPEDANCE. ALL CONNECTORS ARE BNC TYPE. RETURN LOSS (WHERE APPLICABLE) IS ALWAYS GREATER THAN 30 dB. ISOLATION BETWEEN ALL OUTPUTS IS ALWAYS GREATER THAN 40 dB.

SUBCARRIER—Frequency is 4.43361875 MHz (long term drift) within 1 Hz/2 week period. Outputs—Three outputs (one front panel and two rear panel). Output level is 2 V P-P within 0.2 V. Output frequency is unaffected by position of 25-Hz offset switch on front panel.

COMPOSITE SYNC—A front-panel and a rear-panel output is provided. Output level is 4 V within 0.2 V. Risetime is 260 ns within 15%.

PAL PULSE—Two outputs (one front, one rear panel). Amplitude and phasing are internally selected to be either of the following: 1) Squarewave—1 V P-P within 0.05 V with transitions occurring with each horizontal sync pulse. Either positive or negative transition is coincident with leading edge of line sync pulse with 135° or 225° burst phasing, (as internally selected). 2) Pulse—4 V P-P within 0.2 V, duration 4.7 μs within 0.2 μs with negative transition coincident with leading edge of line sync pulse on lines with 135° or 225° burst phasing, (as internally selected).

COMPOSITE BLANKING—One rear-panel output provides 4 V within 0.2 V. Risetime is 260 ns.

LINE DRIVE—One output (on rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns.

FIELD DRIVE—Two outputs (one front panel, one rear panel). Output level is 4 V within 0.2 V. Risetime is 260 ns.

BURST FLAG—One rear-panel output provides 4 V within 0.4 V. Duration is 2.2 μs within 5%, delay from horizontal sync is 5.5 μs within 5%.

1-MHz REFERENCE FREQUENCY—One rear-panel output. Frequency is 1.000000 MHz when subcarrier is 4.43361875 MHz with 25-Hz offset. Amplitude is 1 V P-P within 0.2 V.

25 Hz—One rear-panel output. Output level is 1 V within 0.2 V.

12.5 Hz—One rear-panel output. Output level is 1 V within 0.2 V.

LINE PERIOD—64 μs (derived from PAL subcarrier frequency).

BURST—Half amplitude duration of envelope is 2.2 μs within 5% (approximately 10 cycles). Burst delay is 5.5 μs within 0.2 μs. Burst component is 300 mV P-P within 3%. V component is 212 mV P-P within 3%. U component is 212 mV P-P within 3%. Amplitude ratio of U/V is 1.00 within 1%. Amplitude on successive lines—smaller is between 97% and 100% of the larger. Phasing—135° within 1° and 225° within 1° on successive lines. Phasing between successive bursts is 90° within 1°.

LINE BLANKING—11.8 μs to 12.2 μs.

FRONT PORCH—1.8 μs within 5%.

LINE SYNC PULSE—Width is 4.7 μs within 0.2 μs; risetime is 260 ns within 15%.

FIELD PERIOD—20 ms (digitally derived from 4.43361875 MHz).

FIELD BLANKING—25 lines, 1600 μs (digitally derived from 4.43361875 MHz).

EQUALIZATION PULSE SEQUENCE DURATION—First sequence, 2.5 H (lines); second sequence, 2.5 H (lines).

FIELD SYNC PULSE—Duration 27.3 μs within 0.2 μs.

INTERVAL BETWEEN FIELD SYNC PULSES—47 μs within 0.2 μs.

OTHER CHARACTERISTICS

COMPOSITE VIDEO OUTPUT
Two outputs are provided through BNC type connectors, one front panel and one rear panel. Composite video consists of composite sync and video test signals as selected by front-panel controls. Amplitude is 1 V P-P into 75 Ω. Return loss is at least 30 dB. Isolation is at least 40 dB.

POWER REQUIREMENTS
90 to 136 VAC or 180 to 272 VAC, 48 Hz to 66 Hz. 55 W max at 230 VAC, 50 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

AMBIENT TEMPERATURE—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C (except as noted).

DIMENSIONS AND WEIGHTS

Type 141A	Height	3½ in	8.9 cm
	Width	16¾ in	42.6 cm
	Depth	18½ in	47.1 cm
	Net weight	17¾ lb	8.0 kg
Type R141A	Height	3½ in	8.9 kg
	Width	19 in	48.3 cm
	Depth	18½ in	47.1 cm
	Net weight	18½ lb	8.4 kg

INCLUDED STANDARD ACCESSORIES
75-Ω through-line termination (011-0103-02); 7½ foot 3-wire power cord (161-0036-00); instruction manual (070-1008-00). Type R141A also includes rackmounting hardware.

TYPE 141A PAL TV TEST SIGNAL GENERATOR . . . $2150

TYPE R141A PAL TV TEST SIGNAL GENERATOR . . $2150

TYPE 141A MOD 703Z PAL TV TEST SIGNAL GENERATOR
(Includes convergence test pattern) **$2335**

TYPE R141A MOD 703Z PAL TV TEST SIGNAL GENERATOR
(Includes convergence test pattern) **$2335**

For 525-line, 60-cycle field, 3.575611 MHz subcarrier (Brazilian system):

TYPE 142 PAL TV TEST SIGNAL GENERATOR $2350

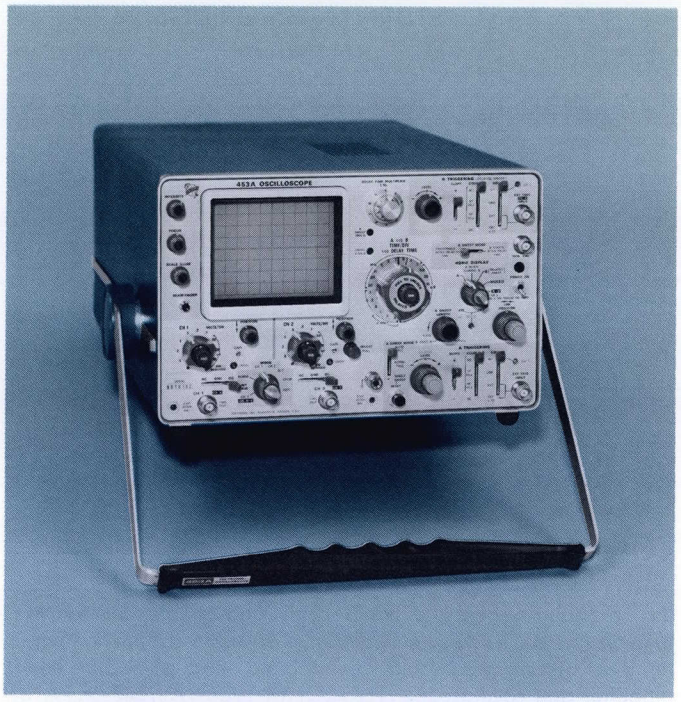
TYPE R142 PAL TV TEST SIGNAL GENERATOR . . . $235

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

453A MOD 127C

Television Oscilloscope

NEW

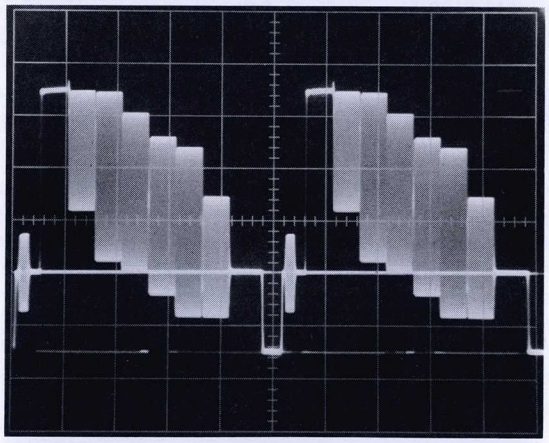


- ***DC-to-60 MHz BANDWIDTH***
- ***5 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***DUAL TRACE***
- ***COMPACT, LIGHT WEIGHT***
- ***CALIBRATED DELAYED SWEEP***

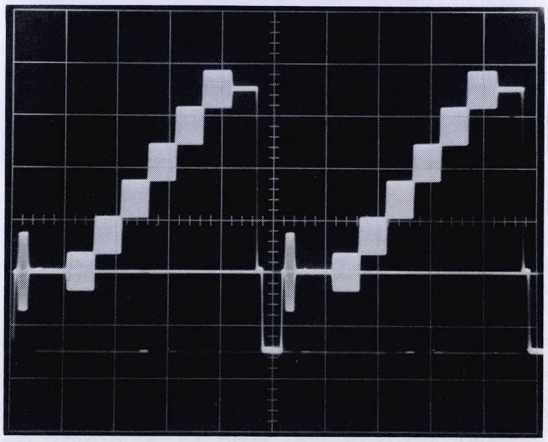
An internal TV Sync Separator circuit permits stable internal Line or Field-rate triggering from displayed composite video or composite sync waveforms. External ÷ 10 trigger sources are replaced by internal TV Sync positions providing Line (Horizontal) sync pulses to the B Sweep circuit and either Field (Vertical) or Line sync pulses to the A Sweep circuit.

Individual line selection of VIT (vertical interval test) signals is facilitated by the delayed sweep features in the 453A. The wide range of delayed sweeps permits accurate alternate-frame color-burst observations in the PAL color system.

Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. Other characteristics are the same as 453A and R453A. A parallax-free, 8 x 10 div, illuminated graticule is standard. Two additional snap-in TV graticules are supplied but may not be illuminated.



NTSC color bar test signal displayed on the 453A MOD 127C.



Modulated staircase test signal displayed on the 453A MOD 127C.

INCLUDED STANDARD ACCESSORIES

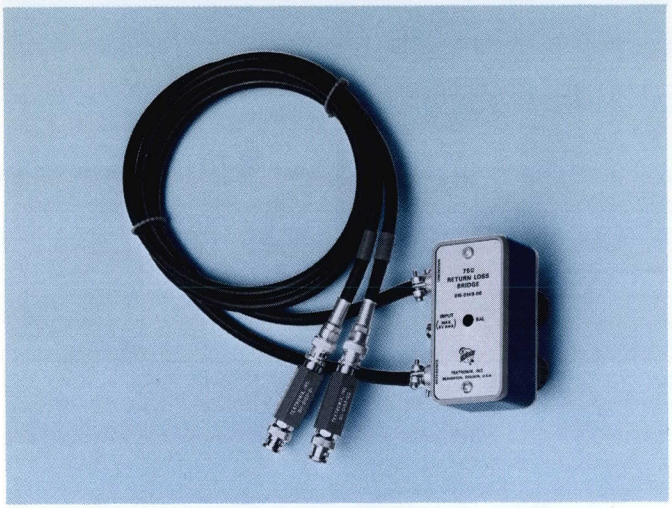
Same as 453A except as follows: delete two P6054 3.5-ft, 10X probe packages (010-6054-01); add two P6054 6-ft probe packages (010-6054-03); two 6-32 adapters (103-0051-01); snap-in light filter/TV graticule (NTSC) (378-0664-01); snap-in light filter/TV graticule (CCIR) (378-0664-02); 453A MOD 127C instruction manual insert.

453A MOD 127C **$2135**

R453A MOD 127C **$2220**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

75 Ω RETURN LOSS BRIDGE



The Tektronix Return Loss Bridge is a compact and rugged device featuring passive components and simple construction. It is designed to measure impedance errors in a 75-Ω system in terms of return loss, using a wideband, high-gain differential amplifier and oscilloscope (TEKTRONIX Type 1A5/547 or 7A13/7000-Series) as the error detector. The TEKTRONIX 011-0103-00 and 011-0103-01 are 75 Ω, 0.2% double-ended termination resistors supplied as removable bridge arms. Two matched coax cables extend the bridge arms and are permanently attached to the bridge. The ability to disconnect either or both bridge arms provides for a maximum degree of flexibility, during both calibration and in making measurements.

The bridge can be driven by a number of different sources such as VIT test signals, squarewaves, sinewaves, sine-squared pulses, multiburst, and swept-frequency sinewaves. With the Return Loss Bridge coupled to the differential amplifier and oscilloscope, a television test signal such as the multiburst can be used to measure impedance errors over the complete video spectrum with a single measurement.

CHARACTERISTICS

RETURN LOSS—At least 54 dB, DC to 10 MHz.

MAXIMUM INPUT VOLTAGE—6 V RMS (6 V RMS, DC to 1.2 MHz decreasing to 0.7 V RMS at 10 MHz when used with Type 1A5 or 7A13).

RETURN LOSS BRIDGE, order 015-0149-00 ..... $100
Includes instruction manual (070-1024-00).

TERMINATIONS

75-ohm termination. 75 ohms within 0.5% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 5 V RMS, center conductor to ground.

BNC, order 011-0102-00 ..... $9.70

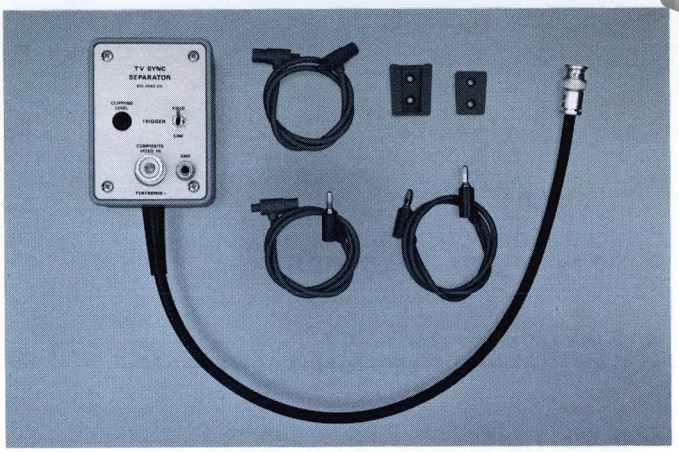
UHF, order 011-0104-00 ..... $9.70

75 ohm feed through termination. 75 ohms within 0.2% (at DC). Return loss is at least 52 dB, DC to 10 MHz, maximum input voltage is 3 V RMS, center conductor to ground.

BNC, order 011-0103-02 ..... $9.70

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

TV SYNC SEPARATOR



The TV Sync Separator provides the trigger facilities for viewing composite video signals on a conventional oscilloscope. It can be used with Tektronix general-purpose oscilloscopes that have a 100-volt calibrator output. When used with other instruments, a separate 100-V source is required to power the unit.

A front panel switch selects field- or line-rate triggers, and a separate output jack supplies field triggers continuously. The unit has a clipping level control, allowing it to be used with signals ranging from 0.5 V to 8.5 V in amplitude.

POWER REQUIREMENTS—7 mA; operates on 100-V DC, or from the output of an oscilloscope calibrator with a frequency near 1 kHz.

INPUT—Composite video signal from signal source or from Vert Sig Out jack on front panel of oscilloscope.

OUTPUT—≈8-V negative-going composite sync for line rate triggering or ≈6-V negative-going field-rate triggers. Selected by toggle switch. Also second output for field-rate triggers.

TV SYNC SEPARATOR, with illustrated accessories
Order 015-0062-00 ..... $95

VIDEO STAIRCASE DIFFERENTIATOR

The Video Staircase Differentiator permits the use of a general-purpose oscilloscope for measuring amplitude linearity in TV systems.

The staircase differentiator is a filter which differentiates the steps of an unmodulated, linearity staircase (VIT signal) into spikes. The spikes appear on a common-reference level. Amplitude linearity is checked by comparing the amplitude of the spikes on the oscilloscope display. The generator used must supply a staircase having equal risetime, for the output amplitude of the differentiator is proportional to the rate of rise. Input impedance of the differentiator is 75 ohms. Return loss is at least 36 dB.

VIDEO STAIRCASE DIFFERENTIATOR
UHF, order 015-0075-00 ..... $25
BNC, order 015-0154-00 ..... $25

CONTENTS

Products in this group have those features required to meet particular measurement requirements. Some features found in general-purpose instruments are omitted in favor of those features required for these specialized applications.

PAGE

CURVE TRACER REFERENCE 280

575 SEMICONDUCTOR CURVE TRACER 281
Provides 5-inch display of semiconductor characteristics

576 SEMICONDUCTOR CURVE TRACER 284
Provides 6½-inch display of semiconductor characteristics

176 PULSED HIGH-CURRENT FIXTURE 289
Allows plotting of high-current curves on 576

410 PHYSIOLOGICAL MONITOR 291
Displays ECG, EEG, other physiological phenomena

MACHINE CONTROL REFERENCE 294

1701 and 1702 MACHINE CONTROL UNITS 295
Provides program positioning for two or three axes

ENGINE ANALYZER REFERENCE 297

ENGINE ANALYZER 298
Displays performance of gas and diesel engines

519 1-GHz REALTIME OSCILLOSCOPE 301
Displays fractional-nanosecond events

130 DIRECT-READING L-C METER 303
Indicates unknown inductance or capacitance

Curve Tracer Reference

Some oscilloscopes are specially designed for displaying semiconductor parameters. Known as curve tracers, these oscilloscopes are capable of displaying one or more characteristic curves of two and three-terminal devices. Each curve is developed by driving one terminal with a constant voltage or current and then sweeping the other with a half sinewave of voltage. If more than one curve is to be drawn, the driving source is stepped through several values and the sweep repeated, once for each step. The horizontal deflection is then a plot of either the driving voltage or the sweep voltage across the device under test, while the vertical deflection is a plot of the current drawn from the sweep source.

The reasons for measuring the characteristics of semiconductor devices are varied. Typical measurements are for the purpose of producing better components, sorting components, predicting performance in a circuit, or simply checking to see if the device meets specs. The characteristics of semiconductor devices that are of practical importance to their use in an electrical circuit can usually be measured with a curve tracer. Many of those measurements also provide good analytical information for people improving component design or maintaining production quality and specifications.

Tektronix offers two curve tracer models: the Type 576 and the Type 575. The charts below, along with the detailed specifications of each on the next 10 pages, should assist you in selecting the right one for your requirements.

576 MEASUREMENT CAPABILITIES

DEVICE	FEATURES
DIODES	1 nA/div sensitivity for leakage measurements—1500-V collector supply—Kelvin sensing for accurate high-current measurements.
FET's	40 V (step + offset) available for base drive—Step offset allows stepping through zero bias—1 nA/div sensitivity measures gate leakage—AC sweep allows examination of resistive region.
SCR's	Calibrated variable step offset accurately determines gate firing potential—Holding current may be read directly.
POWER TRANSISTORS	Kelvin sensing for accurate high-current measurements—Pulsed base allows high-current beta measurements without exceeding dissipation limits or requiring heat sinks. Up to 200 A peak with 176 PULSED HIGH-CURRENT FIXTURE.
TRANSISTORS	EXTENDED RANGES ON ALL TRANSISTOR MEASUREMENTS—Small steps on top of an offset (as much as 100X the step amplitude) permit observation of several voltage-driven steps within the active region. Auto positioning of PNP and NPN displays.
TUNNEL DIODES	AC sweep displays forward and reverse characteristics simultaneously.
ZENERS	High-resolution 2% voltage measurements of the zener region are possible with the use of the CALIBRATED DISPLAY OFFSET and MAGNIFIER.
INTEGRATED CIRCUITS	Input impedances, output impedances, power supply loading, input switching levels, and output levels may be measured. Most measurements require an external power supply.

575 MEASUREMENT CAPABILITIES

DEVICE	FEATURES
DIODES	200 V collector supply. MOD 122C has 1500 V.
TRANSISTORS	Supplies for checking PNP and NPN types.
TUNNEL DIODES	Forward and reverse characteristics can be alternately displayed by manually changing collector supply polarity.
ZENERS	Voltage measurements of zener region with reasonable resolution.

575
Semiconductor Curve Tracer

- ***DISPLAY DYNAMIC CHARACTERISTIC CURVES***
- ***DIRECT COMPARISON OF TRANSISTOR CHARACTERISTICS***
- ***MAKE DIODE MEASUREMENTS***

The Type 575 Transistor-Curve Tracer displays the dynamic characteristic curves of both NPN and PNP transistors. Several different transistor characteristic curves may be displayed, including the collector family in the common-base and common-emitter configuration. In addition to the transistor curves, the Type 575 is used to display dynamic characteristics of a wide range of semiconductor devices.

A special model (Type 575 MOD 122C), although similar to the Type 575, provides much higher voltages for diode breakdown test and collector supply. Horizontal deflection factor selections are extended to 200 V/div to accommodate the higher voltages.

Transistors under test are inserted into either a common-base or common-emitter test circuit. The transistor collector has a sweep voltage applied to it while a step voltage or current is applied to either the base or emitter (whichever is ungrounded). Voltage, for the collector, sweeps between zero and a selectable value. The Step Generator applies steps to the base or emitter that start at zero and build up to a value determined by the number of steps and value of each step as selected with front-panel controls. Each sequence of steps, in conjunction with the sweep voltage on the collector, produces one family of characteristic curves.

CHARACTERISTIC SUMMARY

BASE OR EMITTER STEP GENERATOR—

Type of Steps—Steps are increments of voltage or current and are either positive or negative.

Voltage Increments—Selectable from 10 mV/step to 0.2 V/step ±3% with 2.4-A current capability.

Current Increments—Selectable from 1 μA/step to 200 mA/step, ±3%.

Stepping Rate—2 or 4 times line frequency.

Number of Steps—Continuously variable from 4 to 12 steps per family of characteristic curves.

Single or Repetitive—Stops after a single family of curves is generated, or repeatedly generates the family of curves.

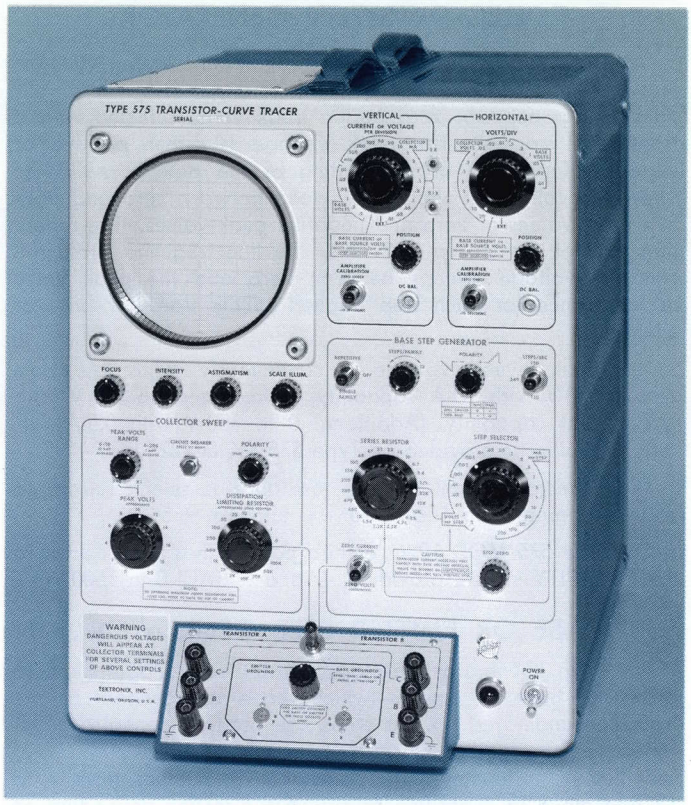
COLLECTOR SWEEP GENERATOR—

Frequency—2 times line frequency.

Peak Sweep Voltage—Continuously variable from 0 V to 20 V minimum with 10-A capability and from 0 V to 200 V minimum with 1-A capability.

Type 575 MOD 122C: Continuously variable from 0-20 V minimum with 10-A capability, 0-200 V minimum with 1-A capability or 0-400 V minimum with 0.5-A capability.

Polarity—positive or negative. A third switch position is added on Type 575 MOD 122C providing + and — (AC) 0 to 1500 V for diode breakdown tests.



VERTICAL DISPLAY

CALIBRATED DEFLECTION FACTOR—

Transistor Collector Current—1 μA/div to 2 A/div, ±3%.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div, ±3%.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div, ±3%.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div, ±3%.

HORIZONTAL DISPLAY

CALIBRATED DEFLECTION FACTOR—

Transistor Collector Voltage—10 mV/div to 20 V/div, ±3%. MOD 122C—10 mV/div to 200 V/div, ±3%.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div, ±3%.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div, ±3%.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div, ±3%.

CRT

DISPLAY AREA—10 x 10 div ($5/16$ inch per div).

ACCELERATING VOLTAGE—4 kV.

PHOSPHOR—P31

OTHER CHARACTERISTICS

COMPARISON SWITCH—Switch allows switching between two semiconductors for comparison.

POWER REQUIREMENTS—105 to 125 V or 210 to 250 V, 50 to 60 Hz, 410 watts max.

575

Semiconductor Curve Tracer

COLLECTOR SWEEP GENERATOR

The Collector Sweep Generator provides the sweep voltages that drive the collector of the transistor under test. These voltages sweep between zero and a peak value selected with a front-panel control. The peak voltage is either positive or negative depending on the setting of the polarity switch to allow the collector voltages to sweep between zero and positive peak values or zero and negative peak values. The repetition rate of the sweep is 2 times the line frequency; thus the collector voltage sweeps between zero and the peak value at least once for each step applied to the transistor base or emitter.

The peak sweep voltage is continuously adjustable from zero to 20 V with 10-A capability or from zero to 200 V with 1-A current capability. (Additional 0 to 400-V with 0.5-A current capability is provided on Type 575 MOD 122C.)

The collector current limiting resistance is selected from 16 values ranging from 1 ohm to 100 kilohms ±5%.

On Type 575 MOD 122C, a third position has been added to the POLARITY switch, providing + and — (AC) 0 to 1500 V.

BASE OR EMITTER STEP GENERATOR

The Step Generator develops current or voltage steps to drive the base or emitter (whichever is ungrounded) of the transistor under test. These steps are used to generate either repetitive or single-family (as selected) characteristic curves for display. The steps are adjustable in number from 4 to 12 and move in a positive or negative direction depending on the polarity switch setting. Step repetition rate is selectable as either 120 steps/s or 240 steps/s (values equal to 2X or 4X the line frequency). A control is available to set the starting point of a series of steps to zero.

Each step has a rise that is selected as either a value of current or a value of voltage. The value of each step rise in current ranges from 0.001 mA/step to 200 mA/step and is selected from 17 values that are in a 1-2-5 sequence. The value of each step rise in voltage is from 0.01 V/step to 0.2 V/step and is selected from 5 values that are in a 1-2-5 sequence. Also a switch is provided for grounding the transistor input to give a zero drive-voltage reference check, and opening the transistor input to give a zero drive-current reference check.

The driving resistance of the step generator, when developing voltage steps, is selected from 24 values that range from 1 ohm to 22 kilohms ±10%. Any other value can be added externally.

VERTICAL-DEFLECTION SYSTEM

Signals used for vertical deflection are selected from various points in the transistor test circuit. Each point has several selectable deflection factors available.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Current—10 μA/div to 1 A/div in 16 steps, 1-2-5 sequence. Push buttons are provided for multiplying each step by 2 or 0.1 thus extending the deflection factor from 1 μA/div to 2 A/div.

Transistor Base or Emitter Current—1 μA/div to 200 mA/div in 17 steps, 1-2-5 sequence.

Transistor Base or Emitter Voltage—10 mV/div to 0.5 V/div in 6 steps, 1-2-5 sequence.

Base or Emitter Source Voltage—10 mV/div to 0.2 V/div in 5 steps, 1-2-5 sequence.

HORIZONTAL-DEFLECTION SYSTEM

Signals used for horizontal deflection are selected from various points in the transistor test circuit. Each point has several selectable deflection factors available.

CALIBRATED DEFLECTION FACTOR

Transistor Collector Voltage—0.01 V/div to 20 V/div in 11 steps, 1-2-5 sequence. (10 mV/div to 200 V/div on Type 575 MOD 122C).

Transistor Base or Emitter Current—0.001 mA/div to 200 mA/div in 17 steps, 1-2-5 sequence.

Transistor Base or Emitter Voltage—0.01 V/div to 0.5 V/div in 6 steps, 1-2-5 sequence.

Base or Emitter Source Voltage—0.01 V/div to 0.2 V/div in 5 steps, 1-2-5 sequence.

CRT

TEKTRONIX CRT

4-kV accelerating voltage, P31 phosphor normally supplied; P1, P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

GRATICULE

External, 3⅛ inch x 3⅛ inch viewing area, 10 divisions each axis with each division measuring 5/16 inch.

OTHER CHARACTERISTICS

TRANSISTOR TEST PANEL—The transistor test panel has provisions for two transistors at the same time. Two sockets accept low-power transistors with short leads and three binding posts alongside the sockets accept other transistors and semiconductors. One switch will change the sockets from the common-emitter to the common-base test circuit configuration. A second switch allows two transistors inserted into the test circuit to be rapidly compared by switching the test conditions from one to the other.

POWER REQUIREMENT

Wired for 105 to 125 VAC (117 V nominal); may be ordered with transformer taps connected for nominal values of 107, 127, 214, 234, or 254 V; 50 to 60 Hz. 410 watts maximum.

TYPE 575 AND TYPE 575 MOD 122C DIMENSIONS AND WEIGHTS

Height	16⅜ in	41.6 cm
Width	13 in	33 cm
Depth	23⅝ in	60 cm
Net weight	66¼ lb	30.1 kg
Domestic shipping weight	≈ 84 lb	≈38.2 kg
Export-packed weight	≈102 lb	≈46.4 kg

TYPE 575 AND TYPE 575 MOD 122C INCLUDED STANDARD ACCESSORIES

Two transistor adapters, long lead (013-0069-00); two transistor adapters, TO-3 (013-0070-01); two 2N1381 transistors (151-0039-00); 3-conductor power cord (161-0010-03); smoke-gray light filter (378-0567-00); instruction manual (070-0255-01); measurement concepts booklet "Semiconductor Device Measurements" (062-1009-00).

TYPE 575 TRANSISTOR CURVE TRACER $1300

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

INCREASED COLLECTOR VOLTAGE

Type 575 MOD 122C, although similar to the Type 575, provides much higher diode breakdown test voltage (variable from zero to 1.5 kV, maximum short circuit current of 1 mA); also provides much higher collector supply (up to 400 V at 0.5 A).

TYPE 575 MOD 122C TRANSISTOR CURVE TRACER $1575

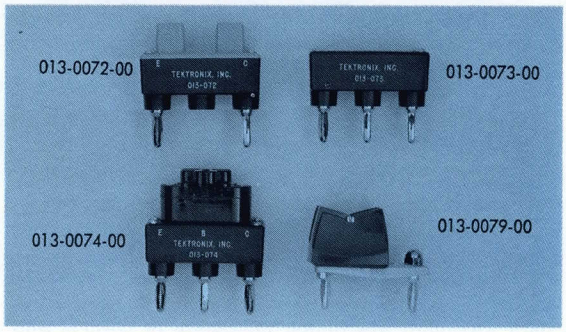
OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience.

RACKMOUNT ADAPTER

Cradle mount to adapt the Type 575 Transistor-Curve Tracer for rackmounting. Consists of a cradle to support instrument in any standard 19-inch relay rack and mask to fit around regular instrument panel. Tektronix blue vinyl finish. Rack height requirements 17½ inch. Order 040-0281-00. $34.50

TYPE 575 OPTIONAL TEST FIXTURES



DIODE TEST FIXTURE

Holds axial-lead diodes. Order 013-0072-00 ..... $6.60

ADAPTER BOX

Allows mounting of additional semiconductor sockets. Order 013-0073-00 ..... $4.40

POWER TRANSISTOR SOCKET

For power transistors with hook leads. Order 013-0074-00 ..... $9.50

DIODE TEST ADAPTER

Production test fixture for rapid handling. Order 013-0079-00 ..... $29.00

CAMERA

The standard C-12 camera satisfies most trace-recording requirements. For applications that might require a different viewing system, lens, or back, refer to camera descriptions or consult your Field Engineer, Representative, or Distributor.

Standard C-12: f/1.9—1:0.85 lens, beam-splitting mirror for straight-on viewing, and use of optional projected graticule; Polaroid Land* Pack-Film Back, order C-12 ..... $490.00

Projected graticule eliminates parallax in displays where external graticules are used, such as the 575, order 016-0204-00 (115 V) or 016-0234-00 (230 V) $175

Mounting Adapter for C-12, order 016-0226-01 .... $16.00

SCOPE-MOBILE® CART

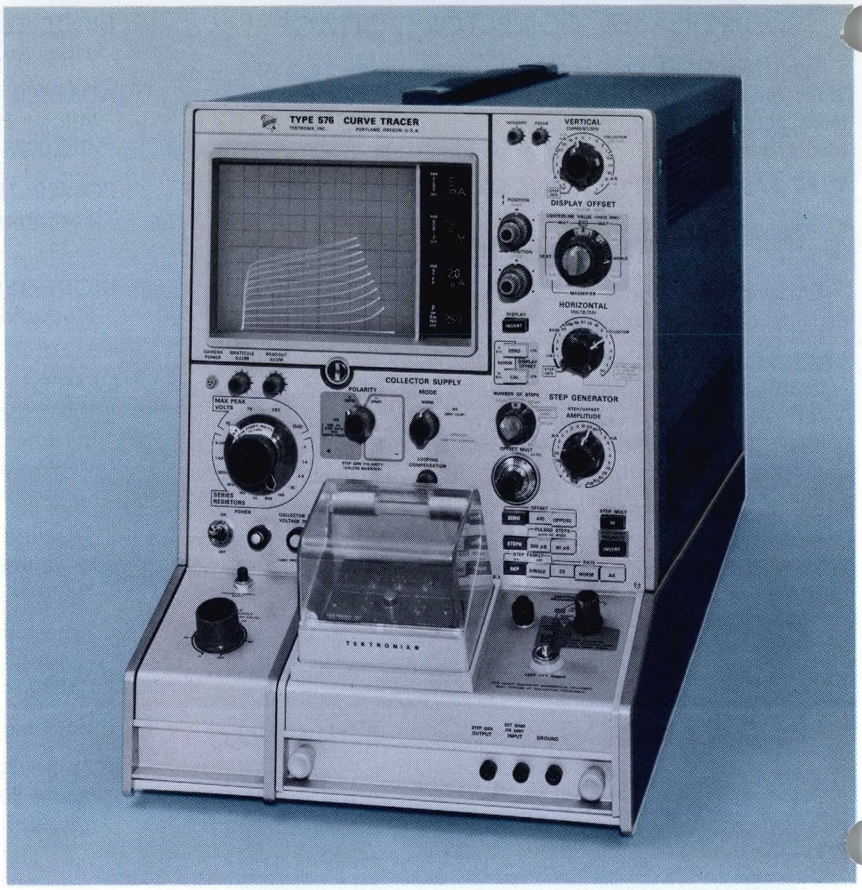
Model 202-1: storage drawer, 9-position tilt-lock oscilloscope tray, order Type 202-1 ..... $145.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

*Registered Trademark Polaroid Corporation

576
Semiconductor Curve Tracer

- BIG 6 1/2-INCH CRT
- AUTO SCALE-FACTOR READOUT INCLUDING β/div or g_m/div
- THREE COLLECTOR SUPPLY MODES
- AUTO POSITIONING AND POLARITY TRACKING
- PULSED BASE OPERATION
- CALIBRATED DISPLAY OFFSET WITH MAGNIFIER
- KELVIN SENSING ADAPTERS FOR HIGH CURRENT TESTS
- PROTECTIVE FEATURES FOR OPERATOR AND DEVICE



The Type 576 brings meaningful performance to semiconductor testing and establishes a new standard in human engineering features. The measurement requirements for diodes, transistors, and FET's (in all their different forms) established the functions of the Type 576; innovative circuits and component engineering make those measurements easy, accurate, safe and more understandable.

The most noticeable new feature is AUTO SCALE-FACTOR READOUT. Placed adjacent to the CRT (where you normally focus your attention) are digital indicators of vertical and horizontal deflection factors, step amplitude, and Beta/div or g_m/div. Readout offers convenience for test setup and labeled waveform photography. It also offers freedom from the simple but bothersome arithmetic required to compute Beta/div or g_m/div or to correct for magnifiers or multipliers. The other features, such as multifunction switching, calibrated display offset, and many more, are equally important to semiconductor testing applications. The following page describes these features around waveform photographs of measurement situations.

CHARACTERISTIC SUMMARY

CRT & READOUT

CRT—6 1/2-inch rectangular; 10 cm x 10 cm calibrated area, 4 kV, P31 phosphor.

Readout—Digital indicators of VERT CURRENT/div, HORIZ VOLTS/div, CURRENT or VOLTS per STEP, and BETA/div or g_m/div.

COLLECTOR SUPPLY

Voltage Range— 0 V to 1500 V, continuously variable.

Polarity—Positive, negative, or AC.

Peak Current— 0.1 A to 10 A; doubled in pulse mode.

Power Limit Setting— 0.1 W (or less) to 220 W in 6 steps.

STEP GENERATOR

Current Steps— 5 nA/step (0.1X MULT) to 200 mA/step; 2 A max.

Voltage Steps— 5 mV/step (0.1X MULT) to 2 V/step; 40 V max including offset.

Calibrated Step/Offset— 0 to X10 the step amplitude setting, AID or OPPOSE.

Number of Steps— 0 to 10, digitally selectable.

Pulsed Steps—Approx 300 μs or 80 μs pulse width.

VERTICAL AND HORIZONTAL AMPLIFIERS

Vert Collector Current— 0.1 μA/div (X10 MAG) to 2 A/div.

Vert Emitter Current— 1 nA/div to 2 mA/div.

Horiz Collector Volts— 5 mV (X10 MAG) to 200 V/div.

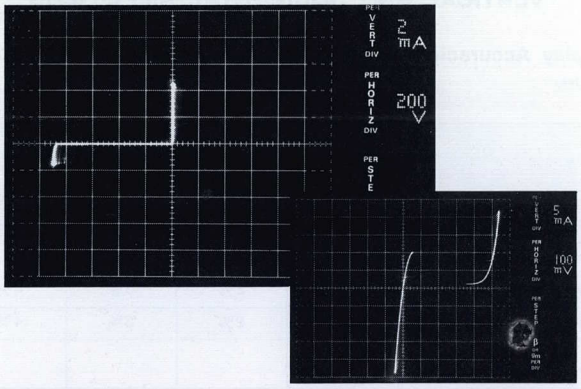
Horiz Base Volts— 5 mV/div (X10 MAG) to 2 V/div.

Display Offset and Magnifier—X10 MAG with calibrated positioning increases resolution and accuracy.

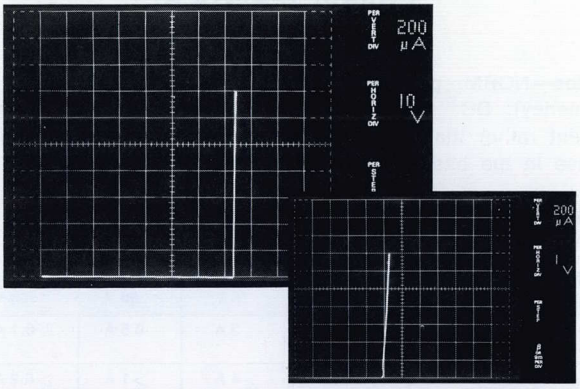
How the TYPE 576 Makes the Measurement . . . Easier

576
Semiconductor Curve Tracer

DIODES

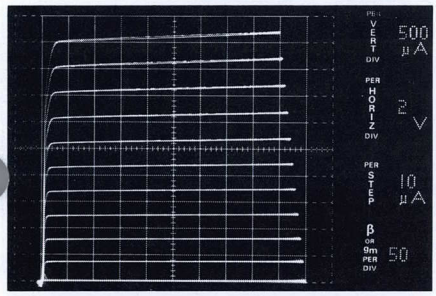


This test shows reverse breakdown and forward current characteristics simultaneously. The AC mode (⊣⊢ and — collector sweep) was selected, which automatically positioned the trace to center-screen. The power limit (0.1 W) was selected with the direct-reading switch. The operator was protected from shock by the protective box, which disconnects voltage to the device when the cover is raised. The inserted waveform shows the forward and reverse characteristics of a tunnel diode. Identical functions were used except at different settings.

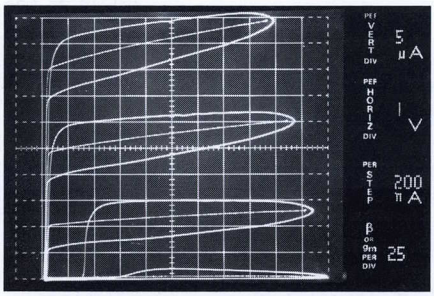


This display of a zener diode test demonstrates the use of the CALIBRATED DISPLAY OFFSET and MAGNIFIER to increase resolution. The main waveform shows the zener region to be somewhere above 73 V. With the DISPLAY OFFSET and MAG, the trace was centered, positioned horizontally exactly 7.5 divisions, and magnified 10 times (see insert). The center graticule line is now a known 75 V with the horizontal scale at 1 V/div. The zener voltage at 1 mA can now be measured at 74.2 V, accurate within 2%.

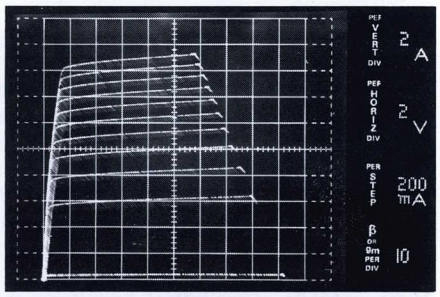
TRANSISTORS



This is an NPN transistor family of curves. When the positive collector supply polarity was selected, the step generator polarity automatically became positive and the trace start was positioned to the proper point. The display shows a full 10-step family but the number of steps could have been digitally selected between 1 and 10. The parameter readout effectively labels the waveform, giving vertical collector current/div, horizontal collector volts/div, current amplitude per step, and computes Beta/div.

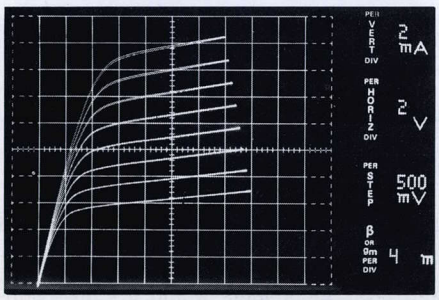


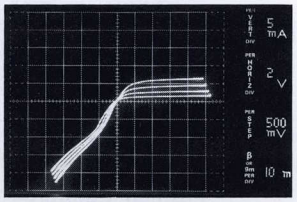
This waveform is a double exposure showing the increased readability for low-current devices obtained by using the DC collector supply mode. The wide "loops" are the result of the collector-to-base capacitance being swept at 120 Hz in the NORM collector supply mode. The center-line (in the middle of each loop) is the display obtained in the DC mode by manually turning the variable voltage control. The DC mode is functional since measurements can be made to 100 nA/div for collector currents, or 1 nA/div in the leakage mode.



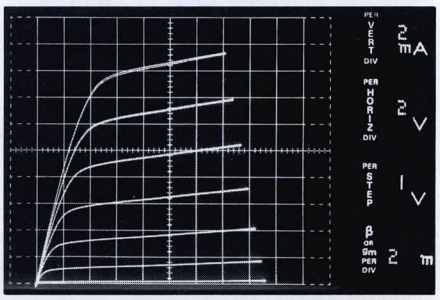
This display is a power transistor test at 17-A collector current with 2 A into the base; Beta/div is shown as 10. Power devices can be checked at 10-A continuous or 20-A peak pulse mode current. Max base is 2 A. The 80-µs pulsed base mode is used for duty-cycle limiting (300 µs also available) and single family operation offers further control. Collector-emitter voltage can be measured more accurately with the TO-3 and TO-66 adapters which employ KELVIN contacts to cancel the effects of contact resistance.

FET's





The Type 576 is particularly well suited for FET measurements. Here a FET is operating in the enhancement mode (positive drain sweep and voltage steps) with the maximum power and gate current selected and limited for device protection. For operation in the depletion mode, the step generator polarity can be inverted (INVERT switch). The insert shows a FET with AC (positive and negative) drain sweep for inspection of the resistive region characteristics.



This drain family shows FET characteristics in both enhancement and depletion modes, accomplished with the CALIBRATED DC STEP OFFSET. The voltage/step is selectable, the number of steps is digitally selectable between 1 and 10, and the first step can be started from any DC plateau between 0 and X10 the amplitude setting, aiding or opposing the step polarity. In this case an opposing DC voltage was selected allowing the positive steps to start below the zero bias point.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes—NORM: positive or negative full wave rectified AC (line frequency); DC: positive or negative DC; LEAKAGE: emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

Voltages—Peak open circuit voltages within +35% and −5% of indicated range.

RANGE	15 V	75 V	350 V	1500 V
MAX CONTINUOUS PEAK CURRENT	10 A	2 A	0.5 A	0.1 A
PEAK PULSE MODE CURRENT	≥20 A	≥4 A	≥1 A	≥0.2 A

Series resistance is from 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak power limit setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock—A protective cover over Test Terminals must be closed to apply collector voltage in 75 V, 350 V, and 1500 V ranges.

STEP GENERATOR

Current Mode—Step/offset amplitude range is 5 nA/step (with 0.1X MULT) to 200 mA/step, 1-2-5 sequence. Max current (steps and aiding offset) is X20 AMPLITUDE setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Max voltage (steps and aiding offset) is at least 10 V. Max opposing offset current is X10 AMPLITUDE switch setting or 10 mA, whichever is less. Max opposing voltage is limited at 1 V to 3 V.

Voltage Mode—Step/offset amplitude range is 5 mV/step (with 0.1X MULT) to 2 V/step, 1-2-5 sequence. Max voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Max current (steps and aiding offset) is at least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short circuit current limiting is 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Max opposing offset voltage; X10 AMPLITUDE switch setting. Max opposing current; limited at 5 mA to 20 mA.

Accuracy—Incremental; within 5% between steps, within 10% with 0.1X MULT. Absolute; within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater. Offset multiplier; 0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

Step Rates— 0.5X, 1X (NORM), and 2X the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps—Approx 80 μs or 300 μs width, at NORM or 0.5X rates.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the AC position. Step polarity may be inverted by actuating the INVERT push button.

Step Family—REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps—Digitally selectable between 1 and 10.

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies—As a percentage of the highest on-screen value.

NORM and DC MODES	NORMAL	OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
		100-40 div	35-15 div	10-0 div
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20 or 2 nA	3% plus 50 mV/vert div			
500, 50 or 5 nA	3% plus 125 mV/ vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor—Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

Horizontal Deflection Factor—Collector volts; 50 mV/div to 200 V/div, 12 steps in 1-2-5 sequence (5 mV/div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps in 1-2-5 sequence (5 mV/div with X10 magnification). Step generator; 1 step/div.

Displayed Noise— 1% or less or:

RANGE	15 V	75 V	350 V	1500 V
VERTICAL—COLLECTOR	1 μA	1 μA	2 μA	5 μA
VERTICAL—EMITTER	1 nA	1 nA	2 nA	5 nA
HORIZONTAL—BASE	5 mV	5 mV	5 mV	5 mV
HORIZONTAL—COLLECTOR	5 mV	5 mV	20 mV	200 mV

Calibrator (CAL)—DC voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls—Fixed 5-div increments within 0.1 div. Continous fine control over 5 div or less.

Display Offset—Provides 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with the X10 MAGNIFIER.

576
Semiconductor Curve Tracer

CRT AND READOUT

CRT— 6 1/2-inch rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied; P2 and P7 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

Readout—The readouts, adjacent to the CRT, are digital indicators of the following display parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

OTHER CHARACTERISTICS

Standard Test Fixture—A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

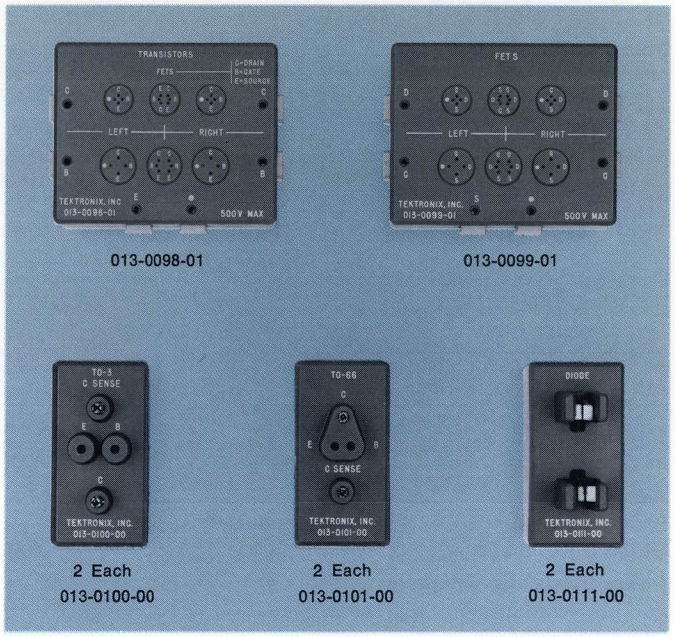
Power Requirements—Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-change line-voltage range selector accommodates 90 VAC to 136 VAC or 180 VAC to 272 VAC (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is ≈60 W.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights

Height	15 in	38 cm
Width	11 1/2 in	29 cm
Depth	23 in	59 cm
Net Weight	70 1/2 lb	32 kg
Domestic shipping weight	≈107 lb	≈48.5 kg
Export-packed weight	≈127 lb	≈57.5 kg

INCLUDED STANDARD ACCESSORIES



013-0098-01 013-0099-01

2 Each 013-0100-00 | 2 Each 013-0101-00 | 2 Each 013-0111-00

TEST ADAPTERS

Not shown: measurement concepts booklet "Semiconductor Device Measurements" (062-1009-00); instruction manual (070-0905-00).

TYPE 576 CURVE TRACER **$2500**

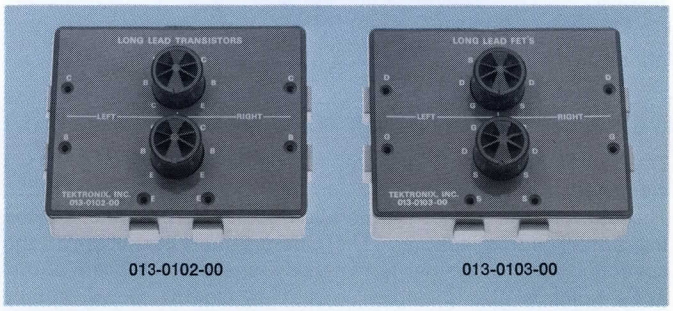
INSTRUMENT OPTION

The Type 576 MOD 301W deletes the parameter readout module, but maintains provision for insertion of the module (020-0031-00) at any time.

Type 576 MOD 301W **$2150**
Auto Scale-Factor Readout Module (020-0031-00) **$375**

OPTIONAL ACCESSORIES

LONG-LEAD ADAPTERS

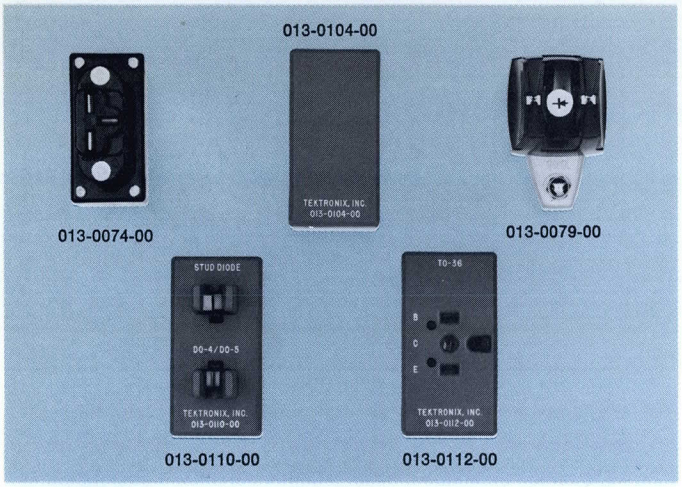


013-0102-00 013-0103-00

Designed to accept untrimmed bipolar or single FET's or transistors.

Long-lead transistor adapter, order 013-0102-00 ..... $28
Long-lead FET adapter, order 013-0103-00 ..... $28

OTHER ADAPTERS



Adapter Box
Blank, for mounting special semiconductor sockets.
Order 013-0104-00 ..... $8

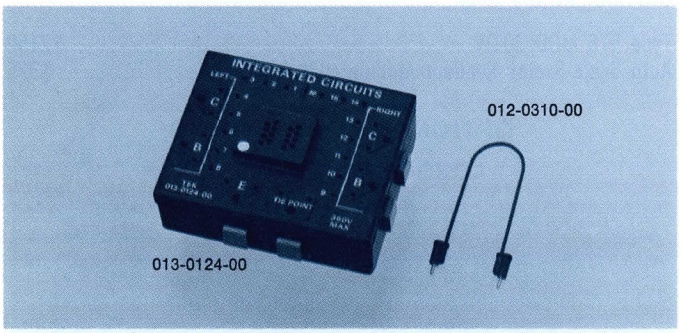
Power Transistor Adapters
For power transistors with hook leads.
Order 013-0074-00 ..... $9.50

For TO-36 transistors. Adapter has Kelvin sensing terminals.
Order 013-0112-00 (standard with 176) $13

Diode Adapters
Magnetic holder for axial lead diodes, providing quick insertion and removal for production applications.
Order 013-0079-00 ..... $29

For stud type (DO-4) and DO-5) diodes. Adapter has Kelvin sensing terminals.
Order 013-0110-00 (standard with 176) $10

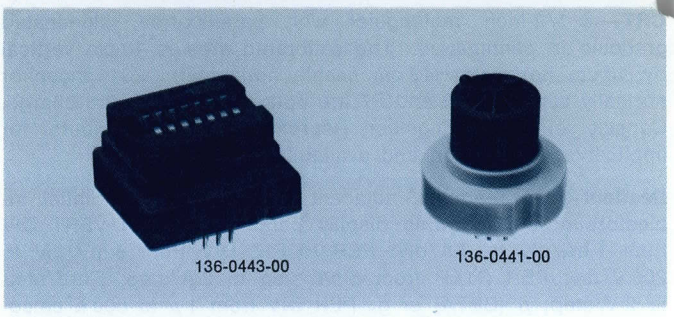
Integrated Circuits Adapter



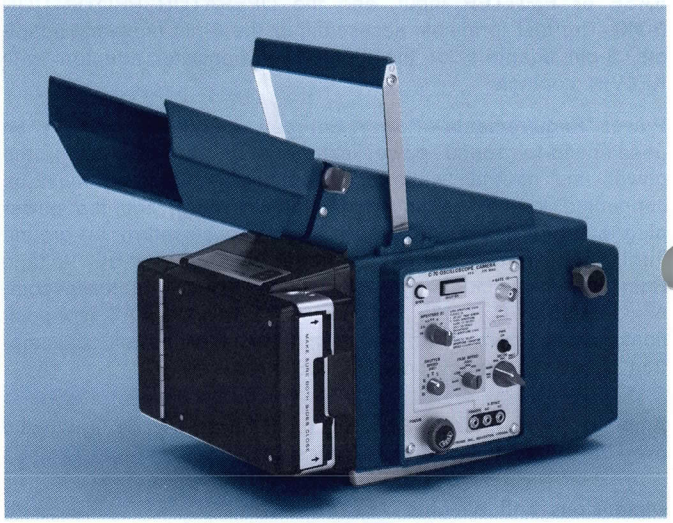
The integrated circuits adapter allows many integrated circuit measurements to be made using the Type 576 Curve Tracer. The appropriate Barnes Corporation socket is plugged into the integrated circuits adapter. The pins are then connected to the collector, base, or emitter terminals by means of the patch cords. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. The pin numbers on the adapter correspond to the IC pin numbers with any of the four Barnes Corporation sockets available from Tektronix. Barnes Corporation, Lansdowne, Pa., has several other sockets available which may be purchased directly from them. All of the ones with yellow bases (and some that are not yellow) are compatible with the adapter pin numbering system.

Integrated Circuits Adapter, with 8 four-inch patch cords (012-0310-00). Order 013-0124-01 ..... $50

Barnes Corporation Sockets



Socket for 8-lead TO package (not shown).
Order 136-0444-00 ..... $9
Socket for 10-lead TO package.
Order 136-0441-00 ..... $10
Socket for 14-lead dual-in-line package.
Order 136-0443-00 ..... $7
Socket for 16-lead dual-in-line package (not shown).
Order 136-0442-00 ..... $7



CAMERA

The C-70 camera is a general-purpose trace-recording camera designed for use with the Type 576 Curve Tracer. It features an f/1.9, 1:0.575 lens, trace-brightness photometer, range-finder focusing, accurate exposure control, electric shutter, and choice of Polaroid[1] Land or Graflok[2] Film Back.

C-70-P CAMERA, Pack-Film Back $785
C-70-R CAMERA, Roll-Film Back $785
C-70-G CAMERA, 4 x 5 Graflok Back $750

Adapter-frame/corrector lens, part no. 016-0264-00, permits use of the C-12 or C-27 Cameras with the Type 576. Refer to the camera section of this catalog for full information.

Adapter frame/corrector lens, part no. 016-0271-00, permits use of the C-50 Camera with the Type 576. Refer to the camera section of this catalog for full information.

SCOPE-MOBILE® CART

Model 202-1 with storage drawer $145

[1]Registered Trademark Polaroid Corporation

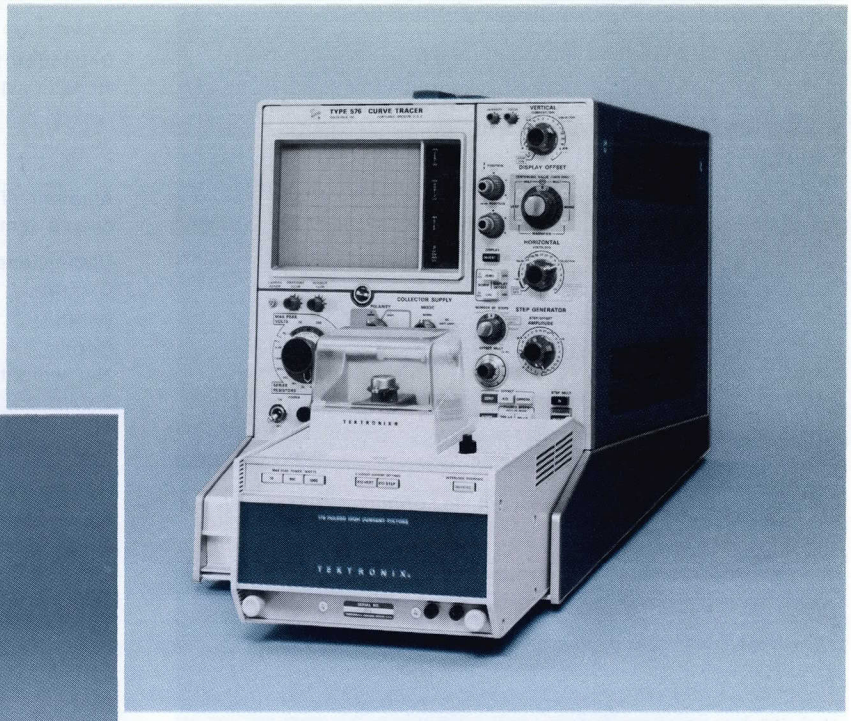
[2]Registered Trademark Graflex, Inc.

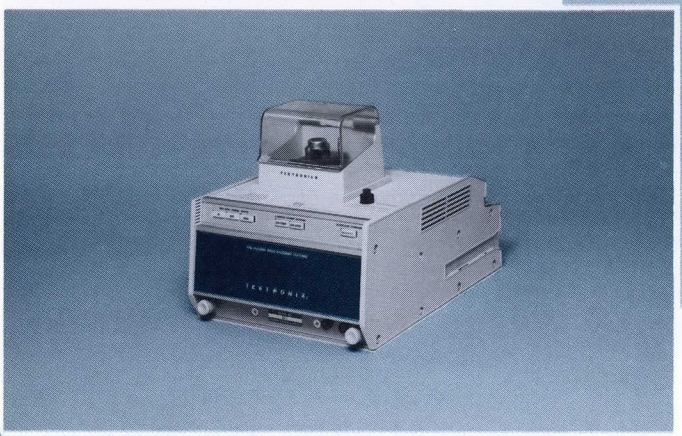
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

176 Pulsed High-Current Fixture

NEW

- 200 AMP PEAK COLLECTOR DISPLAYS
- 20 AMP PEAK BASE SUPPLY





The 176 Pulsed High-Current Fixture extends the capabilities of the 576 Curve Tracer by providing pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over-dissipation. The 176 "front porch" configuration fits in place of the 576 Standard Test Fixture, and is programmed from the 576 mainframe except for controls not provided on the mainframe. The collector pulse is slaved to the 576 in regard to width and repetition rate. The pulse width is selected by depressing the 300 μs or 80 μs push button on the 576 mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT push button on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP push button on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP push buttons provide inputs to the fiber-optic readout to display actual values. **If STEP GENERATOR AMPLITUDE or VERTICAL CURRENT/DIV controls are moved out of the five highest current settings, the multiplication of the affected function automatically drops back to X1.**

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width— 300 μs or 80 μs determined by 576.

Repetition Rate—Power-line frequency.

Polarity— + or — determined by 576 polarity control.

Amplitude—Ranges are 15, 75, 350 volts nominal, controlled by MAX PEAK VOLTS switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

Maximum Peak Watts—Three illuminated push buttons select 10, 100, 1000 watts maximum peak power.

STEP GENERATOR

Current Ranges (X10 STEP selected)—Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.

576 Offset Multiplier— 0 to X100 576 AMPLITUDE switch setting.

Step Rate—Power-line frequency.

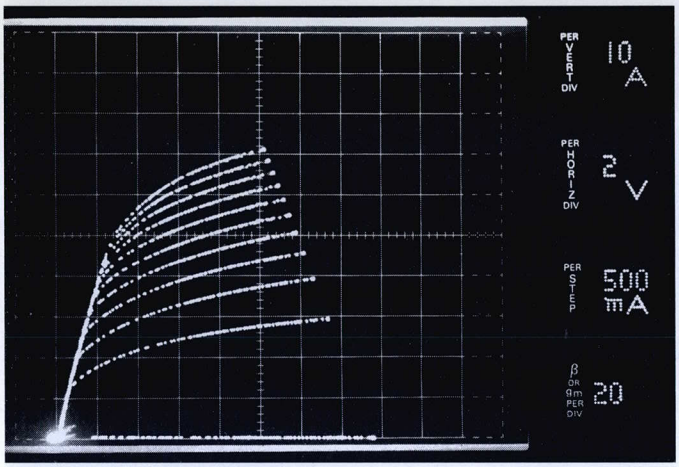
Pulsed Steps— 300 μs or 80 μs wide.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT push button.

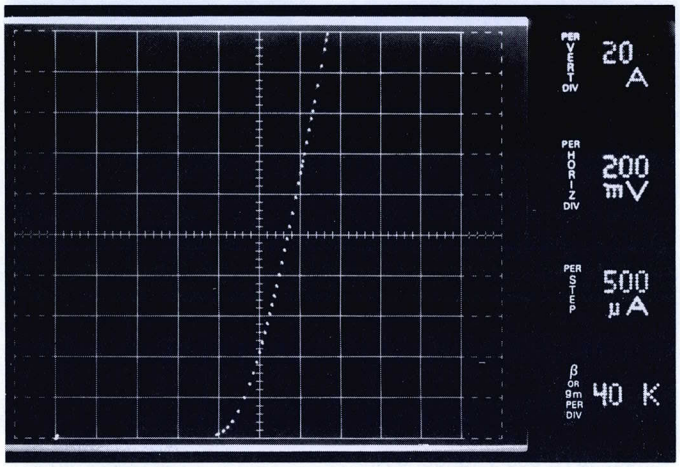
Accuracy (Current steps including offset)—Incremental is within 5% between any two steps; within 10% with 0.1X STEP MULT. Absolute is within 3% of total output ± 1% of one step or within 3% of one step, whichever is greater.

NEW

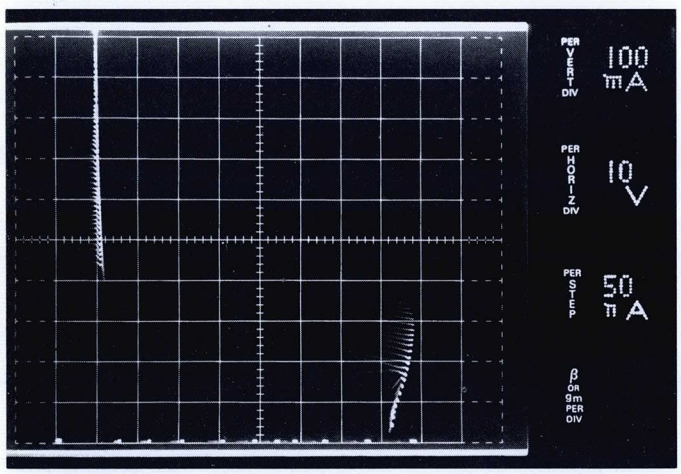
176
Pulsed High-Current Fixture



Collector voltage manually swept to obtain entire family of curves.



15 A rectifier diode driven to 200 A.



NPN (TO-3) $V_{(BR)CES}$ pulsed into secondary breakdown.

VERTICAL AMPLIFIER

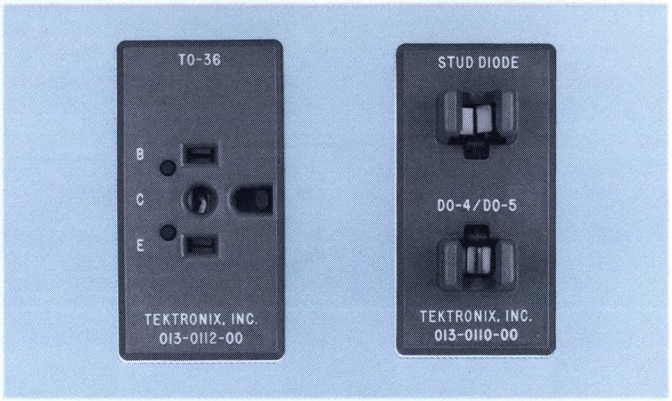
Deflection Factor (X10 VERT selected)— 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid over a temperature range of 0°C to +40°C.

Dimensions and Weights

Height	4 5/8 in	11.8 cm
Width	7 7/8 in	20.0 cm
Depth	11 3/8 in	28.8 cm
Net weight	12 3/4 lb	5.8 kg



INCLUDED STANDARD ACCESSORIES

Adapter TO-36 (013-0112-00); adapter stud diode (013-0110-00); protective cover (337-1194-00); instruction manual (070-1073-00).

176 PULSED HIGH-CURRENT FIXTURE **$1400**

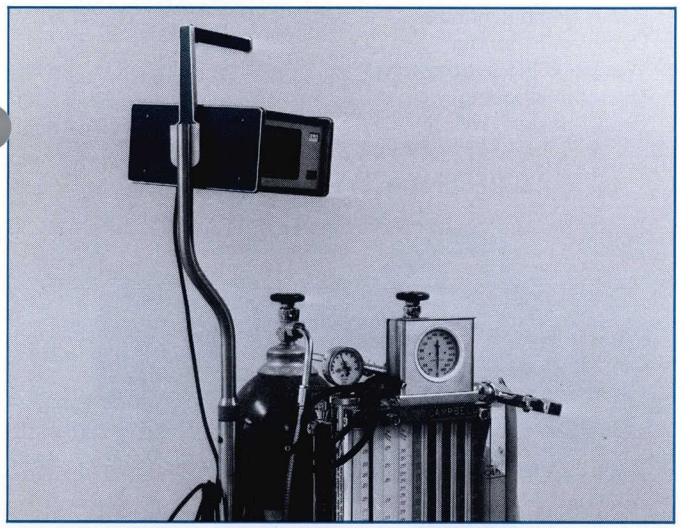
U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

410
Physiological Monitor

- ***DISPLAYS ECG, EEG, OR PULSE WAVEFORMS***
- ***SOLID-STATE RELIABILITY, QUICK TURN-ON***
- ***HEART RATE BEEP and ALARM***
- ***INTERNAL BATTERY PACK UP TO 8 HOURS OPERATION***

The Type 410 is designed for patient monitoring during surgery, recovery, and intensive care. Of special use to the anesthesiologist, it displays on a cathode-ray tube waveforms of the electrocardiogram (ECG), electroencephalogram (EEG), or pulse. During surgery, the Type 410 can give early warning of a developing problem.

Ease of operation, with a minimum of controls, contributes to the usability of the Type 410, as do its other features: 4-second recovery after overdrive by defibrillator or cauterizer, output for strip-chart recorder, and a cabinet finish that is durable and washable.



The Monitor can be conveniently positioned (using the optional mounting stand) at the five-foot level on the anesthesiologist's gas machine for easy viewing, then lifted off and carried with the patient to the recovery room. The 12½-pound weight and battery operation permit easy mobility and continuous operation without disconnecting leads or power.

ECG MEASUREMENTS

Heart rates from 35 beats/min to 180 beats/min can be directly read by observing the point on the CRT graticule scale where the second R wave occurs. A beep sound coincident with each repetition of the ECG waveform provides an audible indication of heart rate, in addition to the waveform display. Thus a sudden change in heart rate can be quickly detected, even without constant observation of the display. Seven commonly-used leads can be selected: I, II, III, aV_R, aV_L, aV_F and V. Silver-silver chloride non-polarizing electrodes are supplied as standard accessories. The Type 410 is also compatible with common needle electrodes and inexpensive disposable surface electrodes.

EEG MEASUREMENTS

EEG input accepts the included silver-silver chloride ECG electrodes supplied with the Monitor. Optional EEG electrodes (identical except for color coding) are also available. Bandwidth in the EEG mode is $\leq$0.1 Hz to 100 Hz $\pm$15%. Deflection sensitivity is 10 mm/50 μV $\pm$5%.

PULSE MEASUREMENTS

Auxiliary input accepts the optional photosensitive pulse sensor. The pulse sensor, containing a light source and photo-resistor, is attached to the patient's finger. As the pulse occurs, the amount of blood in the finger changes the amount of light reaching the photo-resistor. The resulting display provides a quick indication of heart rate. A beep sounds coincident with each pulse, giving an audible as well as visible indication of the patient's heart activity.

AUDIO SIGNAL

Beep sounds at heart rate, providing audible indication of normal or arhythmic heart rate. Automatic alarm sounds if there is a loss of signal for 2 to 4 seconds. Loudness is adjustable. Using the audio output jack disconnects the internal speaker. Signal is disabled in the EEG mode.

BATTERY OPERATION

Removable battery pack contains 10 size "C" NiCd cells, provides 6 hours operation with full accessory load when display baseline stays within 3 divisions of graticule center, increasing to 8 hours in ECG or EEG with baseline kept within 1 division of graticule center. Time decreases above 25° C. Internal charger provides recharge in 14 to 16 hours, operates from 90 V to 136 VAC or 180 V to 272 VAC, 48 Hz to 440 Hz, requires $\leq$7 W at 115 V, 60 Hz. Monitor can also be operated from line (with reduced charge to battery pack).

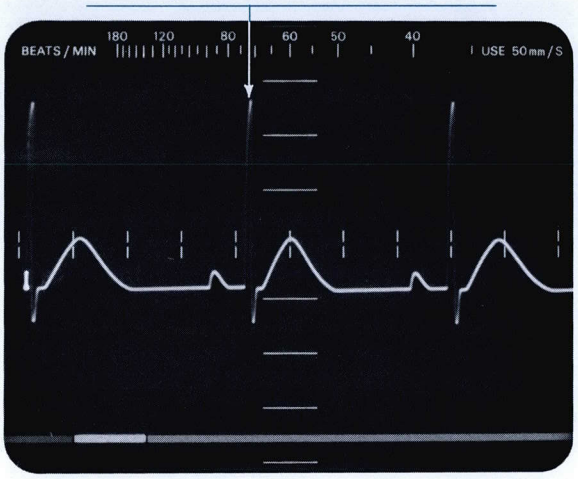
The battery pack incorporates an automatic battery disconnect that terminates discharge before batteries are harmed. The disconnect is activated if the instrument is operated for a prolonged period with the battery condition indicator in the red area.

CLEANING

Monitor and accessories can be damp wiped with mild soap and water.

WAVEFORM SIZE
Vertical size of ECG, EEG, and pulse waveforms is continuously variable from 1/3 to 3 times the height of the calibrated display.

ECG display—approx 72 beats/minute



CATHODE-RAY TUBE
5-inch rectangular CRT has 8 x 10-cm viewing area. P-7 phosphor has long decay time for convenient viewing at slow sweep speeds. The external graticule has a graduated heart-rate scale at the top, a battery-condition scale at the bottom, and a vertical and horizontal center-line scale marked in centimeters.

BANDWIDTH
ECG and Auxiliary modes— 0.1 Hz or less to 250 Hz, ±15%.
EEG mode— 0.1 Hz or less to 100 Hz, ±15%.

SENSITIVITY
ECG mode— 20 mm/mV, ±5%.
EEG mode— 10 mm/50 μV, ±5%.
Auxiliary mode— 2 mm/mV, ±5%.

COMMON-MODE REJECTION RATIO

Mode \ Signal Input Conditions	60 Hz and 5 kΩ Source Impedance Unbalance	25 Hz to Upper Bandwidth Limit and 0 Ω Source Impedance Unbalance
EEG	At least 150,000:1	At least 500,000:1
ECG (Lead Selector I, II or III)	At least 150,000:1	At least 500,000:1
ECG (Lead Selector aV_R, aV_L, aV_F, or V)	At least 100,000:1	At least 100,000:1
(With 100 mV DC differential voltage) EEG or ECG	- - -	At least 150,000:1
AUX	At least 50,000:1	At least 500,000:1

COMMON-MODE DYNAMIC RANGE
+3 V to −3 V.

DIFFERENTIAL DYNAMIC RANGE
Monitor gain characteristics are valid with an input terminal DC potential difference (offset) of up to 50 mV. Typically less than 10 mV difference exists between the non-polarizable silver-silver chloride electrodes supplied with the Type 410. At least 100 mV of either polarity can be applied with no more than 5% reduction in amplifier gain.

DIFFERENTIAL INPUT RESISTANCE
2 MΩ ±15% in EEG and ECG mode, 20 MΩ ±15% in Auxiliary mode.

DRIFT
≤0.5 cm per hour after 10-second warm-up.

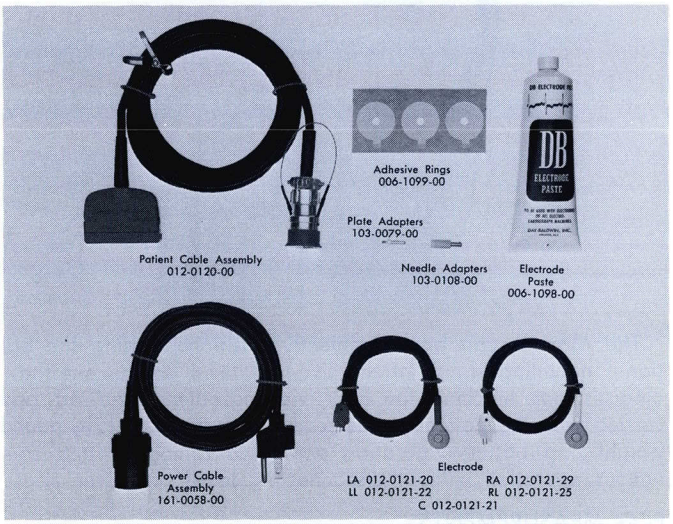
DISPLAY NOISE
≤0.1 cm in the calibrated EEG mode, input shorted.

SWEEP SPEEDS
25, 50, and 100 mm per second; accurate within 5%. Sweep is triggered in ECG and AUX operating modes.

DIMENSIONS AND WEIGHTS

Height	5⅜ in	13.7 cm
Width without handle	8½ in	21.6 cm
Width with handle	9⅛ in	23.2 cm
Depth without handle	10¾ in	27.4 cm
Depth with handle	12⅞ in	32.7 cm
Weight without accessories	12½ lb	5.6 kg
Domestic shipping weight	≈23 lb	≈10.4 kg
Export-packed weight	≈34 lb	≈15.4 kg

REPRESENTATIVE ACCESSORIES



INCLUDED STANDARD ACCESSORIES
Power cable assembly (161-0058-00); patient cable assembly (012-0120-00); electrode LA black (012-0121-20); electrode LL red (012-0121-22); electrode RL green (012-0121-25); electrode RA white (012-0121-29); electrode, chest, brown (012-0121-21); package adhesive electrode rings (006-1099-00); tube electrode paste (006-1098-00); five needle adapters (103-0108-00); five plate adapters (103-0079-00); instruction manual (070-0658-00).

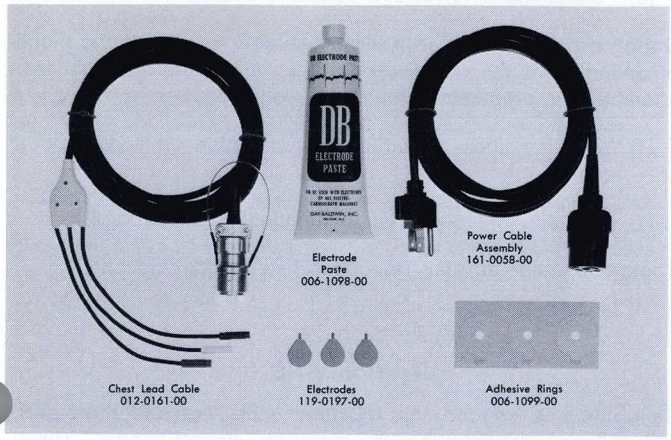
TYPE 410 PHYSIOLOGICAL MONITOR $875

INSTRUMENT OPTIONS

The Type 410 may be purchased without the full complement of standard accessories. These options allow maximum flexibility and value for the user who will be operating a Type 410 in an area where limited types of signals require monitoring. If requirements are expanded subsequent to initial purchase, additional accessory packages are available. (see OPTIONAL ACCESSORIES listing)

CHEST LEAD OPTION

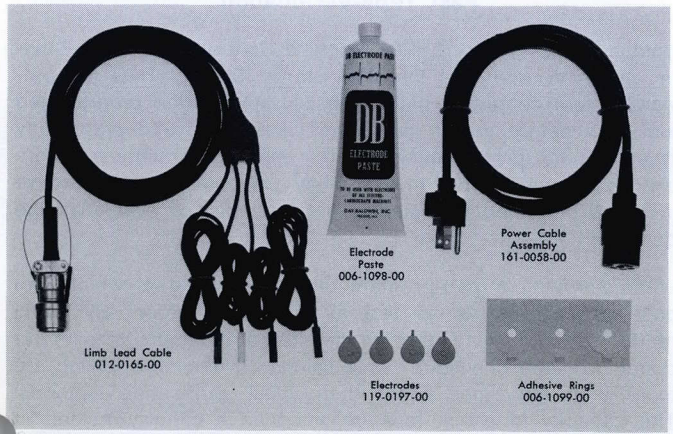
The chest lead option provides a heavy-duty chest lead cable intended for patient monitoring in an intensive care environment.



Accessories include: power cable assembly (161-0058-00); chest lead cable (012-0161-00); 3 electrodes (119-0197-00); electrode paste (006-1098-00); adhesive rings (006-1099-00); instruction manual (070-0658-00).
Order 410 MOD 950A $825

LIMB LEAD OPTION

The limb lead option provides a heavy-duty limb lead cable intended for use during surgery and in general ECG monitoring applications.



Accessories include: power cable assembly (161-0058-00); limb lead cable (012-0165-00); 4 electrodes (119-0197-00); electrode paste (006-1098-00); adhesive rings (006-1099-00); instruction manual (070-0658-00).
Order 410 MOD 950B $835

OPTIONAL ACCESSORIES

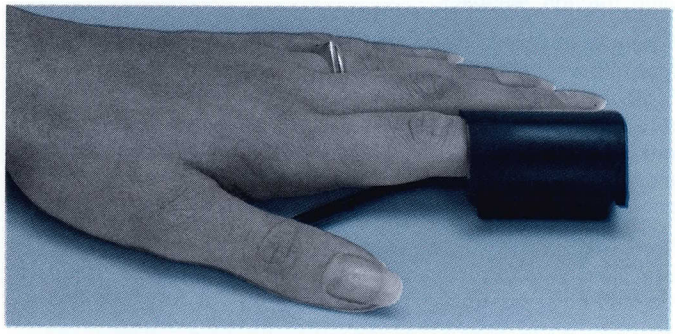
MOUNTING STAND KIT
Mounts Type 410 at the five-foot level, permits swivelling and tipping the Monitor for convenient viewing. Hardware supplied with the fixture attaches to gas machine, bed, flat or round surface up to 1½-inch diameter.
Order 016-0110-00 ..... $40

MOUNTING BRACKET
Mounts Type 410 to flat surface, permits tipping the Monitor for convenient viewing. Mounting screws not included.
Order 407-0393-01 ..... $5

CHEST LEAD CABLE PACKAGE
Patient cable with 3 electrodes installed, electrode paste and rings.
Order 012-0183-00 ..... $75

LIMB LEAD CABLE PACKAGE
Patient cable with 4 electrodes installed, electrode paste and rings.
Order 012-0184-00 ..... $85

PATIENT CABLE PACKAGE
Same as standard accessory package less power cord and manuals.
Order 012-0185-00 ..... $125



PULSE SENSOR ASSEMBLY (PLETHYSMOGRAPH)
Photoresistive sensor for pulse measurements, used with Type 410 Auxiliary input.
Order 015-0104-00 ..... $66

BATTERY PACK
Extra battery pack, in addition to the one supplied with the Type 410, allows one pack to charge while the other is powering the Monitor. Pack contains 10 size "C" NiCd cells and battery charger.
Order 016-0107-02 (For SN B100000 and ABOVE) $140
Order 050-0478-00 (For SN B099999 and BELOW) $146

EEG ELECTRODES
Minus EEG Electrode, order 012-0121-23 ..... $12.50
Plus EEG Electrode, order 012-0121-24 ..... $12.50

BARE WIRE ADAPTER
Order 103-0080-00 ..... $3.40

PLUGS
Mini-phone plug for audio output jack.
Order 134-0079-00 ..... $0.95
7-pin connector for rear-panel output.
Order 131-0551-01 ..... $15.50
2-pin electrode plug, order 134-0089-00 ..... $2.30
7-pin pulse sensor plug, order 134-0090-00 ..... $3.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

1701 and 1702
Machine Control Units

Numerical Control

Numerical Control (NC) is simply a means of directing some or all of the functions of a machine automatically from numerical instructions. These numerical instructions are introduced to the machine by some form of stored input medium such as a punched or magnetized tape. The Machine Control Unit (MCU) interprets these instructions and directs the machine through the required operations with a combination of speed, accuracy, and consistency that cannot be equalled by human operators. Although the machine tool industry is the most conspicuous use area of NC, any mechanism requiring controlled motion is a candidate for numerical control.

Contouring And Point-To-Point

There are two basic types of machine tool control. The simplest is *point-to-point* in which the tool or part is directed to a position and a machine operation such as drilling or punching is performed. The path to that point is of consequence only in terms of time required for movement or obstacles that may exist along that path. Positioning control is another term for point-to-point control.

A more sophisticated NC concept is *continuous path* or *contouring control.* The continuous-path MCU precisely commands tool path in multiple axes and receives confirmation of actual path through feedback.

When feedback is used in an NC system, it is called a *closed-loop* system. Closed-loop requires a *command* signal from the MCU to the machine and feedback to the control from the *position* transducer on the machine. In an open-loop system you do not have feedback. Most open-loop systems depend on stepping motors to maintain positioning accuracy. There is usually a sacrifice of fast feedrate and accuracy in open-loop systems.

The Tektronix 1701 two-axis and the 1702 three-axis MCU's are closed-loop, continuous-path units that are also useful for point-to-point control.

Programming

The 1701 and 1702 MCU's use *absolute dimensioning.* The MCU references all positions to one, common zero-reference point. Tektronix absolute dimensioning is in one quadrant of a Cartesian coordinate system resulting in the following advantages:

(1) Part programming is directly related to the dimensions of a part drawing.

(2) Part program additions or deletions can easily be made.

(3) Starting in the middle of a part program is much simpler.

The 1701 and 1702 combine features of the point-to-point and continuous-path control. The absolute dimensioning, typically found in point-to-point control, is combined with interpolation techniques of contouring control, enabling the MCU's to adapt to both point-to-point and continuous path applications. *Full floating-zero* is a standard feature in Tektronix MC that allows the zero-reference point to be established manually at any position over the full travel of the machine.

There are two types of tape coding recognized by the numerical control industry. The standard for the industry is the familiar USASCII Code. However, previous to the development and wide-spread use of USASCII, the numerical control industry had its own standard, the EIA Code. The EIA Code is the more common in the U.S.; USASCII is generally finding acceptance in the European market. The 1701 and 1702 can accept either code by simply changing a circuit card.

Auxiliary Functions

The purpose of a machine control unit is not merely to control a position or move. The control must also decode from tape and indicate to the machine tool miscellaneous and preparatory functions to be performed.

Tektronix Machine Control Units have a standard feature, the ability to command the machine tool to perform up to 80 *miscellaneous functions.* Examples of miscellaneous functions would be:

(1) Control of the insertion and retraction of cutting tool, punch, or drill on a 2-axis control.

(2) Turning the coolant on or off for a cutting tool or drill.

(3) Positioning a turret and selecting a tool.

During a part program it may be desirable to change the mode of operation of the numerical control via *preparatory functions.* Examples of preparatory functions would be:

(1) Selecting linear or circular interpolation on a contouring control.

(2) Inhibiting the deceleration function of the control.

There are other auxiliary functions listed under options.

Tektronix NC

Tektronix has entered the NC field with two- and three-axis, closed-loop, continuous-path machine control units. These machine control units (MCU) are a direct result of the influence of our own extensive machine tool user experience (from programming to machining) combined with established product design skills. Tektronix MCU's offer the machine tool user and the machine tool manufacturer the new program tape verification option, along with easier maintenance through functional layout and many features not found in other units in its price range. In addition, Field Engineering support is available through 58 Field Offices.

Fast Tape-Verification

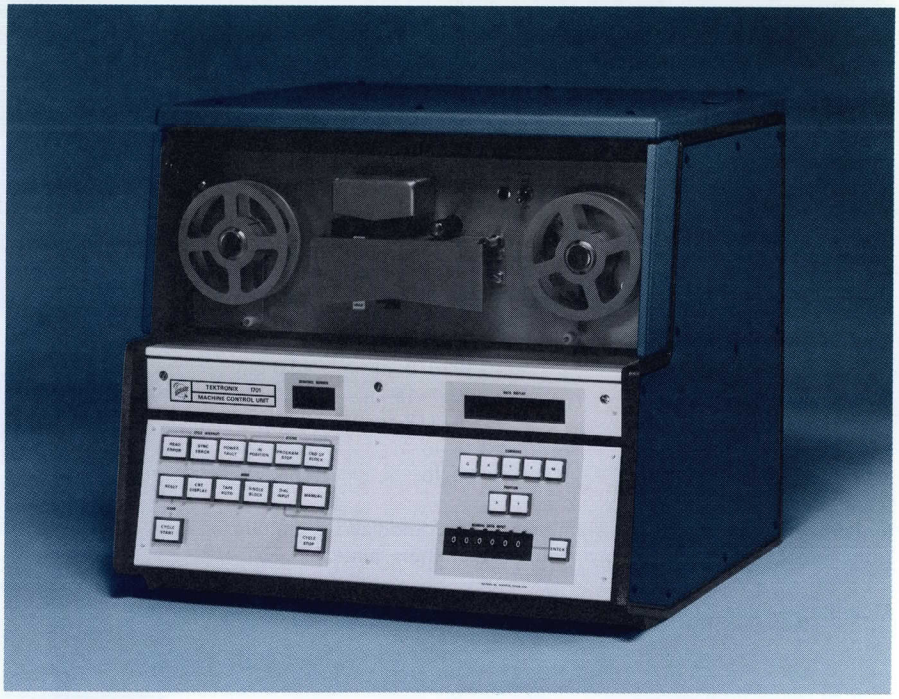
Unique to the 1701 and 1702 Machine Control Units is the built-in ability to interface the 611 Storge Display Unit for previewing tool centerline path. The 611 reveals the programmed tool path before actual machining takes place and graphically reveals most programming errors. Most programming errors are time-wasting, gross errors. They are potentially destructive in terms of ruined workpieces, broken tools, or even machine damage.

When verifying a part-program tape, the speed at which tool path is displayed is as fast as the tape reader. By using reader speed instead of machine speed, minimum time is required for tape checkout. Time savings in tape previewing are more than ten times better than usual verification methods. The capacity to check tape in less than a minute, instead of 20 or 30 minutes, is a breakout of the confining practice of proof by actual machine operation or laborious step-by-step programming checks. Another plus is that the tape verification is performed on the same machine control unit that controls the machine to be programmed and no computer is required.

1701 and 1702
Machine Control Units

NEW

- OPTIONAL, FAST TAPE-VERIFICATION
- DIRECT FEEDRATE PROGRAMMING
- FULL FLOATING ZERO
- 0.0001-INCH RESOLUTION
- COMMAND, POSITION, AND SEQUENCE READOUT
- MANUAL DATA INPUT
- EXCELLENT NOISE IMMUNITY



Standard features of these units include: Linear interpolation; command and position readout for each axis; plus readout capability of G, F and M functions on the 1701. Readout of G and F functions is available on the 1702. Readouts aid in analyzing program and machine errors. Manual Data Input (MDI) allows limited program modifications. Data entered through MDI is not entered on program tape. Direct feedrate programming is provided as well as automatic acceleration and deceleration. Adjustments are minimized, requiring only three per axis of control.

The 1701/1702 units include TTL integrated logic circuitry on plug-in circuit boards, a power supply, an operator's control panel, a sequence number and position readout panel, and a tape reader. An interface to the 611 Storage Display Unit is also standard. The optional 611 Storage Display Unit, used in tape verification, is designed to interface with the 4601 Hard Copy Unit. With this additional option, permanent, reproducible copies are produced in 18 seconds.

Retrofit And Original Equipment

Tektronix Machine Control Units conform to the standards of the machine tool industry so that they interface readily with the many machine tools that are designed for NC. Tektronix MCU's will retrofit to many existing, non-NC machine tools through recognized industry procedures and techniques. Your Tektronix Field Engineer or Representative can provide you with detailed information.

STANDARD FEATURES

1701 Two Axis and 1702 Three Axis MCU's

Resolution— 0.0001 inch.

Command Register Range— 0 to +99.9999 inches each axis.

Maximum Slide Departure— 99.9999 inches each axis.

Position Register Range— −99.9999 to +99.9999 inches each axis.

Maximum Feedrate— 240 inches per minute.

Manual Data Input (MDI) Switches—Six-decimal digits, from 00.0000 to 99.9999.

Floating Zero—Full range.

Programming Format—Word address, absolute dimensions.

Acceleration/Deceleration—Automatic.

Sequence Number Readout— 0 to 999.

Command and Position Readout— 00.0000 to 99.9999.

Basic Clock Rates— 2 MHz, within 4%.

Logic Type—TTL Series 74N logic and TTμL 9000 defined in terms of positive logic using the following definitions: Low Voltage Level = Logic 0, High Voltage Level = Logic 1.

Input Power Requirements— 115/230 V, 50/60 Hz, ≈400 W at 115 V/60 Hz.

Line Noise Immunity— 1200 V, 1 ms; 100 kHz to 30 MHz, 40 dB.

NEW

1701 and 1702
Machine Control Units

ENVIRONMENTAL CHARACTERISTICS

Temperature (Ambient)—Non-operating, −40°C to +60°C; operating, +10°C to +45°C; during calibration, +20°C to +30°C, 1/2 hour stabilization period required.

Humidity—to 95%.

OTHER CHARACTERISTICS

Dimensions and Weights

Height	18 3/8 in	46.8 cm
Width	20 7/16 in	52.0 cm
Depth	20 1/2 in	52.2 cm
Net Weight	≈115 lb	≈52.1 kg
Domestic Shipping Weight	≈130 lb	≈58.9 kg

Finish—Vinyl painted cast aluminum sides, anodized aluminum front panel, top cover is vinyl painted aluminum plate.

Mounting—Four 5/16 × 18 tapped holes in the bottom.

INCLUDED STANDARD ACCESSORIES

1701/1702 user's manual (070-1072-00); 1701/1702 maintenance manual (070-1100-00); Remex Tape Reader manual (062-1259-00); mating power twistlock connector (131-0170-00); machine interface mating connector (131-0239-00); three transducer interface mating connectors (134-0049-00).

1701 Machine Control Unit **$9,750**

1702 Machine Control Unit **$11,000**

OPTIONAL FEATURES

NO COST OPTIONS

Metric Operation—Provides for operation in metric units in place of English units. (Metric system resolution is 0.01 mm with maximum register range of 9999.99 mm.)

ASCII Code—Permits the 1701 or 1702 to accept USASCII Code RS358 in place of EIA Code RS244.

Fast Feedrate—Provides feedrates of 255 inches per minute at 0.0002-inch resolution or 1,000 inches per minute at 0.001-inch resolution.

Leading Zero Option—This option changes the operation of the 1701/1702 so that leading zeros (in the axis commands only) must be programmed, but trailing zeros are not required. This is for those installations where programming trailing zeros in the axis commands would become much more of a chore than programming leading zeros.

Machine Control Unit With Fast Tape-Verification Option

ADDITIONAL COST OPTIONS

S & T Functions—A combined option which provides both spindle speed control and selection of tools. Both speed and tool selection is programmed via two-digit codes (00 to 79).

Order Option 5 ..... **ADD $850**

G80 Series—Provides a selection of seven repetitive routines for drilling, boring, and tapping operations.
Specific requirements of machine tool must be known; price is available by special quote.

Circular Interpolation—Provides simplified data format for programming circular motion within a quadrant.

Feedrate Override—Gives the operator the ability to manually override all traverse rates from 25% to 120% of programmed feedrate.

Order Option 9 ..... **ADD $300**

Jog Switch—Provides variable-feedrate manual positioning control plus a 0.0001 inch and 0.001 inch stepping feature for setup and maintenance.

Order Option 10 ..... **ADD $500**

Additional M Functions—In addition to the standard internal functions (program stop-rewind, etc.), up to 79 functions can be provided for auxiliary machine operations.

611 Storage Display Unit **$2695**

4601 Hard Copy Unit **$3750**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Engine Analyzer

- ***ELIMINATES GUESSWORK***
- ***REDUCES MAINTENANCE COSTS***
- ***DETECTS***
  - ***FAULTY IGNITION***
  - ***FAULTY VALVES***
  - ***BLOWBY***
  - ***DAMAGED RINGS***
  - ***DAMAGED BEARINGS***
  - ***DAMAGED CYLINDER LININGS***
- ***MEASURE AND DISPLAY***
  - ***PRESSURE VS VOLUME***
  - ***PRESSURE VS CRANK ANGLE***
  - ***PRESSURE VS TIME***
  - ***ENGINE VIBRATION***
  - ***ENGINE IGNITION***
- ***CRANK-ANGLE MARKERS***

The Tektronix Engine Analyzer is designed to eliminate guesswork in locating possible failures in gas and diesel engines and compressors. The over-all performance of the engine can be determined by measuring engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer detects and locates malfunctions such as faulty ignition, timing, faulty valves, blowby, and broken or frozen piston rings. Damaged bearings, low compression pressures and other failures that impair the performance of the engine are also indicated on the oscilloscope. With the use of the Rotational Function Generator and pressure transducer, the engine horsepower can be calculated.

The Tektronix Engine Analyzer consists of a Type 561B Oscilloscope or Type 564B Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crank-shaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Polaroid* Trace-Recording Camera, Scope-Mobile® Cart and a tripod for easy mounting of the Rotational Function Generator.

*Registered Trademark Polaroid Corporation

Engine Analyzer

VIBRATION MEASUREMENTS

Vibration measurements are useful in detecting leaking valves, destructive detonation, excessive cylinder wear, blowby, worn bearings, broken compression rings, valve flutter and many other signs of wear and malfunction. The vibration pickup is a piezoelectric crystal mounted in a magnetic head that can be placed anywhere on the engine or compressor.

IGNITION MEASUREMENTS

Ignition measurements are used for proper timing of the engine and can detect bad spark plugs, pulse generator problems, point problems, bad condensers and coil condition. Ignition measurements can also be used to calculate RPM. Ignition measurements are made using a 1000:1 capacitive attenuator that clamps on the secondary coil and spark-plug wire.

PRESSURE MEASUREMENTS

Pressure measurements detect peak firing pressures, compression, early and late cylinder firing, and pre-ignition of the engine under test. Three displays of cylinder pressure are easily and quickly obtained: pressure vs crank angle, pressure vs cylinder volume and pressure vs time.

ENGINE ANALYZER AMPLIFIER

The Type 3A74 Engine Analyzer Amplifier is a four-channel plug-in unit featuring simultaneous displays of pressure, crank-angle markers, engine vibration, and ignition. Channel 1 is a charge amplifier designed for use with the pressure transducer; Channel 2 provides a crank-angle marker display from the Rotational Function Generator plus the magnetic pickup display of top dead center; Channel 3 and Channel 4 are identical amplifiers used for vibration and ignition displays.

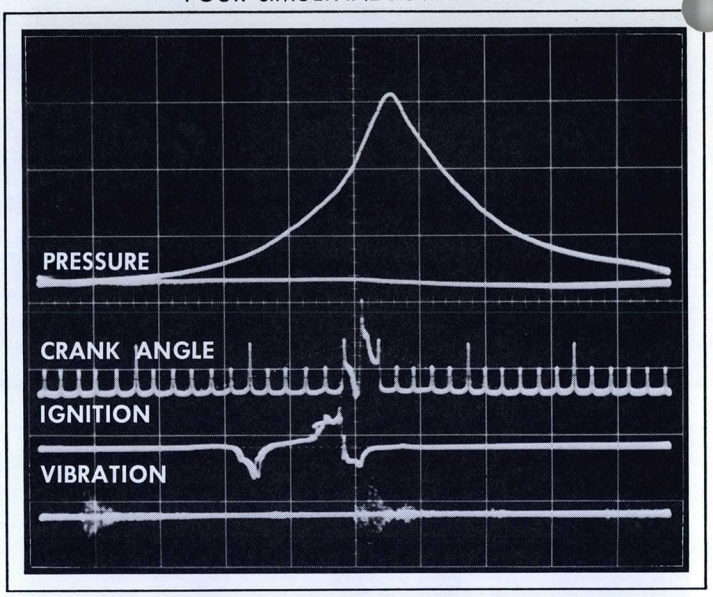
CHARGE AMPLIFIER, CHANNEL 1

1 psi/div to 500 psi/div in 1-2-5 sequence; accurate within 3%. Frequency response: Restore Time — Long is from 0.05 Hz to 10 kHz, Short is from 0.5 Hz to 10 kHz. Maximum charge signal is 0.6 μC (micro coulomb) at 10 kHz, increasing to 2 μC at 2.75 kHz. Restore Time is at least 3 s in the Long position, at least 0.3 s in the Short position. Display noise is less than 0.15 pC (pico coulomb) per 1000 pF of source capacitance, with 1 psi/div and gain set to 100 pC/psi.

CHANNELS 2, 3 and 4

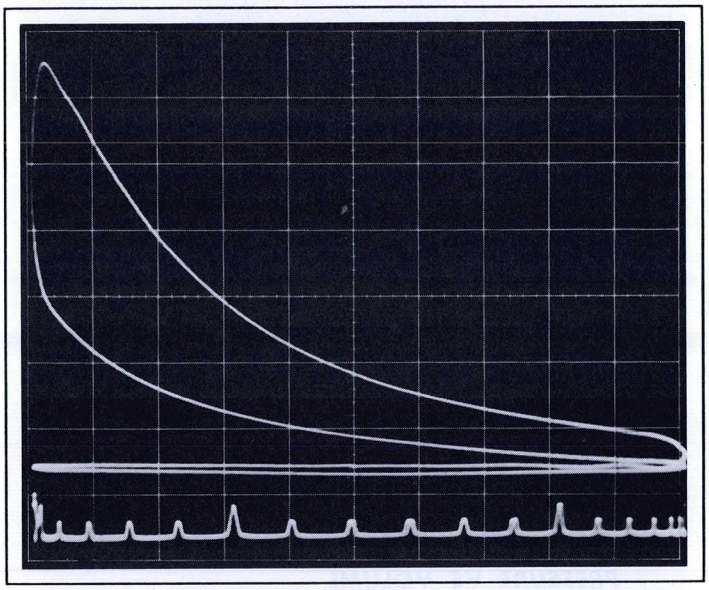
0.02 V/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div. Bandwidth is DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz. Input characteristics are 1 MΩ paralleled by approx 47 pF. Maximum input voltage is 600 V (combined DC plus AC).

FOUR SIMULTANEOUS DISPLAYS



Simultaneous displays of four engine parameters provide the operator with one comprehensive picture of the total engine performance and make identification of malfunctions easy. The top waveform is engine pressure; waveform 2 shows crank-angle markers with the larger marker in the center indicating the top dead center; waveform 3 is engine ignition; waveform 4 is engine vibration showing valves opening and closing and vibration due to combustion.

PRESSURE VS VOLUME



Pressure vs cylinder volume displays are used to determine the indicated engine horsepower and detect over-all problems in engines and compressors. The area within the loop is the mean effective pressure and is used to determine indicated horsepower of the engine.

ENGINE ANALYZER TIME BASE

SWEEP GENERATOR

1 μs/div to 5 s/div and 21 calibrated steps, 1-2-5 sequence; accurate within 3%. 5X magnifier operates over full time base, accurate within 5%.

SINGLE SWEEP

Provides single display for one-shot waveform photography and storage applications. In the Rotational Function Generator mode of operation, single displays of either 360° (2 cycle) or 720° (4 cycle) are possible.

TRIGGER

Automatic, manual, or free-run operation; triggering on + or — slope from an internal, line frequency or external source. In external trigger, a signal from the Rotational Function Generator is available for triggering.

ROTATIONAL FUNCTION AMPLIFIER

Accepts inputs from the Rotational Function Generator providing horizontal displays of piston volume or crank angle. Crank-angle degree markers are internally coupled to Channel 2 of the Type 3A74 Engine Analyzer Amplifier.

ENGINE ANALYZER ACCESSORIES

PRESSURE TRANSDUCER (015-0117-00)

The Pressure Transducer is designed for use at engine speeds up to 6000 RPM, providing thread temperature is limited to 150° C. Engine speed must be derated to 1500 RPM when using the cooling adapter and to 1000 RPM when a 5-inch to 10-inch coupling pipe is used. The piezoelectric Pressure Transducer, when used with the charge amplifier of the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

PRESSURE RANGE is 0 to 3000 psi.

DEFLECTION FACTOR is 1 psi/div to 500 psi/div in 1-2-5 sequence, accurate within 5% throughout calibrated range. Maximum overload pressure is 300%.

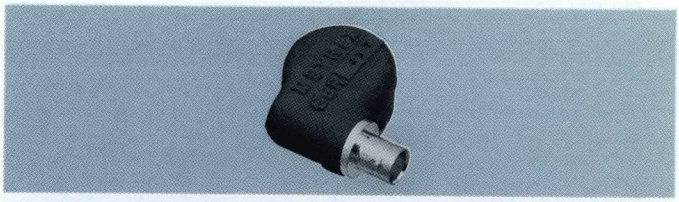
BANDWIDTH in the Long Restore Time position is from 0.05 Hz or less to at least 10 kHz; in the Short Restore Time position, from 0.5 Hz or less to at least 10 kHz.

RESTORE TIME in the Long position is at least 3 seconds; in the Short position is at least 0.3 seconds.

NOISE is not discernible with the 50-ft low-noise cable supplied.

TEMPERATURE RANGE is from —40°C to +150°C. A cooling adapter is supplied for environmental conditions above +150°C.

VIBRATION TRANSDUCER (015-0116-00)



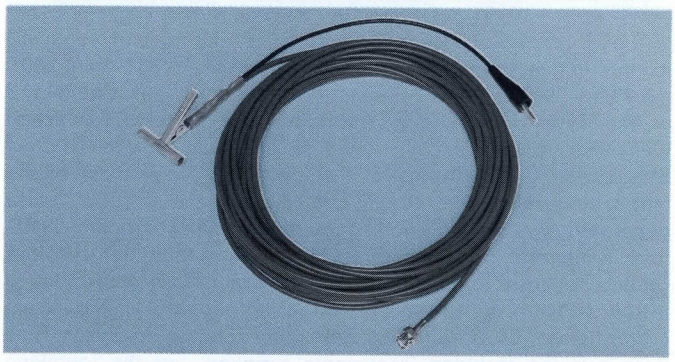
The piezoelectric Vibration Transducer has a magnetic mount and is used with Channel 2, 3 or 4 of the Type 3A74 Engine Analyzer Amplifier with the included 50-ft low-noise cable.

TRANSDUCER SENSITIVITY is nominally 6 mV/g (4.5 mV/g with the included cable). Exact value is shown with the calibration chart supplied with the transducer.

MAXIMUM ACCELERATION is 1000 g's.

TEMPERATURE RANGE is from —40°C to +150°C.

IGNITION PICKOFF CABLE ASSEMBLY (012-0139-00)



The Ignition Pickoff, when used with Channel 2, 3 or 4 with the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

ATTENUATION is nominally 1000:1. Exact attenuation is determined by the capacitance between the pickoff and the secondary lead under test. The oscilloscope calibrator and a piece of ignition cable can be used to calibrate the ignition pickoff and the vertical amplifier.

TIME CONSTANT is at least 6.5 ms.

VELOCITY TRANSDUCER (015-0119-00)

The Velocity Transducer, when used with Channel 2 of the Type 3A74 Engine Analyzer Amplifier and the included 20-ft or 50-ft low-noise cable, has the following characteristics.

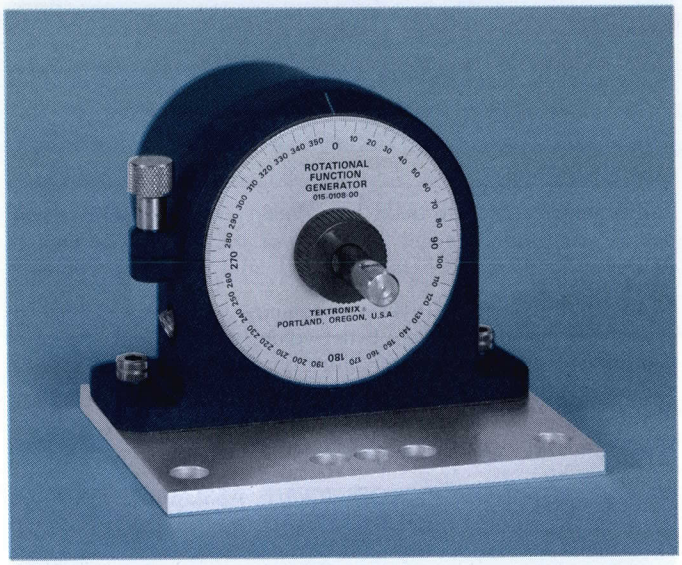
OUTPUT VOLTAGE is at least 15 V P-P at 1000 inch/s and a clearance gap of 0.005 inch using a 20-pitch, 30-tooth ferrous metal gear.

COIL RESISTANCE is 90 Ω to 110 Ω.

COIL INDUCTANCE is 26 mH to 40 mH.

TEMPERATURE RANGE is from —54°C to +107°C.

ROTATIONAL FUNCTION GENERATOR
(015-0108-00)



The Rotational Function Generator is mechanically coupled to the engine under test and generates 10°, 60° and 360° markers. Crank-Angle Markers are displayed on Channel 2 of the Type 3A74 Engine Analyzer. The Rotational Function Generator is mechanically timed to an engine reference point by comparing the display of the top dead center mark of the magnetic pickup from the fly wheel with the 0°/360° pulse generated by the function generator. The Rotational Function Generator also generates a sawtooth ramp for displays related to crank angle, and a waveform that is equivalent to piston volume for P-V curves. The Rotational Function Generator, when used with the Type 2B67 Engine Analyzer Time Base and the included 20-ft cable supplied, has the following characteristics.

MAXIMUM RPM is 20,000 revolutions per minute.

DEGREE MARKER angular accuracy is within 1°.

SHAFT LOAD axial and radial is 10 lb maximum.

CRANK-ANGLE MARKERS are generated every 10°, a pulse of larger amplitude every 60°, and a pulse riding on a pedestal every 360°. The markers are internally coupled to Channel 2 and have an amplitude of at least a division of the display. The magnetic pickup signal can be superimposed on Channel 2 to permit timing of the function generator markers to the engine under test.

CRANK ANGLE displays provide 350° of useable display related directly to crank angle; incremental accuracy is within 3% of full scale display.

PISTON VOLUME displays have an incremental accuracy within 3% of full scale display. The phase shift is 0.5° or less at 20,000 RPM.

TEMPERATURE RANGE —15° C to +75° C.

SYSTEM TEMPERATURE 0° C to +50° C.

ORDERING INFORMATION

TYPE 564B STORAGE OSCILLOSCOPE, without plug-in units **$1095**

OR

TYPE 561B P7 OSCILLOSCOPE, without plug-in units **$595**

TYPE 2B67 ENGINE ANALYZER TIME BASE, order Type 2B67 MOD 730A **$410**
Includes: Engine Analyzer instruction manual (070-0890-00).

TYPE 3A74 ENGINE ANALYZER AMPLIFIER, order Type 3A74 MOD 730A **$850**
Includes: Engine Analyzer instruction manual (070-0890-00).

ENGINE ANALYZER ACCESSORY PACKAGE
Order 015-0126-00 ..... **$900**
Includes: rotational function generator (015-0108-00); pressure transducer (015-0117-00); vibration transducer (015-0116-00); velocity transducer (015-0119-00); ignition pickoff cable assembly (012-0139-00); 20-ft function generator cable (012-0140-00); adapter plate (386-1453-00); extension shaft kit (015-0124-00); cooling adapter (015-0118-00); 3 50-ft low-noise coax cables (012-0137-00); 20-ft low-noise coax cable (012-0136-00); clip marker cable kit (016-0127-00); 18-inch coax cable (012-0076-00); charge amplifier calibrator (011-0095-00); carrying case/trays (202-0170-01); instruction manual (070-0890-00).

For price and availability information on specific items included in the Engine Analyzer accessory package, contact your nearby Tektronix Field Office, Representative or Distributor.

RECOMMENDED OPTIONAL ACCESSORIES

SCOPE-MOBILE® CART
Model 201-1: 9-position tilt-lock oscilloscope tray, order 201-1 ..... $145

TRIPOD
For easy mounting and positioning of the Rotational Function Generator, order 016-0253-00 ..... $33

ROTATIONAL FUNCTION GENERATOR
Rotational Function Generators can be permanently attached to a number of engines for use with the Engine Analyzer when needed, order 015-0108-00 ..... $190

CAMERAS
C-12 with beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid Land Pack Film back, order C-12 ..... $490

Type 561B or Type 564B to C-12 Camera adapter, order 016-0217-00 ..... $16

Projected Graticule for 115 V, order 016-0204-00 .... $175

Projected Graticule for 230 V, order 016-0234-00 .... $175

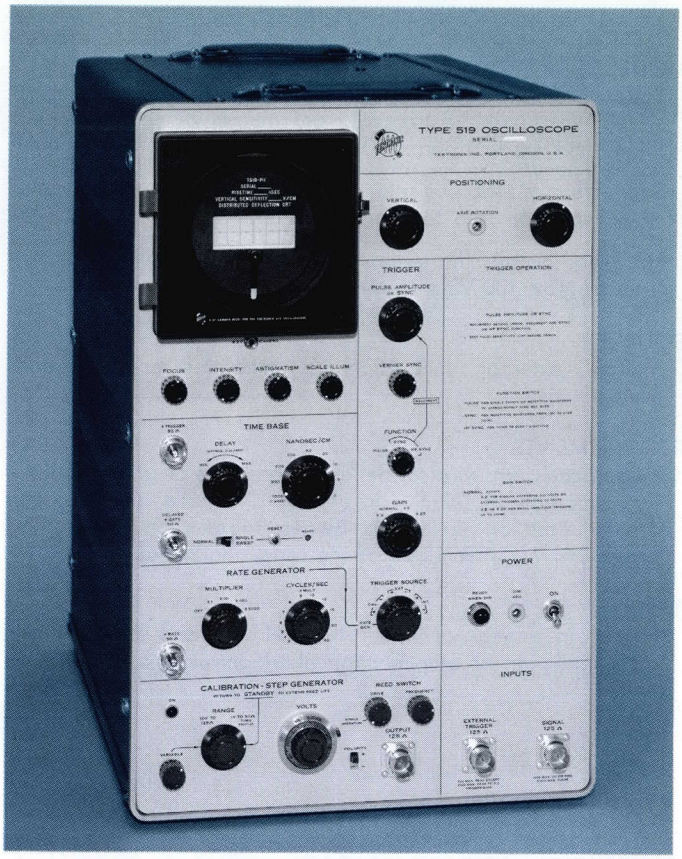
Camera carrying case, order 016-0208-01 ..... $85

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

519

1-GHz Real-Time Oscilloscope

- ***SINGLE-SHOT PHOTOGRAPHS AT 2 NS/CM***
- ***0.004-INCH SPOT SIZE***
- ***SENSITIVE WIDEBAND TRIGGER SYSTEM***
- ***SYNCHRONIZATION TO OVER 1 GIGAHERTZ***
- ***VSWR, 1.25, OR LESS, TO 1 GIGAHERTZ***
- ***DISTRIBUTED-DEFLECTION CRT***
- ***BUILT-IN DELAY LINE***



The Tektronix Type 519 Oscilloscope is a calibrated, high-speed, laboratory instrument designed for observation, measurement, and photographic recording of fractional nanosecond risetimes. A 2 x 6 cm viewing area, coupled with 24-kV accelerating potential, affords bright displays with excellent resolution. Performance features include: bandwidth from DC to beyond 1 gigahertz, risetime less than 0.35 ns, deflection factor $\leq$10 V/cm, linear sweeps to 2 ns/cm, sweep delay through 35 ns, and a wideband trigger system. The single unit houses a fixed signal delay line, a convenient sweep-delay control, a pulse-rate generator, a standard amplitude and waveshape generator, and regulated power supplies and high-voltage supply. Only one connection is necessary for normal operation—a connection of the signal from the device under test.

Combining simple operation with laboratory precision and reliability, the Type 519 ideally suits single-shot or random nuclear events. In addition, the bandwidth permits applications to general measurements where oscilloscope risetime must be less than signal risetime.

VERTICAL DEFLECTION

BANDWIDTH
DC to 1 GHz at 3-dB down.

RISETIME
Less than 0.35 ns.

DEFLECTION FACTOR
$\leq$10 V/cm.

INPUT IMPEDANCE
125 Ω ±2%.

MAXIMUM INPUT SIGNAL
±15 VDC or 15 V RMS, or ±100-V pulse. Maximum power input is 1.8 watts.

SIGNAL DELAY
45 ns approx. Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

TIME BASE
2 ns/cm to 1000 ns/cm in 9 calibrated steps (1-2-5 sequence), accurate within 3%.

SWEEP DELAY
Sweep start delayed 0—35 ns.

SINGLE SWEEP
After a single sweep is generated, the sweep circuit is locked out until the RESET button is pressed then sweep fires on next trigger. An external jack is provided for remote control of single sweep operation.

SYNCHROSCOPE OPERATION
The output signal from either the +TRIGGER 50 Ω, the DELAYED +GATE 50 Ω, or the +RATE 50-Ω connector can be used to control an external device.

RATE GENERATOR
Output pulse approx 15 V, risetime $\leq$ 0.8 ns, duration approx 10 ns. Repetition rate variable between 3 Hz and 30 kHz.

TRIGGER

MODES

Pulse—Permits choice of a free-running sweep or a stable sweep which can be triggered on random or uniform repetition rates up to approx 50 MHz.

Sync—Permits stable displays of signals occurring at a constant repetition rate to over 100 MHz.

HF Sync—Permits the sweep to be synchronized with signals from approx 100 MHz to over 1 GHz.

SOURCES

Internal, external, calibration-step generator, or rate generator.

REQUIREMENTS

Two trace widths vertical deflection and 1 ns or greater duration (Internal) or 20 mV or greater amplitude and 1 ns or greater duration (External). Sweep triggers on either the positive or negative slope of the triggering signal.

TRIGGER GAIN

Four gain settings of X0.2, NORMAL, X5, and X20 provide for attenuation or amplification of trigger signals.

MISCELLANEOUS

CALIBRATION STEP GENERATOR

A step-waveform of approximately 750-Hz repetition rate, with amplitude continuously variable and calibrated from 0 to 10 V into 125 Ω, or 0 to 1 V into 50 Ω (through a T50/T125 adapter) is available at a front-panel 125-Ω connector. Risetime is approximately 0.1 ns and either polarity can be selected. Continously variable uncalibrated amplitudes of 0 to 50 V into 125 Ω are also available.

CATHODE-RAY TUBE

5-inch round, flat-faced tube. 24-kV accelerating potential. Maximum x-radiation at a distance of five centimeters from any external surface of the 519 does not exceed 0.5 milliroentgens per hour under any conditions of normal operation obtained with any adjustment of front panel controls. Supplied with P11 phosphor.

GRATICULE

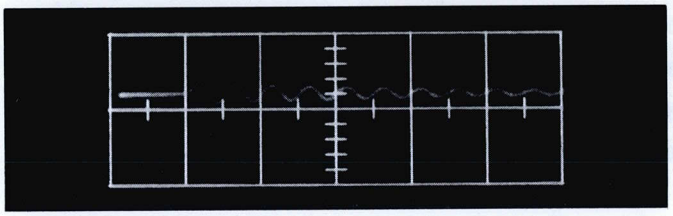
Edge-lighted, 2-cm by 6-cm divisions. The horizontal center line markings are 5 mm apart and the vertical center line markings are 2 mm apart. Illumination is controlled by a front-panel knob. The graticule can be dropped out of view if desired.

CAMERA MOUNTING

A special camera-mounting adapter with swing-away hinging easily accepts a Tektronix C-27-662R or C-51R Camera. Please refer to the Camera Section for complete description.

SINGLE-SHOT PHOTOGRAPHY

A single-shot exposure using a Type C-27-662R Camera was used to take the picture below. The display shows a ≈1-GHz damped wave at 2 ns/cm. The waveform was enlarged 2 times to represent the actual size of the CRT display.



POWER REQUIREMENTS

105 V to 125 V or 210 V to 250 V, 50 to 60 Hz, typically 650 watts. Factory wired for 105 V to 125 V. May be ordered wired for 210-V to 250-V operation.

DIMENSIONS AND WEIGHTS

Height	22¼ in	56.5 cm
Width	14⅝ in	37.2 cm
Depth	25¼ in	64.1 cm
Net weight	97 lb	44.1 kg
Domestic shipping weight	≈130 lb	≈59 kg
Export-packed weight	≈169 lb	≈77 kg

INCLUDED STANDARD ACCESSORIES

Viewing hood (016-0001-01); two 125-Ω terminations (017-0051-00); two 125-Ω insertion units (017-0013-00); 125-Ω coupling capacitor (017-0018-00); 125 Ω 1-GHz timing standard (017-0019-00); Double-button contact assembly (017-0032-00); Panel adapter assembly (017-0033-00); Cable connector (017-0035-00); 125-Ω min loss attenuator, T50/T125 (017-0052-00); 125-Ω adapter N50/N125 (017-0053-00); 125-Ω adapter, T50/N125 (017-0055-00); Delay-line equalizer (017-0057-00); 1-ns cable (017-0507-00); 2-ns cable (017-0508-00); 5-ns cable (017-0509-00); 10-ns cable (017-0510-00); Phone jack plug (134-0069-00); 3-conductor power cord (161-0010-03); Walnut box (202-0083-00); Two reed switches (260-0693-00); Accessory box tray (436-0030-00); instruction manual (070-0243-00).

TYPE 519 OSCILLOSCOPE **$4650**

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 519 in certain applications. A complete list of accessory items can be found in the catalog accessory pages.

ATTENUATORS, ADAPTERS, AND CABLES

125-Ω 2:1 attenuator, order 017-0071-00	$33.00
125-Ω 5:1 attenuator, order 017-0049-00	$33.00
125-Ω 10:1 attenuator, order 017-0050-00	$33.00
125-Ω adapter N50/T125, order 017-0054-00	$20.00
125-Ω 90° elbow assembly, order 017-0043-00	$18.25
125-Ω 20-ns cable, order 017-0511-00	$25.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

130
L-C Meter

- ***MEASURES UP TO 300 μH OR 300 pF***
- ***EASY-TO-READ 4½-INCH METER***
- ***CONVENIENT OPERATION***

The Type 130 L-C Meter is a direct-reading reactance meter that measures small reactances in a series mode at a frequency between 125 kHz and 140 kHz. Meter indicates inductance up to 300 μH and capacitance up to 300 pF. The unknown inductor or capacitor is part of a resonant circuit whose frequency is compared to a 140-kHz reference oscillator. Meter indicates the two oscillator's frequency difference but is calibrated directly in μH and pF. Measurement of very small reactances is possible by using special measurement procedures that are described in the instrument instruction manual.

The Type 130 is particularly useful for measuring small capacitances in the presence of environmental strays. A front-panel Guard Voltage output connector provides in-phase drive to the environmental capacitance to eliminate strays from the measurement. Thus it is possible to measure vacuum tube interelectrode capacitances. Up to 300 pF environmental capacitance around an unknown capacitor can be guarded if the guard terminal loading is not excessive. Loading limits are outlined in the instruction manual.

Resistance loading compensation is optimized for 117-volts RMS operation. The following loads will not appreciably alter the measurement indication:

Capacitance: as low as 100-kΩ shunt.
Inductance: as low as 20-kΩ shunt, up to 10-Ω series.
Correction tables in instruction manual indicate needed corrections for other values of load resistance. Actual corrections determined for each instrument at time of each recalibration.

RANGE SELECTION
Microhenrys—0 to 3, 10, 30, 100, and 300.
Picofarads—0 to 3, 10, 30, 100, and 300.

ACCURACY
Meter indicates within 3% of full scale. Full scale accuracy of any one range can be improved by special calibration at the time measurement is made.

POWER REQUIREMENTS
40 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V to 250 V operation.

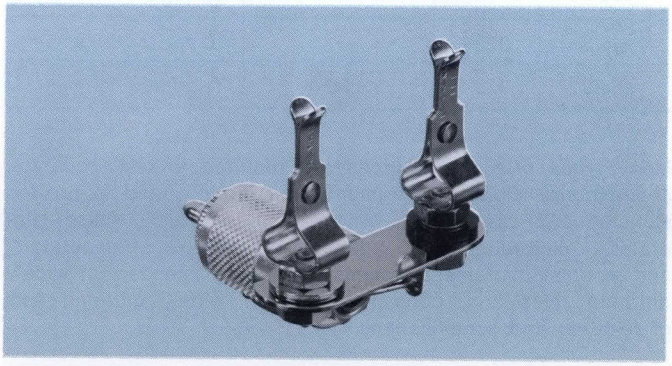
DIMENSIONS AND WEIGHTS

Height	10⅝ in	27.0 cm
Width	7 in	17.8 cm
Depth	11⅛ in	28.3 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈21 lb	≈ 9.5 kg

INCLUDED STANDARD ACCESSORIES
P93C Probe (010-0003-00); black output lead (012-0014-00); red output lead (012-0015-00); 3-conductor power cord (161-0010-03); instruction manual (070-0231-01).

TYPE 130 DIRECT-READING L-C METER $275

OPTIONAL ACCESSORY



PRODUCTION TEST FIXTURE
Reduces production time required to sort and test capacitors and inductors, order 013-0001-00 . . . . . $7.20

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

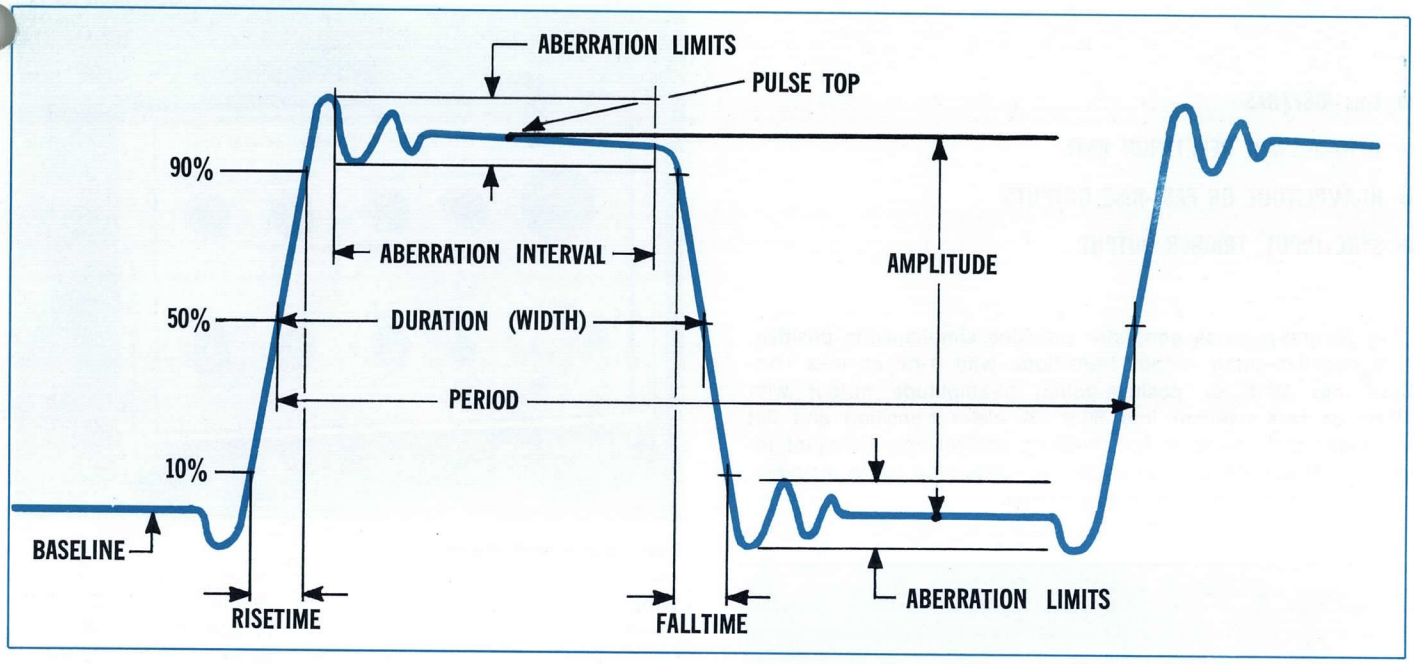
PRODUCT	PAGE	RISETIME	FREQUENCY OR PERIOD RANGE	DURATION	AMPLITUDE (INTO 50 Ω)	OTHER
GENERAL PURPOSE PULSE GENERATORS						
114	309	10 ns	1 μs to 100 ms	100 ns to 10 ms	Variable to ±10 V	
115	310	variable 10 ns to 100 ms	100 ns to 10 ms	50 ns to 500 μs	Variable to ±10 V	delayed, burst, paired, gated pulses
2101	316	5 ns	40 ns to 400 ms	20 ns to 400 ms	Independently Variable + and −10 V	delayed, paired, baseline offset
SPECIAL-PURPOSE PULSE GENERATORS						
109	307	250 ps	Preset 550 p/s to 720 p/s	0.5 ns to 300 ns	Variable to ±55 V	
111	308	0.5 ns	10 Hz to 100 kHz	2 ns to 1.5 μs	≥10 V	Variable pretrigger
R116	312	variable 10 ns to 110 μs	100 ns to 11 ms	50 ns to 550 μs	Variable to ±10 V	Programmable
CALIBRATION-SIGNAL GENERATORS						
106	306	1 ns	10 Hz to 1 MHz	≤45% to ≥55%	≥500 mV; ≥12 V	Squarewave Generator
284	315	≤70 ps	10 μs to 1 ms	Preset >1 μs	Pulse, 250 mV Squarewave, 1 V Sinewave, 100 mV	
2901	318		2 ns to 5 s		≥0.5 V	Time-Mark Generator
SINEWAVE GENERATOR						
191	314		50 kHz; 350 kHz to 100 MHz		5 V P-P	Constant Amplitude
MODULAR INSTRUMENTS					OUTPUT AMPL	
	319	2600-Series Reference				
2601	320	Mainframe				Accepts up to 6 Modules
26A1	321	Operational Amplifier			±50 V, ±50 mA	Module
26G1	322	≤100 ns	rate, 0.01 Hz to 11 kHz ramp, 10 μs to 110 s	rate, 1.5 μs	rate, 3 V ramp, 1 V & 10 V	Rate/Ramp Gen. Module
26G2	322		10 ms to 110 s		1 V & 10 V	Ramp Gen. Module
26G3	323	≤200 ns	Triggered to 1 μs	1 μs to 110 s	±1 V, ±10 V, ±20 mA	Pulse Gen. Module

Many types of signal sources are required to test, calibrate, and exercise modern instruments and circuitry and to provide stimulus and conditioning for research activities. Pulse generators, calibration-signal generators, sinewave generators, and modular instrument systems are usually intended for widely differing roles and, consequently, bear widely differing sets of features and specifications.

General-purpose pulse generators allow variability of important pulse parameters such as period, duration, delay, risetime, falltime, amplitude, and offset in order that the generator may be adapted to the immediate requirement. On the other hand, *special-purpose pulse generators* take advantage of design opportunities to provide capability which would not be feasible in a general-purpose instrument such as programmability and the use of special-purpose generating devices like reed switches and avalanche transistors. *Calibration-signal generators* supply accurate reference waveforms to calibrate or verify performance of oscilloscopes and other instruments.

The *2600 Modular Instrument Series* provides the ability to generate, mix, and condition signals for low-frequency applications.

Other Tektronix Signal Sources used in Time Domain Reflectometry and Automated Measurement Systems are described elsewhere in this catalog.



Pulse generator specifications in this section are given in terms defined in this figure and the Glossary.

GLOSSARY OF TERMS

ABERRATION INTERVAL—The aberration interval extends from 1 risetime (falltime) following the 50% amplitude point of a transition to 1 falltime (risetime) prior to the 50% amplitude point of the following transition.

ABERRATIONS—Deviation of a displayed step function from an ideal step; specified as the maximum permissible percentage deviation from the 0% and 100% levels over the aberration interval.

AMPLITUDE—The full value of the step function, usually specified in voltage but sometimes in current. Amplitude is measured at 50% of pulse width and at 50% of pulse separation.

DELAY TIME—The time period between the trigger output and the pulse output.

DUTY FACTOR—The pulse width divided by pulse period expressed as a percentage. Also known as "duty cycle".

FALLTIME—The period of time required for the trailing edge of the pulse to fall from 90% to 10% of the pulse amplitude. Specified in the same manner as risetime, it is also known as decay time.

PULSE DURATION (WIDTH)—The time interval between the 50%-amplitude points of the leading and trailing edges.

PULSE JITTER—The variation in time between the leading edges of succeeding pulses.

PULSE PERIOD—The time interval between identical points on adjacent pulses, usually measured from the 50% amplitude point of one leading edge to the 50% amplitude point of the leading edge of an adjacent pulse. Also the reciprocal of the repetition rate.

REPETITION RATE—The number of pulses generated per second. Often referred to as frequency, PRF, PRR, or PPS for conciseness in nomenclature.

RISETIME—In the display of a step function, the interval between the time at which the amplitude first reaches specified lower and upper limits. These limits shall be 10% and 90% of the nominal or final amplitude of the step, unless otherwise stated.

106
Squarewave Generator

- 1-ns RISETIME
- 10 Hz-to-1 MHz REPETITION RATE
- HI-AMPLITUDE OR FAST-RISE OUTPUTS
- SYNC INPUT, TRIGGER OUTPUT

This general-purpose generator provides simultaneous positive- and negative-going output transitions with 1-ns or less risetime into 50 Ω, or positive-going, hi-amplitude output with 12-ns or less risetime into 50 Ω. A clean transition and flat top make the 106 ideal for checking oscilloscope transient response. It can be used in such applications as diode recovery, core testing, digital and analog design.

OUTPUT CHARACTERISTICS

CHARACTERISTIC	+ and − FAST-RISE OUTPUTS (terminated in 50-Ω load)	HI-AMPLITUDE OUTPUT
Risetime	≤1 ns at 0.5 V	≤12 ns at 12 V ≤20 ns at 0.5 V ≤120 ns with no load
Repetition Rate	Continuously variable from 10 Hz to at least 1 MHz. <10% change with symmetry control	
Symmetry	Duty cycle variable from ≤45% to ≥55%	
Amplitude	≤50 mV to ≥500 mV	≤0.5 V to ≥12 V, (≤7 V to ≥120 V with no load)
Aberrations	+2%, −2% or +6 mV, −6 mV (whichever is greater) for first 5 ns following leading edge. Typically +0.5%, −0.5% for remainder of pulse top	+2%, −2% for first 100 ns following leading edge. Typically +0.5%, −0.5% for remainder of pulse top

OTHER CHARACTERISTICS

Sync Input—Accepts sinewaves, squarewaves, or pulses. Accepts 5 V-to-100 V peak-to-peak sinewave, 2.5 V-to-50 V pulse or squarewave, 100 Hz to 1 MHz.

Trigger Output—Positive- and negative-going triggers occur within 50 ns of the rise and fall of the HI-AMPLITUDE squarewave. Positive triggers occur within 50 ns of leading edge of fast-rise outputs. Risetime is 50 ns and amplitude is 0.1 V or more into 50 Ω. Time jitter is less than 300 ps.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 103.5 V to 126.5 V or 207 V to 253 V, 50 to 60 Hz. Low or high range selected by rear-panel switch. Approx 85-watts maximum power consumption at 115 VAC.

Dimensions and Weights

Height	6 in	15.2 cm
Width	9 in	22.8 cm
Depth	14 3/4 in	40.0 cm
Net Weight	18 lb	8.2 kg
Domestic shipping weight	≈22 lb	≈9.9 kg
Export-packed weight	≈29 lb	≈13.2 kg

INCLUDED STANDARD ACCESSORIES

5-ns, 50-Ω RG213 cable (017-0502-00); GR-to-BNC, 50-Ω thru-line termination (017-0083-00); instruction manual (070-0523-00). (Power cord for MOD 146B is 161-0031-00.)

106 SQUAREWAVE GENERATOR **$665**

106 SQUAREWAVE GENERATOR MOD 146B **$640**
As above, but less cabinet for mounting in Rack Adapter.

OPTIONAL ACCESSORIES

Rack Adapter for 116 Squarewave Generator

Adapts the 106 MOD 146B for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 106 occupies half-rack width. Two 106's can be mounted side by side, or alongside other half-rack width generators such as the 114 Pulse Generator, 191 Constant Amplitude Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 106 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

106 MOUNTING KIT, order 016-0186-00 ..... $10

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

109
250-ps Pulse Generator

- 250-ps RISETIME PULSES
- ALTERNATE PULSES OF EQUAL OR DIFFERENT TIME DURATION
- 0-55 V CALIBRATED VARIABLE AMPLITUDE
- SELECTABLE POLARITY

The Type 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The Type 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS	
CHARACTERISTICS	**PERFORMANCE**
RISETIME	Less than 250 ps
AMPLITUDE	Adjustable from 0 through 50 V
REPETITION RATE	Preset between 550 p/s and 720 p/s (using two charge lines)
PULSE DURATION	0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate
DECAY	approx 10% in 300 ns
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω

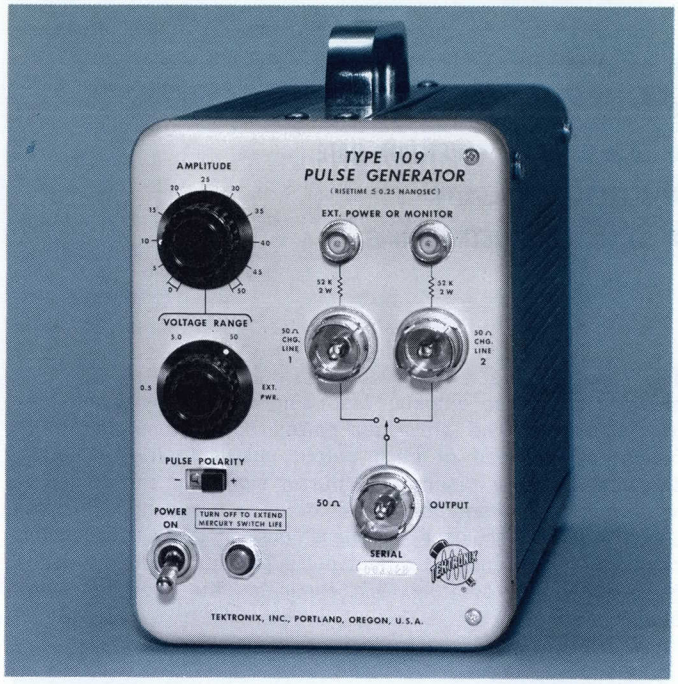
Charge Lines—Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

External DC Charge Voltage Inputs—Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volts input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

Power Requirement—Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

Dimensions and Weights

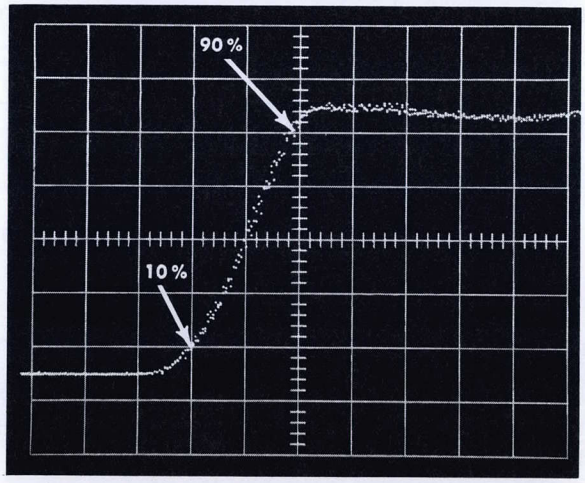
Height	7 3/4 in	19.7 cm
Width	4 7/8 in	12.2 cm
Length	11 7/8 in	30.2 cm
Net weight	8 1/4 lb	3.8 kg
Domestic shipping weight	≈17 lb	≈7.7 kg
Export-packed weight	≈28 lb	≈12.7 kg



Included Standard Accessories—Charge network (017-0067-00); three 5-ns 50-Ω RG213 cables (017-0502-00); 3-conductor power cord (161-0010-03); instruction manual (070-0299-00).

TYPE 109 PULSE GENERATOR **$420**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page



A 109 pulse waveform displayed on a 564B Oscilloscope with 3S2/S-1, a 3T2 Sampling Plug-In Unit, and an input system consisting of a 113 Delay Line and a CT-3 Signal Pickoff. The equivalent sweep speed is 200 ps/div. Combined risetime of the system is less than 400 ps.

111

Pretrigger Pulse Generator

- 0.5-ns RISETIME PULSES
- PULSE DURATIONS to 1.5 μs
- 10 Hz-to-100 kHz REPETITION RATE
- SELECTABLE POLARITY
- 30 to 250-ns PRETRIGGERING

The Type 111 is a low cost, fast-rise pulse generator. The unit provides two pulse outputs: fast-rising output pulses and pretrigger pulses. The pretrigger pulses occur from 30 to 250 nanoseconds ahead of each output pulse. Pretrigger pulses can be used as a regenerated trigger signal for sampling systems without internal delay lines or as a triggering signal for a conventional oscilloscope. The amount of delay between the pretrigger pulse and the output pulse can be varied by means of a front-panel control. This eliminates the need for delay cables.

OUTPUT PULSE CHARACTERISTICS	
CHARACTERISTIC	**PERFORMANCE (into 50 Ω)**
RISETIME	≤0.5 ns (either polarity)
REPETITION RATE	Continuously variable, 10 Hz to 100 kHz
PULSE DURATION	2 ns to 1.5 μs with appropriate charge line
AMPLITUDE	≥10 V
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω
ABERRATIONS	Pulse top: +5%, −5% or total of 5% P-P. Baseline: +10%, −10% or total of 10% P-P

Pretrigger Pulse Characteristics—Amplitude: ≈10 V, duration: ≈300 ns, risetime: ≤7 ns.

Pulse Delay—30 to 250 ns, continuously variable. Time jitter less than 100 ps.

Output Impedance—50 ohms.

External Trigger Signal—+3 V or greater at a rate of rise of 3 V/μs or faster. As long as rate of rise is maintained, repetition rates from 0 to 100 kHz can be used.

Power Requirements—Wired for 105 to 125 V, may be ordered with taps connected for 210 to 250 V. 50 to 800 Hz, approx 35 watts.

Dimensions and Weights

Height	11 7/16 in	29 cm
Width	6 15/16 in	17.7 cm
Depth	11 5/16 in	28.7 cm
Net weight	12 lb	5.4 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈20 lb	≈9.1 kg

Included Standard Accessories—5-ns 50-Ω RG213 cable (017-0502-00); 9-ns 50-Ω charge line (017-0506-00); 50-Ω 10X GR attenuator (017-0078-00); 3-conductor power cord (161-0010-03); instruction manual (070-0252-00).

TYPE 111 PULSE GENERATOR **$435**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

114
10-ns Pulse Generator

- PULSES OR SYMMETRICAL SQUAREWAVES
- 10-ns RISETIME AND FALLTIME
- VARIABLE PULSE PERIOD, WIDTH, AND AMPLITUDE
- ±10 V INTO 50 Ω
- SHORT-PROOF OUTPUT

The 114 is a general-purpose pulse and squarewave generator designed for laboratory and production test facilities. The broad operating range of the 114 makes it well suited for applications such as studying network response to changes in pulse period and/or width, or determining the step response of systems.

OUTPUT CHARACTERISTICS
(terminated in 50-Ω load)

Risetime and Falltime— 10 ns or less.

Pulse or Squarewave Periods— 5 ranges from 1 μs to 10 ms continuously variable from 1 μs to 100 ms.

Pulse Width (Duration)— 5 ranges from 100 ns to 1 ms continuously variable from 100 ns to 10 ms.

Amplitude— 1 V to 3 V and 3 V to 10 V, positive or negative polarity. Variable within each range.

Polarity—Positive or negative.

Aberrations— +5%, −5%, total of 5% P-P (at maximum amplitude).

OTHER CHARACTERISTICS

External Trigger Input Requirement—Trigger signals +2 V to +20 V having a risetime of 1 μs or less. Signals up to 2 MHz may be used.

Trigger Output— 2 V or greater, open circuit; approx 0.5 V into 50-Ω load. Front-panel switch sets trigger output pulse to occur at leading or trailing edge of output pulse.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C (risetime or falltime may increase to 12 ns or less at 50°C).

Power Requirements— 94.5 V to 137.5 V or 189 V to 275 V, 48 to 440 Hz. Low or high range selected by rear-panel switch. 15-watts maximum power consumption.

Dimensions and Weights (with cabinet)

Height	6 in	15.3 cm
Width	9 in	22.8 cm
Depth	12 7/8 in	33.6 cm
Net weight	12 lb	5.4 kg
Domestic shipping weight	≈15 lb	≈6.8 kg
Export-packed weight	≈25 lb	≈11.3 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0465-00); power cord for MOD 146B (161-0031-00).

114 PULSE GENERATOR **$340**

114 PULSE GENERATOR MOD 146B **$315**
As above, but less cabinet for mounting in rack adapter.

OPTIONAL ACCESSORIES
Rack Adapter for 114 Pulse Generator

Adapts the 114 MOD 146B for rackmounting in a 19-inch rack, in 5 1/4-inches of panel height. The 114 occupies half-rack width. Two 114's can be mounted side by side or alongside other half-rack width generators such as the 106 Squarewave Generator, 191 Constant Amplitude Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 114 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapted provides forced air ventilation and rear panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

114 MOUNTING KIT, order 016-0186-00 ..... $10

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

115
10-ns Pulse Generator with Delay

- 100 Hz-to-10 MHz REPETITION RATE
- VARIABLE DC OFFSET
- VARIABLE RISETIME AND FALLTIME
- PAIRED, BURST, GATED, UNDELAYED, AND DELAYED PULSES
- CLEAN PULSES—TOTAL ABERRATIONS 3% OR LESS P-P
- ±10 VOLTS INTO 50 Ω
- SHORT-PROOF OUTPUT

The 115 is a 10-MHz, 10-V, general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude, and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, shapes, and other characteristics are required.

OPERATING MODES

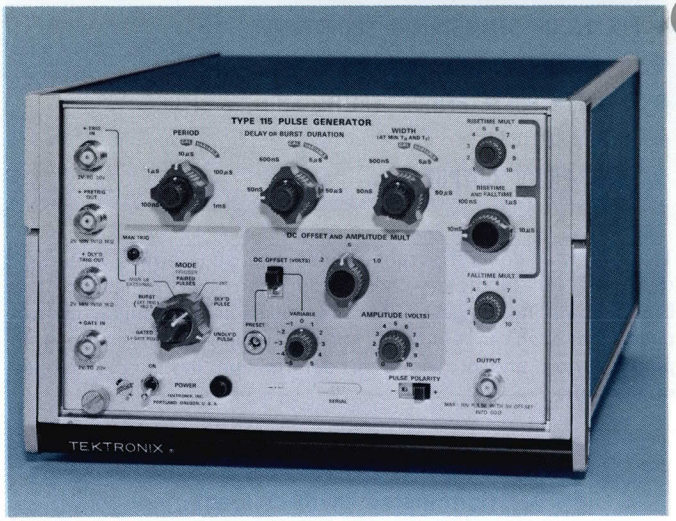
Gated—Provides output pulses for the duration of input gate. First pulse is nearly coincident with input gate and recurs at a repetition rate determined by PERIOD control setting.

Burst—Provides output pulses for the duration of the burst time when initiated by external triggering pulse. Pulse repetition rate determined by PERIOD control. The first pulse in the burst will lag the trigger pulse initiating the burst by an amount dependent upon risetime selected.

Paired Pulses—Provides pairs of pulses; one at the time of normal undelayed pulse, and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Delayed Pulse—Provides pulse at the end of delay time.

Undelayed Pulse—Sequence of pulses with repetition rate set by PERIOD control.



OUTPUT CHARACTERISTICS
(terminated in 50-Ω load)

Risetime and Falltime— 10 ns to 100 μs in four ranges, continuously variable.

Period— 100 ns to at least 10 ms in five ranges, continuously variable. (MINIMUM PULSE SEPARATION 50 ns or less, between the 50% amplitude points of any two adjacent pulses, with risetime and falltimes set to minimum.)

Duty Factor—At least 75%, limited by minimum pulse separation.

Width— 50 ns to at least 500 μs in four ranges, continuously variable.

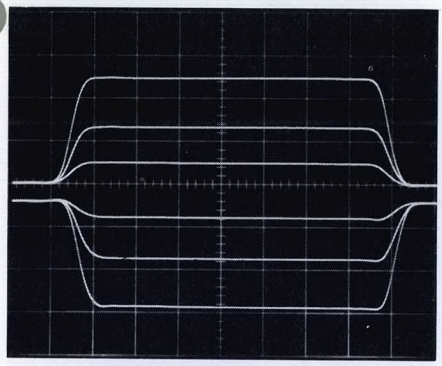
Delay or Burst Time— 50 ns to at least 500 μs in four ranges, continuously variable (refer to pulse separation performance limit above).

Amplitude—Three ranges, continuously variable. At least ±10 V to less than ±200 mV with MULTIPLIER at X1, ±5 V to ±50 mV with MULTIPLIER at X0.5 and ±2 V to ±20 mV with MULTIPLIER at X0.2.

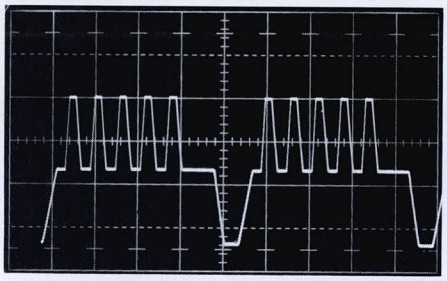
Aberrations— +3%, −3%, total 3% P-P, or 200 mV times the DC OFFSET AND AMPLITUDE MULTIPLIER settings, whichever is greater.

DC Offset—Three ranges, continuously variable. At least ±5 V with MULTIPLIER at X1, at least ±2.5 V with MULTIPLIER at X0.5, and at least ±1 V with MULTIPLIER at X0.2.

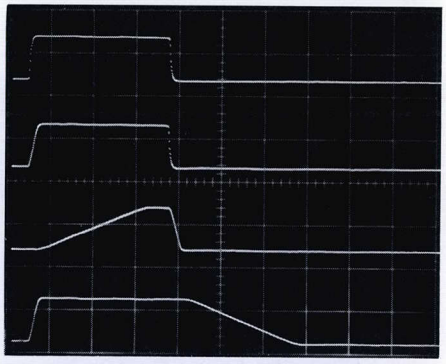
115
10-ns Pulse Generator with Delay



Multiple exposure from a fast-rise oscilloscope showing typical waveform aberrations for positive and negative polarities at various amplitude settings. 20-ns/cm sweep time and 4-V/cm deflection factor.



Single exposure showing combined outputs of two Type 115's. The burst of pulses on top of the positive pedestal was triggered by the + delayed trigger from the instrument generating the pedestal. 10-μs/cm sweep time and 2-V/cm deflection factor



Multiple exposure showing variable risetime and falltime. 500-ns/cm sweep time and 10-V/cm deflection factor.

TRIGGERING

A two-position, front-panel switch provides selection of internal or external trigger source. A manual push button provides a means to trigger a single undelayed pulse, delayed pulse, pulse pair, or burst of pulses.

INPUTS

+ TRIGGER

	PULSE	SINEWAVE
FREQUENCY	At least 0.5-V/μs rate of rise	1 kHz to 10 MHz
MINIMUM AMPLITUDE	+2 V	2-V peak
MAXIMUM AMPLITUDE	+20 V, decreasing to +4 V at 10 MHz	20-V peak, decreasing to 4-V peak at 10 MHz

+ Gate—Accepts gate from +2 V to +20 V.

AUXILIARY OUTPUTS

+ Pretrigger—At least 2 V into 1 kΩ.

+ Delayed Trigger—At least +2 V into 1 kΩ.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of +20°C to +30°C.

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 115 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights

Height	6 in	15.3 cm
Width	9 in	22.8 cm
Depth	15 7/8 in	42.0 cm
Net weight	15 lb	6.8 kg
Domestic shipping weight	≈20 lb	≈9.1 kg
Export-packed weight	≈27 lb	≈12.2 kg

INCLUDED STANDARD ACCESSORIES

50-Ω, 5-W termination (011-0099-00); 50-Ω BNC cable (012-0057-01); instruction manual (070-0786-00).

115 PULSE GENERATOR **$865**
115 PULSE GENERATOR MOD 146B (without cabinet) **$840**

Same accessories as above with the addition of a detachable power cord (161-0031-00).

OPTIONAL ACCESSORIES

Rack Adapter for 115 Pulse Generator

Adapts the 115 MOD 146B for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 115 occupies half-rack width. Two 115's can be mounted side by side, or alongside other half-rack width generators such as the 106 Squarewave Generator, 114 Pulse Generator, 191 Constant Amplitude Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 115 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapter provides forced air ventilation and rear panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

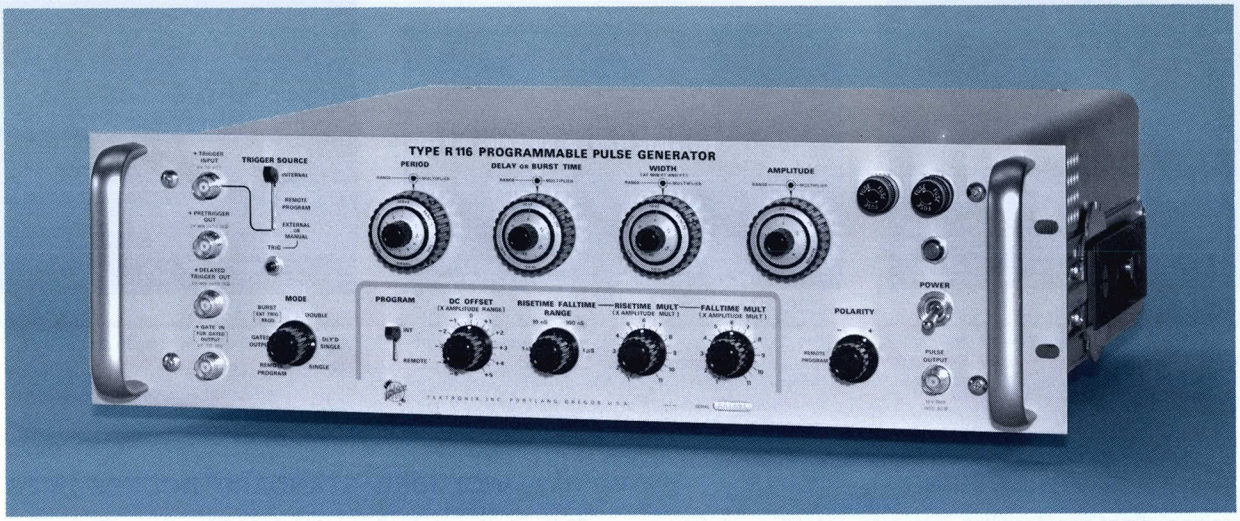
Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).
115 MOUNTING KIT, order 016-0186-00 ..... $10

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

R116

10-ns Programmable Pulse Generator with Delay



CALIBRATED AND PROGRAMMABLE PARAMETERS

- MODE
- TRIGGER SOURCE
- PERIOD
- DELAY OR BURST TIME
- WIDTH
- POLARITY
- AMPLITUDE
- DC OFFSET
- RISETIME AND FALLTIME

The R116 is a broad-range, programmable pulse generator intended primarily for applications where various combinations of pulse amplitude, width, polarity, and other features are required in rapid sequence.

All functions and parameters are easily programmable with no need for extra-cost modifications. The R116 can also be operated manually from calibrated front-panel controls for initial test setup and for applications not requiring external programming. Full programming capability requires 21 bits and 7 analog lines.

PULSE CHARACTERISTICS (at 10-volts amplitude)

CHARACTERISTICS	RANGE	BASIC ACCURACY (% of dial)	REQUIRED PER PROGRAM
*RISETIME AND FALLTIME	10 ns to 110 μs	±5% (except ± 10% on 1 and 10 ns range. <10 ns uncalibrated.)	3 bits + 2 resistors
*PERIOD	100 ns to 11 ms	±3%, except shortest period range is ±5%	4 bits + 1 resistor
*WIDTH	50 ns to 550 μs	±3%, except shortest width is ±5%.**	3 bits + 1 resistor
*DELAY OR BURST TIME	50 ns to 550 μs	±3% +10 ns	3 bits + 1 resistor
*AMPLITUDE (into 50 Ω)	0.4 to 2 V 1 to 5 V 2 to 10 V	±3% ±15 mV ±3% ±25 mV ±3% ±50 mV	2 bits + 1 resistor
*DC OFFSET (continuous)	−5 V to +5 V	±5% ±200 mV	1 resistor
POLARITY	positive or negative		1 bit
DUTY FACTOR	At least 75%†		
ABERRATIONS	+3%, −3%, total of 3% P-P for a ±10 V pulse.		

*These parameters are calibrated and continuously variable.

**Accurate only when risetime and falltime are set at minimum; if set equal width, reading is approx correct.

†Limited by a minimum pulse separation of 100 ns between the 50% amplitude points of any two adjacent pulses with the rise and falltimes set to minimum.

R116

10-ns Programmable Pulse Generator with Delay

PROGRAM ACCURACY

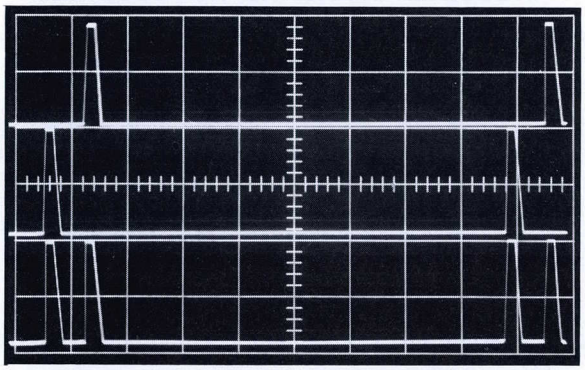
Accuracy of the remote program when using recommended program resistor values is the same as the corresponding front-panel control plus 2%, plus any error in the value of the program resistor. For example, the period which has a basic accuracy of ±3% from the front panel would have a maximum error of ±5%, plus the error in the programming resistor when it is remotely programmed. Accuracy of remote programming may be improved by calibrating the instrument for remote programming rather than for front-panel operation.

OPERATING MODES

Single—Undelayed pulses.

Delayed Single—Pulses occurring at the end of the delay time.

Double—Pairs of pulses: one occurring at the time of the normal, undelayed pulse, one occurring at the end of the delay time. 100-ns minimum pulse separation.



Multiple exposure showing timing relationships between Delayed Single, Single, and Double operating modes. Oscilloscope triggered from R116 Pretrigger. 50-μs/cm sweep time, 5-V/cm deflection factor.

Burst—Output pulses obtained for the duration of Burst Time when initiated by external triggering pulse. Pulses occur at internal repetition rate.

Gated Output—Output pulses obtained for the duration of input gate. Pulses are synchronous with input gate and occur at repetition rate set by period control.

Remote Program—Permits remote programming of the operating mode. Programming requires 4 bits.

INPUTS

+ **Trigger**—Accepts pulses with 0.5-V/μs minimum rate of rise or sinewaves from 1 kHz to 10 MHz. Pulse amplitude may be +2 V to +20 V, decreasing to a maximum of +4 V at 10 MHz. Sinewave amplitude may be 2 to 20 V peak-to-peak, 1 kHz to 5 MHz, decreasing to 4 V peak-to-peak at 10 MHz.

+ **Gate**—Accepts gate from +2 V to +10 V. Output pulses start approx 100 ns after gate reaches +2-V level and continue until gate drops to 0 V. Output pulses synchronous with gate. DC-coupled input.

AUXILIARY OUTPUTS

+ **Pretrigger**— 2 V minimum into 1 kΩ.

+ **Delayed Trigger**— 2 V minimum into 1 kΩ.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of +20°C to +30°C.

Power Requirements— 94.5 V to 137.5 V or 189 V to 275 V, selectable by rear-panel switch. 48 to 66 Hz, 100 watts maximum.

Dimensions and Weights

Height	5 1/4 in	13.3 cm
Width	19 in	48.3 cm
Depth	17 1/2 in	44.5 cm
Net weight	47 lb	21.3 kg
Domestic shipping weight	≈64 lb	≈29.0 kg
Export-packed weight	≈86 lb	≈39.1 kg

INCLUDED STANDARD ACCESSORIES

30-inch, 50-Ω BNC cable (012-0057-01); 50-Ω BNC termination (011-0099-00); 36-pin remote program connector (131-0293-00); slide-out assembly (351-0084-00); set mounting hardware, cabinet feet kit (016-0052-00); 3-conductor power cord (161-0024-03); instruction manual (070-1042-00).

R116 PULSE GENERATOR **$2100**

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. See catalog accessory pages for additional information.

Circuit Board Extension—Permits mounting of circuit boards away from surrounding circuitry for convenient servicing, order 012-0078-00 ..... $19

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

191

Constant-Amplitude Signal Generator

- **350-kHz to 100-MHz SINEWAVES**
- **5-mV to 5.5-V CONSTANT AMPLITUDE**
- **50-kHz AMPLITUDE REFERENCE**

The 191 is a variable-frequency, sinewave generator with a constant-amplitude output over the entire frequency range. Both output amplitude and frequency are calibrated. Amplitude is held constant during frequency variations by continuous sampling of peak-to-peak voltage.

OUTPUT CHARACTERISTICS

Frequency Range—Continuously variable and calibrated in 7 ranges from 350 kHz to 100 MHz, plus 50-kHz reference output. Accuracy within ±2% of selected frequency with output terminated in 50 Ω or unterminated (except ±5% on 0.5-5 V range with output unterminated).

Amplitude Range— 5 mV to 5 V peak-to-peak in 3 ranges (10 calibrated steps per range) into 50 Ω termination. Unterminated output is 2X indicated output. Amplitude is continuously variable (uncalibrated) between steps and to 10% over the top of each range.

Amplitude Accuracy— 50-kHz reference output accurate within ±3% of indicated amplitude on 0.5-5 V range, ±4% on 50-500 mV range, and ±5% on 5-50 mV range, into ±1% 50 Ω termination. Accuracy improved with a more accurate termination. Unterminated output is 2X indicated amplitude, at same accuracy. When the frequency is varied from 350 kHz to 100 MHz, the output amplitude into 50 Ω (at the output connector or through no more than 5 ns of RG8 cable) will not vary more than ±3% from actual amplitude at 50 kHz, except when using the 5-mV range the output may vary +3%-5% on frequencies from 42 MHz to 100 MHz.

Harmonic Content—Typically less than 5%.

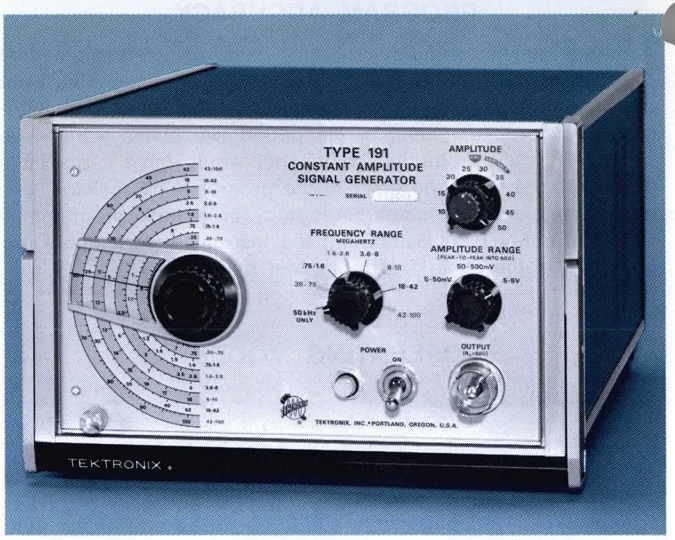
OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 103.5 V to 126.5 V or 207 V to 253 V, low or high range selected by rear-panel switch. 50 to 400 Hz, approx 25 watts.

Dimensions and Weights

Height	6 in	17.1 cm
Width	9 in	22.8 cm
Depth	15 3/4 in	40.0 cm
Net weight	16 lb	7.2 kg
Domestic shipping weight	≈21 lb	≈9.5 kg
Export-packed weight	≈32 lb	≈14.5 kg



INCLUDED STANDARD ACCESSORIES

5-ns, 50-Ω RG213 cable (017-0502-00); 50-Ω GR to BNC thru-line termination (017-0083-00); right-angle, 3-conductor power cord (161-0024-03); instruction manual (070-0522-00); (power cord for MOD 146B is 161-0031-00).

191 CONSTANT-AMPLITUDE SIGNAL GENERATOR **$495**

191 MOD 146B CONSTANT-AMPLITUDE SIGNAL GENERATOR .. **$470**
As above, but less cabinet for mounting in rack adapter.

OPTIONAL ACCESSORIES

Rack Adapter for 191 Constant Amplitude Generator

Adapts the 191 MOD 146B for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 191 occupies half-rack width. Two 191's can be mounted side by side, or alongside other half-rack width generators such as the 106 Squarewave Generator, 114 Pulse Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 191 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

191 MOUNTING KIT, order 016-0186-00 ..... $10

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

284
70-ps Pulse Generator

- PULSE OUTPUT WITH 70-ps OR LESS RISETIME
- SINEWAVE AND SQUAREWAVE OUTPUTS
- COMPACT, SOLID-STATE DESIGN

The 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pretrigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent 50-Ω signal source for TDR measurements. The 284 is available in a cabinet version, or modified for rackmounting in standard 19-inch rack using the optional Rack Adapter.

OUTPUT CHARACTERISTICS

Pulse Output— 70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of approx 50 kHz. Aberrations immediately following positive-going transitions are less than ±3%, 3% total peak-to-peak; after 2 ns, less than ±2%, 2% total peak-to-peak. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

Squarewave Output—Periods of 10 μs, 1 μs, or 100 ns. Output amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

Sinewave Output—Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

Trigger Output—Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When PULSE OUTPUT is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

TIMING AND AMPLITUDE ACCURACY

OUTPUT	PERIOD	TIMING ACCURACY	AMPLITUDE ACCURACY		
			1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%
	100 ns	±0.05% *	±2%†	±2.5%†	±3%†
Sine-wave	10 ns 1 ns	±1%		±20%	

* crystal controlled

† 20 ns after transition

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements—6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

Dimensions and Weights

Height	6 in	15.3 cm
Width	4 1/2 in	11.4 cm
Depth	15 in	38.1 cm
Net weight	8 lb	3.6 kg
Domestic shipping weight	≈16 lb	≈7.2 kg
Export-packed weight	≈24 lb	≈10.9 kg

INCLUDED STANDARD ACCESSORIES

50-Ω, BNC coaxial cable (012-0057-01); right angle, 3-conductor power cord (161-0024-03); instruction manual (070-0754-00).

284 PULSE GENERATOR **$555**

284 PULSE GENERATOR MOD 146B **$530**
As above, but less cabinet for mounting in rack adapter (power cord is 161-0031-00).

OPTIONAL ACCESSORIES

Rack Adapter for 284 Pulse Generator

Adapts the 284 MOD 146B for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 284 occupies quarter-rack width. Two 284's can be mounted side by side or one 284 can be mounted alongside one half-rack width generator such as the 106 Squarewave Generator, 191 Constant Amplitude Generator, 114 Pulse Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator.

The Adapter provides forced air ventilation. Blank panels are provided to cover unused openings when the Adapter is not filled. Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

284 MOUNTING KIT, order 016-0187-00 ..... $15
Includes a quarter-rack width blank panel (016-0109-00).

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

2101

5-ns Pulse Generator with Delay

- 2.5 Hz-to-25 MHz REPETITION RATE
- VARIABLE BASELINE OFFSET
- 5-ns RISETIME AND FALLTIME
- PAIRED, UNDELAYED, DELAYED, AND OUTPUT LOCKED ON MODES
- EXTERNAL GATE INPUT
- SIMULTANEOUS POSITIVE- AND NEGATIVE-GOING PULSES—10 VOLTS INTO 50 Ω
- SHORT-PROOF OUTPUTS

The 2101 is a compact, 25-MHz, 10-V, general-purpose pulse generator with simultaneous positive- and negative-going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration, and delay, within the calibrated range of the respective control. Ranges may be extended by user-supplied capacitors to reduce the repetition rate and to increase the duration and delay. The only limiting factor in extending the range is the physical size of the user-supplied timing capacitors.

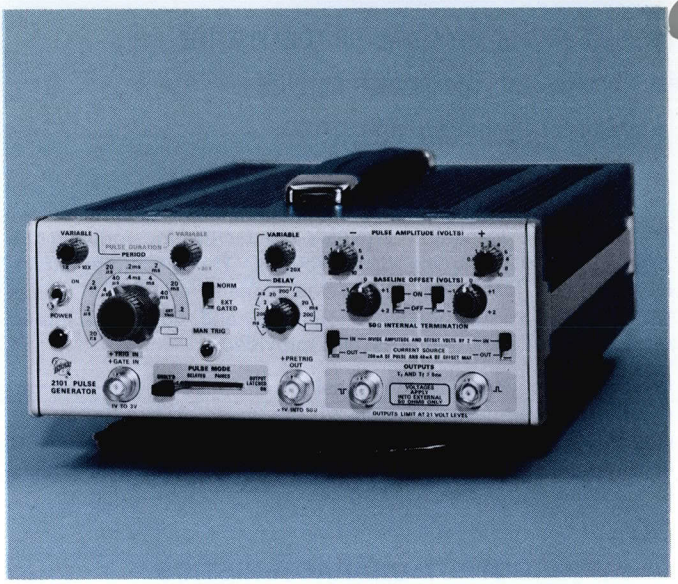
An external gate input permits output pulses for the duration of the gate signal, useful for all pulse modes, except OUTPUT LOCKED ON mode. Independent baseline offset controls are provided for the positive-going and negative-going pulse outputs.

OUTPUT CHARACTERISTICS
(terminated in 50-Ω load)

Risetime and Falltime— 5 ns or less.

Period— 40 ns to 400 ms in 7 ranges, continuously variable (MINIMUM PULSE SEPARATION— 20 ns or 20% of DURATION, whichever is greater, between the 50%-amplitude points of any two adjacent pulses).

Duty Factor—At least 80% for periods 100 ns or greater; at least 70% for the 0.2 s DURATION position. As the period is decreased below 100 ns, the duty factor decreases to 50% at 40 ns period. Minimum off time is 20 ns.



Duration— 20 ns to 400 ms (to 4 s with external trigger) in 7 ranges, continuously variable.

Delay— 20 ns to 4 s in 8 ranges, continuously variable (refer to pulse separation performance limit above).

Amplitude— 50-Ω Internal Termination Switched Out: 0.3 V or less to 10 V, continuously variable. Current output is 6 mA or less to 200 mA, continuously variable. 50-Ω Internal Termination Switched In: 0.2 V or less to 5 V.

Baseline Offset— 50-Ω Internal Termination Switched Out: At least + and −2 V, + and −40 mA, continuously variable around zero. 50-Ω Internal Termination Switched In: At least + and −1 V, continuously variable around zero. Control calibrated for external load impedance of 50 ohms.

Aberrations— +3%, −3%, or total of 3% P-P, or +100 mV, −100 mV, or total of 100 mV P-P, whichever is greater.

OPERATING MODES

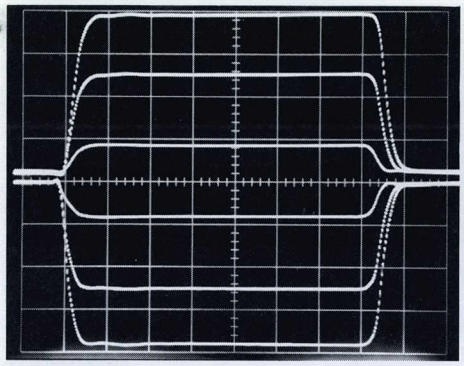
Undelayed—Sequence of pulses with repetition rate set by PERIOD control.

Delayed—Pulse output is delayed for a time interval determined by DELAY controls. Delay time is the time between leading edges of an undelayed pulse and the delayed pulse.

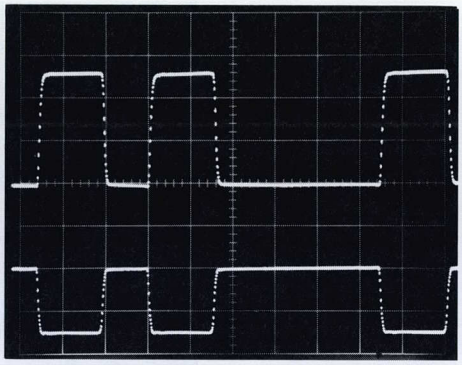
Paired—Provides pairs of pulses, one at the time of normal undelayed pulse and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Output Locked On—A DC output is provided which is locked to a level determined by PULSE AMPLITUDE and OFFSET controls.

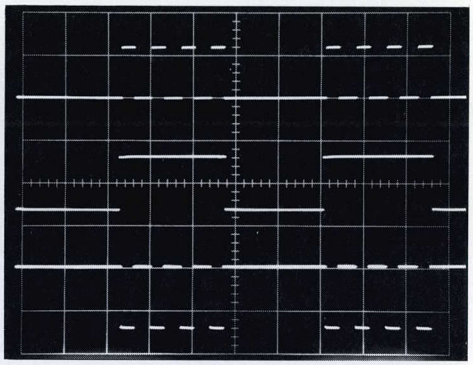
2101
5-ns Pulse Generator with Delay



Multiple exposure from a fast-risetime oscilloscope showing typical waveform aberrations for positive and negative polarities of various amplitude settings. 10-ns/div sweep time and 2-V/div deflection factor.



Single exposure showing simultaneous positive- and negative-going paired pulse outputs. 50-ns/div sweep time and 2-V/div deflection factor.



Type 2101 in the external gated mode. Single exposure top to bottom. Gated positive-going pulses, gating signal, negative-going pulses. 20-μs/div sweep time and 1-V/div deflection factor.

TRIGGERING

PERIOD switch provides selection of internal or external trigger source. A manual push button provides a means to produce one pulse generation cycle when the PERIOD switch is set for EXT TRIG.

INPUTS

+ **Trigger**— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC to peak AC. Input resistance 200 Ω.

+ **Gate**— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC + peak AC. Input resistance 200 Ω.

OTHER CHARACTERISTICS

+ **Pretrigger Out**—At least 1 V into 50 Ω.

Source Resistance— 50 Ω within 5% with the internal termination switched in.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz, 55 watts maximum at 115 VAC and 60 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

Dimensions and Weights

Height	4 1/4 in	10.9 cm
Width	8 in	20.3 cm
Depth	14 3/4 in	37.5 cm
Net weight	8.1 lb	3.6 kg
Domestic shipping weight	≈15 lb	≈6.8 kg
Export-packed weight	≈25 lb	≈11.3 kg

INCLUDED STANDARD ACCESSORIES

Two 50-Ω, 5-W terminations (011-0099-00); three 50-Ω BNC cables (012-0117-00); instruction manual (070-1029-00).

2101 PULSE GENERATOR **$700**

OPTIONAL ACCESSORIES

Rack Adapter for 2101 Pulse Generator

Adapts the 2101 for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 2101 occupies half-rack width. Two 2101's can be mounted side by side, or alongside other half-rack width generators such as the 106 Squarewave Generator, 191 Constant Amplitude Generator, 114 Pulse Generator, 115 Pulse Generator, and 2901 Time-Mark Generator. The 2101 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapters provide forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

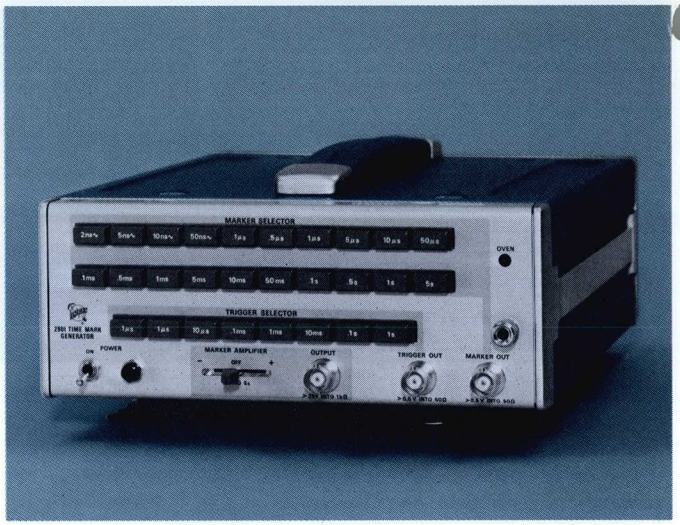
RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

2101 MOUNTING KIT, order 016-0188-00 ..... $5

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

2901
Time-Mark Generator

- 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES
- 500-MHz SINEWAVE OUTPUT
- CRYSTAL-CONTROLLED OSCILLATOR



The 2901 is a compact, wide-range, time-mark generator. It is CRYSTAL-CONTROLLED and provides 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES, and 8 TRIGGER-PULSE INTERVALS.

Marker push buttons are self-canceling so that when any marker button is pushed other buttons are automatically released. More than one marker interval can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The 2901 is fully solid-state, utilizing digital integrated circuits extensively. Outputs are derived from a temperature-stabilized, 10-MHz, crystal oscillator. A rear-panel connector is provided to allow the 2901 to be used as a divider for external oscillator inputs. This instrument offers great versatility for many laboratory or production-line applications.

OUTPUT CHARACTERISTICS

Crystal-Controlled Oscillator— 10 MHz ±10 P/M from 20°C to 30°C, 10 MHz ±20 P/M from 0° to 50°C. Frequency stability is within 3 P/M in any 24-hour period from 20°C to 30°C. Accuracy and stability specifications are valid only after the instrument has been plugged in for 2 hours and turned on for at least 30 minutes.

Marker Output—Positive-going markers with 16 intervals from 0.1 μs to 5 s in 1-5-10 sequence, 0.5 V minimum peak amplitude into 50 Ω.

Marker Amplifier Output—Positive- or negative-going markers with 14 intervals from 1 μs to 5 s in 1-5-10 sequence. 25-V minimum amplitude into 1 kΩ from 5 μs to 5 s; at least + or −22 V into 1 kΩ at 1 μs.

Sinewave Outputs— 5-ns, 10-ns, and 50-ns sinewave signals at Marker Output connector with 0.5-V minimum peak-to-peak amplitude into 50 Ω. 2-ns sinewave signal at Marker Output connector with 0.3-V minimum peak-to-peak amplitude into 50 Ω.

Trigger Output—Positive-going pulses with 8 intervals of 0.1 μs to 1 s in 1-10 sequence, 0.5-V minimum amplitude into 50 Ω, 1-V minimum amplitude into 1-MΩ.

External Clock Input—Required signal amplitude is at least 2-V peak-to-peak for sinewaves, or at least 2-V peak for pulses into 50 Ω. Frequency range is 50 kHz or less, to at least 10 MHz. The 2 ns, 5 ns, 10 ns, and 50 ns sinewaves are operative only when the external oscillator input is 10 MHz.

OTHER CHARACTERISTICS

Operating Temperature Range— 0°C to +50°C.

Dimensions and Weights

Height	4 1/4 in	10.9 cm
Width	8 in	20.3 cm
Depth	10 7/8 in	27.6 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

INCLUDED STANDARD ACCESSORIES

Two 50-Ω, BNC coaxial cables (012-0057-01); 50-Ω, BNC termination (011-0049-01); instruction manual (070-0995-00).

2901 TIME-MARK GENERATOR **$640**

OPTIONAL ACCESSORIES

Rack Adapter for 2901 Time-Mark Generator

Adapts the 2901 for rackmounting in a 19-inch rack, in 5 1/4 inches of panel height. The 2901 occupies half-rack width. Two 2901's can be mounted side by side, or alongside other half-rack width generators such as the 106 Squarewave Generator, 114 Pulse Generator, 115 Pulse Generator, 191 Constant Amplitude Generator, and 2101 Pulse Generator. The 2901 may also be mounted with a quarter-rack width 284 Pulse Generator.

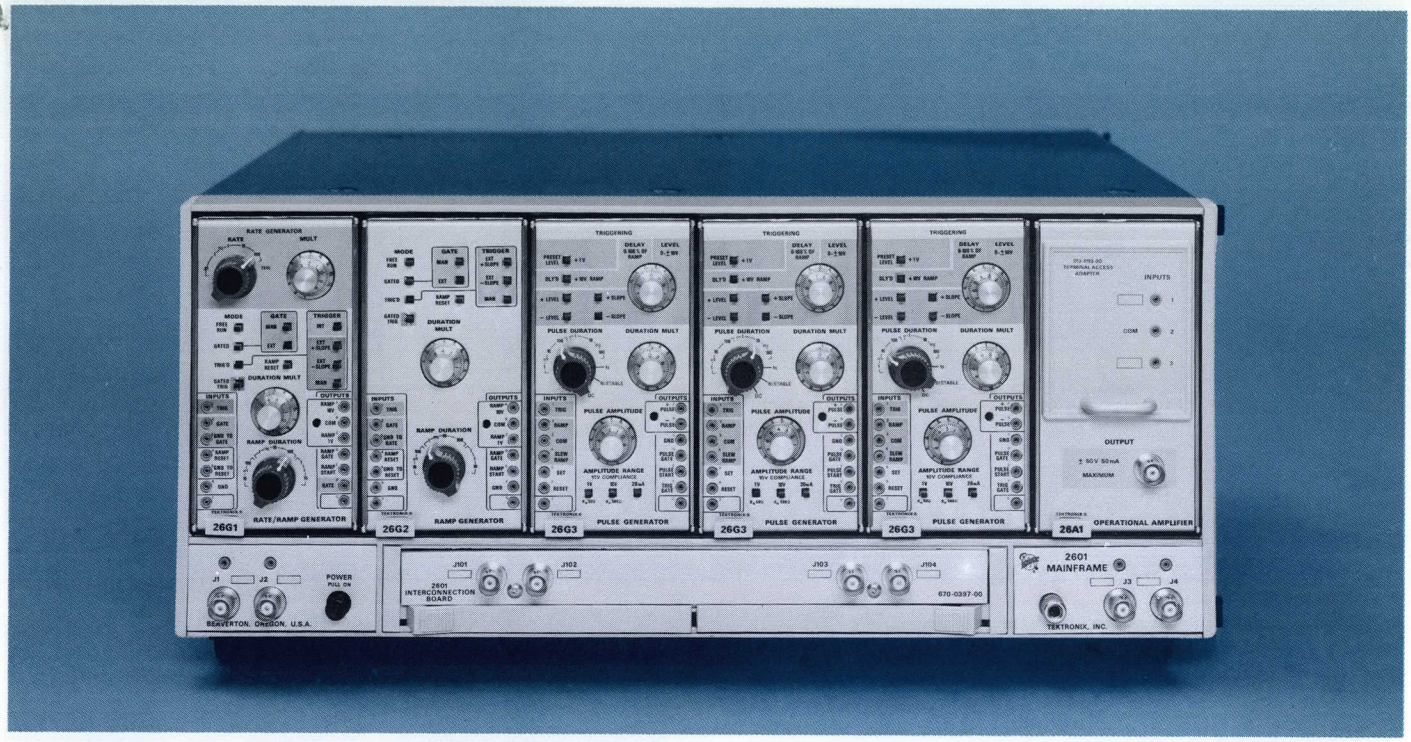
The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... $225
Includes a half-rack width blank panel (333-1384-00).

2901 MOUNTING KIT, order 016-0188-00 ..... $5

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page



The 2600 Series is a modular, instrumentation system of signal generators and signal conditioners. Plug-In Modules permit a building block approach to specialized systems.

The system is presently of the following components, described fully on the following pages:

2601 Mainframe provides power for, and interconnection between, up to six plug-in units.

26G1 Ramp/Rate Generator provides ramps of variable duration at a variable rate.

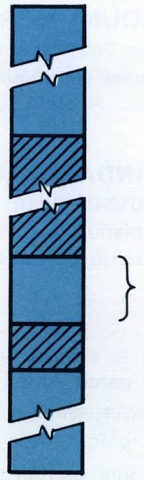
26G2 Ramp Generator provides voltage ramps of variable duration at a rate determined by an external source.

26G3 Pulse Generator provides current or voltage pulses of variable duration and amplitude when externally triggered.

26A1 Operational Amplifier is easily adapted for many uses, including processing signals generated by other plug-ins.

The interconnection system stresses flexibility and ease of set-up change. The plug-in unit front-panel pin connectors are duplicated at the rear connector, permitting interconnection through the pull-out interconnection board system. Spare connectors, lines, and power sources are available in anticipation of future and specialized requirements.

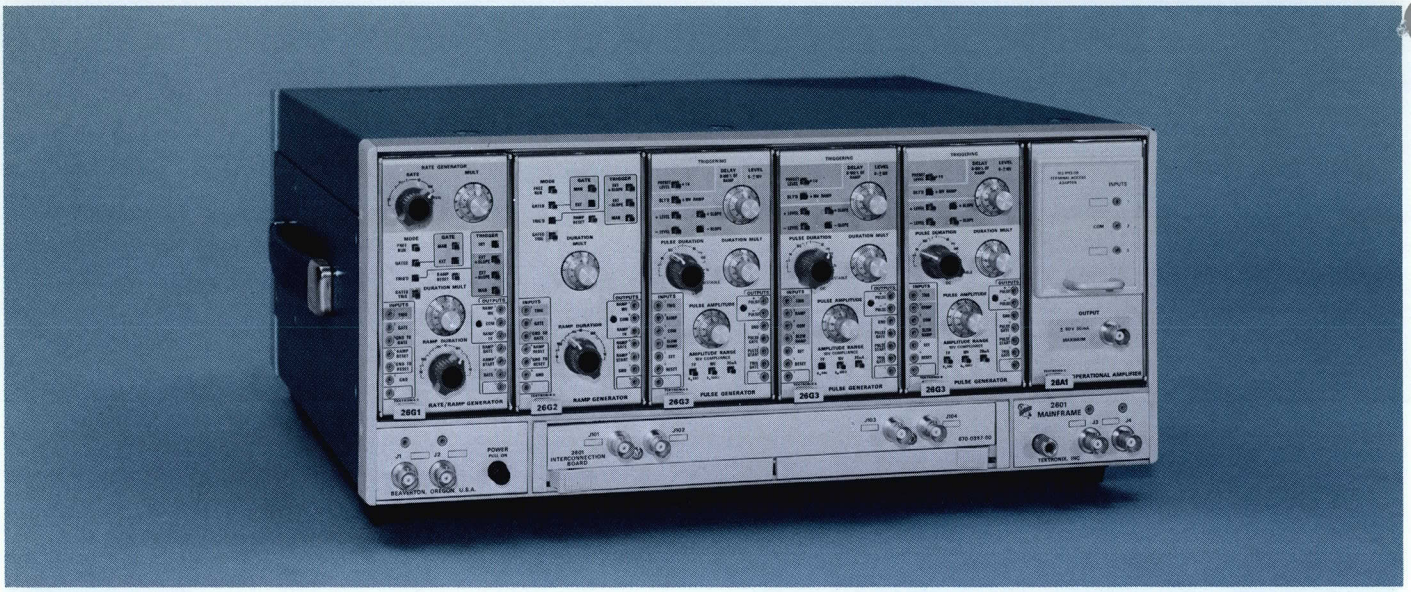
The characteristics of the input and output signals maintain compatibility not only with each other, but with other units such as the 7000 Series, 4501, 601, 602, 611, etc. Where applicable, inputs and outputs from the units are fully compatible with commercial logic such as DTL, TTL, etc. Refer to the chart below for logic level ranges.



$+V_{Safe}$:	Maximum long-term non-destructive input voltage (DC plus Peak AC)
V_{On} (Max):	Maximum recommended voltage level for initiation and/or sustaining the function
V_{On}:	Minimum (least positive) voltage assuring the function for all conditions of temperature and circuit tolerances
Indeterminate State:	Functional performance not specified
V_{Off} (Max):	Maximum (most positive) voltage assuring no function for all conditions of temperature and circuit tolerances
V_{Off}:	Recommended voltage level for non-function operation
$-V_{Safe}$:	Maximum, long-term non-destructive input voltage (DC plus Peak AC)

NEW

2601
Power Supply



- POWERS UP TO SIX PLUG-IN UNITS
- PULL-OUT INTERCONNECTION BOARD
- REAR PANEL INPUT/OUTPUT CONNECTORS

The 2601 Mainframe is a power supply and interconnection system for 2600-Series plug-in units. Its electronically-preregulated power supplies require no fan or vent holes for cooling. Further regulation, when necessary, takes place in each individual plug-in unit, thus enhancing the overall system accuracy.

Interconnection between the six plug-ins and the front- and rear-panel connectors can be made on the pull-out interconnection board, which improves appearance, reduces accidental removal, and improves control accessibility. It also allows each plug-in to be removed without interference. Additional boards may be ordered to permit different interconnection formats to suit various requirements.

CHARACTERISTICS

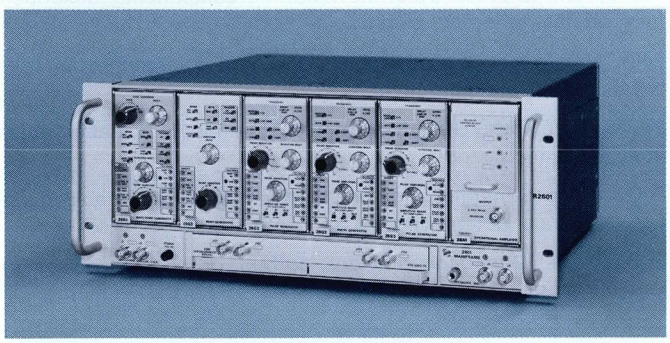
Interconnection System—Inputs and outputs to plug-ins are duplicated through the plug-in connector and the 2601 internal wiring to the pull-out interconnection board. Interconnection on the board (as well as on the front panels) is by a 0.040-inch pin-and-jack system. Low-level inputs, high-level outputs, and high-frequency signals are connected via front panel BNC connectors to maintain maximum transmission fidelity.

Preregulated Power Supplies—+17 V at 1.25 A, −17 V at 1.25 A, +7 V at 6.5 A. These supplies are typically regulated within each module to +15 V, −15 V, and +5 V. Supplies are available on the pull-out interconnection board, as well as to each plug-in.

Power Requirements—Quick-change line voltage selector permits operation from nominal line voltages of 100 V, 110 V, 115 V, 127 V, 220 V, 230 V, 240 V, 250 V; ±10%. 95 W maximum. Line frequency range, 48 Hz to 440 Hz.

DIMENSIONS AND WEIGHTS

	2601		R2601	
	in	cm	in	cm
Height	7 7/8	20.1	7	17.9
Width	17 5/8	44.8	19	48.4
Depth	16 1/2	42.0	15 1/2	39.5
	lb	kg	lb	kg
Net weight	22 1/4	10.1	23	10.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈41	≈18.6	≈42	≈19



RACKMOUNT VERSION

Electrically identical to the 2601, the R2601 has the feet and handle replaced with flanges for mounting in a 7-inch space in a standard 19-inch rack. A slide-out assembly is available as an optional accessory.

INCLUDED STANDARD ACCESSORIES

6 two-inch patch cords (012-0200-00); 4 six-inch patch cords (012-0201-00); instruction manual (070-1064-00). R2601 also includes rackmount hardware (016-0164-00).

2601 MAINFRAME **$495**

R2601 MAINFRAME **$495**

2601 MAINFRAME, Option 1, without pull-out interconnection board and patch cords $450

R2601 MAINFRAME, Option 1, without pull-out interconnection board and patch cords $450

Refer to the last page of this section for optional accessories.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

26A1
Operational Amplifier

NEW

- ±50 V, 50 mA OUTPUT
- OPEN LOOP GAIN 10,000
- 5 MHz UNITY-GAIN BANDWIDTH

The 26A1 is an operational amplifier with a wide output voltage swing, wide common-mode range, and high slewing rates suited to a broad range of applications, including final processing of signals generated in the 2600-Series system. Plug-in terminal access adapters provide space for the necessary operational amplifier input and feedback elements; the characteristics of the operational amplifier can be altered by simply replacing adapters or the clip-on components.

OPERATIONAL AMPLIFIER

Open Loop Gain—At least 10,000 into 1 kΩ load.

Unity-Gain Bandwidth—At least 5 MHz into 1 kΩ load.

Common-Mode Rejection Ratio—At least 10,000:1 at 60 Hz.

Slew Rate—At least 50 V/μs into 1 kΩ load.

INPUT

Common-Mode Input Voltage Range—At least ±50 V.

Input Leakage Current—300 pA or less at 25°C.

Equivalent Input Drift—100 μV/°C or less.

Equivalent Input Noise—10 μV RMS or less.

Maximum Safe Differential Input—100 V.

OUTPUT

Voltage Range—At least ±50 V.

Current Limit—At least ±50 mA.

Output Resistance—150 Ω or less.

WEIGHTS

Net weight	1 1/2 lb	0.7 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

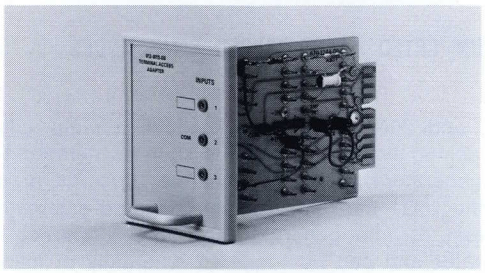
INCLUDED STANDARD ACCESSORIES

3 two-inch patch cords (012-0200-00); terminal access adapter (013-0113-00); resistor-capacitor kit (020-0039-00); instruction manual (070-1068-00).

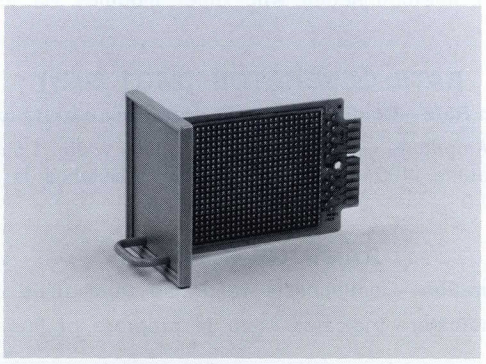
26A1 OPERATIONAL AMPLIFIER **$280**

Please refer to the last page of this section for optional accessories.

OPTIONAL ACCESSORIES



Additional Terminal Access Adapters—Order 013-0113-00 . . $15



Terminal Access Adapter Kit

Contains mechanical parts for custom-building terminal access adapter. One section of the etched circuit board mates the adapter connector in the plug-in unit; the remainder of the board is a construction area for passive or active circuitry.

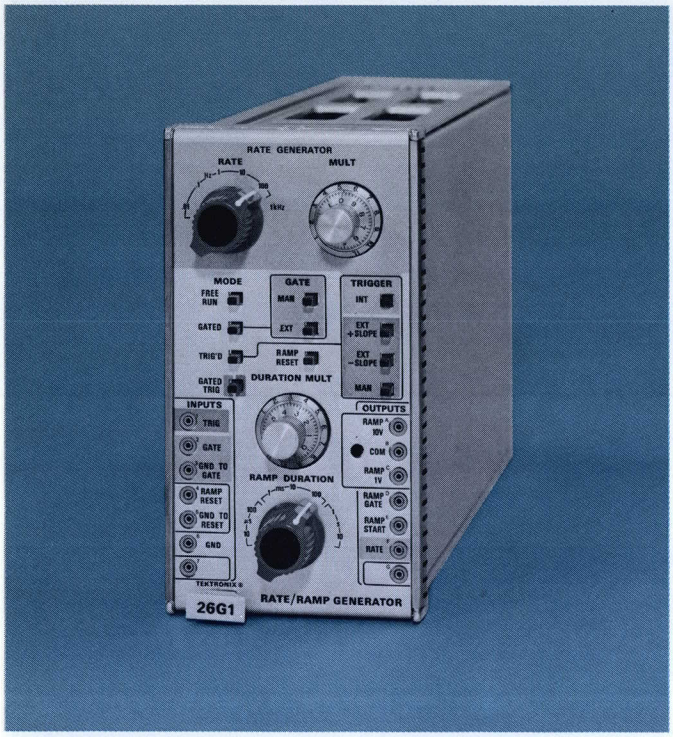
Order 013-0114-00 ..... $8

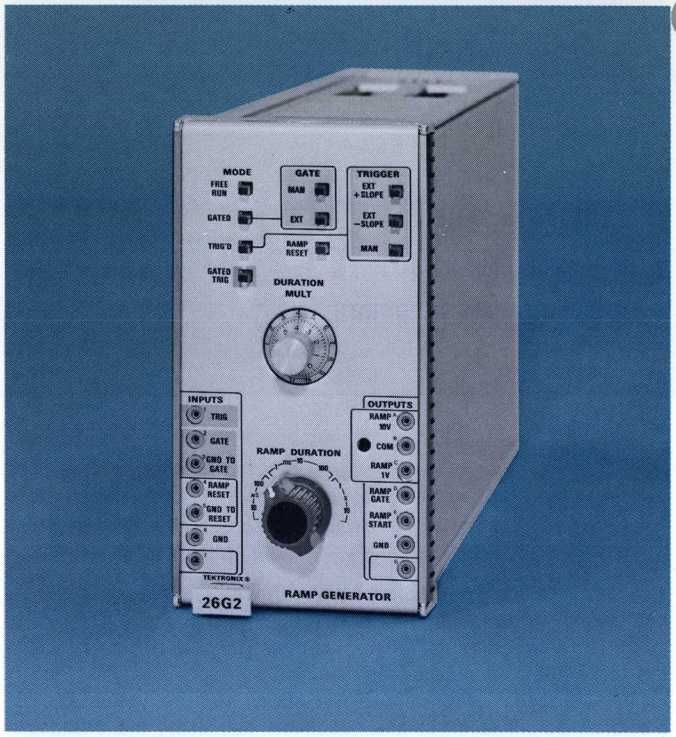
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

26G1 Rate/Ramp Generator

26G2 Ramp Generator





- **0.01 Hz to 11 kHz CONTINUOUSLY CALIBRATED RATES (26G1 Only)**
- **10 μs to 110 s CONTINUOUSLY CALIBRATED RAMPS**
- **FREE-RUN, GATED and TRIGGERED RAMP MODES**

The 26G1 and 26G2 Generators produce a ramp voltage well suited to analog timing applications such as delayed triggering of pulse generators. The ramp can be triggered or gated, or both. In the 26G1 the ramp can be triggered externally, manually, or from its rate generator; the 26G2 does not have the rate generator and can be triggered externally or manually.

All front panel connections are duplicated at the rear connector for interconnecting with other modules via the mainframe.

RATE GENERATOR (26G1 Only)

Repetition Rate—Continuously calibrated from 0.01 Hz to 11 kHz.

Output—Amplitude, +3 V within 20%; pulse width, 1.5 μs within 30%; risetime, 100 ns or less. Output resistance is approximately 50 Ω.

RAMP GENERATOR

Ramp Duration—Continuously calibrated from 10 μs to 110 s.

Output Indicator—Indicates ramp in progress or has just occurred.

MODES

Free Run—Provides successive ramps.

Gated—Successive ramps are generated for the duration of gate signal. Last ramp is not terminated at end of gate. Internal connector permits gate to also control rate generator.

Triggered—One ramp cycle is generated for each trigger.

Gated Triggered—Allows ramp to be generated by triggers only during the time a gate signal is present.

Ramp Reset—Terminates ramp and resets circuitry for generation of new ramp (locks out ramp until released).

INPUTS

Trigger—Requires at least 1 V to generate ramp. Positive or negative slope is selectable.

Gate—Ramp generated while gate is elevated to at least 1 V (26G1 and/or rate generator with internal jumper).

Ground to Gate—Closure to ground provides ramp gating.

Ramp Reset—Ramp is reset upon receipt of at least 1 V signal.

Ground to Reset—Closure to ground initiates ramp reset.

Ground—Provides reference ground (as opposed to high current or shield ground).

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

OUTPUTS

Ramp, 10 V—Provides 10 V ramp into at least 3 kΩ.

Common—Reference ground for ramp outputs.

Ramp, 1 V—Provides 1 V ramp with 50 Ω output resistance.

Ramp Gate—Provides +3 V signal during ramp generation.

Ramp Start—Provides +3 V pulse coincident with start of ramp.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

Net weight	1 3/4 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

INCLUDED STANDARD ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00); instruction manual (070-1065-00—26G1, 070-1066-00—26G2).

26G1 RATE/RAMP GENERATOR **$430**
26G2 RAMP GENERATOR **$300**

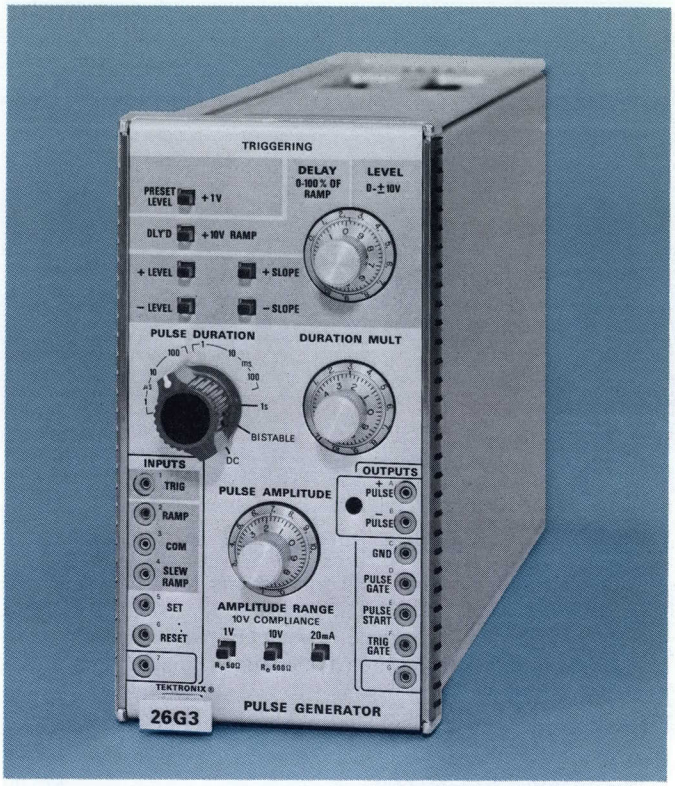
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

26G3
Pulse Generator

NEW

- **1 μs to 11 s CONTINUOUSLY CALIBRATED PULSE WIDTHS**
- **1 V, 10 V, or 20 mA MAXIMUM AMPLITUDES, CONTINUOUSLY CALIBRATED**
- **SIMULTANEOUS POSITIVE AND NEGATIVE PULSES**

The 26G3 generates precise rectangular pulses whose duration and amplitude are selected by the calibrated front panel controls. The generator has accurately-controlled voltage level selection of the triggering point; when a 10-V ramp is used as a triggering source the 26G3 can pick off a voltage proportional to time, thus providing a calibrated time delay.



PULSE GENERATOR

Pulse Duration—Selects calibrated pulse durations of 1 μs to 1 s in decade steps. Also selects Bistable mode where each succeeding trigger reverses the output state, and DC mode which provides a continuous output as determined by amplitude controls.

Duration Multiplier—Selects continuously calibrated pulse durations from 1.00 to 11.00 times pulse duration.

Output Indicator—Indicates pulse is in progress or has just occurred.

Output—Simultaneous (within 50 ns) positive and negative pulses, continuously calibrated over three ranges: 0 to 1 V, 0 to 10 V, or 0 to 20 mA.

Accuracy—Amplitude, within 1% of full scale after the first 10%. Within 3% of indicated duration from 1 μs to 100 ms, within 5% on 1 s range.

Source Resistance—1 V range, 50 Ω within 1%. 10 V range, 500 Ω within 1%.

Risetime, Falltime— 200 ns or less for pulse amplitudes of 10% to 100% of full scale.

Delay After Trigger— 250 ns or less.

TRIGGER MODES

Preset Level, 1 V—Triggering level passing +1 V initiates output pulses.

Delayed, +10 V Ramp—Triggering occurs as the +10 V ramp passes the amplitude level selected by the calibrated Delay control.

+ or — Triggering—Occurs at a selectable level and slope between 0 and + or −10 V.

INPUTS

Trigger—Accepts input signals for preset level, plus level and minus level modes.

Ramp—Accepts +10 V ramp for delayed trigger mode.

Common—Reference ground for ramp inputs.

Slew Ramp—Accepts signal to algebraically sum with ramp.

Set—At least +1 V required to set output to high state independent of other inputs.

Reset—At least +1 V required to reset output to low state independent of pulse width control.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

OUTPUTS

+ Pulse, — Pulse—Provides simultaneous positive- and negative-going pulses.

Ground—Provides reference ground for output signals.

Pulse Gate—Provides +3 V gate signal, coincident with output pulse.

Pulse Start—Provides +3 V trigger signal, coincident with leading edge of pulse.

Trigger Gate—Provides a signal that is 0 V before triggering level is reached and +3 V after triggering level is passed.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

Net weight	1 3/4 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

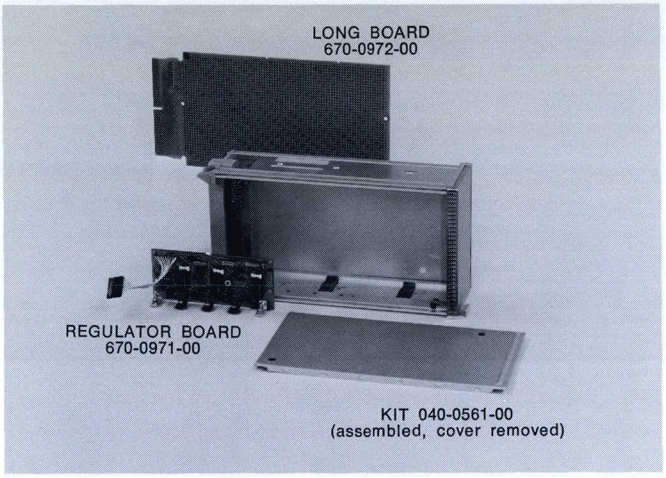
INCLUDED STANDARD ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00); instruction manual (070-1067-00).

26G3 PULSE GENERATOR **$485**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

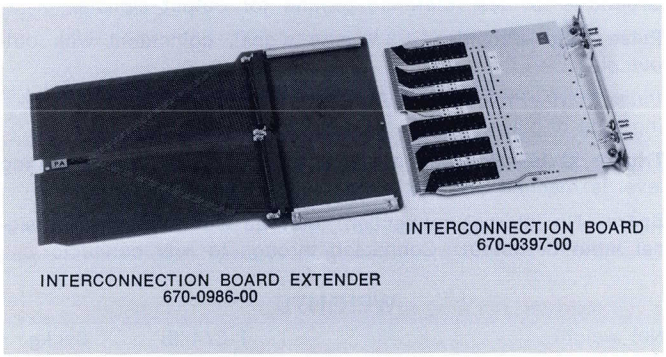
OPTIONAL ACCESSORIES



BLANK PLUG-IN KIT

Provides mechanical parts and instructions for construction of specialized plug-ins. The kit includes a short board to mate the plug-in to the mainframe connector; also available is a long board which has an area for circuitry construction, and a regulator board which provides +15 V, −15 V, and +5 V when installed in the blank plug-in.

BLANK PLUG-IN KIT, 040-0561-00 ..... $27.50
LONG BOARD, 670-0972-00 ..... $25.00
REGULATOR BOARD, 670-0971-00 ..... $60.00



INTERCONNECTION BOARD

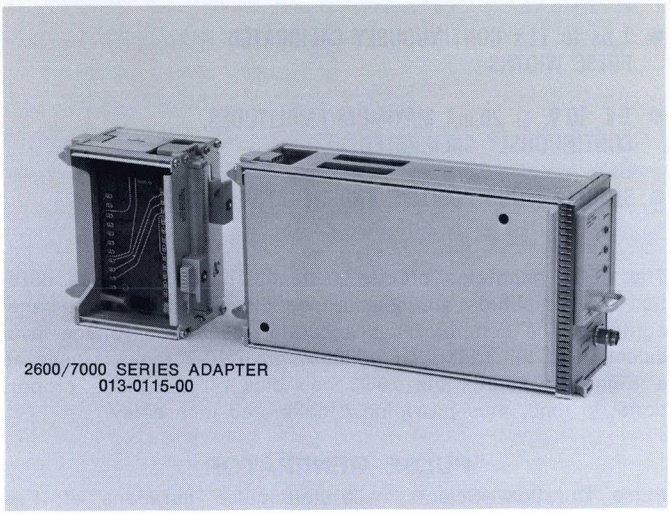
Additional interconnection boards permit plugging in different interconnection formats to suit varying requirements.

Order 670-0397-00 ..... $65.00

INTERCONNECTION BOARD EXTENDER

Allows access to board connectors while instrument is in operation.

Order 670-0986-00 ..... $60.00



2600/7000-SERIES ADAPTER

Permits the 2600-Series plug-ins to be operated in 7000-Series oscilloscopes. The adapter provides regulated power to the plug-in and extends the plug-in length for mechanical compatibility. It permits limited input or output interconnections between the plug-in and oscilloscope.

Order 013-0115-00 ..... $50.00

CABLES, CORDS, AND CONNECTORS

BNC-to-0.040 inch Pin Adapter Cable, 175-1178-00 .... $10.00
2-inch Red Patch Cords (package of 25), 012-0200-01 .. $20.00
6-inch Blue Patch Cords (package of 25), 012-0201-01 .. $20.00
12-inch Black Patch Cords (package of 25), 012-0202-01 $25.00
Pin/Jack Combination (package of 50), 020-0036-00 ... $15.00
Panel Jacks (package of 25), 020-0037-00 ..... $7.50
Board Jacks (package of 25), 020-0038-00 ..... $4.00

R2601 SLIDE-OUT ASSEMBLY

Order 351-0296-00 ..... $16.20

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

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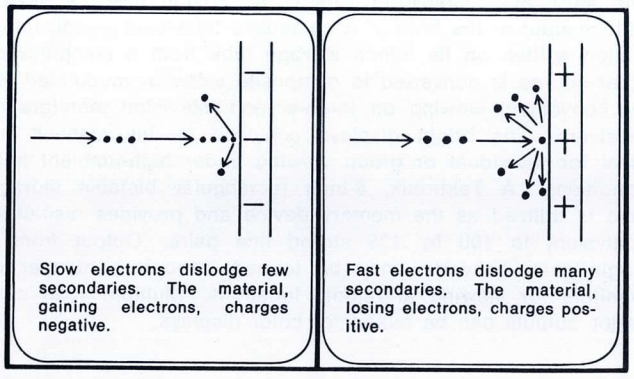
STORAGE CRTS FOR INFORMATION DISPLAY

The Tektronix bistable storage tube is a significant breakthrough in CRT design. Initially introduced as an oscilloscope display medium, this rugged CRT design is now incorporated into several Tektronix information display products. For display of computer-generated graphics and alphanumerics, the bistable CRT eliminates or minimizes the need for refreshed memory systems. The computer need only write once and then go on to other work. The CRT display remains, flicker-free, for further examination.

The Tektronix direct-view bistable storage tube (DVBST) is based on a secondary emission principle. When a stream of primary electrons strikes the phosphor target, secondary electrons are dislodged from the phosphor surface. As the potential increases, each primary electron displaces more than one secondary electron, resulting in the material charging positive.



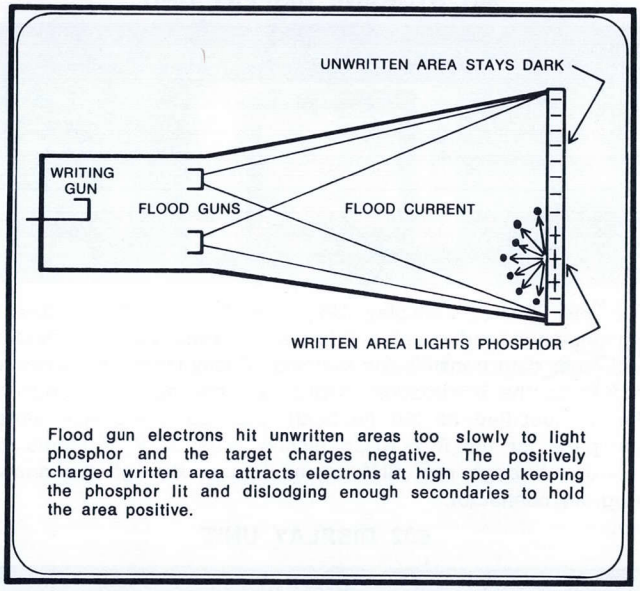
Slow electrons dislodge few secondaries. The material, gaining electrons, charges negative.

Fast electrons dislodge many secondaries. The material, losing electrons, charges positive.

In addition to the normal CRT writing guns, flood guns are used to cover the complete phosphor screen uniformly with low-velocity electrons. A conductive transparent face plate under the phosphor completes the circuit and allows storage to take place.

The normal writing gun bombards the phosphor screen with a beam of high-speed focused electrons. The beam writes and also dislodges great numbers of secondary electrons. The written surface where the waveform is traced out loses electrons and charges positive.

By using the flood-electron guns, the display may be stored. The flood guns emit low-velocity electrons over the whole CRT-screen area. The electrons strike the unwritten area too slowly to jar loose many secondaries. As a result, these areas merely collect electrons until they are driven negative and can attract no more current.



Flood gun electrons hit unwritten areas too slowly to light phosphor and the target charges negative. The positively charged written area attracts electrons at high speed keeping the phosphor lit and dislodging enough secondaries to hold the area positive.

The latent image where the beam has written attracts flood electrons at such a velocity so each entering primary dislodges sufficient secondaries to hold the phosphor target positive. Thus, the written area neither gains nor loses electrons but remains positively charged and continues to attract flood current. As a result of this equilibrium, the trace is stored.

This is the basis for all Tektronix direct-view bistable storage tubes. Since this process is primarily internal to the CRT, other advantages are provided. Maintenance is reduced because of the reduction in external electronics which is needed to display information on refreshed CRT's. The direct-view storage CRT is durable and does not require special operating consideration or care.

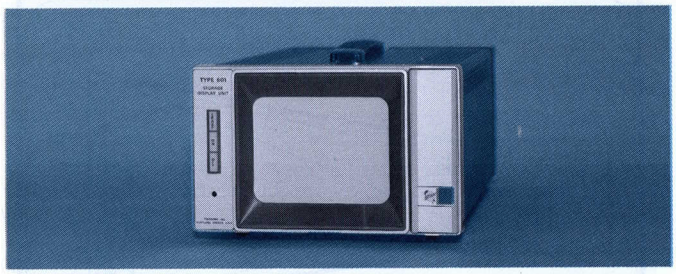
An important characteristic of a bistable storage tube is the ability to display dynamic information in a refreshed mode. Thus, information which is most meaningful when presented in a refreshed mode may be displayed in a manner the same as that for displaying data on oscilloscope CRT's.

The 611 Storage Display Unit has an 11-inch CRT. A slightly modified version of this CRT is used in Tektronix terminals. A "write-thru" feature of the 611 allows the operator to display cursors or any generated pattern without degrading previously stored data and without storing new data. In the "write-thru" and "non-store" modes the display remains on screen as long as it is refreshed.

In recognition of the increasing needs for readout devices for computer consoles and remote terminals, Tektronix has devoted considerable time and effort to designing and producing display components which will effectively fulfill these needs. These products cover a wide range of applications including scientific research, process monitoring, production control, retrieval of information necessary for managerial decisions, classroom needs, and computer program development.

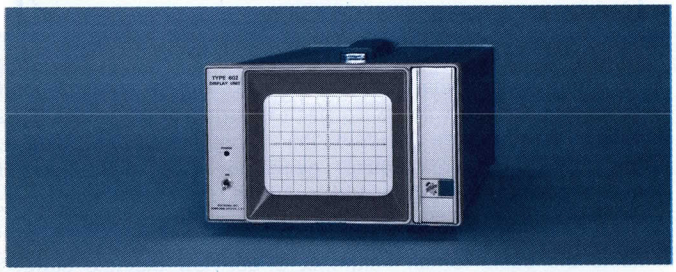
The following is a summary of the Tektronix Information Display Devices. The specification pages contain a more detailed description of the technical aspects and full capabilities of each device.

601 STORAGE DISPLAY UNIT



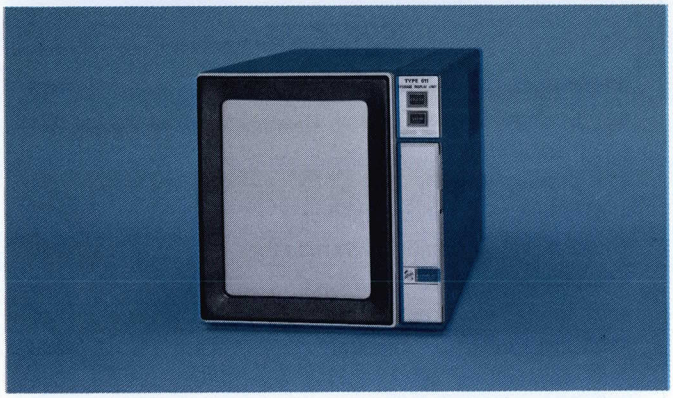
The 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. Costly memory devices for refreshing the information display are not necessary. Resolution is specified at 100 (vertical) and 125 (horizontal) stored line pairs for the 8 x 10 cm display area. X, Y, Z inputs are provided through rear BNC connectors or through the remote program connector.

602 DISPLAY UNIT



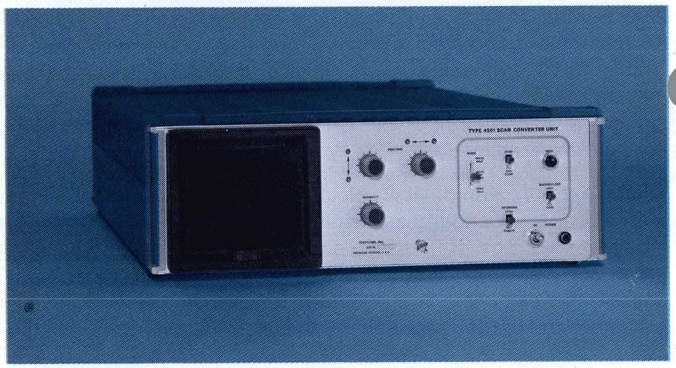
The 602 Display Unit is a compact, solid-state refreshed instrument with excellent resolution providing accurate displays of information through X, Y, and Z signal inputs. The 602 is particularly suited for applications which require unusually high resolution. Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5 μA beam current. Typical application areas are: phase shift and frequency ratio measurements, graphic and alphanumeric displays from computers, high-resolution raster displays with intensity modulation and Y-T plots of amplitude versus time.

611 STORAGE DISPLAY UNIT



The 611 Storage Display Unit is designed to function as a readout device for computer terminals. With X, Y and Z input signals provided by peripheral equipment, this instrument is capable of displaying high-density alphanumeric and complex graphic information without drift or annoying flicker. The screen is 21 cm x 16.2 cm with resolution equivalent to 400 (vertical) and 300 (horizontal) stored line pairs. 4000 characters, 90 x 70 mils in size may be clearly displayed.

4501 SCAN CONVERTER UNIT



The 4501 Scan Converter Unit is an analog memory device with readout in the form of a composite television signal. Information written on its 5-inch storage tube from a computer or other source is converted to composite video or modulated RF for convenient viewing on large-screen television monitors or receivers. The bright displays achieved in this manner are ideal for individual or group viewing under high-ambient light conditions. A Tektronix, 5-inch rectangular bistable storage tube is utilized as the memory device and provides resolution equivalent to 100 by 125 stored line pairs. Output from a single scan converter may be looped through a number of monitors for viewing at remote locations. Multiple scan converter outputs can be mixed for color displays.

T4002 GRAPHIC COMPUTER TERMINAL

The T4002 with optional interactive graphics is a completely self-contained, desk-top terminal which provides a high-resolution, flicker-free display with both high-speed complex graphic and high-density alphanumeric capability. Its unique direct-view storage tube eliminates the requirement for a separate refresh memory and minimizes the information rate requirements of the data source. The annoying flicker associated with most refreshed displays is also eliminated. The new data is written only once and can be sent to the terminal at a convenient rate of 5,000 characters per second (AVERAGE).

The T4002 Graphic Computer Terminal consists of a display unit, terminal control, character generator, keyboard module, input/output interface and auxiliary unit.

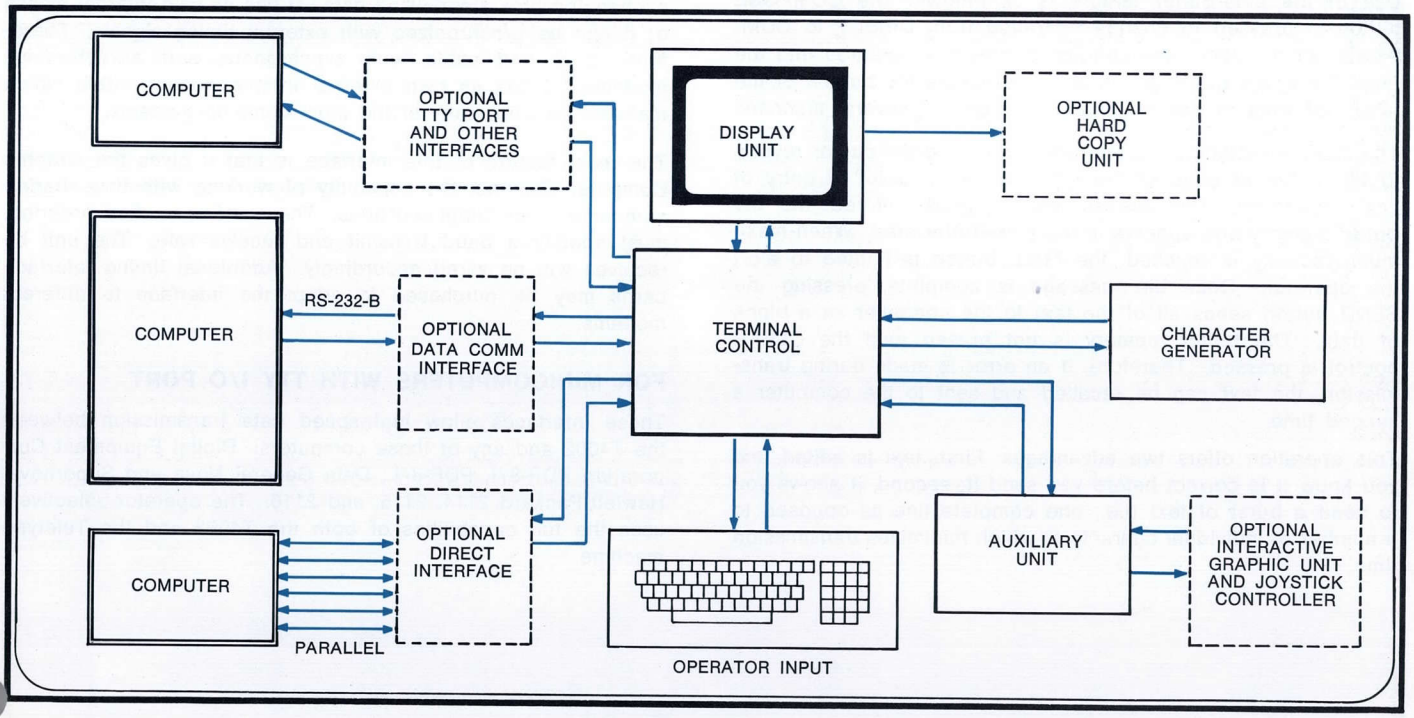
The terminal control provides timing logic, data buffers, interconnection logic, function decoding, line-buffer control, D/A converters and plot logic for the character generator, keyboard and auxiliary module. All the data is routed and priorities determined by the terminal control.

The character generator provides a complete set of USASCII printable characters with both upper and lower case, numerals and special symbols. Two sizes of characters (and two sizes of italics) are under program control.

The control panel is designed for ease of operation with panel controls held to a minimum by automatic control functions. The standard keyboard contains keys for 96 USASCII characters and 32 control characters.

The direct-view bistable storage tube provides most of the economic advantage of this type of system by eliminating costly refresh memory devices. The 11-inch, flicker-free display (6 1/2 x 8 1/4-inch screen) accommodates 39 lines of alphanumeric characters of 85 symbols each, permitting 3300 70 x 90 mil characters to be displayed. Resolution is equivalent to 287 x 400 line pairs. Stored information may be erased in less than 0.5 second.

The T4002 has a one-line 84-character local memory which displays data in a refreshed mode in a 1 cm x 21 cm area at the bottom of the CRT. This Line-Buffer feature is used, among other things, for composing and verifying alphanumeric data before it is sent to the computer as a message block.



T4002 GRAPHIC COMPUTER TERMINAL BASIC BLOCK DIAGRAM

OPERATING MODES

Four modes of display are selectable on the T4002: (1) alphanumeric; (2) point plotting; (3) incremental plotting; and (4) linear interpolate (vector). A fixed grid of 1024 x 1024 addressable points is available in any of the graphic modes. Of these points, 1024 x 760 points are viewable.

INTERACTIVE GRAPHICS

Tektronix Interactive Graphic devices offer distinct advantages in applications which require inputs of graphic data to the computer. These small modules plug into the Graphic Computer Terminal and interface the terminal to devices which output X and Y analog signals. The Interactive Graphic Units generate a clearly visible, parallax-free, cross-hair cursor which always covers the entire XY dimension of the screen. Upon command, they will digitize the graphic address at the intersection of the cross-hair cursor to a resolution within one LSB in 1,020 bits.

The cursor generation system has several advantages over other types of systems. These advantages minimize tracking errors, and eliminate drift and registration problems.

LINE BUFFER

The Line-Buffer feature of the T4002 Graphic Computer Terminal consists of a one-line, 84-character local memory. This memory is used in conjunction with a 1-cm x 21-cm refreshed area at the bottom of the tube. The information is in alphanumeric form, thus the user can edit the text before sending the information to the computer as a one-line message block. Information may be updated and verified, corrected if necessary, before it is sent to the computer.

Use of the Line-Buffer feature is as follows: The COMPOSE button is pressed to change operation from DIRECT to COMPOSE. At this time, any characters previously entered into the Line Buffer are presented in one line across the bottom of the tube. Information can be changed in one of several manners.

The CLEAR button clears the Line Buffer and the cursor reverts to the left-hand edge of the refreshed area (point of entry of next character). The desired text is typed, entered into the buffer memory and appears in the Line-Buffer area. When maximum capacity is reached, the FULL button is lighted to alert the operator. Once the message is complete, pressing the SEND button sends all of the text to the computer as a block of data. The buffer memory is not erased until the CLEAR control is pressed. Therefore, if an error is made during transmission, the text can be recalled and sent to the computer a second time.

This operation offers two advantages. First, text is edited and you know it is correct before you send it; second, it allows you to send a burst of text (i.e., one complete line as opposed to a number of individual characters) which minimizes transmission time.

The Line-Buffer area is also convenient for correcting messages. If the message is not correct as first typed, editing is accomplished as follows: The keyboard is backspaced until the cursor is positioned above the location where a change is desired. Backspacing across a character erases that character from the buffer memory. The character is deleted and the erased part of the text is retyped.

INTERFACE UNITS

Several interface options are available for the T4002 which increase its efficiency and versatility as a data communications terminal.

FOR DEC PDP-8 SERIES

Separate interfaces are available for computers with negative input/output buses and computers with positive input/output buses. Data is transferred in parallel under Program Data Transfer control of the PDP-8. When receiving input data from the PDP-8, the unit decodes the data, converts the logic, and provides transfer timing information to the Terminal Control. When transmitting output data, the unit changes the Terminal Control data to match the PDP-8 logic and transfers it under control of the computer's timing pulses. Each unit has its own external interconnecting cable wired for direct connection to the PDP-8's Input/Output Bus.

FOR DATA COMMUNICATION SYSTEMS

An interface allows the Tektronix Graphic Computer Terminal to communicate with devices which transfer data serially in either a full or half duplex mode. It is designed to conform to EIA Standard RS-232-B (October, 1968) which defines the minimum required circuits and electrical signal characteristics for exchanging binary serialized data. It has its own internal clocks or it can be synchronized with external timing signals. Therefore, it is compatible with synchronous and asynchronous modems. It has its own external interconnecting cable which matches up with many of the most common modems.

The main feature of this interface is that it gives the Graphic Computer Terminal the capability of working with time-sharing computers over telephone lines. The customer, when ordering, must specify a baud transmit and receive rate. The unit he receives will be wired accordingly. Additional timing interface cards may be purchased to adapt the interface to different modems.

FOR MINICOMPUTERS WITH TTY I/O PORT

These interfaces allow high-speed data transmission between the T4002 and any of these computers: Digital Equipment Corporation PDP-8/I, PDP-8/L, Data General Nova and Supernova, Hewlett-Packard 2114, 2115, and 2116. The operator selectively uses the full capabilities of both the T4002 and the Teletype machine.

APPLICATIONS

The following are intended to illustrate examples of T4002 applications. These brief examples should not be considered as all encompassing. The T4002 is a versatile Graphic Computer Terminal capable of solving an extremely wide range of applications.

MATHEMATICAL CALCULATION

The most common usage of time-sharing terminals today is calculation. With FORTRAN, engineers and scientists can create complex and highly repetitive routines for the computer to handle, insert the variables or parameters, and in a very short time obtain output. This allows exploration of a broad range of possible solutions, and decision-making based on analysis of a large sample or of ALL possible outcomes.

The T4002 is particularly useful in this kind of problem solving when the output is graphic rather than numeric. Certain kinds of problems need to be reduced to graphic form just to enable the user to understand the answer. Other problems lend themselves to easier solution when graphics can be used to reduce a mass of data to a form from which conclusions can more easily be drawn.

INQUIRY PROCESSING

A typical application for inquiry processing is a master file of customers with frequent requests for access to change data or for information on which to take action. A personnel system in a medium or large-size corporation is another data base which can be economically handled with display terminal access and input. Particular advantage is gained in situations where the customer is "on-line" at the same time as his record (customer service telephone answering).

MANAGEMENT INFORMATION RETRIEVAL

A series of displays, graphs, or charts, with appropriate titling and explanations is very conveniently displayed with the T4002 on the executive's desk top. It can be called up by the executive himself, using simple instructions to the computer. The individual manager can implement his own particular needs for information, with the emphasis on data summary and exception reporting, within a standardized format so that the programming effort does not become prohibitive. Updating of the data for these displays can be done automatically with the updating cycles of the master files.

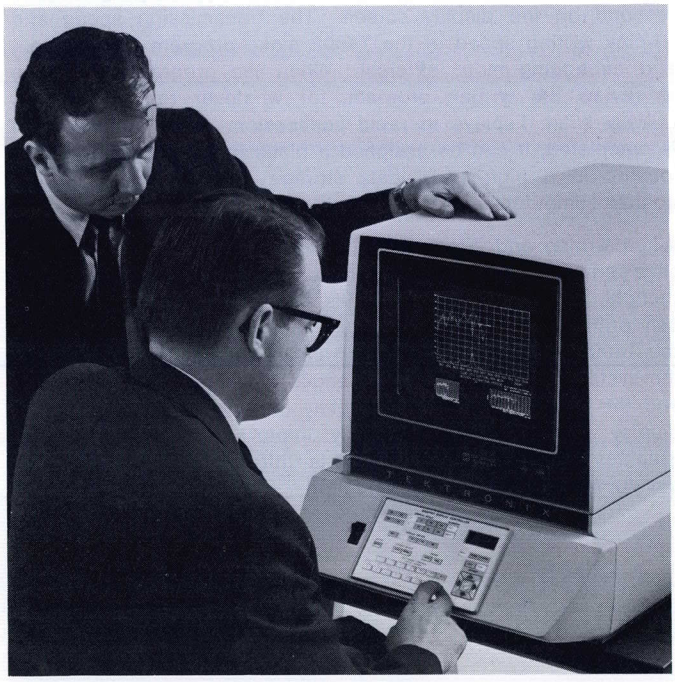
PROGRAMMING AND DEBUGGING

The T4002 is well suited for use in a time-sharing or multiprogramming environment, particularly for on-line conversational program development. The terminal can be connected to a computer with the appropriate program in its library and the user can begin to write his problem-oriented program. As each line of the program is completed, the computer will examine it against the parameters of the support program and respond on the display screen. The transmission speed and display writing speed of the T4002 make program development and debugging more efficient. When the programmer wishes to review the written program, for whatever reason, he can quickly scan displays in rapid succession. When the program is completed, it can be assigned a place in the program library, located in a high-speed data storage unit, peripheral to the central computer, available for immediate use.

When writing and "debugging" programs, a teletype readout is slow enough that the programmer often loses his train of thought. The mind usually thinks much faster than a teletype can print out program elements. The tremendous speedup of the T4002 with its quick readout allows a rapid input back into the system. Thus, ideas and changes are applied without delay and the effects may be immediately observed. This interactive display capability is particularly important when developing graphics programs, since there is little delay from program development to program observation.

T4005 GRAPHIC DISPLAY

Rapid access to computer-generated plots is available using the T4005 Graphic Display. The T4005 is more than a large-screen display device; it's also a graphic controller for selecting and manipulating the display, as well as routing the information to separate display devices.



Computer plots of complex graphics which up to now have required several minutes to plot, can now be displayed in a matter of seconds. Detailed analysis can be made of any selected portion of the display. This is accomplished by positioning a "frame" of a selected size and aspect ratio around the point of interest. Pushing a button erases the original display and in seconds replots only the previously framed portion for close examination. Magnification up to 32 times is available, enough to resolve the individual computer-generated dots which comprise the display.

Up to 8 commonly-referred-to displays can be stored for rapid recall, using the memory files of the associated computer. Once filed, they are protected from accidental erasure, but can be modified or replaced as desired.

The T4005, and companion 4201 which is essentially the controller section without display device, may be interfaced to the IBM 1130. A standard software package is included.

4601 HARD COPY UNIT

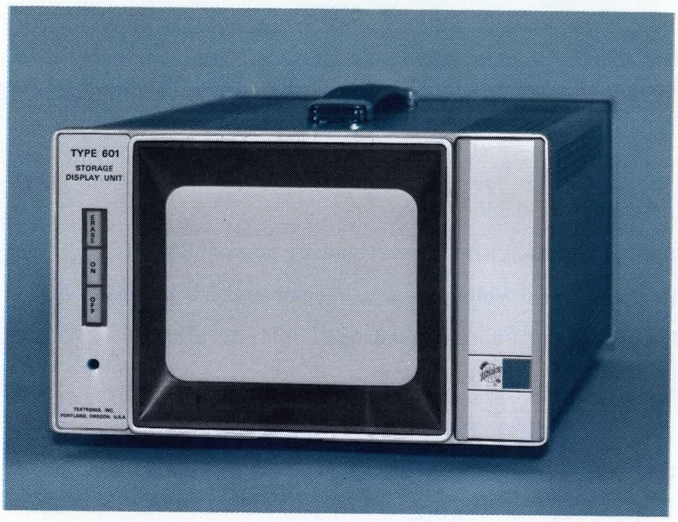
Permanent copies of CRT displays are quickly available from Tektronix 611, T4002, and T4005. The 8½ x 11-inch copies provide the high image contrast required for high-resolution reproductions of complex graphics and alphanumerics. Copy cost is low, and copies are available in seconds, without tying up valuable computer time. The 4601 copy command may be initiated by pressing a front panel control on the self-contained unit, or by supplying an external command.

PLEASE HAVE YOUR NAME ADDED TO THE TEKTRONIX MAIL LIST OR CONTACT ANY LOCAL TEKTRONIX FIELD ENGINEER OR APPLICATION ENGINEER FOR ADDITIONAL INFORMATION.

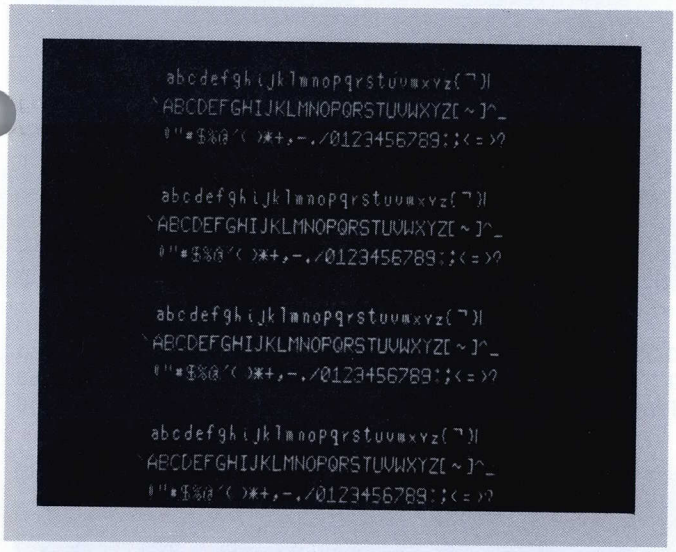
An actual size segment of the 8 1/2 x 11-inch hard copy

601
Storage Display Unit

- **FLICKER-FREE, BISTABLE STORAGE**
- **HIGH-RESOLUTION ALPHANUMERIC AND GRAPHIC DISPLAYS**
- **REMOTE PROGRAMMING OF DISPLAY FUNCTIONS**



The Type 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. The Tektronix-developed bistable Storage CRT used in the Type 601 eliminates the need for costly memory devices for refreshing the information display. The built-in vertical and horizontal differential amplifiers permit Y versus T plots up to 100 kHz for remote storage monitor applications. All solid-state modular circuit design insures long-term stable performance.



Stored display of standard ASCII character sets, photographed with C-30A Camera.

OPERATING FUNCTIONS

The Erase and Non-Store operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector. Manual control of Erase and Power On-Off is provided on the front panel. A "ready-to-write" mode is established by erasing the CRT manually or remotely. Remote programming of the Type 601 is achieved by grounding the appropriate contacts at the rear program connector. The Intensity, Focus, Astigmatism, and Operating Level Controls are located behind the front access door for convenience of the operator.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

Deflection Factor—Vertical: 1 V for 8-cm deflection, adjustable from 0.75 V to 1.1 V using internal controls. Horizontal: 1 V for 10-cm deflection, adjustable from 0.9 V to 1.1 V using internal controls. With Attenuation Resistors: Up to 150-V full screen can be obtained by adding attenuation resistors to input circuits.

Phase Difference—Not more than 1° between X and Y up to 100 kHz.

X-T Displays—Useful to 100 kHz for displaying waveforms on a Y versus T plot.

Initial Beam Position—Positioned by internal adjustment to any point on the screen. Position drift is not more than 1 mm/h after 20-min warm up.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ paralleled by approx 50 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

Recommended Source Impedance— 1 kΩ or less.

601
Storage Display Unit

Z AXIS

The Z-axis on-time should be at least 9 μs to insure good storage of each written dot. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

Input—Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V or less.

Input R and C— 100 kΩ paralleled by approx 50 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

Recommended Source Impedance— 1 kΩ or less.

CRT DISPLAY AND STORAGE

Tektronix CRT—5-inch flat-faced bistable storage tube, phosphor similar to P1.

Display Size— 8 cm vertically and 10 cm horizontally.

Resolution—Equivalent to 100 vertical x 125 horizontal stored line pairs. (Resolution is measured using 100 x 125 stored dots since closely spaced line pairs exceed 25% incremental storage.)

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 3% in the vertical direction, and 5% in the horizontal direction.

Viewing Time—At least 15 minutes without loss of resolution. Viewing time may be extended to one hour; however, several erasures may be required to fully remove previously stored data.

Dot Writing Time— 9 μs or less is required to write (store) one dot.

Information Storage Rate— 100 thousand dots per second.

Line Writing Speed (Stored)—At least 5 cm/ms (at specified resolution).

Erase Time—200 ms is required to clear screen of stored information.

OTHER CHARACTERISTICS

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz, 57 watts maximum power consumption. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights (cabinet included)—

Height	6 in	15.3 cm
Width	8 1/2 in	21.6 cm
Depth	17 3/8 in	44.1 cm
Net weight	17 1/2 lb	8.0 kg
Domestic shipping weight	≈24 lb	≈10.9 kg
Export-packed weight	≈30 lb	≈13.6 kg

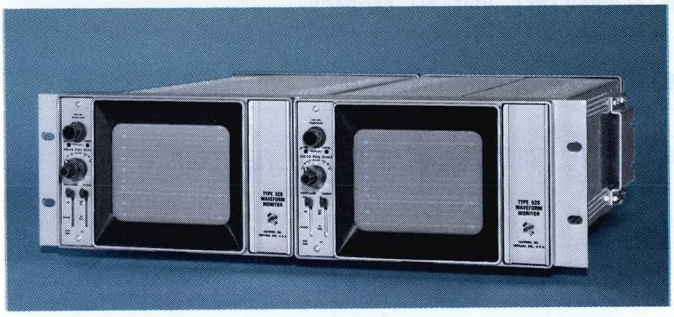
Included Standard Accessories—Program connector (131-0570-00); connector cover (200-0821-00); instruction manual (070-0747-00).

TYPE 601 STORAGE DISPLAY UNIT **$1175**

TYPE 601 MOD 146B STORAGE DISPLAY UNIT **$1150**
Standard instrument, less cabinet, for mounting in rack adapter.

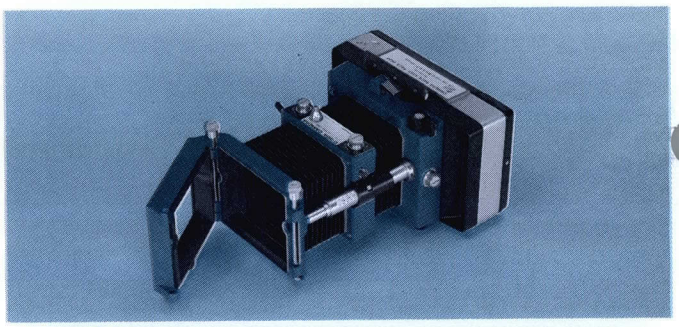
OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the Type 601 in certain applications.



5 1/4-Inch Rack Mounting Adapter For Type 601, 602, and 528—Accepts two Type 601's side-by-side in a standard 19-inch rack, includes rim clamps which allow fastening or removing instruments from the front, order 016-0115-02 ..... $95

Panel Assembly—For covering 1/2 of rack adapter when only one Type 601 is rackmounted, order 016-0116-00 ..... $8



C-30A Camera—f/1.9 lens, magnification variable from 1.5:1 to 0.7:1; Polaroid Land* Pack-Film, order C-30A-P $480
Type 601 to C-30A Camera adapter, order 016-0248-00 ... $16

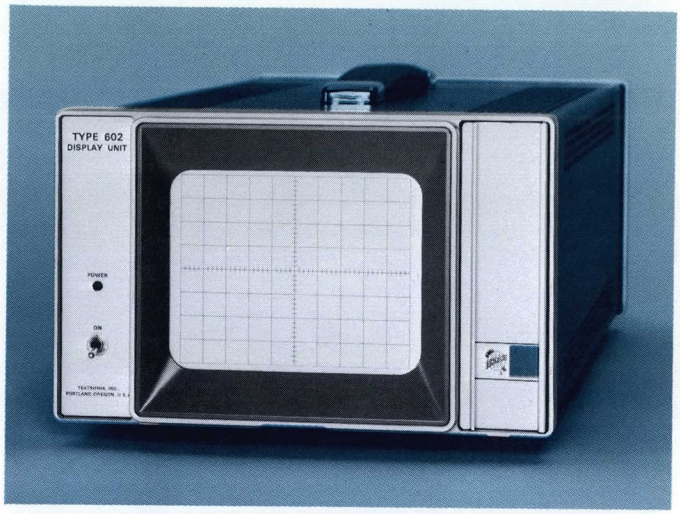
C-30A Camera Carrying Case—Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film, order 016-0126-00 ..... $38

*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

602
Display Unit

- 1-MHz X AND Y BANDWIDTH
- 100-mV/cm X AND Y DEFLECTION FACTORS
- X-Y PHASE DIFFERENCE WITHIN 1° TO 1 MHz
- UNIFORMLY SMALL SPOT SIZE
- DC-COUPLED Z AXIS



The Type 602 Display Unit is a compact, solid-state instrument with excellent resolution providing accurate displays of information from X, Y, and Z signal inputs. Application areas are: phase shifts and frequency ratios using *Lissajous* figures, graphic and alphanumeric displays from computers, high-resolution raster displays, with intensity modulation, and Y-T plots of amplitude versus time displays.

Permanent records of the Type 602 display are provided on Polaroid prints using the Tektronix C-30A Camera with adapter. Two Type 602's may be mounted side-by-side using an optional rack adapter.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

Bandwidth—DC to 1 MHz at 3-dB down.

Deflection Factor—Vertical: 90 mV/cm to 135 mV/cm, internally variable. Horizontal: 90 mV/cm to 110 mV/cm, internally variable.

Phase Difference—Not more than 1° between X and Y amplifiers up to 1 MHz.

Beam Position—Front panel vertical and horizontal position ranges permit setting zero signal position to any point on screen. Position shift is not more than 1 mm/h after 20-min warm up.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ ±10% paralleled by 30 pF or less.

Maximum Input Voltage— ±10 V DC plus peak AC.

Recommended Source Impedance— 1 kΩ or less.

Z AXIS

A linear Z-axis amplifier permits intensity modulation of the writing beam. Analog input: DC to 1 MHz over 0.0 V to +1 V range. Signal input is via a BNC connector on the rear panel.

Input R and C— 100 kΩ ±10% paralleled by 70 pF or less.

Maximum Input Voltage— ±10 V DC and peak AC.

Recommended Source Impedance— 1 kΩ or less.

CRT

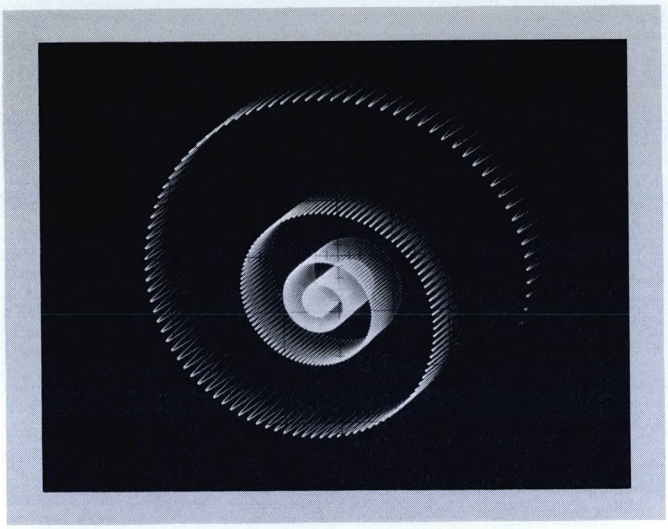
Tektronix CRT— 5-inch flat-faced rectangular CRT with P31 phosphor standard, P7 phosphor optional.

Display Size— 8 cm vertically and 10 cm horizontally.

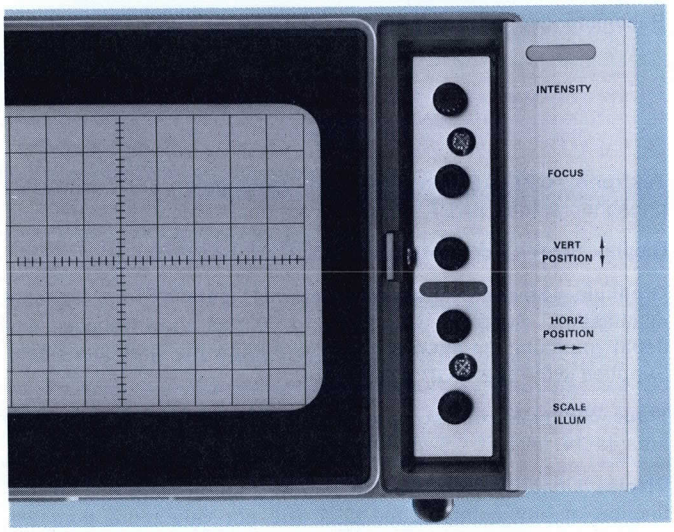
Graticule—Standard graticule: Internal, parallax-free, variable illumination. Supplied with standard 602, as shown above. Optional graticule: Internal 8 x 10-cm outline (no graticule lines). Supplied with 602 MOD 174K.

Trace Width—Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5-μA beam current.

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 2% in the vertical direction, and 6% in the horizontal direction.



Displayed is a low-frequency damped sinewave with 90° phase difference between X and Y inputs. A 1-MHz timing sinewave is also applied to the X, Y and Z input. Intensity modulation with the 1-MHz timing waveform adds the third display parameter and creates the illusion of depth.



Controls are conveniently located behind the front panel door.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz. 50 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Temperature—Electrical specifications are valid over the range of 0°C to +50°C ambient.

Finish—Blue vinyl painted cabinet, aluminum construction.

Dimensions and Weights (cabinet included)—

Height	6 in	15.3 cm
Width	8 1/2 in	21.6 cm
Depth	17 3/8 in	44.1 cm
Net weight	17 1/2 lb	7.9 kg
Domestic shipping weight	≈22 lb	≈ 9.9 kg
Export-packed weight	≈28 lb	≈12.7 kg

Included Standard Accessories—Smoke-gray filter, installed (378-0586-00); instruction manual (070-0799-00).

If optional P7 phosphor is ordered, smoke-gray filter (378-0586-00) is deleted and orange filter (378-0595-00) is added.

TYPE 602 DISPLAY UNIT **$750**

TYPE 602 MOD 174K DISPLAY UNIT **$750**
Standard instrument with optional internal 8 x 10-cm outline graticule.

TYPE 602 MOD 146B DISPLAY UNIT **$725**
Standard instrument, without cabinet, for mounting in rack adapter. Requires 5 1/4-inch vertical rackmounting space.

OPTIONAL ACCESSORIES

Optional accessories serve to extend the usefulness of the 602 in certain applications. Photos are shown with 601 description.

5 1/4-Inch Rack Mounting Adapter For Type 601, 602, and 528—Accepts two instruments side-by-side in a standard 19-inch rack, includes rim clamps which allow fastening or removing instruments from the front, order 016-0115-02 ..... $95

Panel Assembly—For covering 1/2 of rack adapter when only one Type 602 is rackmounted, order 016-0116-00 ..... $8

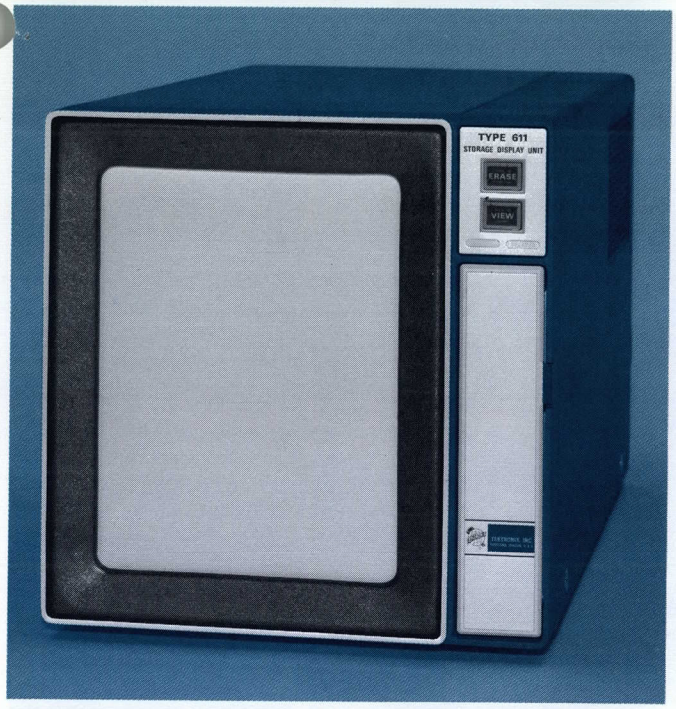
C-30A Camera—f/1.9 lens, magnification variable from 1.5:1 to 0.7:1; Polaroid Land Pack-Film Back, order C-30A-P .. $480

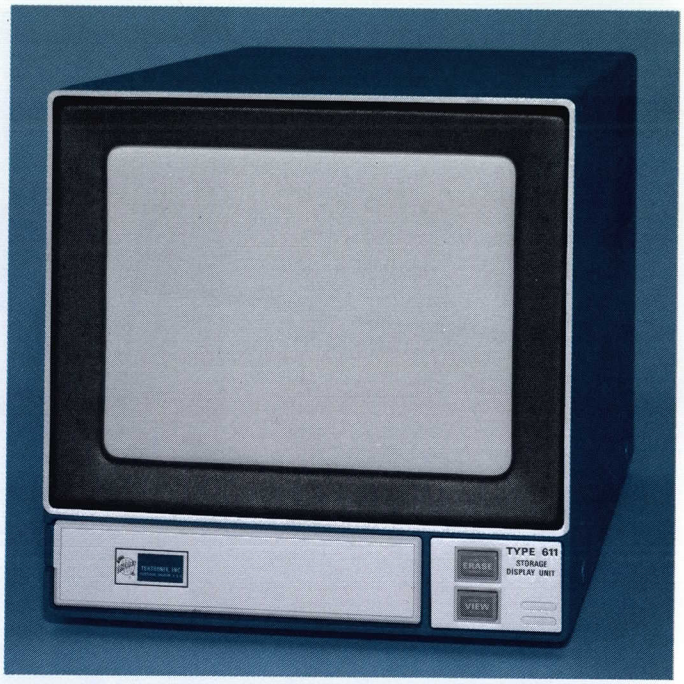
Type 602 to C-30A Camera adapter, order 016-0248-00 .. $16

C-30A Camera Carrying Case—Constructed of heavy-gage, high-impact plastic, has foam-backed, vacuum-formed styrene liner. Holds C-30A Camera, all standard accessories and extra film, order 016-0126-00 ..... $38

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

611
Storage Display Unit





Type 611 MOD 162C features a horizontal display format.

- **FLICKER-FREE BISTABLE STORAGE**
- **HIGH-RESOLUTION ALPHANUMERIC AND GRAPHIC DISPLAYS**
- **HARD COPY COMPATIBLE**
- **WRITE-THRU ABILITY**
- **REMOTE PROGRAMMING OF DISPLAY FUNCTIONS**

The Type 611 Storage Display Unit permits stored displays of combined alphanumeric and graphic information from digital computers and other data transmission systems. The Tektronix-developed bistable Storage CRT used in the Type 611 eliminates the need for costly memory devices for refreshing the information display and provides high information density without flicker or drift and with excellent resolution. A write-thru feature provides the operator the ability to visually position the writing beam to any point on the CRT display area without disturbing previously stored information. All solid-state circuit design insures long-term stable performance. The standard instrument provides a vertical format display area with the same aspect ratio as a typewritten page. A horizontal format display is available in a Type 611 Mod 162C.

CHARACTERISTIC SUMMARY

VERTICAL AND HORIZONTAL

Calibrated Deflection Factor— 1-V full screen deflection X and Y axis.

Settling Time—3.5 μs/cm + 5 μs.

Z AXIS

Turn-on Level— +1 V or greater.

Turn-off Level— +0.5 V or less.

Input R and C— 100 kΩ paralleled by 70 pF.

STORAGE CRT

Display Area—Vertical: 21 cm. Horizontal: 16.2 cm. 25% incrementally storable.

Resolution—Equivalent to 400 stored line pairs along the vertical axis; 300 stored line pairs along the horizontal axis.

Erase Time— 0.5 seconds.

Dot Writing Time— 5 μs.

OTHER

Remote Control of Erase, Non-Store, View and Write-Thru

Power Requirements—90 to 136 or 180 to 272 VAC, 48 to 66 Hz, 250 watts.

The Type 611 Storage Display Unit (MOD 162C shown) is ideally suited for information display applications. Up to 4000 alphanumeric characters may be stored and legibly displayed. These displays are directly copied by the 4601, providing an accurate representation of the display on 3M Type 777 Dry-Silver Paper.

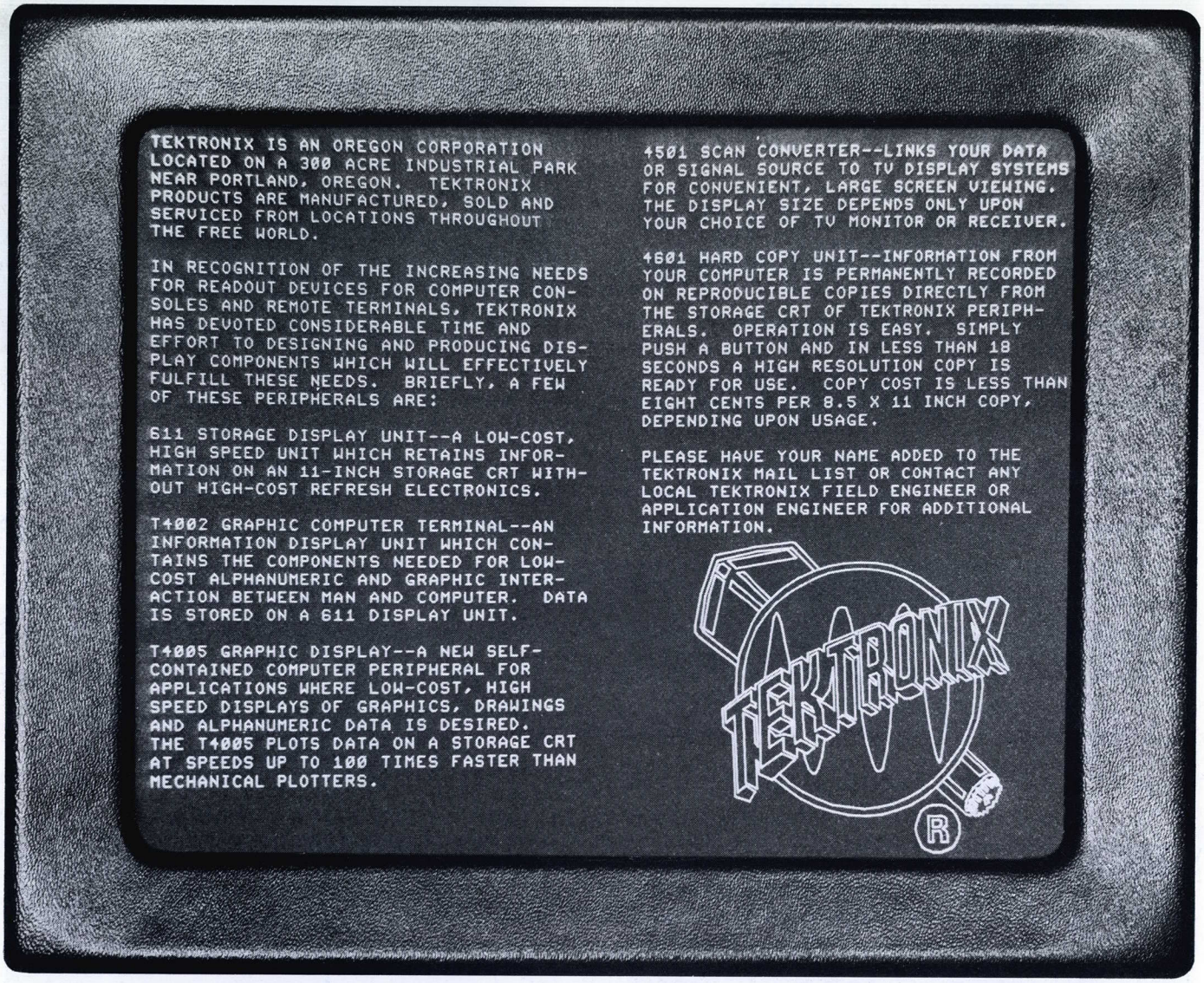
OPERATING FUNCTIONS

The operating functions are View, Erase, Non-Store, and Write-Thru. View and Erase are under manual or programmable control; Non-Store and Write-Thru are under programmable control. The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to a "ready-to-write" mode. As new information is written, it is retained on the CRT in the "view" mode. Within 90 seconds after the display is written, the 611 will automatically switch to a "hold" mode. This holds data stored on the CRT at a low brightness to extend storage time. Pressing the VIEW switch while in the "hold" mode, returns the display to the "view" mode for at least 60 seconds, but not more than 90 seconds. The "view" mode may be programmed for continuous viewing.

A special "write-thru" feature is provided for displaying additional information on a screen which may already contain stored information. In the "write-thru" mode the CRT beam is unblanked and a cursor, or any generated pattern, may be displayed without destroying previously stored data and without storing new data. This function is useful for positioning cursors and locating the CRT writing beam. In the "write-thru" and "non-store" modes the display remains on screen as long as it is refreshed.

The Intensity, Focus, Operating Level, Power Switch and Test Spiral controls are located behind a front-panel access door. Pushing the Test Spiral switch causes the instrument to complete an erase cycle and store a single-shot test pattern presentation. Pulling Test Spiral switch provides a "non-store" mode with repetitive test pattern for focusing and other tests.

The Erase, Non-Store, Write-Thru and View operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector. Manual control of Erase and View is provided on the front panel. Remote programming of the Type 611 is achieved b grounding the appropriate contacts at the rear program connector. The remote switching device must be capable of switching +10 V to approx ground (+0.5 V to −10 V) and handle up to 5 mA of current.



Alphanumeric and graphic display taken from a Type 611 MOD 162C used in a remote computer terminal application.

VERTICAL AND HORIZONTAL AMPLIFIERS

Deflection Factor—Vertical: 1-V full scale (16.2 cm for square format or 21 cm for rectangular format), accuracy within 2%.

Horizontal: 1-V full scale (16.2 cm), accuracy within 2%.

With Attenuation Resistors: Up to 75-V full screen for vertical or horizontal deflection can be obtained by adding attenuation resistors to input circuits.

Initial Beam Position—Any one of 9 initial beam positions can be selected by internal switches. Each position is adjustable ±10% of full scale both vertically and horizontally.

Settling Time— 3.5 μs/cm + 5 μs, to within 1 spot diameter of final position.

Positional Stability—0.16 mm (or less)/hour with 75-Ω source impedance at 20° C to 30° C. Within 1.6 mm/hour with 75-Ω source impedance at 10° C to 50° C, reference 25° C.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ paralleled by approx 70 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

Z AXIS

Input—Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V or less.

Input R and C—100 kΩ paralleled by approx 70 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

611
Storage Display Unit

CRT DISPLAY AND STORAGE

Tektronix CRT— 11-inch flat-faced bistable storage tube, phosphor similar to P1.

Display Size—Vertically: 21 cm (approx 8 1/4 inches), Horizontally: 16.2 cm (approx 6 3/8 inches). Display area is up to 25% incrementally storable.

Resolution—4,000 characters based on a 90 x 70 mil matrix, clearly legible with good spacing. Equivalent to 400 vertical x 300 horizontal stored line pairs. (Resolution is measured using 400 x 300 stored dots since closely spaced line pairs exceed 25% incremental storage.)

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 10%.

Viewing Time—At least 15 minutes without loss of resolution. Viewing time may be extended to one hour; however, several erasures may be required to fully remove previously stored data.

Dot Writing Time— 5 μs is required to write (store) one bit of information.

Erase Time—500 ms or less.

OTHER CHARACTERISTICS

Erase Interval Pulse—A negative-going erase pulse is provided at the rear program connector to inhibit external equipment during an erase cycle. Amplitude change is approx +10 V to +0.3 V, source impedance approx 2 kΩ.

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 250 watts maximum at 115 V and 60 Hz. Rear panel selection provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights—

Height	11 7/8 in	30.1 cm
Width	11 5/8 in	29.5 cm
Depth	22 3/8 in	56.8 cm
Net weight	51 lb	23.1 kg
Domestic shipping weight	≈62 lb	≈28.1 kg
Export-packed weight	≈72 lb	≈32.6 kg

Included Standard Accessories—Program connector (131-0570-00); connector cover (200-0821-00); instruction manual (070-0752-01).

TYPE 611 STORAGE DISPLAY UNIT **$2695**

TYPE 611 MOD 162C STORAGE DISPLAY UNIT **$2695**
Horizontal display format with same accessories as standard instrument.

ACCESSORIES

Viewing Accessories—Combination light filters and implosion shields improve contrast for high ambient light viewing.

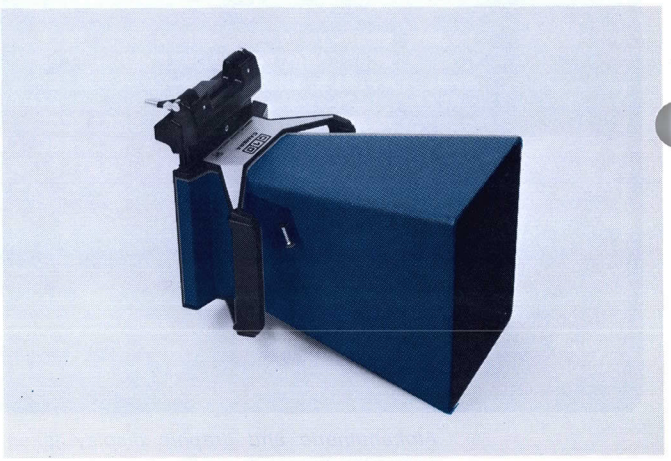
Filter 014-0039-00 offers high resolution, reflection free viewing with improved contrast and cleans easily.
Order 014-0039-00 ..... $125

The matt finish of filter 015-0145-00 improves contrast but causes slight loss of resolution. Order 015-0145-00 ..... $35

The glossy surface of filter 014-0040-00 improves contrast, retains resolution but causes reflections. Order 014-0040-00. $35

Hard Copy Unit—The 4601 used in conjunction with Tektronix Storage Display Units provides a convenient means for permanently copying alphanumeric and graphic displays. High-resolution displays obtained on the Type 611, T4002, or T4005 are copied by the 4601, providing an accurate representation of the stored display on 8 1/2 x 11-inch 3M Type 777 Dry-Silver Paper.

4601 HARD COPY UNIT **$3750**



Camera—The C-10 is a fixed-focus, light-weight camera designed for use with all Tektronix Information Display Products which have an 11-inch CRT. An f/8 lens with sufficient depth of field and convenient hand grips allows the C-10 to be held against the display area for photographing displays. The C-10 includes a Polaroid[1] 4 x 5 film holder.

C-10 CAMERA **$400**

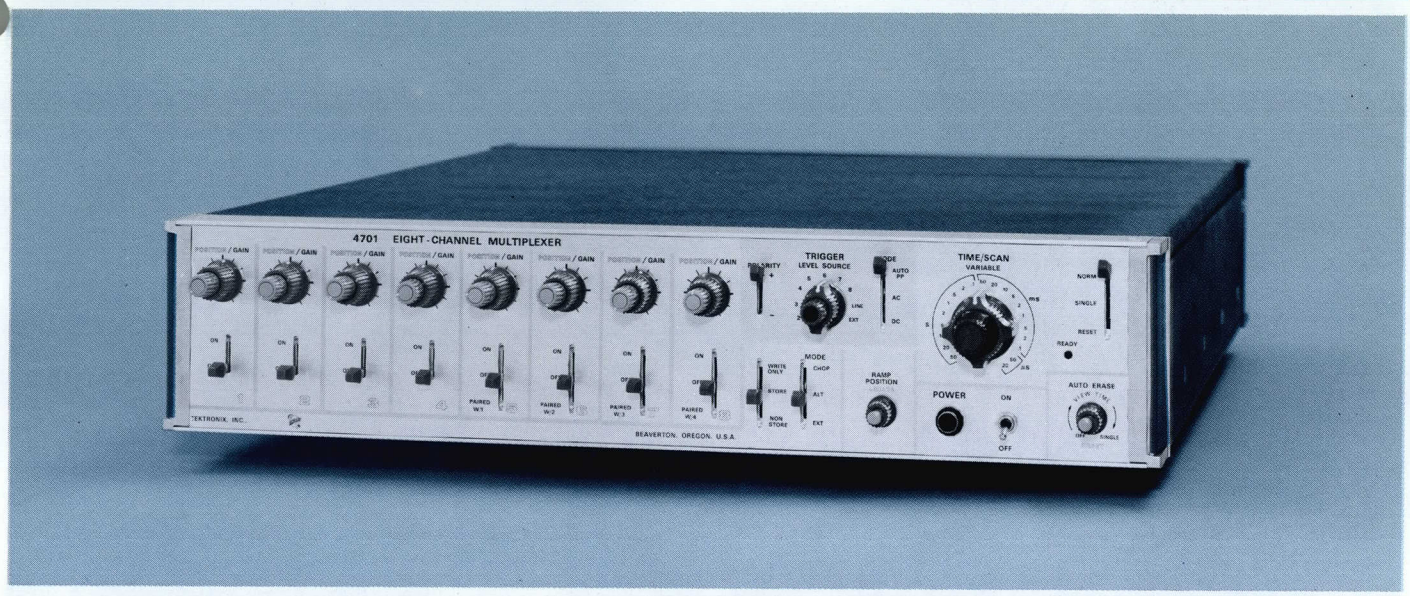
Rack Adapter—Rack height for the 611 is 14 inches, rack depth is 21 3/8 inches. Rack adapter includes slide-out assembly. Front panel finish is black, order 040-0551-00 ..... $95

[1]Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

4701
Eight-Channel Multiplexer

NEW



- 8 Channels with Differential Inputs
- Calibrated Timebase
- Four Channel X-Y Plot
- Mixed X-Y, Y-T Displays

The 4701 Eight-Channel Multiplexer features eight vertical channels and a calibrated timebase that provides signal conditioning for the Tektronix display instruments including the Type 601 and 611 Storage Display Units, the Type 4501 Scan Converter and the Type 602 Display Unit. The 4701 provides conventional 8-channel Y-T displays, 4-channel displays and mixed displays of X-Y and Y-T.

The 4701 also provides automatic erase for the Tektronix storage display units. The calibrated timebase provides full screen displays from 10 μs to 50 s and an oscilloscope type trigger circuit with automatic, AC or DC triggering.

VERTICAL CHARACTERISTICS

Deflection Factor— 1 V to 10 V, continuously variable.

Bandwidth—DC to 1 MHz.

Input Impedance— 1 MΩ paralleled by ≈ 20 pF.

Common-Mode Rejection Ratio—at least 100:1.

Output— 1 V into 50 Ω with 1 V input.

Operating Modes—Alternate in sequence 1 thru 8. Chopped: internal switch selects chopping rates of approximately 2.5 kHz, 30 kHz or 300 kHz. Externally programmed: 3 lines of TTL compatible binary code select the channel which is to be programmed.

X-Y Plots—Selected by the selector switch on channels 5, 6, 7 and 8 that select channels 1, 2, 3 and 4 respectively for their X display.

HORIZONTAL CHARACTERISTICS

Timebase—Provides full screen normal or single sweep displays from 10 μs to 50 s in a 1, 2, 5 sequence. A non-calibrated mode is continuously variable between steps.

Triggered Modes—Automatic peak-to-peak, AC coupled and DC coupled, plus and minus slope.

Trigger Inputs—Can be internal from each selected channel, external, or from the power line.

Automatic Erase—Provides automatic control of the Tektronix storage display unit and permits the 4701 to retain the display in a view mode from 0.5 s to 30 s, (continuously variable) after all channels are displayed.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 400 cycles, 21 watts maximum.

Dimensions and Weights—Height 3 1/2 inches, width 16 7/8 inches, depth 20 1/8 inches, and weight approximately 15 pounds.

Included Standard Accessories— 6 foot interconnecting cable (012-0258-00); 25-pin male connector (131-0570-00); instruction manual (070-1164-00).

4701 EIGHT-CHANNEL MULTIPLEXER **$1500**

To adapt the 4701 for use in a standard 19-inch rack, order rackmounting kit 602-0307-00 ..... $30

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

T4002

Graphic Computer Terminal

Shown with optional joystick

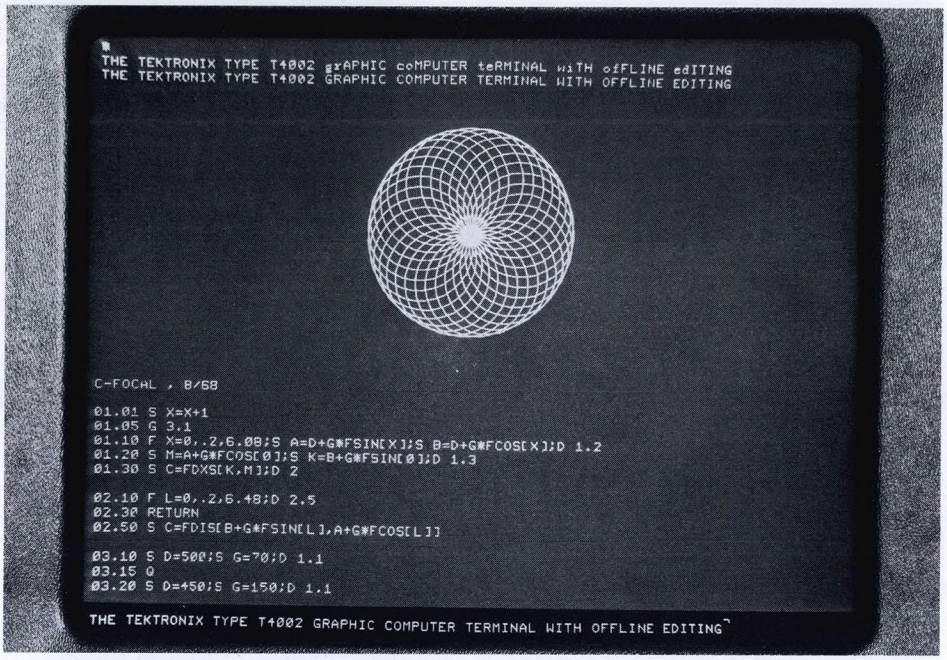
- INTERACTIVE GRAPHICS
- SOFTWARE SUPPORTED
- HARD-COPY COMPATIBLE
- RETAINS DISPLAYS WITHOUT REFRESHING
- HIGH DENSITY ALPHANUMERIC AND COMPLEX GRAPHIC DISPLAYS
- LINE-BUFFER AREA FOR EDITING

The Tektronix T4002 Graphic Computer Terminal is a completely self-contained, desk-top, information display terminal designed for rapid and efficient information exchange between man and computer. Complete communication interaction is achieved through the T4002 data-entry keyboard and optional Tektronix Interactive Graphic Units. The display device is a Tektronix developed, direct-view bistable storage tube which displays alphanumeric and graphic computer outputs without refreshing.

The Tektronix 4601 Hard Copy Unit or C-10 Camera produce permanent copies of the T4002 display. The Hard Copy Unit produces high quality, reproducible 8 1/2 x 11-inch paper copies of the stored screen contents in seconds. Copy command is either manual or computer initiated for unattended operation. The camera photographs the stored and line-buffer screen contents on a 4 x 5 Polaroid* film.

*Registered Trademark Polaroid Corporation

T4002
Graphic Computer Terminal



The Line-Buffer feature of the T4002 simplifies text composition, verification and correction. The first line in the above photograph is incorrect. The line is recalled from the buffer memory and corrected in the Line-Buffer area at the bottom of the display. After correction, the line is retransmitted to the stored display area.

CHARACTERISTIC SUMMARY

CONTROL PANEL

Power—Key switch.

Keyboard—Full USASCII (128 codes).

Control Lock—Key switch for security purposes.

Mode Controls and Indicators:

On Line/Local—Indicates on-line or off-line connection.

Transmit/Receive—Communication-mode status.

ASCII/TTY—Communication-code indicator.

Display/Auxiliary (or both)—Input source indicator.

Special Functions:

Page Full—Halts output when screen is full of alphanumerics.

Margin Shift—Allows four fixed margin positions for increased information.

Comm Error—Lights on detected error at interface bus.

Data Received—Indicates computer input to T4002.

Interrupt—Used to halt computer output.

DISPLAY CAPABILITY

96 USASCII symbols including both upper and lower case characters, numbers and special symbols.

Graphics:

1024 x 1024 addressable points.
1024 (X) by 760 (Y) viewable points.
Incremental plot.
Point plot.
Linear interpolation (vector).

Alphanumeric:

39 lines, 85 characters per line in stored area.
1 line, 84 characters in Line-Buffer area.
2 sizes of characters and italics under program control.
5000 characters per second (average) writing capability.

DISPLAY CHARACTERISTICS

Display Area—15.2 cm x 21 cm.

Erase Time—0.5 second.

Resolution—Equivalent to 400 x 287 line pairs.

INTERFACE UNITS

For Digital Equipment Corporation PDP-8 Series Computers with negative input/output buses.

For use with devices which transfer data serially in either full or half-duplex mode. Conforms to EIA Standard RS-232B (October, 1968).

For Digital Equipment Corporation PDP-8 Series Computers with positive input/output buses.

For computers with TTY I/O port.

CONFIGURATION

The T4002 console contains the following system components: display unit, terminal control, character generator, input/output interface, and keyboard. Space is provided within the terminal to accommodate an auxiliary module for expanding system capability. Interfaces are available for direct coupling to computers or data communication systems.

DISPLAY UNIT

A Tektronix, 11-inch, direct-view, bistable storage tube is used as the display medium. High-density alphanumerics and complex graphics are presented without flicker or drift. The 15.2-cm by 21-cm screen will accommodate up to 39 lines of alphanumeric characters with 85 symbols per line. More than 3300 characters may be displayed with excellent clarity. Resolution achieved is equivalent to 400 x 287 line pairs. Viewing time is at least 15 minutes. Viewing time may be extended to one hour; however, successive erasure of previously stored information may be required.

T4002
Graphic Computer Terminal

LINE BUFFER AREA

The Line Buffer capability of the T4002 makes use of one 84-character line of discrete memory. Data is entered through the keyboard, stored in memory, and displayed in a 1-cm x 21-cm continuously refreshed, flicker-free area at the bottom of the screen. The information in this memory can be verified and edited before it is sent to the computer as a single message block.

A cursor is always positioned over the next area to be written. Any character may be changed by backspacing the cursor to the character to be changed. Backspacing past a character erases that character from local memory. Pressing the SEND control transmits the Line Buffer Area information to the computer if ON LINE, or to the designated output device if in LOCAL.

KEYBOARD

Manual entry of data is through a solid-state circuit keyboard with full USASCII capability (128 codes). 96 upper and lowercase characters, numbers and special symbols are provided for alphanumeric data entry. Two sizes of characters and two sizes of italics are under program control. 32 additional control characters are included for communications between the computer and the terminal. All controls are program callable. The keyboard has 2-key rollover protection.

TERMINAL CONTROL

The Terminal Control is the traffic director which interfaces all of the major components of the system. It provides interface logic, code conversion, data timing, data-buffering, mode switching and digital/analog conversion. Terminal Control routes alphanumeric data to the character generator and controls graphics directly. The Terminal Control's I/O interface bus is TTL compatible.

The T4002 operates in one of four display modes set by Terminal Control in response to control characters or control bits.

Alphanumerics—Prints, on a fixed format, alphabetical and numerical characters according to the USASCII code.

Graphics—The T4002 operates under program control in one of three modes to form graphic figures. The terminal then assembles incoming data as XY information and either plots points or draws lines to form graphic figures. The three graphic modes are:

1. Incremental plot: In this mode, the T4002 increments the plot position one point in any one of eight directions from the last point location, according to an assigned code in the data word.
2. Point plotting: In this mode, the X and Y address in each data word is decoded and the point is printed on command from Terminal Control.
3. Linear interpolation: In this mode, the T4002 draws a smooth line between two sets of XY coordinates contained in a data sequence. The line (or vector) can be intensified or dark. The lines can be any length, but for uniform intensity, they should be held to two inches or less.

Character Input Speeds—Data character input speeds to Terminal Control are as follows:

Alphanumeric— 5,000 characters per second (average).

Incremental Plot— 75,000 intensified (displayed) points per second maximum. 15,625 unintensified (not displayed) points per second maximum.

Point Plot—Same as for incremental plot except points must be adjacent.

Linear Interpolation— 2 ms/vector for unintensified (not displayed) vectors. 8 ms/vector for intensified (displayed) vectors.

CHARACTER GENERATOR

The character generator provides a set of 96 USASCII characters, including 1 "space" and 1 "delete" character. Two sizes of characters are under program control, 70 x 90 mils and 140 x 180 mils. At least 5000 characters per second (average) may be generated.

T4002
Graphic Computer Terminal

CONTROLS AND INDICATORS

In addition to a standard alphanumeric keyboard, other labeled and light-coded controls are provided to enhance ease of operation. The number of panel controls is minimized and control functions made automatic where practical (see photo of keyboard).

Control Characters—The USASCII provides for 32 control characters to be utilized for communication between computers and remote I/O equipment. Keys to activate these control characters are provided on the right portion of the keyboard. Functions peculiar to the T4002 are also controlled from this keyboard area. Certain of these control characters are easily rewired to perform application oriented functions in addition to the defined functions.

View/Hold—Switches the display from a hold mode to a view mode for 60 to 250 seconds.

Erase—Erases the entire stored display area.

Format Controls—Provide a means of moving the cursor when fixed-format alphanumerics are used. The five format buttons (top left of keyboard) move the cursor UP, DOWN, RIGHT, LEFT or HOME (fixed point upper left corner—resets T4002 from Graphics to Alphanumerics).

Power Off/On/Control Lock—Key-operated, 3-position rotary switch controls line voltage to the T4002. A color-coded mechanical flag showing through the POWER ON aperture indicates the position of the switch. CONTROL LOCK is a "security" position in which input from the T4002's control panel and keyboard is locked out.

On Line/Local—Controls on-line and off-line terminal operation and indicates status.

Transmit/Receive—Controls and indicates the communication mode status.

ASCII/TTY—Controls and indicates communication code being output by the keyboard.

Input: Keyboard/Aux—Controls and indicates selection of KEYBOARD and/or AUXILIARY as input to computer.

Output: Display/Aux—Controls and indicates selection of the DISPLAY and/or AUXILIARY or both to receive output from computer.

Page Full—Indicates full page and stops information from computer (in alphanumeric mode only).

Margin Shift—Allows a choice of four fixed margin positions, starting on the left and moving to the right. Useful when writing columns of short statements.

Comm Error—Indicates an error at the terminal control interface.

Data Received—When the computer makes an entry to the display, the indicator lights. Pressing the control extinguishes the indicator.

Interrupt—Pushing this button initiates a function which may be interpreted by the computer as an interrupt.

Direct/Compose—Controls and indicates text editing function.

Direct: Each character is processed as it is typed.

Compose: Corrections, additions and deletions are made from the keyboard and displayed as edited in the line-buffer area.

Full/Clear—FULL indicates the capacity of the 84-character line-buffer's memory has been reached. Pressing the CLEAR button while in the COMPOSE mode will clear the storage register.

Send—Pressing this control while in COMPOSE causes the information in the line-buffer to be transmitted to the computer if in ON LINE and to the designated output device if in LOCAL.

SOFTWARE

The T4002 Graphic Computer Terminal is supplied with a standard Utility Software Package. It provides the routines to exercise the various functions of the terminal in its different modes of operation; and also subroutines for outputting all ASCII characters.

In addition, a Fundamental Plot Package of FORTRAN subroutines is supplied enabling the user to graphically operate in Point Plot, Incremental Plot and Linear Interpolate, to draw axes, do scaling, and perform other graphic manipulations.

The Standard Software Package offered with the T4002 is for users facilities which support a FORTRAN capable of either "A" format (i.e., unspecified character format) or assembly level access from FORTRAN. The T4002 Graphic Computer Terminal software will be negotiated on an individual basis for users whose facilities do not support FORTRAN.

When ordering the T4002, please specify the following information about the intended facility:

Hardware—Computer type, by make and model.

Software—If an operating system is used, please identify by manufacturer and indicate any variation. What languages does the facility support (please state levels). Which of these languages allows assembly level access?

OTHER CHARACTERISTICS

Power Requirements—A quick-change line-voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. Frequency range is 48 to 66 Hz. Maximum consumption at 115 V is 400 watts.

Operating Temperature Range— +10°C to +40°C.

Dimensions and Weights

Height	19 3/8 in	48.7 cm
Depth	34 7/8 in	88.7 cm
Width	19 in	48.3 cm
Net weight	130 lb	46.8 kg
Domestic shipping weight	191 lb	86.6 kg

Included Standard Accessories—Specifications manual (070-0996-00), display unit maintenance manual (070-1051-00), keyboard unit maintenance manual (070-1052-00), drawer unit maintenance manual (070-1053-00).

T4002 GRAPHIC COMPUTER TERMINAL, without interface **$8800**

The T4002 is available with a blue cabinet. Order **T4002 GRAPHIC COMPUTER TERMINAL** option one (without interface) **$8800**

ACCESSORIES

Viewing Accessories—Combination light filters and implosion shields improve contrast for high ambient light viewing.

Filter 014-0039-00 offers high resolution, reflection free viewing with improved contrast and cleans easily.

Order 014-0039-00 . . . . . $125

The matt finish of filter 015-0145-00 improves contrast but causes slight loss of resolution. Order 015-0145-00 . . . . . $35

The glossy surface of filter 014-0040-00 improves contrast, retains resolution but causes reflections. Order 014-0040-00. $35

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

DATA COMMUNICATION INTERFACE UNIT

Serial Asynchronous Interface for Data Communication Systems—This interface allows the Graphic Computer Terminal to operate with systems which transfer data serially in either a full-duplex or half-duplex mode. It conforms to EIA Standard RS-232-B (October, 1968) which defines the minimum required circuits and electrical signal characteristics for exchanging binary serialized data. Internal clocks or external timing signals may be used. Transmit and receive rates are independent of each other and must be specified on order. Standard rates are 110, 150, 300, 600, 1200, 1800, 2000, 2400 bits/sec inclusive. For other optional rates, contact your Application Engineer.

Included Standard Accessories—Interconnecting cable to RS-232-B type modems (015-0150-00); user's manual (070-1049-00); instruction manual (070-0998-00).

Order 021-0002-00 Serial Data Communications Interface (please specify standard send and receive rates) $600

Additional Timing Interface Control Boards may be ordered if operation is planned at more than one transmit/receive rate. Order Timing Interface Control Boards (specify send and receive rates) $175

TELETYPE PORT INTERFACE UNITS

Serial Asynchronous Teletype Port Interface Unit—The Teletype Port Interface allows high-speed data transmission between the Tektronix T4002 Graphic Computer Terminal and a computer through the computer's TTY I/O port. Currently, T4002 Teletype Port Interfaces are available for the following minicomputers: Digital Equipment Corporation PDP-8/I and PDP-8/L Computers, Data General Corporation Nova and Supernova Computers, Hewlett-Packard 2114, 2115 and 2116 Computers. Interfaces for other computers are under development. Contact your Application Engineer concerning your interface requirements.

The Teletype Port Interface allows the operator to selectively use the full capabilities of either the T4002 or the teletypewriter. To operate the T4002 and computer, standard computer/terminal programming procedures are followed. To switch from T4002 to TTY operation, the user simply pushes the T4002 front panel LOCAL/ON LINE button to LOCAL. This electrically disconnects the T4002 and connects the teletypewriter to the computer through the TTY port interface, and automatically changes the data rate to 110 baud.

When using the TTY Port Interface, data is transferred serially by the interface in a full-duplex mode. The receiving rate is adjustable between 125 baud and 125 kilobaud. The transmitting rate is adjustable between 125 baud and 6.25 kilobaud. The interface is compatible with the full USASCII code and will assemble the information in the graphic compatible format when the T4002 is in a graphic mode of operation. The TTY Port Interface is current operated like the teletypewriter and is provided with necessary cabling and connectors for direct connection to the computer I/O Bus. As an option, it may be converted to an EIA RS-232-B configuration (voltage operation) for use with modems or couplers by the replacement of two optional plug-in cards and a connecting cable. Also the computer's previously existing TTY interface electronics is utilized, retaining the computer/Teletype system capabilities, including the reader and punch.

The operational characteristics of each unit are determined by the computer with which it interfaces. The rear panel mechanical configuration of each unit is compatible with the appropriate TTY and computer connections. A switch on the rear panel allows the user to select either MODEM or TTY capability when optional circuit boards are installed.

With this Interface, users of minicomputers utilize the many advantages of the T4002 Graphic Computer Terminal in applications where high display speeds and graphics are beneficial. One of the greatest advantages of the T4002 is the fact that programming is made so much easier and quicker than with slower terminals. The speed of the T4002 readout allows the programmer to retain his train of thought when writing and "debugging" programs. The tremendous speedup of the T4002 with its quick readout allows a rapid input back into the system. Thus, ideas and changes are applied without delay and the effects may be immediately observed. This interactive display capability is particularly important when developing graphics programs, since there is little delay from program development to program execution.

Also, the T4002 provides users the capability of displaying information in a graphic format. Many kinds of applications, such as scientific computations and process controls, give the user a clearer, more concise understanding of the information when it's presented graphically. Other problems lend themselves to easier solution where graphics reduce a mass of data to a format from which changes, trends and conclusions are easily drawn.

SOFTWARE

The Teletype Port Interface Unit is provided with software which facilitates program access to the T4002 and Interactive Graphics Units. Documentation includes program descriptions, flow diagrams and program listings.

ORDERING

When ordering, please specify your computer system configuration by manufacturer, model and/or type number, and your TTY or data communications I/O options.

Each interface includes an interconnecting cable and necessary accessories to match computer specified in order, software package to match computer specified in order, instruction manual, and user's manual.

For PDP-8/I & PDP-8/L, order 021-0004-00 ..... **$750**
For Nova and Supernova, order 021-0005-00 ..... **$750**
For 2114, 2115, and 2116, order 021-0006-00 ..... **$750**

Optional Accessories—To convert the TTY Interface to a RS-232-B compatible Interface requires the substitution of the following accessories.

Timing interface control board, (please specify baud send and receive rate) $175.00
Level converter board, order 670-0798-00 ..... $100.00
Modem cable (RS-232-B), order 015-0150-00 ..... $50.00
User's manual, order 070-1049-00 ..... $2.50
Interface unit maintenance manual, order 070-0998-00 $3.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

T4002 Interface Units

DIRECT INTERFACE UNITS

Interface Units 021-0001-00 and 021-0003-00 match the Tektronix T4002 Graphic Computer Terminal to the Digital Equipment Corporation's PDP-8 family of small computers with negative or positive input/output buses respectively. Data is transferred in parallel under Program Data Transfer control of the computer. When receiving input data from the computer, the interface decodes the data, converts the logic and levels, and provides transfer timing information to Terminal Control. When transmitting output data, the interface changes the Terminal Control data to match the computer logic and levels and transfers it under control of the computer's timing pulses. The interface has its own external interconnecting cable wired for direct connection to the computer's input/output bus.

Parallel Interface for Digital Equipment Corporation PDP-8/I Computer with Negative Input/Output Buses—Included standard accessories are: interconnecting cable to PDP-8/I (015-0151-00); circuit card assembly, I/O bus terminator card (018-0036-00); user's manual (070-1050-00); instruction manual (070-0997-00).

Order 021-0001-00 Parallel Interface $675

Parallel Interface for Digital Equipment Corporation PDP-8/I or PDP-8/L Computer with Positive Input/Output Buses—Included standard accessories are: either interconnecting cable to PDP-8/I (015-0151-00), or interconnecting cable to PDP-8/L (015-0159-00) (please specify); circuit card assembly, I/O bus terminator card (018-0035-00); user's manual (070-1050-00); instruction manual (070-1041-00).

Order 021-0003-00 ..... $675

Auxiliary Interface (Blank Module)—A plug-in frame, securing hardware and I/O connectors for users who wish to construct special interfaces. Order 040-0507-00 ..... $83

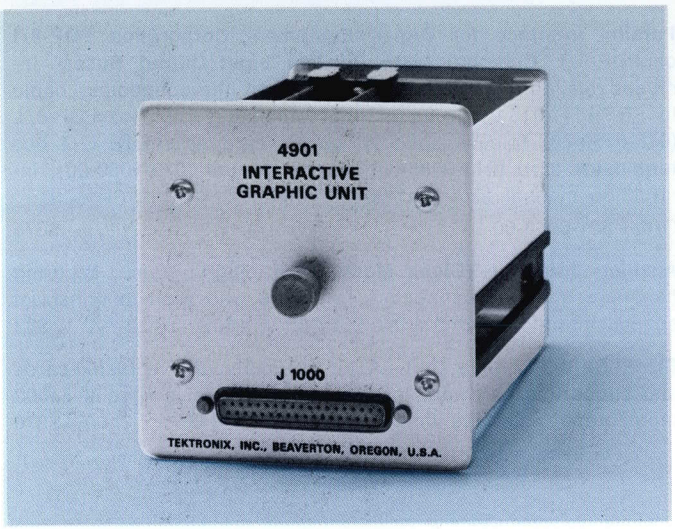
Blank Card Interface Unit—A kit assembly of five blank cards and supporting hardware for user fabrication of a special T4002 input/output interface unit. Order 040-0552-00 ..... $270

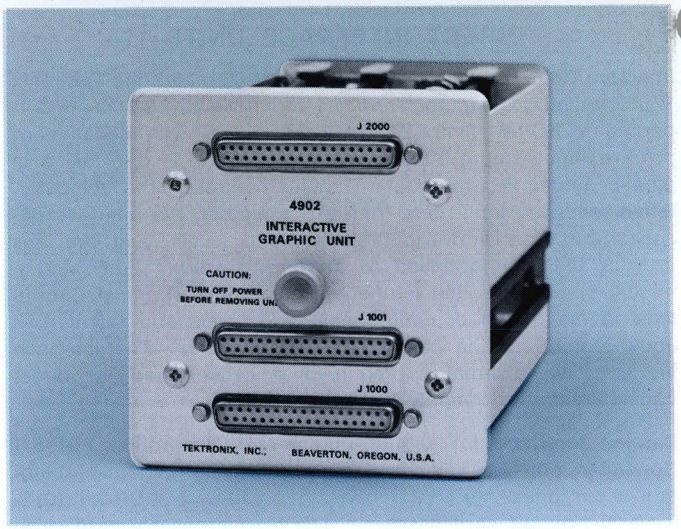
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

4901 and 4902

Interactive Graphic Units





- **INTERACTIVE GRAPHICS FOR T4002 GRAPHIC COMPUTER TERMINAL**
- **SOFTWARE SUPPORTED**
- **CLEARLY VISIBLE, PARALLAX-FREE, FULL-SCREEN, HIGH-RESOLUTION CURSOR**
- **RESOLUTION WITHIN ONE LSB IN 1020 BITS**
- **COMPATIBLE WITH GRAPHIC INPUT DEVICES WHICH OUTPUT ANALOG SIGNALS OF +5 V OR LESS**

4901 INTERACTIVE GRAPHIC UNIT

The 4901 Interactive Graphic Unit interfaces the Tektronix T4002 Graphic Computer Terminal* with graphic input devices which output X and Y analog signals. Analog signals are received by the 4901 from the graphic input device. The 4901 continuously compares these signals with the data in the T4002 D/A converters. Upon command from the computer, the T4002 keyboard, or an external graphic device, the 4901 will digitize the graphic address of the intersection of the crosshair cursor. The digitized graphic address is sent to the computer through the T4002 I/O interface unit.

The 4901 generates a refreshed, clearly visible, full-screen cursor which always covers the entire X, Y dimensions of the T4002 storage display. The cursor forms perpendicular, horizontal and vertical lines which have a clearly discernible intersection. This provides a sharply defined point for use in accurate graphic formatting. Cursor positioning is controlled by the X, Y inputs from the external graphic device.

The cursor position accuracy is within one Least Significant Bit (LSB) in each of the two axes. This accuracy is accomplished by counting, in one direction only, the X, Y registers which generate the crosshair cursor. This means that the point of interest is always approached from the same direction, providing accuracy to one LSB.

The cursor generation system uses the T4002 D/A converter system. This common system provides several advantages. It eliminates tracking errors, and drift and registration problems which usually exist between the display system and the graphic input device in equipment where two different converter systems are used. A single system also eliminates a number of critical calibration adjustments and allows the user to take full advantage of the complete addressability of the display system.

The 4901 interfaces with the T4002 Graphic Computer Terminal through the T4002's auxiliary I/O and is housed in the T4002 console space provided for auxiliary modules.

T4002's below Serial #B010180 must be modified for use with 4901 and 4902. Contact your Tektronix Application Engineer for information.

4902 INTERACTIVE GRAPHIC UNIT

The 4902 is an electronic interface between the Tektronix T4002 Graphic Computer Terminal* and several kinds of auxiliary input devices, which output analog signals of +5 V or less. The 4902 Interactive Graphic Unit performs all the functions of the 4901 Interactive Graphic Unit plus the following additional features:

Point Digitization—The 4902 can digitize and transmit to the computer, data representing either a single point or an array of points, programmable from 16 to 1024 maximum.

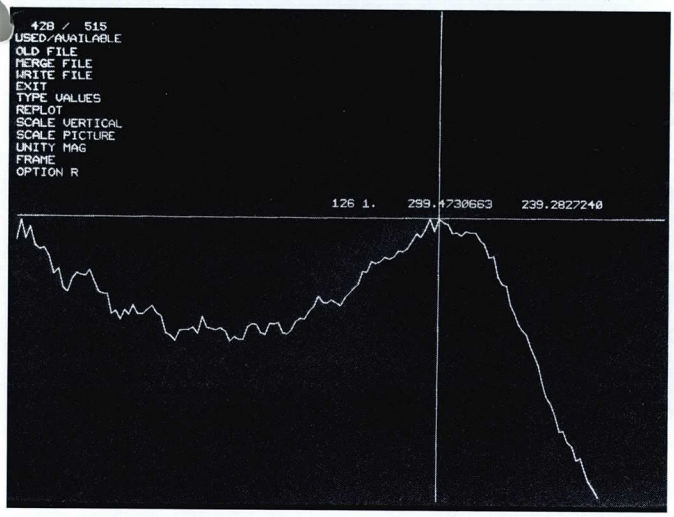
Programmable and Strappable Features—The modes of operation of the 4902 are under program control utilizing ASCII control functions and a control word with specific bit assignments. The ASCII control function used in the 4902 can be selectively patched to any one of the 32 ASCII functions thereby maintaining computer data communication and system compatibility requirements, such as line control, coding, and record lengths. Parity can be strapped for either odd or even depending upon system configuration.

The 4902 interfaces with the T4002 through the T4002's Auxiliary Channel and is housed within the T4002 console in the space provided for auxiliary modules.

Front panel connections J1000, J1001, and J2000 are provided for connecting up to three input devices as additional ones are made available, and to provide input interfaces for the operator who wishes to use a device which he designs. Optional 4951 Joystick, connects to J1000.

4901 and 4902
Interactive Graphic Units

NEW



The above photograph pictures the clearly visible parallax-free, crosshair cursor generated by the 4901 or 4902. The cursor always covers the entire X, Y dimensions of the display. Positioning accuracy is within one LSB along each axis.

COMMON CHARACTERISTICS
X AND Y DIFFERENTIAL AMPLIFIERS

Sensitivity—1 bit/5 mV.

Gain Accuracy—Within 1.5% of full scale.

Common Mode Signal Range—At least ±15 V.

Differential Input Signal Range—5.115 V or less.

Maximum Safe Input Voltage—+22 V to −22 V, each input referenced to program ground.

Maximum DC Offset—50 mV or less.

Nominal Input Resistance—Single-ended 80 kΩ, differential 160 kΩ.

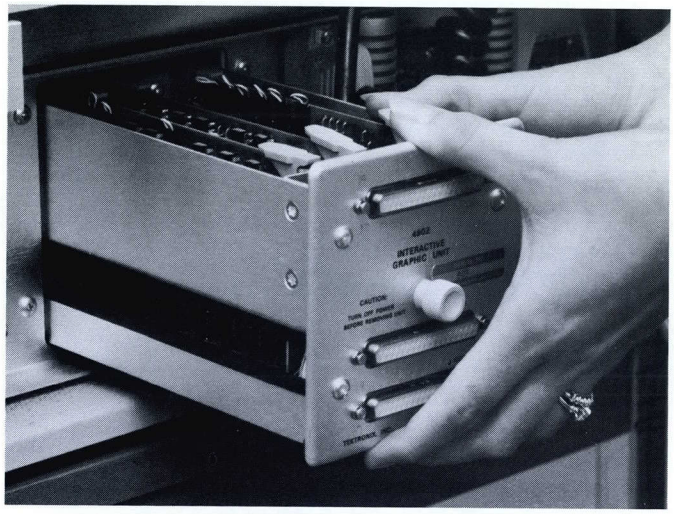
Maximum Input Current Offset—plus inputs, 75 μA; minus inputs, 250 nA.

T4002/4901 or 4902/Graphic Input Device System Resolution—X axis resolution is within one addressable point (1 LSB) between and including points 3 to 1023. Y axis resolution is within one addressable point (1 LSB) between and including points 0 to 1020.

Time to Digitize—XY point, 20 ms or less, including 10 ms cursor turn on; Y point only, 10 ms or less.

Data Multiplexing Time Delay Requirement—5 μs or less plus delay added by parallel interface units.

Program Digitize Delay—At least 10 ms must be allowed between cursor turn on and first digitized command following turn on. Applies to 4901 only.



The 4902 being placed into the T4002.

SOFTWARE

Each Interactive Graphic Unit is provided with a standard Software Package consisting of the routines necessary to facilitate communication between a computer and the T4002 Graphic Computer Terminal/Interactive Graphic Unit.

The standard Software Package is for user's facilities which support FORTRAN capable of either "A" format (i.e., unspecified character format) or assembly level access from FORTRAN. The Interactive Graphic Unit software will be negotiated on an individual basis for user's facilities which do not support FORTRAN.

A Fundamental Interactive Graphic Package is available for FORTRAN users. It includes FORTRAN routines for the user to create, modify, and manipulate graphic displays.

Documentation will include program descriptions, flow diagrams and program listings.

When ordering the 4901 and 4902 Interactive Graphic Unit, please specify the following information about the intended facility:

Hardware—Computer type, by make and model.

Software—If an operating system is used, please identify by manufacturer and indicate any variation. What languages does the facility support (please state levels). Which of these languages allows assembly level access?

INTERACTIVE GRAPHIC UNIT INTERFACE CONNECTIONS

Logic—The logic form is positive, and logic levels are standard TTL. All TTL input control lines present 5 or less normalized loads to a TTL output. Input pulse widths are at least 500 ns.

Cursor Intensity Input Voltage Range—+5 V to +15 V.

OTHER CHARACTERISTICS

Operating Temperature Range—+10° to +40°C.

Net Weight—Approximately 2 lb; 1 kg.

4901 INTERACTIVE GRAPHIC UNIT **$525**
Includes instruction manual 070-1059-00.

4902 INTERACTIVE GRAPHIC UNIT **$750**
Includes instruction manual 070-1107-00.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

4901 and 4902

Interactive Graphic Units

4951 JOYSTICK

The 4951 Joystick inputs signals to the Tektronix 4901 and 4902 Interactive Graphic Units. These signals provide the X and Y information for positioning the cursor generated by the 4901 and 4902. The Joystick elements which sense the X and Y voltages are high-resolution potentiometers, controlled with a single handle, centered on a sphere mounted within a shroud. The potentiometers have low start-up and in-motion torque for very positive operator control of the screen position of the cursor.

The Joystick has an IG OFF/CURSOR BRIGHTNESS control which turns the Joystick on and adjusts the intensity of the displayed cursor. A READY light, when lit, indicates that the Interactive Graphic Unit is ready to accept new information.

The Joystick is equipped with its own interconnecting cable for the Interactive Graphic Unit. Instruction manual (070-1060-00) is included.

CHARACTERISTICS

X and Y Resolution—Within one LSB of a previously stored point.

Cursor Brightness Voltage Output Range— +6 V or less to at least +14 V.

Seek Input Voltage Range— +2.4 V to +5.5 V.

Joystick Excursion—Side-to-side excursion is 66° within 4°; corner-to-corner excursion is 94° within 4°.

Operating Temperature Range—0°C to +50°C.

Finish—Anodized aluminum.

Net Weight—2½ lb; 1.1 kg.

Dimensions—Diameter: 6 inches, 15.3 cm; height: approximately 5.4 inches, 13.8 cm.

4951 JOYSTICK **$300**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

T4005
Graphic Display

NEW

- Drive capability for four display devices, individually selectable, remote or local operation.
- 8192 x 8192 Display Matrix capacity.
- Display Scale selections: 8192, 4096, 2048, 1024, 512, and 256 points per axis.
- Magnification sufficient to resolve each plotted point. Aspect ratios from 32:1 to 1:32.
- Origin offsetting anywhere within the 8K x 8K display matrix with 16-point resolution.
- Movable Frame windows the area to be displayed next. Zooming feature allows sequential framing in all display scale settings.
- Positionable Locator to position plot origin.
- Eight sense lines individually set by push button.
- Eight push-button interrupts (manual or program disabled).
- Programmable software status lights under Interrupt push buttons.
- Real Time Clock.
- Computer control of most Front-Panel functions.
- Interrupt structure can be disabled manually or by computer.
- Hard copy compatible.

The Tektronix T4005 Graphic Display is an integrated self-contained computer peripheral designed for high-speed, low-cost displays of large drawings, graphics and text. With the aid of appropriate parallel interfaces, the T4005 requests, accepts, controls, and displays data from present day digital computers routinely used for generating drawings and graphics. Graphic data is displayed on a Tektronix developed Storage Display Unit containing an 11-inch Storage CRT. Displays, written once on the Tektronix Storage CRT, are retained in a "view" mode without flicker, drift, or loss of resolution. When old data is erased, the display unit is ready to store new data within 500 ms after initiation of the erase function.

The operator controls and the hardware which converts computer outputs into the drive signals for graphic and alphanumeric displays are contained in the Graphic Display Controller component of the T4005. This hardware performs a number of graphic editing and enhancement functions such as scaling, magnifying, origin offsetting, windowing, and intensity augmenting.

Provisions for driving three additional display devices, and provisions for auxiliary functions add to the versatility of the T4005.

NEW

T4005
Graphic Display

DISPLAY UNIT

The T4005 dislay medium is a Tektronix developed 611 Storage Display Unit. The storage CRT in the 611 retains complex alphanumerics and graphics on an 11-inch display area after the information is written one time. The ability to store information on the CRT is accomplished through a process primarily internal to the CRT. This eliminates the need for costly refresh hardware and provides flicker-free, stable displays.

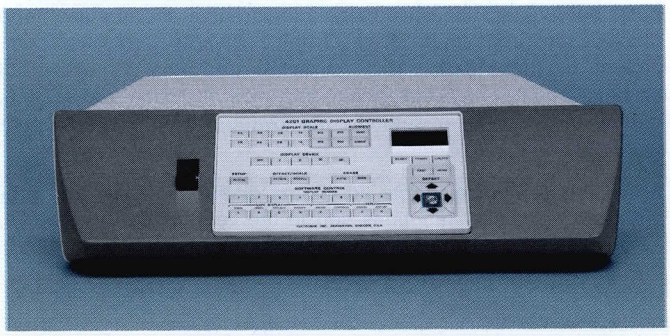
The storage display area is 21 x 16.2 cm. Resolution is equivalent to 400 x 300 stored line pairs. Storage capacity is at least 4000 clearly spaced, legible characters, based on a 90 x 70 mil dot matrix. Display view time is at least 15 minutes without loss of resolution. Viewing time may be extended to one hour; however, several erasures may be required to fully remove previously stored data. The erase cycle duration is 500 ms. Dot writing time is 5 μs; beam positioning time is 3.5 μs/cm plus 5 μs stabilizing time. Line writing time in the stored mode is at least 25 cm/ms at specified resolution.

Operating Functions—The operating functions are View, Erase, Non-Store, and Write-Thru. View and Erase are under manual or software control; Non-Store and Write-Thru are under software control. The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to a "ready-to-write" mode. As new information is written, it is retained on the CRT in the "view" mode. Within two minutes after the display is written, the 611 will automatically switch to a "hold" mode. This holds data stored on the CRT at a low brightness to extend storage time. Pressing the VIEW switch while in the "hold" mode, returns the display to the "view" mode for at least one minute, but not more than two minutes. The "view" mode may be programmed for continuous viewing for as long as fifteen minutes.

A special "write-thru" feature is provided for displaying cursors on a screen which may contain stored information. In the "write-thru" mode a clearly visible cursor, or any generated pattern, is displayed at an intensity too low to be stored. Thus, both stored and dynamic (non-stored) data may be viewed simultaneously. In the "write-thru" and "non-stored" mode, the display remains on screen as long as it is refreshed.

GRAPHIC DISPLAY CONTROLLER

The Graphic Display Controller (GDC) is a slide-out drawer unit which contains operator controls and the graphic control electronics. The GDC may be purchased separately as the 4201 Graphic Display Controller. The following discussion applies to the 4201 Graphic Display Controller as well as the GDC portion of the T4005 Graphic Display.



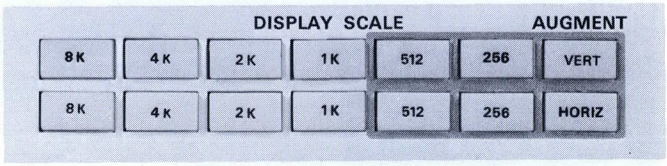
4201 Graphic Display Controller

DISPLAY DRIVER

The GDC has a D/A converter and an output architecture capable of driving four Tektronix Display Devices. A Display Controller driver card is required for each display device. The T4005 is supplied with one Display Controller/611 card. Optional cards may be purchased to drive other display devices.

GRAPHIC CONTROLLER PANEL

The Graphic Display Controller Panel is equipped with backlighted push buttons. The Push On/Off buttons are the primary means of mode selection and control of the display device. The secondary means of control is through the use of computer software. An indicator window gives the status of four computer/T4005 functions. The control panel may be removed from its housing and remotely located to serve the user's convenience. An optional cable is available for this purpose.



DISPLAY SCALES

The Display Scale push buttons, when lit, indicate the selected vertical and horizontal scale values. Six scales are available in each axis. A lit scale indicates how many step commands the GDC must receive along each axis to drive the D/A converter of that axis over its full range of 1024 distinct analog levels. The number of steps required are: 8192, 4096, 2048, 1024, 512, or 256. With display scales of 8K, 4K, and 2K, there are more steps than the 1024 D/A levels available. At these display scales, the access steps are uniformly absorbed without change in the D/A converter output. As an example, in the 4K selection, every fourth step results in a one-level change in the D/A output, while the other three steps are absorbed. The display scales are operated manually or by computer command.

FRAMING

Framing is the T4005 feature which performs in hardware the "windowing" function most often done in software by other graphic systems. A visible, non-stored Frame is positioned around the area the operator wishes to display next. Frame sizes range from 256 to 8192 dots on each axis, independently selectable, so that aspect ratios from 32:1 to 1:32 are possible. Displays selected by the 256 x 256 Frame become highly magnified so that each computer generated point is clearly visible.

ZOOMING

Zooming is the T4005 feature which allows Framing to occur on any stored display. When display scales are selected in the Frame mode, a Frame appropriately scaled with respect to the stored display is presented. Thus, one can Zoom from 8K x 8K, to 2K x 2K, and then to 512 x 512, and finally to 256 x 256.

T4005
Graphic Display

NEW

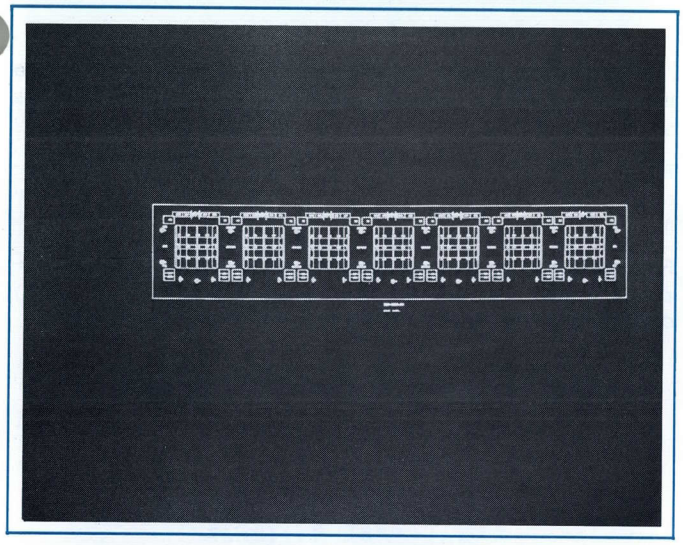


Figure 1

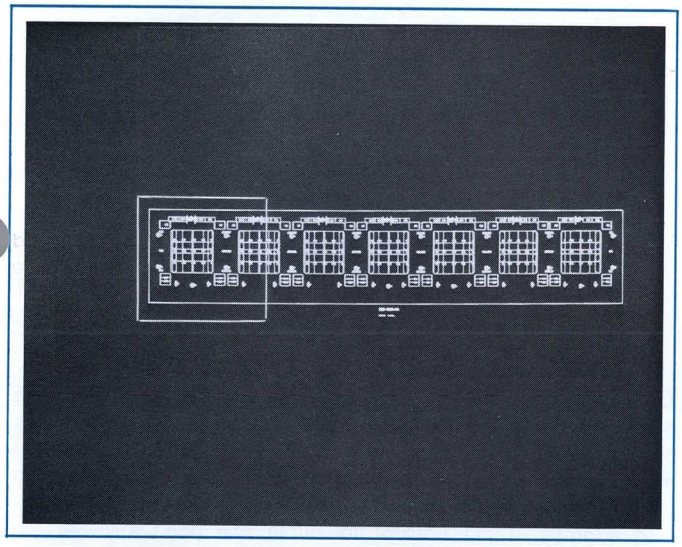


Figure 2

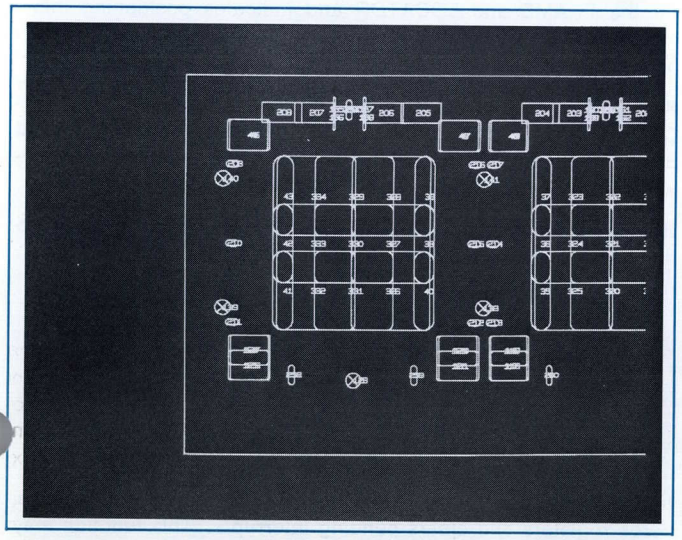


Figure 3

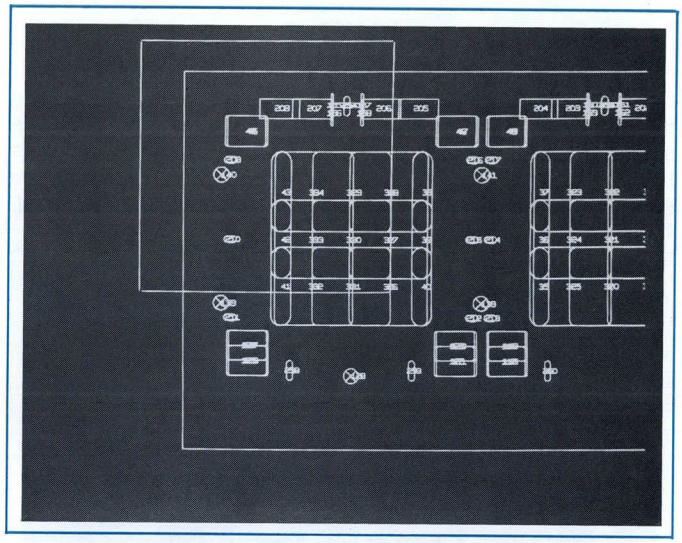


Figure 4

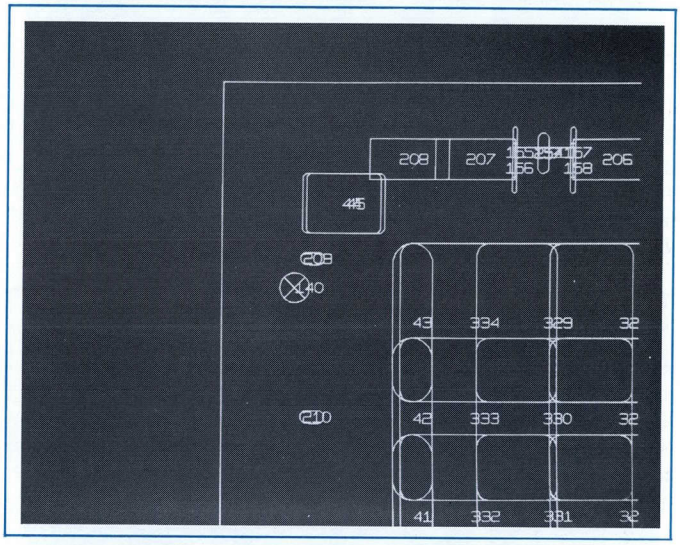


Figure 5

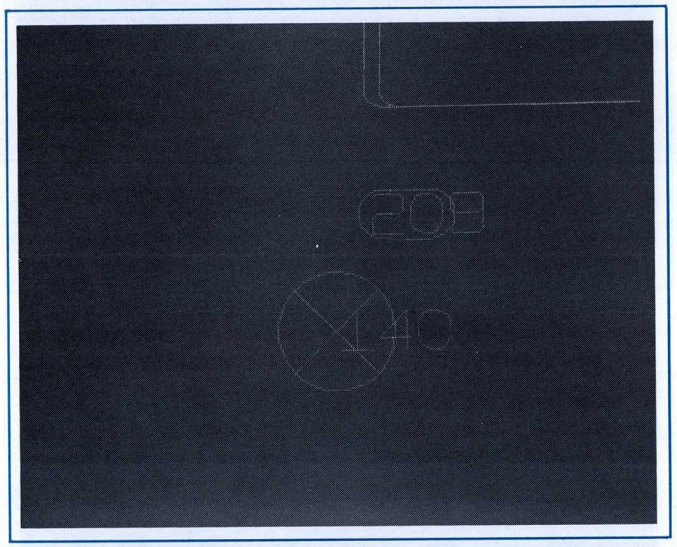
The above photographs illustrate the use of Framing and Zooming to magnify any portion of a display. Figure 1 shows, at 8K x 8K display scales, a complete drawing of seven identical parts to be produced from one piece of metal. Figures 2 through 5 illustrate how a portion of this drawing is magnified for detailed examination. Figure 2 shows a 2K x 2K Frame placed around the area at the left which contains the first part. Only that portion of the drawing windowed by the 2K x 2K Frame reappears in Figure 3. A 1K x 1K Frame is then placed over the upper left portion of this display as shown in Figure 4. The portion of the display windowed by this 1K x 1K Frame is then replotted as shown in Figure 5. Any selected part of the original 8K x 8K display may be magnified as much as 32 times by this straightforward procedure.

ANNOTATION

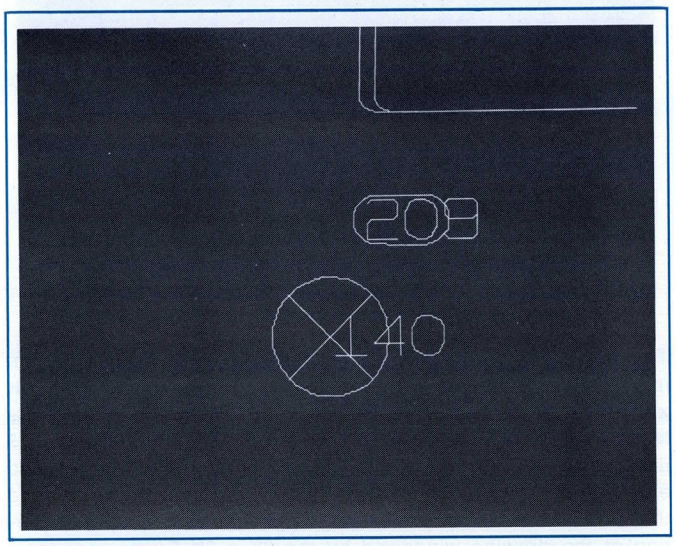
In the above photographs, 20% of the storage CRT screen is an annotation area. A T4005 feature called Shift allows the computer to address this area which is outside of the 16 x 16 cm plotting area of the T4005's D/A converters. Thus, annotation need not overlay plotted data.

AUGMENT

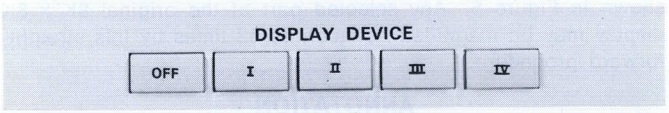
In the highly magnified 512 and 256 display scales, the computer data may be displayed as received. This results in a separation between the displayed dots. If a brighter display is preferred, Augment can be selected to insert additional dots between those generated from the computer data received. The augment function is selected manually or by computer command.



A non-augmented 256 x 256 display. Non-augmented displays are used for examining in detail the actual computer generated dot pattern.



An augmented 256 x 256 display with additional dots inserted by the T4005.



DISPLAY DEVICE

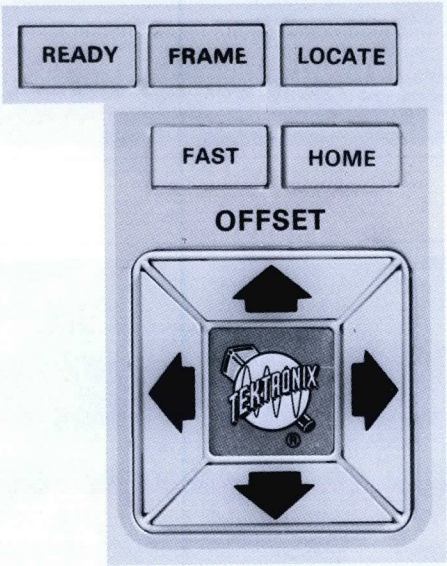
Indicates selected status of each of the four display devices which may be attached to the GDC. Each device is selected manually or by program control.

DISPLAY MODE CONTROLS

READY, FRAME, and LOCATE are functions which indicate the current operating mode of the T4005. The controls are operated manually or by computer command.

Ready—Removes the Not-Ready status flagged to the computer, and readies the GDC to process computer write commands.

Frame—Places a write-thru frame, whose aspect ratio is dependent upon the Display Scales selected, on those display devices selected by the GDC.



Locate—Places an "L" shaped write-thru Locator on those display devices selected by the GDC. The Locator serves uses such as locating the point from which subsequent display commands are started. The Locator can be used in conjunction with software and the interrupt structure, to determine the precise address of the Locator to within one point anywhere in the 8192 x 8192 graphic matrix.

Offset—A 4-button group which provides positioning control for the FRAME and LOCATOR and indicates positioning information such as which direction the cursor may be offscreen and when a selected frame is larger than the display.

Fast—Provides two positioning speeds for FRAME and LOCATE. Pushing and lighting FAST selects a speed for rapid positioning. The second initiation turns the light off and selects a slow speed for precise positioning.

Home—When pressed, returns the FRAME or LOCATOR to the lower left hand corner (0,0) of the screen.

SET UP

Initial—Sets the T4005 hardware to a predetermined state, zeros registers and clears pending interrupts. This function may be computer controlled.

OFFSET/SCALE

Retain—Places in the Retain Storage Registers the current Display Scale values and the current contents of the X and Y axis Offset Registers.

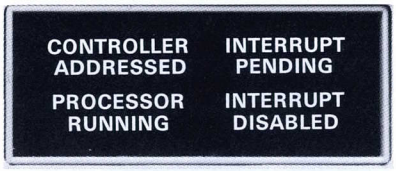
Recall—Places the contents of the Retain Storage Registers into the Display Scale Registers and the Offset Registers, re-establishing the retained display scale and offset parameters. Also, it initiates a display interrupt and places the GDC in the READY mode.

ERASE

Screen erase can be initiated several ways. Activating erase clears the full screen contents and returns the CRT to a ready-to-write mode within 500 ms after the function is activated.

Auto—When in this mode, the selected Display Device(s) are automatically erased when DISPLAY or RECALL is initiated or when the fully READY mode is reached.

Manual—Erases the selected Display Device(s) any time it is initiated.



STATUS INDICATORS

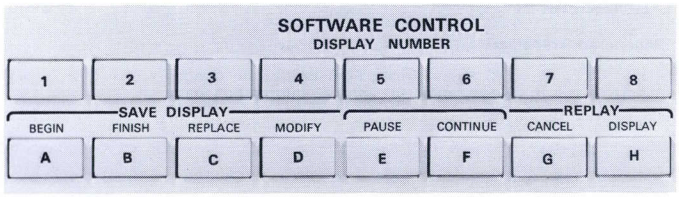
Indicates status of the T4005/Computer system. Backlighted labels light when the indicator structure is addressed.

Controller Addressed—Indicates the T4005 has been addressed by the computer within the last 0.5 second.

Interrupt Pending—Indicates the T4005 has requested an interrupt but it has not been serviced.

Processor Running—Indicates the computer is running, e.g. not in a WAIT condition.

Interrupt Disabled—Indicates the T4005 interrupt capability has been manually disabled or the computer has not enabled the T4005's interrupt hardware.



SOFTWARE CONTROL

The circuitry in support of software interaction consists of an interrupt structure, status information and a real-time clock.

The interrupt structure is activated when Buttons A-H on the Graphic Controller Panel are pushed. Computer interrupt subroutines must service the pending interrupt before a new interrupt is initiated. In addition to Buttons A-H, the computer can also sense the state of DISPLAY NUMBER buttons 1-8 (only one of which is selected at any one time). Thus, 64 distinct interrupt states can be sent to the computer by the use of Display Number buttons and interrupts buttons A-H. The interrupt feature may be logically disconnected from the computer by use of the interrupt control switch located at the rear of the T4005. This three position switch allows the interrupt structure to be connected, disconnected, or placed under computer control.

Ninety-six bits of status information are gated to the computer by three GDC Status Gates. Depending upon the computer interface installed, these information bits may be transferred to the computer as 8, 12, 16, or 24 bit words.

A real time clock is turned on and off by computer control commands. The clock interrupts the computer every 16.7 ms. External frequencies to 500 kHz may be applied to the clock for interrupting the computer at any selected interval.

SOFTWARE

The T4005, when ordered with the IBM 1130 Interface Unit 021-0018-00, is provided with the following software:

T4005/1130 Saveplot System. This system is a comprehensive set of routines allowing the user to display and record computer-generated plots for later replay.

Control Function Subroutines. These subroutines provide access to and support of the full set of Graphics Display Controller functions.

Text Handling Subroutines. These subroutines aid the user in displaying alphanumeric data in various formats on the T4005. Five character sets, including one for APL, are available.

Program descriptions and usage information is included with the above software. Flow diagrams, program listings and a cross-reference program directory are available as optional accessories.

Software provided with other than the IBM 1130 Interface will be negotiated on an individual basis.

OTHER CHARACTERISTICS

T4005 Power Requirements—A quick-change line-voltage selector provides six ranges: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, and 224 to 272 V. Frequency range is 48 to 66 Hz. Maximum power dissipation at 115 VAC is 310 watts.

4201 GDC Power Requirements—Same as T4005 except maximum power consumption is 81 watts at 115 VAC.

T4005 and 4201 Operating Temperature—Normal operation over 10°C to 40°C range.

Dimensions and Weights

	T4005		4201	
	INCHES	cm	INCHES	cm
Height	20	50.8	5 1/4	13.3
Depth	29 1/2	73.8	28 3/4	73.0
Width	19	48.3	19	48.3
	POUNDS	kg	POUNDS	kg
Net Weight	107	48.7	40	18

NEW

T4005

Graphic Display

T4005 Included Standard Accessories—Drawer unit user's manual 070-1085-00, maintenance manual 070-1086-00, 611 Storage Display Unit manual 070-0752-01.

T4005 GRAPHIC DISPLAY, without interface **$7850**

4201 Included Standard Accessories—Drawer unit user's manual 070-1085-00, maintenance manual 070-1086-00.

4201 GRAPHIC DISPLAY CONTROLLER, without interface **$4950**

INTERFACE UNITS

The interface for the IBM 1130 Computer includes an interconnecting cable (012-0215-00) and interface manual (070-1087-00).

Order Interface Unit 021-0018-00 ..... **$850**

The T4005 Graphic Display and 4201 Graphic Display Controller can be interfaced with most present day digital computers. Tektronix will quote interface costs and availability upon request.

OPTIONS

The T4005 and 4201 are available with a blue cabinet. Order

T4005 GRAPHIC DISPLAY option one (without interface) **$7850**

4201 GRAPHIC DISPLAY CONTROLLER option one (without interface) **$4950**

Driver Cards—The T4005 Graphic Display and 4201 Graphic Display Controller will drive the following Tektronix Display Units: 601 Storage Display Unit, 611 Storage Display Unit, 4501 Scan Converter. The T4005 and 4201 is interfaced with each display device by a driver card.

Order driver cards as follows:

T4005/4201 to 601 or 4501 Scan Converter order 670-0925-00 . **$200**

T4005/4201 to 611 Storage Display Unit order 670-0926-00 ... **$200**

20-Foot Interconnecting Cable—The T4005 or 4201 control panel may be detached for remote operation, through use of this cable.

Order 012-0216-00 ..... **$75**

ACCESSORIES

Viewing Accessories—Combination light filters and implosion shields improve contrast for high ambient light viewing.

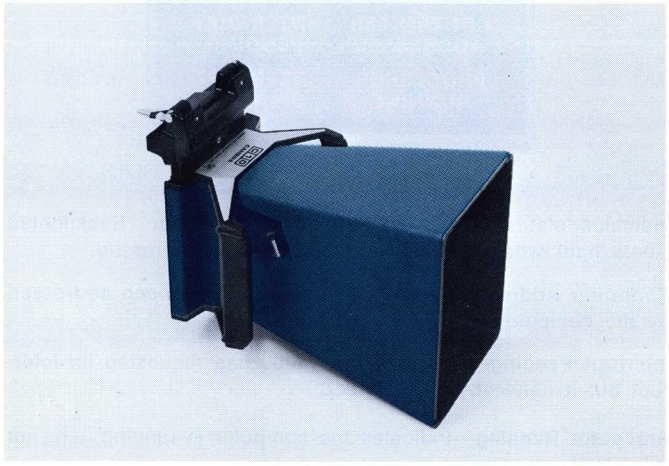
Filter 014-0039-00 offers high resolution, reflection free viewing with improved contrast and cleans easily.
Order 014-0039-00 ..... $125

The matt finish of filter 015-0145-00 improves contrast but causes slight loss of resolution. Order 015-0145-00 ..... $35

The glossy surface of filter 014-0040-00 improves contrast, retains resolution but causes reflections. Order 014-0040-00. $35

Hard Copy Unit—The 4601 used in conjunction with Tektronix Storage Display Units provides a convenient means for permanently copying alphanumeric and graphic displays. Hi-resolution displays obtained on the T4005 are copied by the 4601, providing an accurate representation of the stored display on 3M Type 777 Dry-Silver Paper.

4601 HARD COPY UNIT **$3750**



Camera—The C-10 is a fixed-focus, light-weight camera designed for use with the Type T4005. An f/8 lens with sufficient depth of field and convenient hand grips allow the C-10 to be held against the display area for photographing displays. The C-10 housing accommodates a Graflok[1] 4 x 5 back.

C-10 CAMERA **$400**

[1]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

4501
Scan Converter

- **LINKS DATA AND SIGNAL SOURCES TO LARGE-SCREEN TV MONITORS OR RECEIVERS**
- **CONFORMS TO EIA OR CCIR STANDARDS**
- **OUTPUT DRIVES SEVERAL MONITORS**
- **DC-TO-10 MHz X AND Y AMPLIFIERS**
- **REMOTELY PROGRAMMABLE**

The 4501 Scan Converter accepts alphanumeric and graphic data—in the form of analog inputs—and converts it to displays on TV receivers and monitors. The hi-contrast TV displays are ideal for individual or group viewing—even under bright light conditions. The displays may be viewed as light data on a dark background or as dark data on a light background, selected from the 4501 front panel.

The 4501 uses a Tektronix bistable storage CRT. Data may be written once on the storage CRT and retained for an hour *without refreshing.* The results are: call for your data once, then view it as long as one hour on a TV-size display. The 4501 also transfers continuously written data to your TV display.

The output video signal conforms to EIA 525-line, 60-field television standards. Provision is made to internally switch to CCIR, 625 line, 50 field to accommodate European television standards. The modulated RF output permits displaying information on Channel 2, 3, or 4 of conventional television receivers.

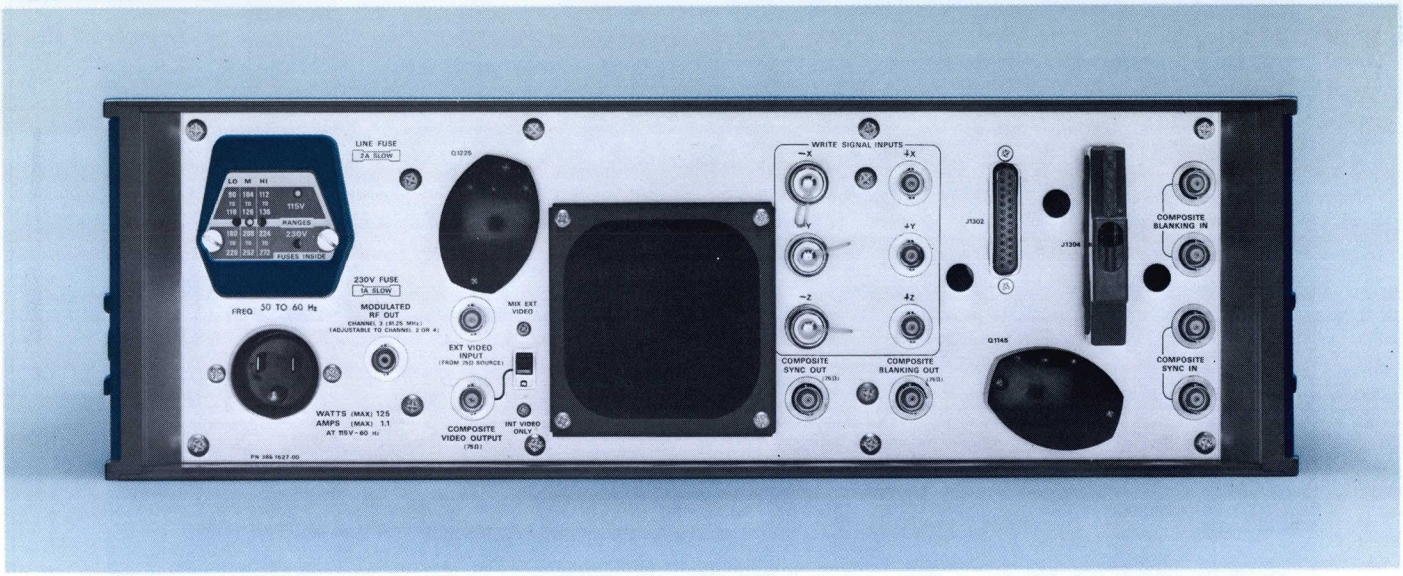
DISPLAY MODES

The scan converter may be operated in a STORE or NON-STORE mode. In the STORE mode, information from X, Y and Z-axis signal inputs is stored in a conventional manner on the storage CRT. Conversion is obtained by raster scanning the storage target with the CRT writing beam. The detected signal is then combined with internally generated television sync and blanking, and is provided at the rear panel as composite video or modulated RF. Operation of the Type 4501 in the NON-STORE mode is similar to operating in the STORE mode except displays are not retained. In this mode dynamic displays of changing information may be scan converted for large-screen viewing.

Associated with the STORE and NON-STORE operating modes are the WRITE ONLY, WRITE AND READ and READ ONLY operating functions. The WRITE AND READ function permits a display to be visually written and read simultaneously. This is accomplished by "time-sharing" the single electron beam. Using the same deflection amplifiers and electron beam to perform the write and read functions insures excellent input-output tracking, thus adding negligible position errors to the output monitor.

VERTICAL AND HORIZONTAL AMPLIFIERS

The DC coupled X (horizontal) and Y (vertical) differential input amplifiers provide cancellation of common-mode signal components, permit convenient polarity inversion and provide a means for mixing of two signals from separate sources. The display aspect ratio is 3 units vertical and 4 units horizontal. Access to (+) and (—) inputs is through rear-panel BNC connectors. Simultaneous access to the (+) inputs is available through the remote program connector.



Bandwidth—At least 10 MHz within center 7.5-cm scan area, +20°C to +30°C.

Deflection Factor—Vertical: 0.75-V full screen (7.5 cm), variable from 0.375-V full screen to 1.125-V full screen with internal adjustment. Horizontal: 1.0-V full screen (10 cm), variable from 0.5-V full screen to 1.5-V full screen with internal adjustment.

Phase Difference—Within 10° between X and Y at 10 MHz.

Dot Settling Time—0.15 μs or less to within 1% of final position.

Position Stability—Within 10 mV of graticule center, +20° C to +30° C; within 50 mV of graticule center, 0° C to +50° C.

Gain Stability—Within 1% of setting, +20° C to +30° C; within 4%, 0° to +50° C.

Polarity—(+) X input moves the beam up, (—) X input moves the beam down, (+) Y input moves the beam right, (—) Y input moves the beam left.

Input R and C—1 MΩ within 2%, paralleled by 47 pF.

Maximum Input Voltage—200 V, (DC plus peak AC).

Differential Input—Linear common mode signal range: + and — 2.5 V, total not to exceed 5 V P-P. Common mode rejection ratio: ≥500:1 at 10 kHz; ≥100:1 at 1 MHz; ≥10:1 at 10 MHz.

Z AMPLIFIER

The DC-coupled Z-axis amplifier provides cancellation of common-mode signal components, permits convenient polarity inversion and provides a means for mixing of two signals from separate sources. In all WRITE modes, the CRT beam intensity is determined by the Z-axis input and the INTENSITY control. Access to (+) and (—) inputs is through BNC connectors on the rear panel. Simultaneous access to the (+) input is available through the remote program connector.

The Z amplifier input has two operating modes: LINEAR and LIMITING.

LINEAR AMPLIFIER CHARACTERISTICS (Single ended or differential input)

Bandwidth— ≥5 MHz with 1-V input.

Risetime— ≤75 ns with 1-V input step.

Amplitude Requirements—Maximum intensity is achieved at 1.0 V P-P. Normal writing intensity is produced by 0.5 V P-P and minimum useable intensity is 0.05 V P-P.

Polarity—Positive signal on the (+) input increases intensity, negative signal on the (—) input increases intensity. (Intensity modulation of the CRT beam is the resultant difference between the signal applied to the (+) and (—) Z-axis inputs).

Input R and C— 1 MΩ, ±2% paralleled by 47 pF.

Maximum Input Voltage— 200 V (DC plus peak AC).

Linear Common Mode Signal Range— + and — 2.5 V, not to exceed 5 V P-P.

Common Mode Rejection Ratio— ≥500:1 at 10 kHz; ≥100:1 at 1 MHz; ≥10:1 at 10 MHz. (A single-ended signal to either (+) or (—) input receives rejection of common-mode components existing on the signal lead and the signal ground).

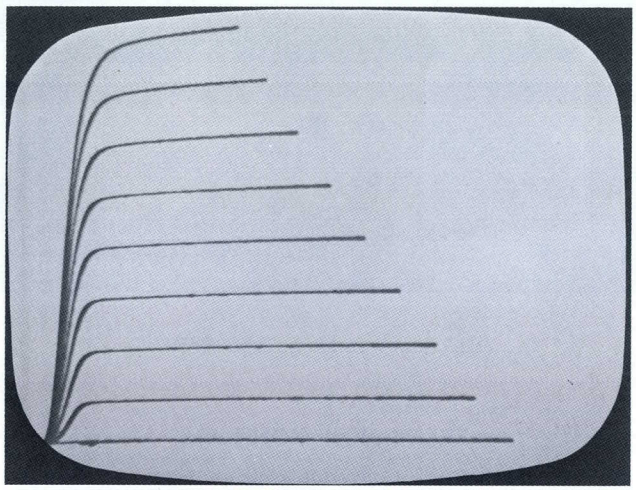
LIMITING AMPLIFIER CHARACTERISTICS

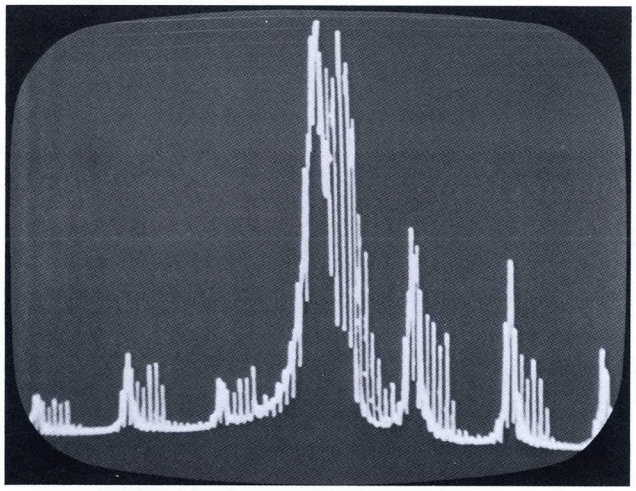
A single-ended signal at the (+) input connector can be routed through an amplitude limiting stage by moving an internal switch. The drive signal to the Z-axis amplifier is automatically limited to 1 V P-P.

Input Requirements—Voltage levels of +1 V or more turn the beam on to a fixed level. The fixed level can be adjusted with the intensity control. Voltage levels of +0.5 V or less keep the beam turned off.

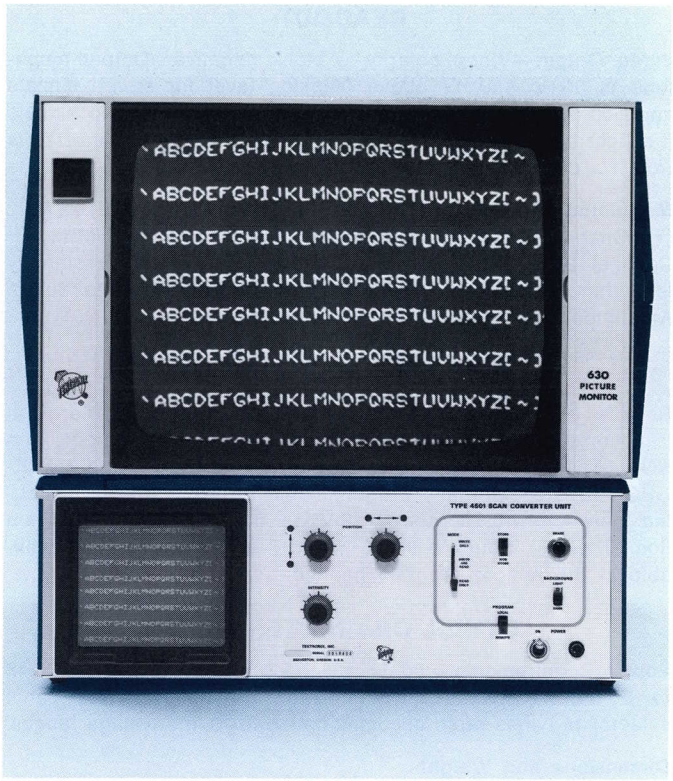
Maximum Input Voltage— 50 V (DC and peak AC).

4501
Scan Converter





Displays may be viewed with a light or dark background (top and bottom photo). The front-panel BACKGROUND switch provides a choice of LIGHT (written area is displayed dark on a light background) or DARK (written area is displayed light on a dark background).



The information written on the 5-inch CRT of the scan converter (bottom) is converted to composite video and is displayed on the Tektronix monitor (top).

STORAGE CRT

Tektronix CRT— 5-inch, flat-faced bistable storage tube, phosphor similar to P1.

Aspect Ratio—Three units vertically by four units horizontally.

Resolution—Equivalent to 100 vertical 125 horizontal stored line pairs.

Display Time—At least 15 minutes without loss of resolution. Display time may be extended to one hour; however, several erasures may be required to fully remove previously stored data.

Dot Writing Time—8 μs or less.

READ RASTER

Readout is accomplished by scanning the CRT storage target with a TV raster. The necessary TV sync, blanking and raster scanning voltages are developed in the scan converter unit. Sync and video are combined to assemble a composite TV signal. An internal switch permits selection of either EIA 525-line, 60-field or CCIR 625-line, 50-field TV standards. Provision is made to automatically utilize external sync and blanking when these signals are connected to the scan converter.

Sync Frequency

	EIA	CCIR
Vertical	60 Hz or $\frac{1}{525}$ H	50 Hz or $\frac{1}{625}$ H
Horizontal	15.75 kHz within 0.12%	15.625 kHz within 0.12%

Composite Sync and Blanking Outputs—Conforms to EIA or CCIR timing requirements. Amplitude is —4 volts within 0.2 V into 75 Ω.

Composite Sync and Blanking Inputs—Inputs must meet EIA or CCIR timing requirements. 75-Ω loop through connections allow one or more units to be driven by the same source. Return loss is $\geq$30 dB, 50 Hz to 5 MHz.

READOUT

Video Output—Video polarity is black negative. Output amplitude is 30 to 150 mV above blanking level for stored signals and 600 to 800 mV above blanking level for non-stored signals if a light background large display is being used. The inverse is true if a dark background display is used.

Modulated RF Output—The carrier frequency is set to 61.25 MHz (TV Channel 3) and is internally adjustable from 55.25 MHz (TV Channel 2) to 67.25 MHz (TV Channel 4). Frequency stability is within 250 kHz of carrier frequency from 20° C to 30° C. Amplitude is at least 10 mV P-P into 75 Ω.

REMOTE PROGRAMMING

Remote programming of the Type 4501 Scan Converter Unit is accomplished through 2 rear-panel program connectors. The NON-STORE, ERASE, READ ONLY, WRITE ONLY and BACKGROUND are externally programmable by grounding or switching between +0.5 V and −10 V on the appropriate program line. The (+) inputs to the X, Y and Z amplifiers are also available at the remote program connectors.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 125 watts maximum at 115 V 60 Hz. Rear-panel selector provides rapid accommodation for 6 line voltage ranges.

Dimensions and Weights

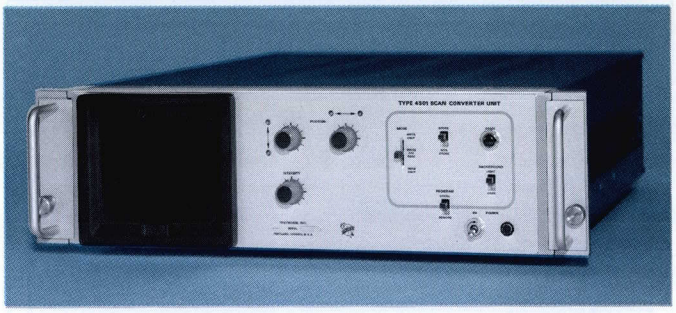
Type 4501	Height	6 in	15.3 cm
	Width	16 3/4 in	42.6 cm
	Depth	21 1/4 in	54.0 cm
	Net Weight	37 1/4 lb	17.0 kg
	Domestic shipping weight	64 lb	29.0 kg
Type R4501	Height	5 1/4 in	13.4 cm
	Width	19 in	48.3 cm
	Depth	20 1/2 in	52.0 cm
	Net Weight	37 1/4 lb	17.0 kg
	Domestic shipping weight	68 lb	30.9 kg

Temperature—Performance characteristics are valid over an operating temperature range of 0° C to +50° C.

Included Standard Accessories—25-pin connector (131-0570-00); connector cover (200-0821-00); 25-ft, 75-Ω, BNC cable (012-0157-00); 37-pin connector (131-0422-00); connector cover (200-0660-01); UHF to BNC adapter (103-0015-00); 3-conductor power cord (161-0010-03); instruction manual (070-0943-00). Type R4501 also includes rackmounting hardware.

TYPE 4501 SCAN CONVERTER UNIT **$2500**

TYPE R4501 SCAN CONVERTER UNIT (rackmount model) **$2500**



Rackmount version, Type R4501

TELEVISION MONITORS

The Type 4501 Scan Converter Unit provides an output in the form of composite or modulated RF. High resolution displays are achieved using the Tektronix Picture Monitor and other quality monitors and receivers. Tektronix field offices will supply ordering information on monitors and receivers.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

4551
Light Pen

NEW

- POINT, DRAW, WRITE, MAGNIFY ON TV MONITORS AND RECEIVERS
- USE IN BROADCASTING, TEACHING, COMPUTER-AIDED INSTRUCTION
- ANALOG AND DIGITAL OUTPUTS

The 4551 Light Pen Unit, when used in any 525/60 or 625/50 line TV system, produces a visible location indicator (cursor) on all TV displays in the system. The cursor may appear as a crosshair ⊹, a rectangular box ▭, or the crosshair may be enclosed by the box ⊞. Conventional video mixing techniques are used to insert the cursor into the TV display system. The cursor tracks the position of a pen as the user moves it across the screen of the TV display.

The cursor calls the attention of the TV audience to any point on the display. For example, news commentators will use the Light Pen Unit to call attention to areas on weather maps during weather broadcasting. Instructors on educational TV programs can use the Light Pen Unit to keep the attention of the audience concentrated on the appropriate point as material is discussed from sources such as blackboards, charts, books and drawings. Medical usage includes applications such as surgery which is being monitored by TV for lecturing purposes. The lecturing physician would use the Light Pen Unit to point to each anatomical area as it is discussed.

In any application where the Light Pen Unit is used, the user reduces distractions by removing himself and physical pointers from the display.

At any time the cursor's position is defined as a set of X-Y coordinates. Analog and digital signals corresponding to the X-Y coordinates are available at rear panel connectors. These signals may be fed into a data system for use in applications such as computer-aided instruction. For example, the computer would generate a display through appropriate software and ask a question of the student. The student points to an answer with the Light Pen Unit. Output signals from the Light Pen Unit would be used by the computer to validate the student's answer.

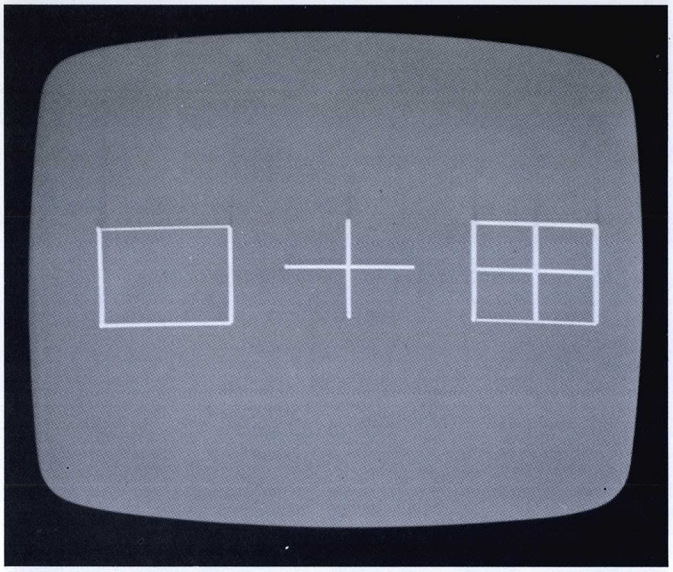
A pen connects to the Light Pen Unit through a modified BNC connector. Switches on the pen tip are used for controlling the cursor position and for writing on the display. One of these switches consists of a pair of rings (conducting surfaces) separated by a 5-mm gap (non-conducting surface). To illustrate how this functions, first assume that a stationary cursor is on the screen. To move the cursor the operator places the pen against the display area. The cursor will remain stationary until the user bridges the gap on the pen with his finger. When this is done the cursor moves to the pen's position. As long as the gap is bridged and the pen is held against the display, the cursor tracks the pen movements. To stop the cursor movement, the operator simply lifts his finger.

Users who wish to write on the TV display may do so by using the Light Pen Unit with the Tektronix 4501 Scan Converter. These two devices are plug-to-plug compatible. The pen has a switch in its tip which activates the write function. When the user presses the pen tip against the display area, outputs from the Light Pen Unit are fed to the 4501. As the pen is moved to write or draw, its movements are converted to stored images in the 4501. The 4501 then displays the written image on the monitor or receiver. To the user the image appears as if it is written directly on the TV screen. To remove written data from the 4501, the user pushes Erase, a Light Pen Unit front panel control. This erases all stored data from the 4501 and readies it to store new data.

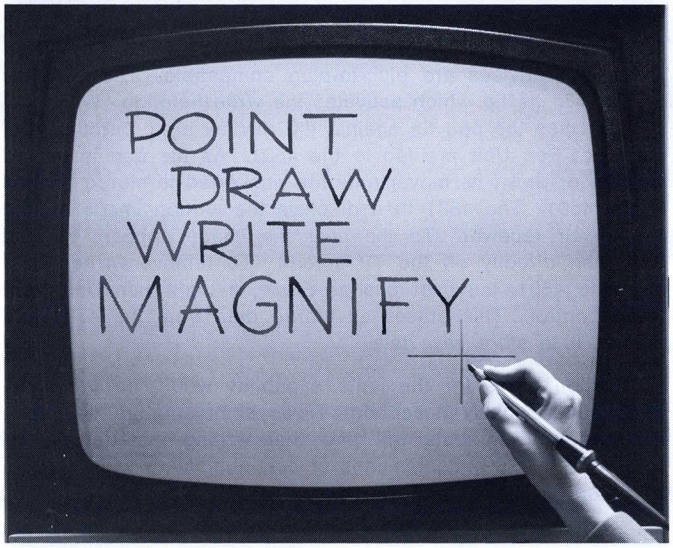
Application areas for the write capability would be the same as those previously described. News commentators, teachers, lecturers and students will find that writing material on TV screens is a convenient means of communicating with a large, scattered audience.

The Light Pen, when used with a scan converter such as the 4501, provides a convenient means to magnify displays. Data received from a source such as a computer is retained by the 4501 and converted to a display on the TV screens. To magnify, a cursor is placed over that portion of the display which is to be enlarged. With the Light Pen Unit operating in the MAG mode, the area enclosed by the cursor is magnified up to five times. In the MIXED mode, the area enclosed by the cursor is displayed alternately as a magnified and then a non-magnified area. The user views this as superimposed displays. The magnification ratio is variable by a front panel control on the Light Pen Unit.

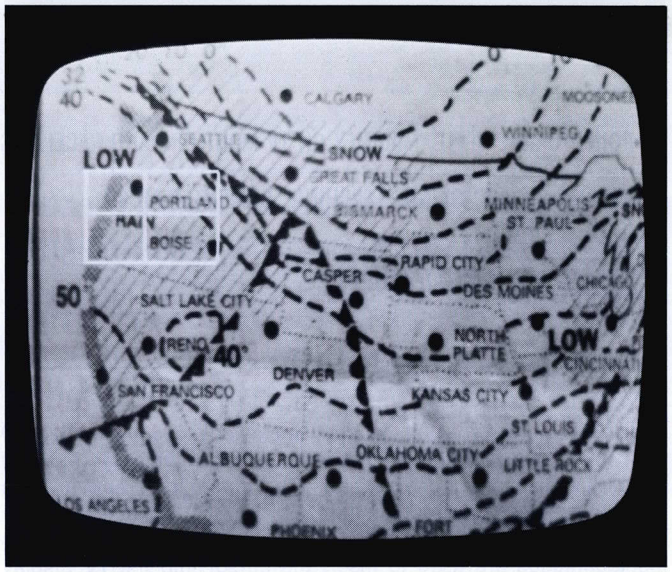
4551
Light Pen



The above photos (multiple exposure) show the crosshair, box, and boxed crosshair cursor which the Light Pen Unit inserts into the TV display.



Artist conception of 4551 features.



The boxed-crosshair cursor is being used in a broadcasting application to attract the viewers attention to the geographic area being discussed.

LIGHT PEN CHARACTERISTICS

Output Signals—For analog applications the voltage output level varies from 0 to 5 V (nominal) as a function of the cursor position. Output current is 1 mA or less. The recommended load impedance should be at least 5 kΩ. In digital applications the vertical coordinates are provided by 9 parallel lines of binary information. The horizontal coordinates are also provided by 9 parallel lines of binary information. The lines are TTL compatible and each has a fan-out capability of 5 TTL loads.

OTHER CHARACTERISTICS

Power Source—Quick-change line voltage selector provides 4 ranges as follows: 90 V to 118 V, 104 V to 136 V, 180 V to 236 V, 208 V to 272 V. Line frequency range is 48 Hz to 440 Hz. Power requirement is approximately 20 Watts.

Dimensions and Weights—

Height	4 in	10.2 cm
Width	8 in	20.4 cm
Depth	16 in	40.7 cm
Net Weight	10 lb	4.5 kg

4551 LIGHT PEN UNIT **$1800**
Includes instruction manual, 070-1149-00.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

4601
Hard Copy Unit

NEW

- PERMANENT HI-RESOLUTION COPIES OF CRT DISPLAYS
- LOW INITIAL COST
- 18-SECOND COPY TIME
- COMPACT, SELF-CONTAINED

T4002 Graphic Computer Terminal with 4601 Hard Copy Unit

The 4601 used in conjunction with Tektronix Storage Display Units provides a convenient means for permanently copying alphanumeric and graphic displays. Hi-resolution displays obtained on the 611, T4002 and T4005 are copied by the 4601, providing an accurate representation of the stored display on 3M Type 777 Dry-Silver Paper.

Since the 4601 is completely self-contained, installation consists merely of connection to the power line and to the appropriate Tektronix unit. Copy command may be initiated by pressing a front panel control, or by supplying an external command.

HOW THE 4601 WORKS

The signal source is "looped through" the 4601 to the Tektronix Display Device. When the copy command is received, the signal source is automatically disconnected from the Display Device.

Hard Copy is produced by systematically scanning the target of the storage unit. Scanning ramps are generated by scan generators located in the Hard Copy Unit. An electrical signal is taken from the target electrode and fed to the Z axis of a line scan CRT. A fiber optic faceplate couples the light output from the phosphor to the recording material. Heat development of the latent image takes place after this exposure. Hard Copy is available about 18 seconds after initiation of the copy command.

THE COPY MEDIUM

The processing unit in the 4601 is designed to be used with 3M Brand Type 777 Dry-Silver Paper.

Type 777 Paper provides the high image contrast required for high-resolution copies of complex graphics and alphanumerics. It offers the user the stability normally associated with wet-process photosensitive paper, plus the convenience of dry print-out papers. Cost is low: 5 to 8 cents per 8½ by 11-inch copy, depending on usage. Further economies can be realized using smaller copies. Copy size is adjustable from 8½ by 6 inches to 8½ by 14 inches. Roll size is 8½ inches by 500 feet.

Dry-Silver prints can be handled much like any conventional paper. Records can be easily written upon with pencil or pen. Pencil marks are erasable. Shelf life of unexposed paper is six months, providing the paper is not removed from its protective wrapper and is stored at room temperatures.

4601
Hard Copy Unit

TEKTRONIX IS AN OREGON CORPORATION LOCATED ON A 300 ACRE INDUSTRIAL PARK NEAR PORTLAND, OREGON. TEKTRONIX PRODUCTS ARE MANUFACTURED, SOLD AND SERVICED FROM LOCATIONS THROUGHOUT THE FREE WORLD.

IN RECOGNITION OF THE INCREASING NEEDS FOR READOUT DEVICES FOR COMPUTER CONSOLES AND REMOTE TERMINALS, TEKTRONIX HAS DEVOTED CONSIDERABLE TIME AND EFFORT TO DESIGNING AND PRODUCING DISPLAY COMPONENTS WHICH WILL EFFECTIVELY FULFILL THESE NEEDS. BRIEFLY, A FEW OF THESE PERIPHERALS ARE:

611 STORAGE DISPLAY UNIT--A LOW-COST, HIGH SPEED UNIT WHICH RETAINS INFORMATION ON AN 11-INCH STORAGE CRT WITHOUT HIGH-COST REFRESH ELECTRONICS.

T4002 GRAPHIC COMPUTER TERMINAL--AN INFORMATION DISPLAY UNIT WHICH CONTAINS THE COMPONENTS NEEDED FOR LOW-COST ALPHANUMERIC AND GRAPHIC INTERACTION BETWEEN MAN AND COMPUTER. DATA IS STORED ON A 611 DISPLAY UNIT.

T4005 GRAPHIC DISPLAY--A NEW SELF-CONTAINED COMPUTER PERIPHERAL FOR APPLICATIONS WHERE LOW-COST, HIGH SPEED DISPLAYS OF GRAPHICS, DRAWINGS AND ALPHANUMERIC DATA IS DESIRED. THE T4005 PLOTS DATA ON A STORAGE CRT AT SPEEDS UP TO 100 TIMES FASTER THAN MECHANICAL PLOTTERS.

4501 SCAN CONVERTER--LINKS YOUR DATA OR SIGNAL SOURCE TO TV DISPLAY SYSTEMS FOR CONVENIENT, LARGE SCREEN VIEWING. THE DISPLAY SIZE DEPENDS ONLY UPON YOUR CHOICE OF TV MONITOR OR RECEIVER.

4601 HARD COPY UNIT--INFORMATION FROM YOUR COMPUTER IS PERMANENTLY RECORDED ON REPRODUCIBLE COPIES DIRECTLY FROM THE STORAGE CRT OF TEKTRONIX PERIPHERALS. OPERATION IS EASY. SIMPLY PUSH A BUTTON AND IN LESS THAN 18 SECONDS A HIGH RESOLUTION COPY IS READY FOR USE. COPY COST IS LESS THAN EIGHT CENTS PER 8.5 X 11 INCH COPY, DEPENDING UPON USAGE.

PLEASE HAVE YOUR NAME ADDED TO THE TEKTRONIX MAIL LIST OR CONTACT ANY LOCAL TEKTRONIX FIELD ENGINEER OR APPLICATION ENGINEER FOR ADDITIONAL INFORMATION.

TEKTRONIX®

[4601 COPY OF SCREEN CONTENTS OF T4002 GRAPHIC COMPUTER TERMINAL]

Photo of a 4601 copy

CHARACTERISTICS

Copy Size—Adjusted to 8½ x 11 inches at factory, variable between 8½ x 6 inches and 8½ x 14 inches.

Copy Time—18 seconds for first copy.

Warmup Time—20 minutes.

Remote Copy Command—Closure to ground for at least 5 μs.

Resolution (with 3M Brand Type 777 Paper)—Essentially the same as displayed on the 611, T4002, or T4005 Display Device. Actual-size copies of a 4000-character display, based on a 90 x 70 mil matrix, are clearly legible.

Ambient Temperature—Between +20°C and +30°C is recommended. If extreme environmental conditions exist, other recording papers may be substituted. Contact your local Tektronix Field Office.

Compatibility—Designed for use with Tektronix T4002 Graphic Computer Terminal, T4005 Graphic Display, and Type 611 Display Units serial numbers B142240 and above. Type 611's below this serial number require a modification; contact your local Tektronix Field Office for additional information.

Power Source (factory-wired options)—90 to 136 VAC, 115 V nominal, 50 or 60 Hz. Maximum power consumption at 115 V, 60 Hz is 1450 W for first 40 s after turn on, 220 to 520 W for normal operation, 100 W standby.

Dimensions (height, width, length)—11 x 17 x 24 inches; 27.9 x 42.7 x 61 cm.

Weight—Approximately 69 pounds; approximately 31 kg.

Included Standard Accessories— 25-pin input connector (131-0570-00); two 6-foot interconnecting cables (012-0258-00); 6-foot detachable power cord (161-0065-01); instruction manual (070-1156-00).

4601 HARD COPY UNIT **$3750**
The standard 4601 has a light tan cabinet and the output scan voltage is 5 V. The 4601 is available in a blue cabinet with an output scan voltage of 1 V.

4601 HARD COPY UNIT Option One **$3750**

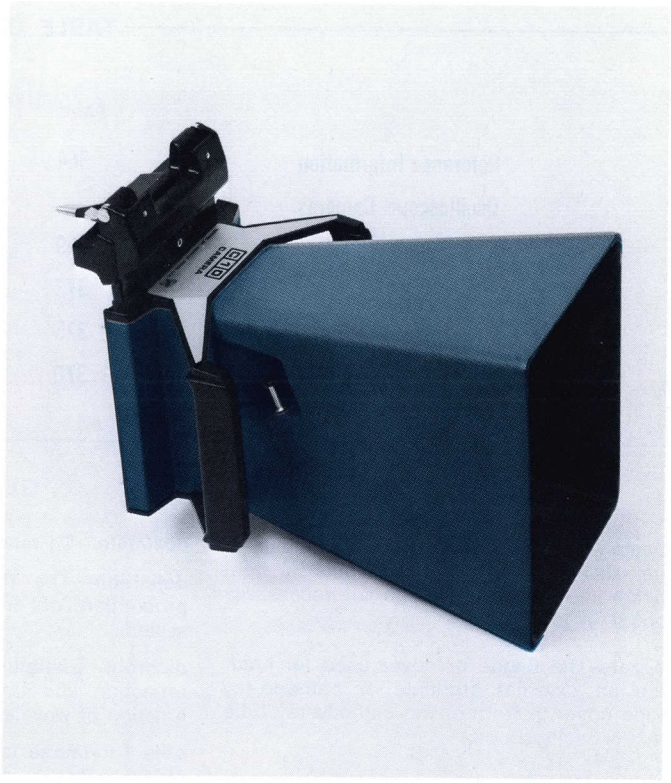
Paper—One roll is included with the 4601. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... $40 each.

For one carton of 4 rolls, order 006-1603-01 .... $143 each.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

C-10
Camera



- **LIGHTWEIGHT**
- **FIXED FOCUS**

The C-10 is a fixed-focus, light-weight, trace-recording camera designed for use with the Tektronix 611 11-inch Storage Display Unit, T4002 Graphic Computer Terminal, or T4005 Graphic Display. An f/8 lens with sufficient depth of field, and convenient hand grips allow the C-10 to be held against the CRT without sacrificing picture quality. The camera includes a Polaroid[1] 4 x 5 film holder. Graflok[2] 4 x 5 accessories can also be used.

Lens— 64.40 mm, f/8 trace-recording lens stops down to f/22.

Shutter Speeds— 1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60 and 1/125 plus Bulb and Time.

Relative Aperture—f/8, 11, 16, 22.

Object-To-Image Ratio— 1:0.5, records entire 11-inch CRT display on a standard 4 x 5 Polaroid film packet.

Film Back—Graflok back with Polaroid cut-film holder mounted. Cut-film holder accepts 3,000-speed film which develops outside the camera in about 15 seconds.

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.

Mechanical—Hand held via convenient hand grips on each side. Camera housing of die-cast high-impact plastic.

Dimensions and Weights
(Back in Place)

Length	13 3/4 in	34.9 cm
Width	10 3/8 in	26.4 cm
Height	8 3/4 in	22.3 cm
Net Weight	5 1/2 lb	2.5 kg

Included Standard Accessory—Instruction manual (070-0988-00).

C-10 CAMERA **$400**

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

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GLOSSARY

beam splitter—A device such as a prism or half-silvered mirror which splits a light beam into 2 or more beams not necessarily equal in intensity.

bezel—The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube in an oscilloscope.

cable release—a cable provided for remote actuation of a camera shutter.

camera adapter—a mounting frame used to attach a camera to an oscilloscope.

collimate—To render parallel.

definition—The degree of clarity of reproduction of an object by an optical system.

dichroic—Exhibiting the quality of selective reflection and transmission of light as a function of wavelength.

object-to-image ratio—The camera or lens object-to-image ratio is the ratio of the object size to the image size. For example, a 1:1 lens is one whose object is the same size as the image. As the object-to-image ratio increases, so does the writing speed.

parallax—The apparent displacement of an observed object due to the angle of observation.

postfogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light after the image producing exposure.

prefogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light before the image producing exposure.

resolving power—The degree to which a system or a device distinguishes fineness of detail.

Tektronix cameras, component parts and accessories are specifically designed to solve a wide range of oscilloscope trace-recording needs. Of the many design considerations made during the development of a Tektronix oscilloscope-camera system, one of the most important considerations is ease of operation. The attention given to this objective is evident from the improvements of the C-50, C-51, C-70 and the new C-52 Cameras. The ability of a particular user to photograph a given event is primarily dependent upon the selection of the oscilloscope-camera system and secondarily, his ability to apply certain photographic techniques.

The various Tektronix cameras can be classified into four groups. These groups are: C-50, C-51 and C-52 (recommended for the 7000 Series); C-70 (recommended for the 5030, 5031 and Type 576 Curve Tracer); the C-12 and C-27 (recommended for the 500 Series); and the C-30A, C-31 and C-32 (recommended for the 300 and 400 Series). The C-10 is a special-purpose camera designed for use with the Tektronix Type 611 Storage Display Unit. When a camera is recommended for a particular oscilloscope, that is not to imply that the camera would not be suitable for use with other instruments. The application would be the primary determining factor.

The C-50, C-51, C-52 and C-70 are compact cameras with features not available on other cameras, to add to photographic ease and convenience. These cameras are focused by merging two bars of light which are projected from the camera to the CRT. The exposure photometer projects the virtual image of a spot of light into the plane of the CRT where the spot can be matched to the trace intensity. When the camera is properly focused, a locking mechanism secures the aperture and shutter speed controls so that if one is moved, the other tracks to maintain the correct exposure ratio.

Factors to consider in choosing the most appropriate camera include: lens type, CRT phosphor, type and size of print desired, ability to up-grade or add to a present camera, type of viewing, compatibility with different oscilloscopes, and writing speed requirements. These factors are discussed below.

VIEWING

All cameras may be easily swung away from the display area for wide-angle viewing. The C-12, C-27, C-50, C-51, C-52, and C-70 Cameras also provide a comfortable viewing tunnel, through which the display may be viewed without interference from ambient light. The C-12 features a beam-splitting mirror, which simulates a viewing position directly in front of the CRT, and thus eliminates parallax. A projected graticule is available for use with the C-12 in applications where parallax is to be further reduced, or a special-purpose graticule or mask is needed.

CAMERA FLEXIBILITY AND COMPATIBILITY

Tektronix cameras are designed to offer maximum flexibility and compatibility. These two considerations are so broad the information is presented in a chart form for ease of understanding. Please see the component pages in this section. Your Field Engineer will be pleased to assist you in those instances where additional information is required.

PICTURE SIZE

With either Polaroid Land[1] or conventional films, the exposable area of the film must be at least as large as the image from the lens. Image size will depend on the object-to-image ratio of the camera lens and on the size of the oscilloscope display. For example, the Graflok[2] Back with 120 or 620 roll film would probably not be used with a 1:0.85 lens and a 10-cm wide oscilloscope display. This is because the image of the display is 8.5 cm wide and the exposable area (long dimension) of the film is only 7.8 cm maximum (it can be as short as 5.7 cm, depending on film format). The film size should be at least 5 mm larger than the size of the image to allow for normal tolerances in the construction of the Camera Backs and for the position of the film in the back.

ASA RATINGS, FILM AND BACK TYPES

Polaroid Pack Backs, Roll Backs and Graflok Backs may be interchanged on each camera.

Polaroid films can also be used in a Polaroid 4 x 5 film holder with the 4 x 5 Graflok Back. This combination, used with Type 57 film (3000 speed), a 1:1 lens, and a C-27 or C-52 Camera will give full-size records of graticule areas as large as 8 x 10 cm. A Standard C-27 Camera (1:0.85 lens) equipped in the same way will make a complete record of a 10 x 10-cm graticule.

If you want to obtain a negative from which a number of prints can be made, either Type 55 P/N film (which comes in Polaroid Land 4 x 5, only) or conventional film is satisfactory.

Conventional cut film and 120 roll film can be used with either the 4 x 5 or 2¼ x 3¼ Graflok Back and the proper holder or adapter. A number of film types, manufactured by Eastman Kodak, Agfa, Ansco, and others, are available in both forms, at ASA speeds from 64 to 1250.

A detailed list of film types and characteristics of these and other films not mentioned here can be obtained from the respective manufacturer.

Polaroid Type 47 and Type 107 (roll film and pack film, respectively) each have an ASA equivalent exposure index of 3000. Polaroid Type 410 ASA 10,000 roll film is especially suited for high-speed photography. Each film type has 8 exposures, develops in 15 seconds and has an exposable area of 9.5 cm x 7.3 cm. Continuous-tone slides can be made using Polaroid Type 46 or 46-L; each film type is on an 8-exposure roll and develops in 2 minutes. Roll film develops inside the film back; pack film develops outside.

ASA exposure ratings are measured under a specific set of conditions. Oscilloscope exposures differ from these conditions such that ASA ratings do not accurately apply to oscilloscopes. However, the writing speed of ASA 10,000 may generally be expected to be approximately 2 to 2.5 times that of ASA 3000 for oscilloscope photography.

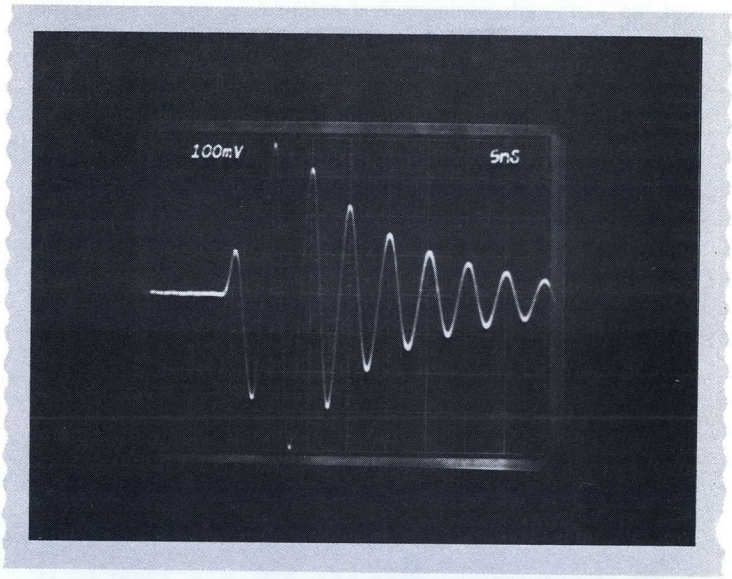
PHOTOGRAPHIC WRITING SPEED

Photographic writing speed describes the ability of a particular camera, film, oscilloscope, and phosphor to record fast moving traces. The writing speed figure expresses the maximum single event spot velocity (usually in centimeters per microsecond) which may be recorded on film.

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.

The illustration below shows one way in which writing speed can be measured to determine if a particular system has the ability to record an important single-sweep display which will be difficult if not impossible to repeat. There is displayed a single trace of a damped sinewave whose frequency and amplitude is such that the rapidly rising and falling portions of the first cycle or two fail to record. The peak to peak amplitude of the sinewave should be three to four times as great as the horizontal distance occupied by one cycle.

The writing speed capability of the oscilloscope is determined as follows: mask out the sinewave peaks on the photograph leaving the central one-third visible. View the photograph while backlighted. Starting from the left, find the first rapidly rising or falling portion of the damped sinewave which is discernible. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion. The writing speed in centimeters per microsecond is calculated by:



Photographic writing speed = 3.14 Df where f is the frequency of the damped sinewave in megahertz. The above photo was taken with a 7704 Oscilloscope with P11 phosphor using a C-51-R Camera.

Although the writing speed is an important characteristic of the oscilloscope, it does not completely describe the ability of the oscilloscope to present detailed information.

Writing speeds have been specified for certain Tektronix oscilloscopes such as the 454A and the 7000 Series. The specification represents the minimum photographic writing speed which can be expected without employing special photographic techniques such as prefogging and post-fogging. In addition, a considerable safety margin is provided for the oscilloscope users since the writing speed specification is based upon minimal performance, not average. The oscilloscope-camera user, by selecting either the 454A or one of the 7000-Series Oscilloscopes, knows in advance the minimum writing speed he may expect. The writing speed of other oscilloscope-camera systems should, generally, be determined experimentally on an individual basis.

LENSES

Each of these lens systems was specifically designed for oscilloscope applications. Their essential differences are in their ability to photograph extremely dim traces such as those produced in single-sweep applications at the highest sweep rates, and their angular coverage, or ability to photograph large or small displays.

Two factors which should be considered in selecting a lens are the f number and the object-to-image ratio, since writing speed is directly dependent upon both. Writing speed for a given system can always be expected to increase as the f number decreases and the object-to-image ratio increases.

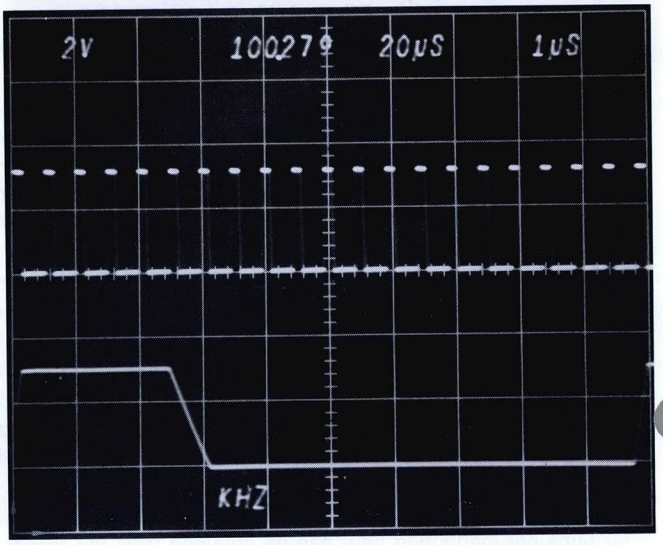
There are basically five different lenses which are available for the C-12 and C-27 cameras which add to the flexibility of these cameras. The f number and object-to-image ratios are: standard general-purpose f/1.9-1:0.85 and f/1.9-1:0.7, high speed f/1.9-1:0.5, precise full-size image and high writing speed f/1.4-1:1 and the extra-high writing speed f/1.3-1:0.5. The C-51 has an f/1.2 lens with an object-to-image ratio of 1:0.5. This is the best light-gathering lens available in any Tektronix camera. 7000-cm/μs writing rate is obtained using C-51-R camera, Type 410 film (10,000 speed) and a 7704 with optional P-11 phosphor.

The C-50, C-51, C-52, C-70, C-30A, C-31 and C-32 do not have the lens flexibility of the C-12 and C-27 since the lens of each camera is fixed. The individual specification pages for each camera contains a complete description of the camera's lens system.

CRT SELECTION

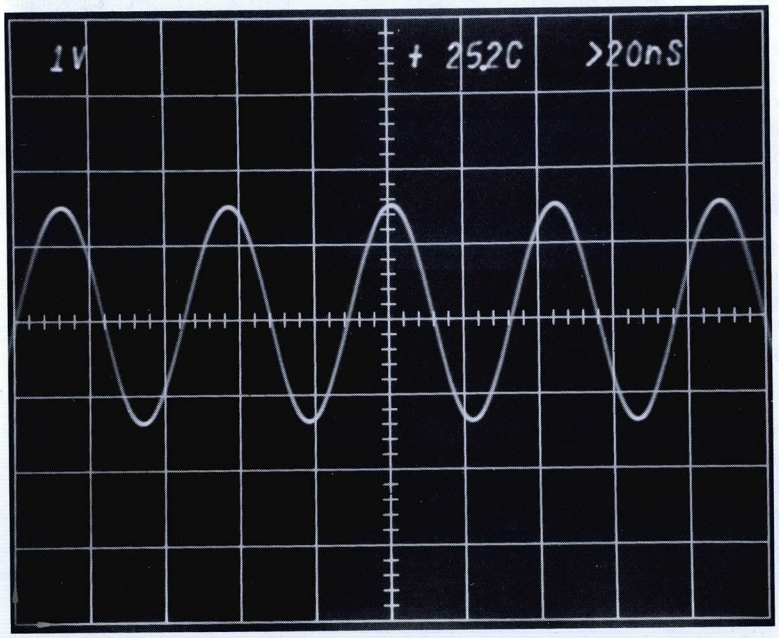
There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications.

The catalog description of each oscilloscope indicates the phosphor normally supplied. However, phosphors may be ordered which would be more suitable for particular requirements. The phosphor data chart in the General Oscilloscope Reference Section will help in your selection.



GENERAL PURPOSE

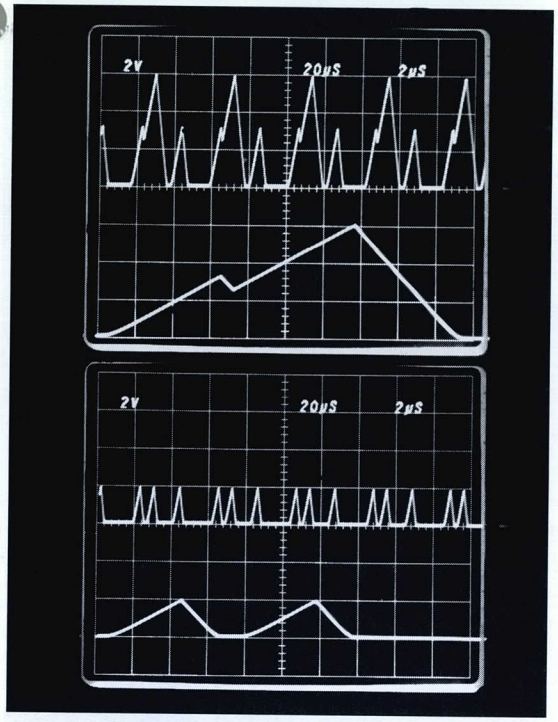
f/1.9, 1:0.85 object-to-image ratio . . . image brightness sufficient for most applications. When photographing 8 x 10-cm graticules, or 10 x 10-division graticules provides the largest size image that will still fall within the maximum recording area of 3¼ x 4¼ size Polaroid film. Taken with C-27 and 7514 Oscilloscope, in alternate sweep mode.



PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED

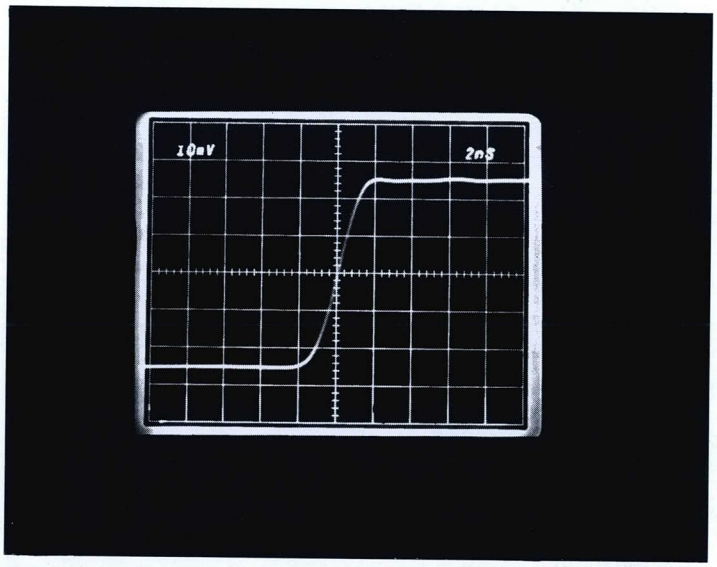
f/1.4, 1:1 object-to-image ratio . . . for precise full-size records . . . measurements can be scaled directly off photograph with maximum resolution, writing speed is faster than C-50 with general-purpose lens. Taken with C-52-G and 7504 Oscilloscope.

Photos on these two pages reproduced in actual size



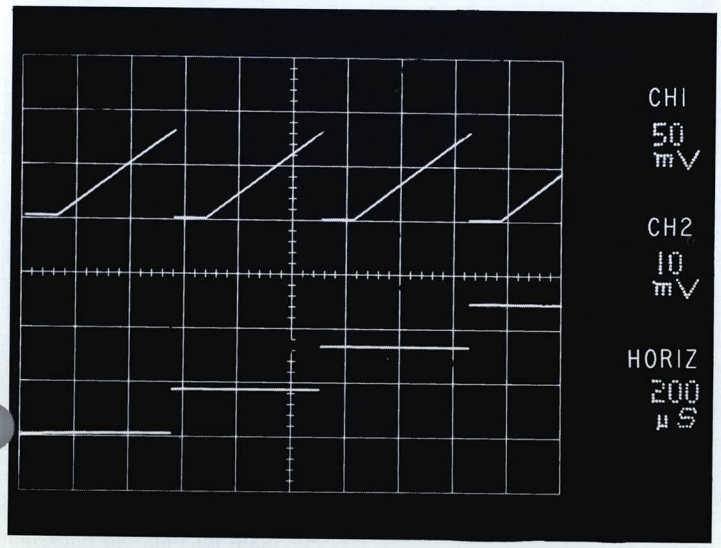
FILM ECONOMY AND HIGH WRITING SPEED

f/1.3, 1:0.5 object-to-image ratio . . . efficient use of film combined with high-writing speed lens. Taken with C-27 and 7000-Series Oscilloscope, using alternate sweep mode.



MAXIMUM WRITING SPEED LENS

f/1.2, 1:0.5 object-to-image ratio . . . for applications where writing rate is the prime consideration. Repetitive event photographed with C-51-R and 7704 Oscilloscope. Single-sweep writing speed is 3300 cm/μs with standard P31 phosphor and 7000 cm/μs with optional P11 phosphor.



RECORDS READOUT AND DISPLAYS ON 6½-INCH CRT'S

f/1.9, 1:0.575 object-to-image ratio . . . designed especially for oscilloscope with 6½-inch CRT's and fiber-optic readout. Taken with C-70 and 5030 Oscilloscope.

OSCILLOSCOPE/CAMERA ADAPTERS
($16 each)

OSCILLOSCOPE TYPE	RECOMMENDED CAMERA	C-12 ADAPTER PART NUMBER	C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-50 SERIES ADAPTER PART NUMBER[4]
321A	C-30A			016-0242-00	
422	C-30A			integral	
453A	C-30 Series			integral	
454A	C-30 Series			integral	
491	C-30A			integral	
502A	C-27-547	016-0226-01	016-0225-03	016-0243-00	016-0225-03
503	C-12 or C-27				
504	C-12 or C-27				
519	C-27-662R or C-51R		integral		integral
520	C-27-549		016-0225-03		016-0225-03
521	C-27-549				
522	C-27-549				
528	C-27		016-0249-03	016-0248-00	integral
529	C-27	016-0217-00[2]	016-0224-00	016-0244-00	016-0224-00
544	C-12 or C-27	016-0226-01	016-0225-03	016-0243-00	016-0225-03
545B	C-12 or C-27				
546	C-12 or C-27				
547	C-12 or C-27				
549	C-12			016-0243-00[3]	
556	C-12 or C-27			016-0243-00	
561B	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00
564B	C-12 or C-27				
565	C-27-547	016-0226-01	016-0225-03	016-0243-00	016-0225-03
568	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00
575	C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03
576	C-70[1]	See Adapter frame/corrector lens at right (not for C-30 Series)			
601	C-30A	016-0263-00	016-0249-03	016-0248-00	integral
602	C-30A				
647A	C-27-662R or C51-R		016-0223-00		016-0223-00
4501	C-30A	016-0263-00	016-0249-03	016-0248-00	integral
5030	C-70[1]	See Adapter frame/corrector lens at right (not for C-30 Series)			
5031	C-70[1]				
7403N[5]	C-50	016-0263-00	016-0249-03	016-0248-00	integral
7503	C-50				
7504	C-50				
7514	C-50				
7704	C-51				
some Hewlett-Packard	call Tektronix Field Office or Representative	016-0229-00	016-0228-00		016-0228-00
some Fairchild Dumont			016-0227-00		016-0227-00

[1]No additional adapter is required with C-70 Camera.

[2]Requires slight modification to the 529.

[3]C-30 Series Cameras are not easily removed from the 549.

[4]Requires battery pack 016-0270-00 when not used with 7000 Series.

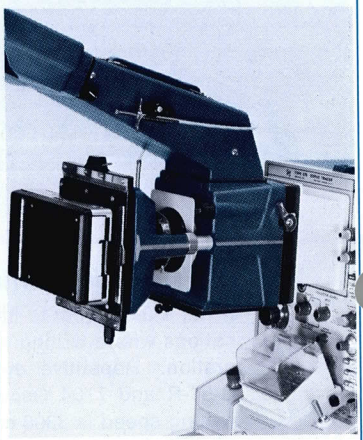
[5]When cameras other than C-50 or C-51 are used, some corner cropping will result.

ADDITIONAL ADAPTERS

ADAPTER FRAME/CORRECTOR LENS FOR C-12 OR C-27 CAMERA

This adapter allows a C-12 or C-27 Camera to photograph displays and adjacent scale-factor readout on the 576 Curve Tracer, 5030 and 5031 Oscilloscopes. A corrector lens is included to compensate for the increased distance (2 7/8 inches) from CRT to film. Object-to-image ratio with a standard camera (1:0.85 lens) is about 1:0.45. The adapter frame requires use of a standard camera adapter (016-0226-01 for C-12, or 016-0225-03 for C-27), not included.

Order 016-0264-01 ..... $35



Camera mounted to 576 Curve Tracer using adapter frame and standard 5-inch round CRT adapter. Corrector lens is gray piece in middle of camera.

ADAPTER FRAME/CORRECTOR LENS FOR C-50 CAMERA

This adapter allows a C-50 Camera to photograph displays and adjacent scale-factor readout on the 576 Curve Tracer, 5030 and 5031 Oscilloscopes. A corrector lens is included to compensate for the increased distance (1-3/8 inches) from CRT to film. Object-to-image ratio with the C-50 Camera (1:0.7 lens) is about 1:0.55. No additional adapters are required for mounting. The range-finder focusing feature of the C-50 is not usable, due to the increased distance to the CRT. Use a Graflok back or focus plate (not included for focusing. Order 016-0271-00 ..... $16

Focus plate for Polaroid roll-film back, order 387-0460-00 ..... $5

Focus plate for Polaroid pack-film back, order 387-0893-00 ..... $5

C-12 and C-12E

- ***STRAIGHT-ON BINOCULAR VIEWING***
- ***LIFT-ON MOUNTING, SWING-AWAY HINGING***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***ROTATING & SLIDING BACK***
- ***LENS & BACK OPTIONS***
- ***ACCEPTS PROJECTED GRATICULE ACCESSORY***

The C-12 is a general-purpose trace-recording camera suitable for use with most Tektronix full-size oscilloscopes. The special beam-splitting mirror in the C-12 (and a conventional mirror) reflects an uninverted image through the viewing tunnel, giving the viewer the impression of a straight-on view of the CRT. This is especially desirable when the oscilloscope has an external graticule, since parallax errors are reduced. The beam-splitting mirror also allows use of the Projected Graticule accessory. The beam-splitting mirror transmits approximately 65% of available light to the film.

STANDARD C-12

LENS
75-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
1:0.85, records 8 x 10-cm graticule on 3¼ x 4¼ Polaroid[1] film.

FILM BACK
Polaroid Pack-Film Back accepts 3000-speed film which develops outside camera in about 10 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging with C-12 Camera Adapter (not included). Accepts Projected Graticule.

DIMENSIONS AND WEIGHTS

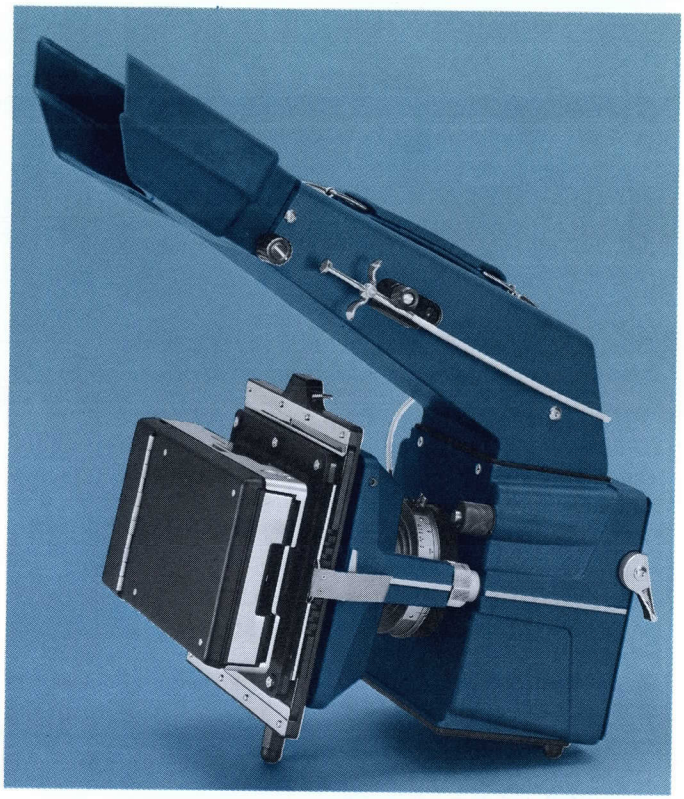
Height	15⅜ in	39.0 cm
Width	7½ in	19.0 cm
Depth	17¼ in	43.8 cm
Net weight	12¼ lb	5.6 kg
Domestic shipping weight	≈16 lb	≈ 7.3 kg
Export-packed weight	≈33 lb	≈15.0 kg

INCLUDED STANDARD ACCESSORIES
Cable release (122-0586-02); focus plate (387-0893-00); instruction manual (070-0383-02).

C-12 CAMERA **$490**

ROLL-FILM CAMERA identical to the Standard C-12, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back.
C-12-R CAMERA **$490**

[1]Registered Trademark Polaroid Corporation.



ELECTRICALLY-ACTUATED CAMERAS

All C-12 Cameras are available with an electric shutter and speed computer, instead of the standard mechanical shutter. These cameras are useful in areas where a large number of cameras need to be remotely controlled, or where there is limited access to the oscilloscope and camera. Other features of the electrically-actuated cameras (designated by suffix "E") are identical to the standard cameras.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30, and 1/60 second (accurate within 20% from 0°C to +40°C) plus Bulb and Time.

SHUTTER LIGHT
The shutter light indicates that the shutter is open.

REMOTE ACTUATION
Remote actuation is obtained with a single ground closure.

LINE VOLTAGE
115 VAC ±10% or 230 VAC ±10%, 50 to 60 Hz.

C-12-E ELECTRIC SHUTTER CAMERA, Pack-Film Back **$760**

C-12-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$760**

All cameras are sold without mounting adapter; see next page.

OPTIONAL ACCESSORIES

PROJECTED GRATICULE for 115 volts, order 016-0204-00 $175

PROJECTED GRATICULE for 230 volts, order 016-0234-00 $175

CARRYING CASE, order 016-0208-02 ..... $85

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

CUSTOM C-12 CAMERAS				
LENS (Writing speed compared to Standard f/1.9, 1:0.85 lens)	ELECTRIC SHUTTER/ SPEEDCOMPUTER	POLAROID FILM BACK	ORDER NUMBER	PRICE
FILM ECONOMY & MEDIUM WRITING SPEED—f/1.9, 1:0.7. Records two 6 x 10-cm or three 4 x 10-cm graticules on each film. Writing speed 1.25X Standard Lens.	No	Pack Film Roll Film	C-12-547 C-12-547 R	$510
	Yes	Pack Film Roll Film	C-12-547 E C-12-547 RE	$780
HIGH WRITING SPEED—f/1.9, 1:0.5 Records fast-writing displays such as single-shot transients. Writing speed 1.5X Standard Lens.	No	Pack Film Roll Film	C-12-549 C-12-549 R	$530
	Yes	Pack Film Roll Film	C-12-549 E C-12-549 RE	$800
PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED—f/1.4, 1:1. Records full-size image of 8 x 10-cm graticule (on 4 x 5 film with optional Graflok[2] Back). Writing speed 1.75X Standard Lens.	No	Pack Film Roll Film	C-12-608 C-12-608 R	$695
	Yes	Pack Film Roll Film	C-12-608 E C-12-608 RE	$965
ULTRA-HIGH WRITING SPEED—f/1.3, 1:0.5 Where writing speed is prime consideration. Records two 6 x 10-cm graticules on each film. Writing speed 3X Standard Lens.	No	Pack Film Roll Film	C-12-662 C-12-662 R	$670
	Yes	Pack Film Roll Film	C-12-662 E C-12-662 RE	$940

Any C-12 Standard or Custom Trace-Recording Camera can be ordered less back. Use suffix "N" after the Order Number and deduct $85 from the price. 4 x 5 or 2¼ x 3¼ Graflok Backs are shown on page 374. Additional accessories for Graflok Backs are readily available from local camera shops. Accessories available are: 2 or 6-exposure Film Holder, 16-exposure Film Pack Adapter, 8, 10 or 12-exposure 120 Roll-Film Holder and Polaroid Land 4 x 5 Film Holder.

C-12 cameras are sold without mounting adapter. Order 016-0226-01 for Tektronix Oscilloscope with 5-inch round CRT (except Type 519 and 520). Order 016-0217-00 for Tektronix Oscilloscopes with 5-inch rectangular CRT (except Type 528, 601, 602, 7000 Series, and 647A. Order 016-0263-00 for Type 528, 601, 602, and 7000 Series). Adapters are available for some non-Tektronix Oscilloscopes. Price is $16 each.

[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Projected Graticule for C-12

The Projected Graticule for the C-12 Camera eliminates parallax and provides an area that can be used for write-in data.

Parallax is the apparent displacement of the trace in relation to the graticule. Error is introduced since the graticule and CRT phosphor are on different planes.

To eliminate parallax, a virtual image of the graticule is presented at the CRT phosphor plane, as viewed by the operator and as projected to the camera film plane.

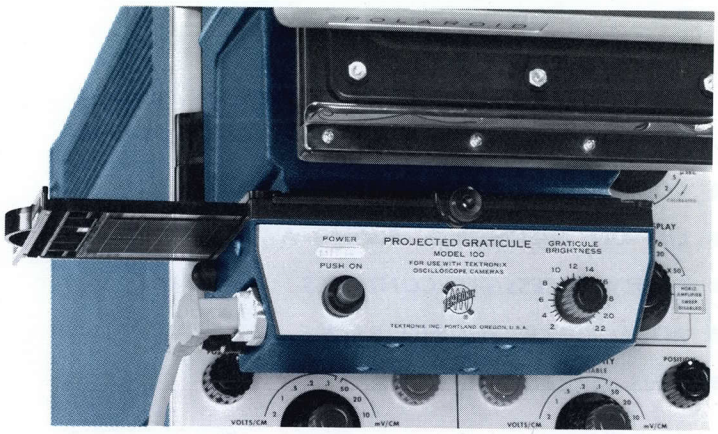
Special graticules, reference waveforms, or any image that can be recorded on a film transparency, can be superimposed on the CRT display. The graticule is held in a slide assembly and is easily slipped in and out of the Projected Graticule case, making possible rapid change of graticules. The included slide assembly has a clear window. Assemblies can be obtained (see below) in several colors to match or contrast the projection with the CRT phosphor.

The projected graticule provides up to an 8 x 10-cm projection, a portion of which can be used for write-in data.

The light source is indexed in approx ½-f stop increments for use as a film exposure guide. This source can also be used for precise prefogging of film for increased sensitivity in fast writing-speed applications.

Operates on 90 to 130 V, or 180 to 260 V, 50 to 440 Hz.

Although the Projected Graticule case is small (it adds only 2¼ inches to camera height), clearance problems exist with the Type 81A Adapter and a few plug-in unit/probe combinations. **If in doubt about compatibility, please consult your Tektronix Field Office, Representative or Distributor.**



PROJECTED GRATICULE for 115 volts (016-0204-00) . . $175

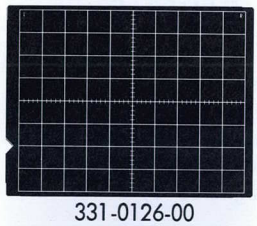
PROJECTED GRATICULE for 230 volts (016-0234-00) . . $175

Includes: power cord (161-0015-01); 4 x 10 cm graticule with write-in area and short minor lines (331-0117-00); 6 x 10 cm graticule with write-in area and short minor lines (331-0111-00); 8 x 10 cm graticule without write-in area, but with full minor lines (331-0119-00); 4 x 10 cm graticule mask (331-0118-00); 6 x 10 cm graticule mask (331-0116-00).

GRATICULE SLIDE ASSEMBLIES . . . . . $3 each

Clear Window 122-0659-00	Green Window 122-0668-00
Blue Window 122-0667-00	Amber Window 122-0669-00

OPTIONAL GRATICULES and MASKS . . . . . $1.40 each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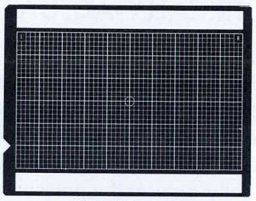
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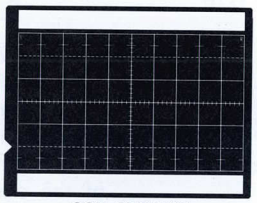
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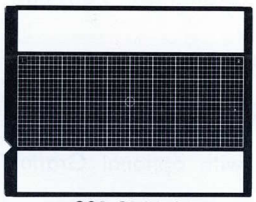
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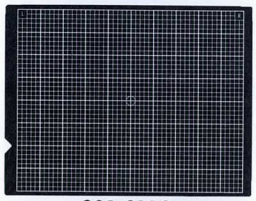
6 x 10 cm Mask 331-0116-00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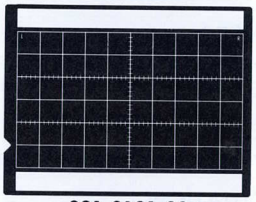
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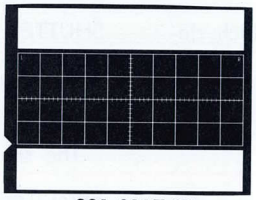
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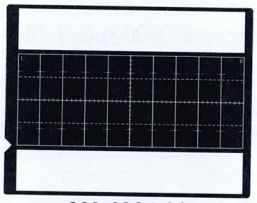
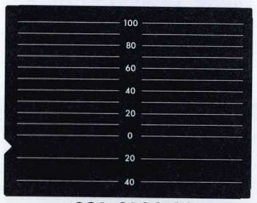

331-0136-00

4 x 10 cm Mask 331-0118-00



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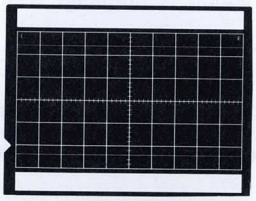
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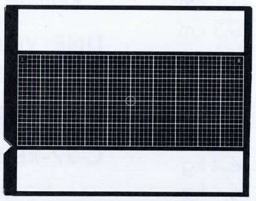
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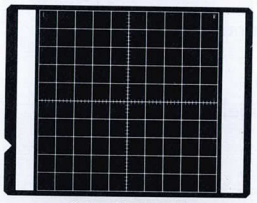
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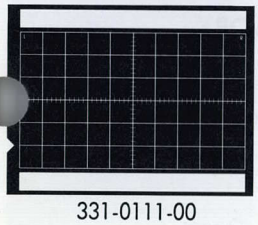
10 x 10 div Mask (for Type 570, 575, 536) 331-0129-00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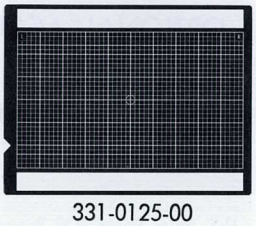
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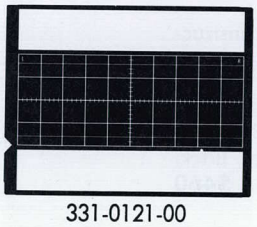
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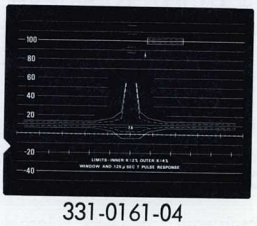

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U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

- ***COMFORTABLE BINOCULAR VIEWING***
- ***LIFT-ON MOUNTING, SWING-AWAY HINGING***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***ROTATING & SLIDING BACK***
- ***LENS & BACK OPTIONS***

The C-27 is a general-purpose trace-recording camera suitable for use with most Tektronix full-size oscilloscopes. The viewer sees the CRT without the use of mirrors. As a result the maximum amount of light is transferred to the film. The viewing tunnel can be easily removed, and the carrying handle folded out of the way. This allows camera mounting on two 7-inch rack-model oscilloscopes placed one over the other. In addition the camera frame can be rotated 90° or 180°, thus positioning the viewing tunnel at either side or at the bottom of the camera. The opening at the camera front allows the complete photographic coverage of large graticules such as the Type 502A Oscilloscope.

STANDARD C-27

LENS
75-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
1:0.85, records 8 x 10-cm graticule on 3¼ x 4¼ Polaroid[1] film, 10 x 10-cm graticule with optional Graflok[2] Back and 4 x 5 film.

FILM BACK
Polaroid Pack-Film Back accepts 3000-speed film which develops outside camera in about 10 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging with C-27 Camera Adapter (not included).

DIMENSIONS AND WEIGHTS

Height with viewing tunnel	17 3/16 in	43.7 cm
Height without viewing tunnel	8 in	20.3 cm
Width	7½ in	19.0 cm
Depth with viewing tunnel	13⅜ in	33.9 cm
Depth without viewing tunnel	12 in	30.5 cm
Net weight	10½ lb	4.8 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈36 lb	≈16.4 kg

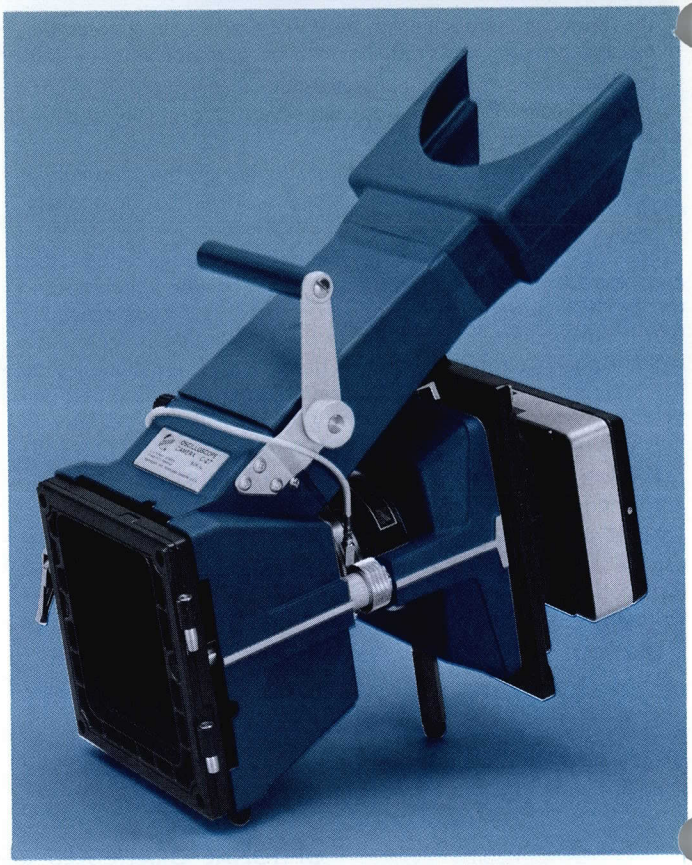
INCLUDED STANDARD ACCESSORIES
Cable release (122-0586-02), focus plate (387-0893-00), instruction manual (070-0383-02).

C-27 CAMERA **$460**

ROLL-FILM CAMERA identical to the Standard C-27, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back.

C-27-R CAMERA **$460**

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.



ELECTRICALLY-ACTUATED CAMERAS

All C-27 Cameras are available with an electric shutter and speed computer, instead of the standard mechanical shutter. These cameras are useful in areas where a large number of cameras need to be remotely controlled, or where there is limited access to the oscilloscope and camera. Other features of the electrically-actuated cameras (designated by suffix "E") are identical to the standard cameras.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second (accurate within 20% from 0°C to +40°C) plus Bulb and Time.

SHUTTER LIGHT
The shutter light indicates that the shutter is open.

REMOTE ACTUATION
Remote actuation is obtained with a single ground closure.

LINE VOLTAGE
115 VAC ±10% or 230 VAC ±10%, 50 to 60 Hz.

C-27-E ELECTRIC SHUTTER CAMERA, Pack-Film Back **$730**

C-27-RE ELECTRIC SHUTTER CAMERA, Roll-Film Back **$730**

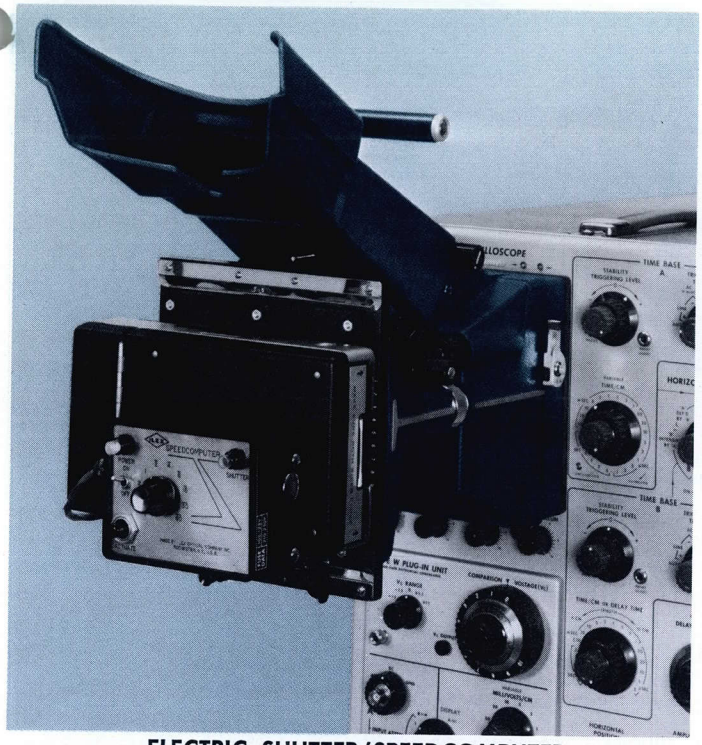
OPTIONAL ACCESSORY

CARRYING CASE, order 016-0208-02 ..... $85

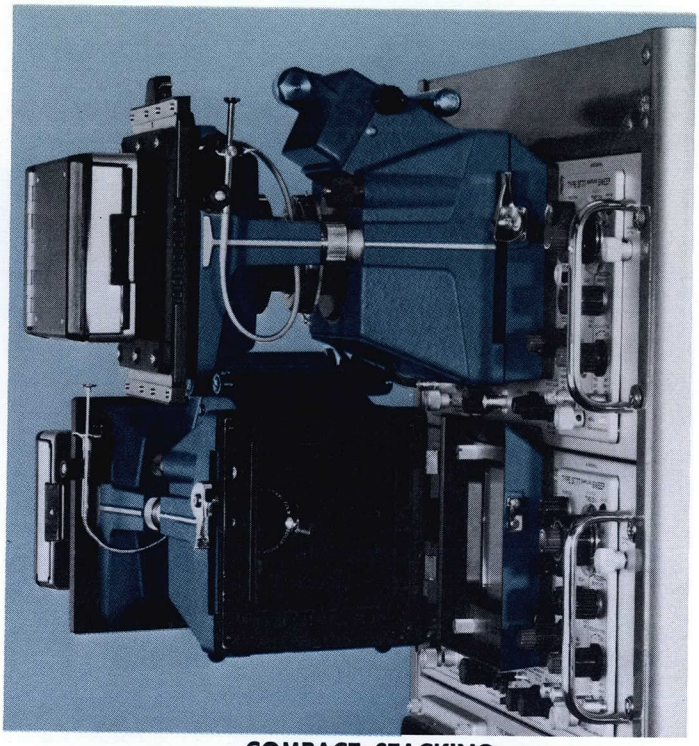
All C-27 cameras are sold without mounting adapter; see next page.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

C-27 and C-27E



ELECTRIC SHUTTER/SPEEDCOMPUTER



COMPACT STACKING

CUSTOM C-27 CAMERAS				
LENS (Writing speed compared to Standard f/1.9, 1:0.85 lens)	ELECTRIC SHUTTER/ SPEEDCOMPUTER	POLAROID FILM BACK	ORDER NUMBER	PRICE
FILM ECONOMY & MEDIUM WRITING SPEED—f/1.9, 1:0.7. Records two 6 x 10-cm, three 4 x 10-cm or one 10 x 10-cm graticule on 3¼ x 4¼ film. Writing speed 1.25X Standard Lens.	No	Pack Film Roll Film	C-27-547 C-27-547 R	$480
	Yes	Pack Film Roll Film	C-27-547 E C-27-547 RE	$750
HIGH WRITING SPEED—f/1.9, 1:0.5 Records fast-writing displays such as single-shot transients. Writing speed 1.5X Standard Lens.	No	Pack Film Roll Film	C-27-549 C-27-549 R	$500
	Yes	Pack Film Roll Film	C-27-549 E C-27-549 RE	$770
PRECISE FULL-SIZE IMAGE & HIGH WRITING SPEED—f/1.4, 1:1. Records full-size image of 8 x 10-cm graticule (on 4 x 5 film with optional Graflok Back). Writing speed 1.75X Standard Lens.	No	Pack Film Roll Film	C-27-608 C-27-608 R	$665
	Yes	Pack Film Roll Film	C-27-608 E C-27-608 RE	$935
ULTRA-HIGH WRITING SPEED—f/1.3, 1:0.5 Records two 6 x 10-cm graticules on each film. Writing speed 3X Standard Lens.	No	Pack Film Roll Film	C-27-662 C-27-662 R	$640
	Yes	Pack Film Roll Film	C-27-662 E C-27-662 RE	$910

Any C-27 Standard or Custom Trace-Recording Camera can be ordered less back. Use suffix "N" after the Order Number and deduct $85 from the price. 4 x 5 or 2¼ x 3¼ Graflok Backs are shown on page 374. Additional accessories for Graflok Backs are readily available from local camera shops. Accessories available are: 2 or 6-exposure Film Holder, 16-exposure Film Pack Adapter, 8, 10 or 12-exposure 120 Roll-Film Holder and Polaroid Land 4 x 5 Film Holder.

All C-27 cameras are sold without mounting adapter. Order 016-0225-03 for Tektronix Oscilloscopes with 5-inch round CRT (except Type 519). Order 016-0224-00 for Tektronix Oscilloscopes with 5-inch rectangular CRT (except 528, 601, 602, 7000 Series and 647A). Order 016-0249-03 for Type 528, 601, 602, and 7000 Series. Order 016-0223-00 for Type 647A. Adapters are available for some non-Tektronix Oscilloscopes. Price is $16 each.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

C-12 and C-27 Accessories

MECHANICAL SHUTTER/LENS

Shutter speeds from 1 to 1/50 second, plus Bulb and Time.

f/1.9—1:0.7 lens, film economy, medium writing rate, Pi Alphax or Ilex No. 3 shutter. Order 122-0547-00 ..... $200

f/1.9—1:0.5 lens, high writing rate, Pi Alphax or Ilex No. 3 shutter. Order 122-0549-00 $220

f/1.4—1:1 lens, precise full-size image, high writing rate, Pi Alphax No. 3 shutter. Order 122-0608-00 ..... $385

f/1.3—1:0.5 lens, ultra-high writing rate, Ilex No. 3 shutter. Order 122-0662-00 ..... $360

f/1.9—1:0.85 lens, general purpose, Pi Alphax or Ilex No. 3 shutter. Order 122-0692-00 $180

Coiled X sync cable has standard ASA connector which mates to the flash sync connectors on C-30-Series Cameras, C-12 and C-27 Cameras. Other end has 2 prong male plug. Order 175-0461-00 ..... $4.70

ELECTRIC SHUTTER/LENS

Requires speedcomputer for operation. Speedcomputer is included with all C-12-E and C-27-E cameras.

f/1.9—1:0.7 lens, film economy, medium writing rate, No. 3 electric shutter. Order 122-0772-00 ..... $200

f/1.9—1:0.5 lens, high writing rate, No. 3 electric shutter. Order 122-0773-00 ..... $220

f/1.4—1:1 lens, precise full-size image, high writing rate, No. 3 electric shutter. Order 122-0840-00 ..... $385

f/1.3—1:0.5 lens, ultra-high writing rate, No. 3 electric shutter. Order 122-0769-00 .. $360

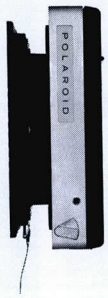
f/1.9—1:0.85 lens, general purpose, No. 3 electric shutter. Order 122-0771-00 ... $180

Speed computer. Order 122-0767-02 ... $270

Bracket for C-12, C-27. Order 122-0713-00 $7

Bracket for C-30A, C-31, or C-32. Order 407-0477-01 ..... $1.10

FILM BACKS



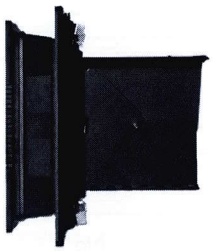
Polaroid Land 3¼ x 4¼ Pack-Film Back, 8 exp
Order 122-0671-00 ... $85

Focus Plate for above.
Order 387-0893-00 .... $5

Polaroid Land 3¼ x 4¼ Roll-Film Back, 8 exp
Order 122-0603-00 ... $85

Focus Plate for above.
Order 387-0460-00 .... $5

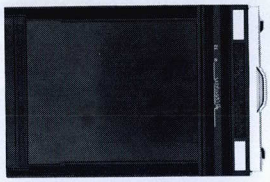
(Focus Plates not needed if Graflok Back is available.)



4 x 5 Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, roll-film (120) holders, Polaroid 4 x 5 Film Holder.
Order 122-0604-00 ... $50

2¼ x 3¼ Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, roll-film (120) holders.
Order 016-0233-00 ... $50

ACCESSORIES FOR GRAFLOK BACKS
Available from local camera store



Cut Film Holder
2 exposures
(Dark slide required for above)

Film-Pack Adapter
16 exposures

Film Holder
6 exposures

120 Roll-Film Holder
8 exposures, 2¼ x 3 1/16
Use with 1:0.7 lens

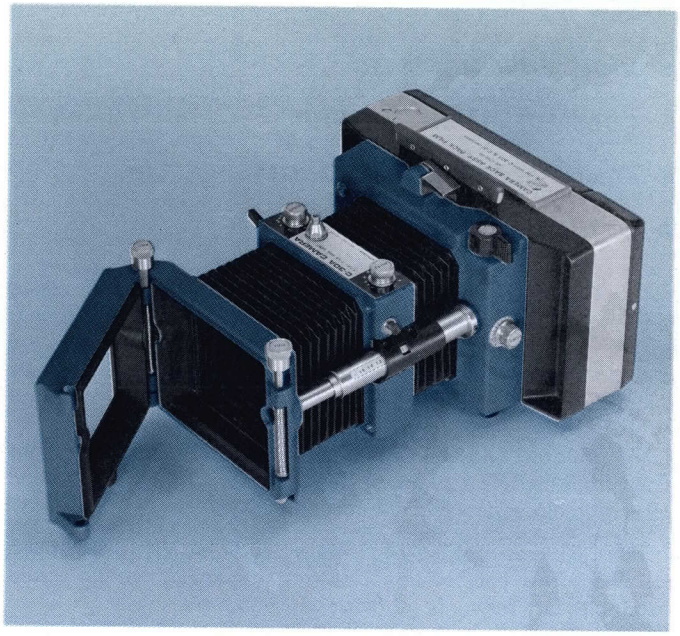
120 Roll-Film Holder
10 exposures, 2¼ x 2¾
Use with 1:0.5 lens

120 Roll-Film Holder
12 exposures, 2¼ x 2¼
Use with 1:0.5 lens

Polaroid Land 4 x 5 Film Holder
1 exposure

C-30A

- ***VARIABLE MAGNIFICATION***
- ***COMPACT, LIGHT WEIGHT***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***OPTIONAL FILM BACKS***



The C-30A is a compact, light-weight trace-recording camera designed for use with Tektronix portable instruments. It mounts directly to 422, 453A, and 454A Oscilloscopes and the 491 Spectrum Analyzer. Camera adapters are available for other portable and full-size oscilloscopes. The camera swings open from the left or right, as desired, and can be quickly lifted off the oscilloscope when not needed.

The C-30A uses an f/1.9 lens and features an adjustable magnification from 1:1.5 to 1:0.7. Optional film backs can be rapidly interchanged without refocusing the camera. Dark slides are included with all the film backs to prevent film exposure while changing backs.

LENS
56-mm f/1.9 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

MAGNIFICATION
Variable in indexed steps of 1.5, 1.4, 1.3, 1.2, 1.1, 1.0, 0.9, 0.85, 0.8 and 0.7. At 0.7 magnification, an 8 x 10-cm graticule can be recorded in its entirety.

FILM BACK
Polaroid[1] Pack-Film back accepts 3000-speed film which develops outside the camera in about 15 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging from left or right side. Mounts directly to 422, 453A and 454A Oscilloscopes and 491 Spectrum Analyzer. Optional camera adapters allow use with other Tektronix Oscilloscopes.

DIMENSIONS AND WEIGHTS

Height	5½ in	14 cm
Width	7 9/16 in	19.2 cm
Depth	10 in	25.4 cm
Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 9 lb	≈ 4.1 kg
Export-packed weight	≈14 lb	≈ 6.4 kg

INCLUDED STANDARD ACCESSORIES
Light seal (354-0279-00); light seal (354-0280-00); focus plate (387-0893-00); instruction manual (070-0808-01).

C-30A-P CAMERA, Pack-Film Back **$480**

C-30A-R ROLL-FILM CAMERA is identical to the standard C-30A-P, except a Polaroid Roll-Film Back is substituted for the Pack-Film Back and the focus plate is changed to (387-0460-00).

C-30A-R CAMERA, Roll-Film Back **$480**

C-30A-G GRAFLOK[2] BACK CAMERA is identical to the standard C-30A-P, except a 2¼ x 3¼ Graflok Back is substituted for the Roll-Film Back and the focus plate is removed from the standard accessories. The Graflok Back has a built-in focusing screen and accepts standard cut-film holders, film-pack adapters and roll-film (120) holders.

C-30A-G CAMERA, Graflok Back **$445**

C-30A-N CAMERA, No Back **$395**

OPTIONAL LENS

A portra lens will enable the Type C-30A Camera to photograph test setups. The depth of field when using the portra lens will vary with the f stop and magnification settings used. Generally, at f/1.9 there will be very little depth of field; while at f/16, the depth of field will allow quite a wide range of distance to be accommodated, depending upon the picture sharpness required. At a distance of 21 inches, a subject area 22 inches in diameter can be covered. Lens stores inside C-30A when not used; hardware included.

Order 016-0246-00 ..... $11

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

- ***HIGH WRITING SPEED***
- ***COMPACT, LIGHT WEIGHT***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***OPTIONAL FILM BACKS***

The C-31 is a compact, high-performance camera designed for Tektronix portable oscilloscopes. It provides the high-writing speed required when the 453A and 454A Oscilloscopes are operated single-shot at the fastest sweep rates. The C-31 mounts directly to these oscilloscopes, and also to the Type 422 and 491 Spectrum Analyzer. Camera adapters are available for other portable and full-size oscilloscopes. The camera swings open from the left or right, as desired, and can be quickly lifted off the oscilloscope when not needed.

The C-31 uses an f/1.2—1:0.5 lens and Polaroid[1] 10,000-speed roll film. This combination provides the fastest writing speed available for Tektronix portable oscilloscopes.

Optional film backs can be rapidly interchanged without refocusing the camera. Dark slides are included with all the film backs to prevent film exposure while changing backs.

LENS
56-mm f/1.2 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

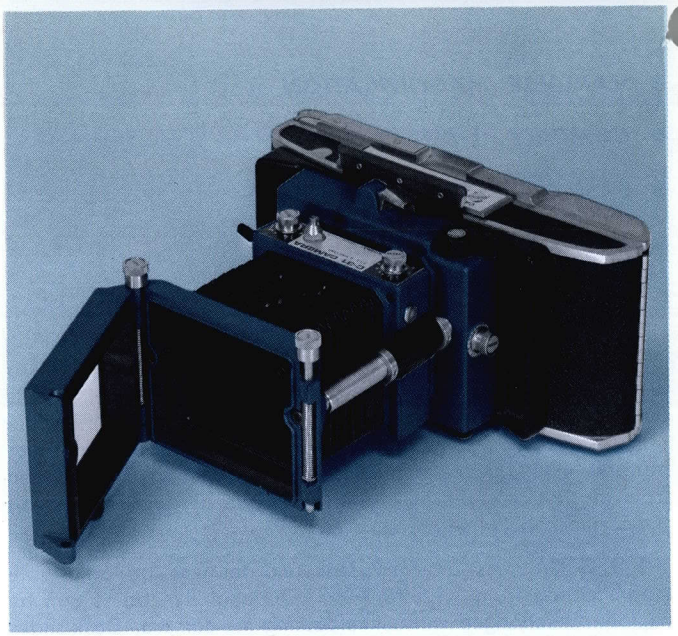
OBJECT-TO-IMAGE RATIO
1:0.5, records 8 x 10-cm graticules on 3¼ x 4¼ Polaroid film.

FILM BACK
Polaroid Roll-Film Back accepts 10,000-speed and 3,000-speed roll film which develops inside the camera in about 15 seconds.

PHOTOGRAPHIC WRITING SPEED (without film fogging, using 10,000-speed roll film.)

OSCILLOSCOPE	P31 PHOSPHOR	P11 PHOSPHOR
7704	3300 cm/μs	7000 cm/μs
7504	2250 cm/μs	3500 cm/μs
7503	2250 cm/μs	3500 cm/μs
454A	1600 div/μs (1280 cm/μs)	3200 div/μs (2560 cm/μs)

MECHANICAL
Lift-on mounting and swing-away hinging from left or right side. Mounts directly to 422, 453A and 454A Oscilloscopes and 491 Spectrum Analyzer. Optional camera adapters allow use with other Tektronix Oscilloscopes.



DIMENSIONS AND WEIGHTS

Height	5 9/16 in	14.1 cm
Width	9⅛ in	23.1 cm
Depth	10⅝ in	27.0 cm
Net weight	6¾ lb	3.1 kg
Domestic shipping weight	≈12 lb	≈5.4 kg
Export shipping weight	≈17 lb	≈7.7 kg

INCLUDED STANDARD ACCESSORIES
Light seal (354-0279-00); light seal (354-0280-00); focus plate (387-0460-00); instruction manual (070-0783-02).

C-31-R CAMERA, Roll-Film Back **$585**

C-31-P PACK-FILM CAMERA is identical to the standard C-31-R, except a Polaroid Pack-Film Back is substituted for the Roll-Film Back and the focus plate is changed to (387-0893-00). Polaroid 10,000 ASA speed film is not available in Film Packs.

C-31-P CAMERA, Pack-Film Back **$585**

C-31-G C RAFLOK[2] BACK CAMERA is identical to the standard C-31-R, except a 2¼ x 3¼ Graflok Back is substituted for the Roll-Film Back and the focus plate is removed from the Standard Accessories. The Graflok Back has a built-in focusing screen and accepts standard cut-film holders, film-pack adapters, and roll-film (120) holders.

C-31-G CAMERA, Graflok Back **$550**

C-31-N CAMERA, No Back **$500**

[1]Registered Trademark Polaroid Corporation

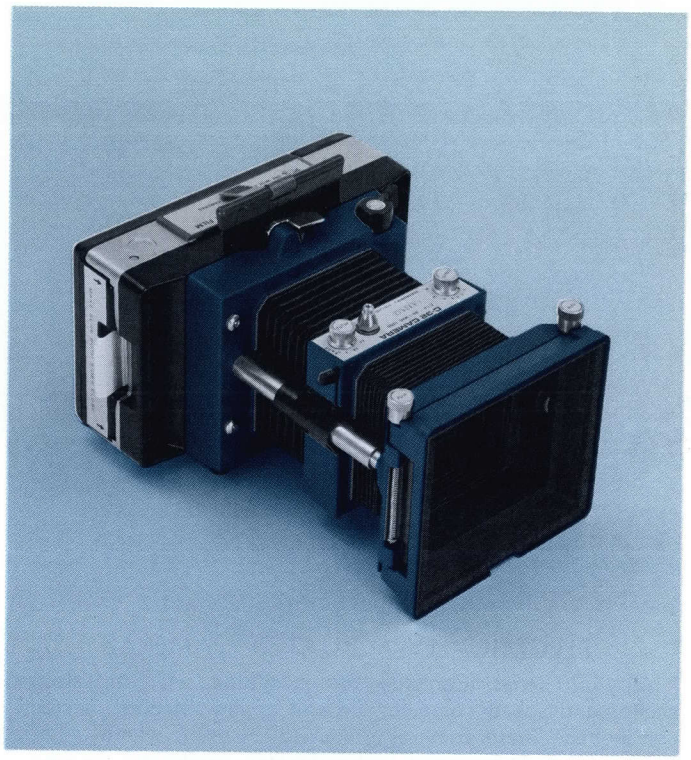
[2]Registered Trademark Graflex, Inc.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

C-32

NEW

- ***HIGH WRITING SPEED***
- ***VARIABLE MAGNIFICATION***
- ***COMPACT, LIGHT WEIGHT***
- ***EASILY-ACCESSIBLE CONTROLS***
- ***OPTIONAL FILM BACKS***



The C-32 is a compact, high-performance camera, designed for Tektronix portable oscilloscopes. It provides the high-writing speed required when the 453A and 454A Oscilloscopes are operated single-shot at the fastest sweep rates. The C-32 mounts directly to these oscilloscopes, and also to the Type 422 and 491 Spectrum Analyzer. Camera adapters are available for other portable and full-size oscilloscopes. The camera swings open from the left or right, as desired, and can be quickly lifted off the oscilloscope when not needed.

The C-32 uses an f/1.4 lens and features five selectable object-to-image ratios. It has maximum resolution and minimum distortion at 1:1 object-to-image ratio. The C-32 is useable at 1:1.2, 1:1.1, 1:0.9 and 1:0.85 with some noticeable distortion. Optional film backs can be rapidly interchanged without refocusing the camera. Dark slides are included with all the film backs to prevent film exposure while changing backs.

LENS
60-mm f/1.4 oscilloscope recording lens, stops down to f/16.

SHUTTER SPEEDS
1 to 1/50 second plus Bulb and Time.

OBJECT-TO-IMAGE RATIO
Five selectable positions, 1:1.2, 1:1.1, 1:1, 1:0.9 and 1:0.85. The 1:0.85 ratio records 8 x 10 cm graticules on $3\frac{1}{4} \times 4\frac{1}{4}$ Polaroid[1] film. When using a 1:1, 1:1.1 or 1:1.2 ratio a 4 x 5 Graflok[2] back is required to record a full 8 x 10 cm graticule.

FILM BACK
Polaroid Pack-Film back accepts 3000-speed film which develops outside the camera in about 15 seconds.

MECHANICAL
Lift-on mounting and swing-away hinging from left or right side. Mounts directly to the 422, 453A, and 454A Oscilloscopes and 491 Spectrum Analyzer. Optional camera adapters allow use with other Tektronix Oscilloscopes.

DIMENSIONS AND WEIGHTS

Height	$5\frac{1}{2}$ in	14.0 cm
Width	$7\frac{9}{16}$ in	19.2 cm
Depth	10 in	25.4 cm
Net weight	5 lb	2.3 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED STANDARD ACCESSORIES
Light seal (354-0279-00); light seal (354-0280-00); focus plate (387-0893-00); instruction manual (070-0783-02).

C-32-P CAMERA, Pack-Film Back **$625**

C-31-R ROLL-FILM CAMERA is identical to the standard C-32-P except a Polaroid Roll-Film Back is substituted for the Pack-Film Back and the focus plate is changed to (387-0460-00).

C-32-R CAMERA, Roll-Film Back **$625**

C-32-G GRAFLOK BACK CAMERA is identical to the standard C-32-P, except a $2\frac{1}{4} \times 3\frac{1}{4}$ Graflok Back is substituted for the Pack-Film Back and the focus plate is removed from the Standard Accessories. The Graflok Back has a built-in focusing screen and accepts standard cut-film folders, film-pack adapters, and roll-film (120) holders.

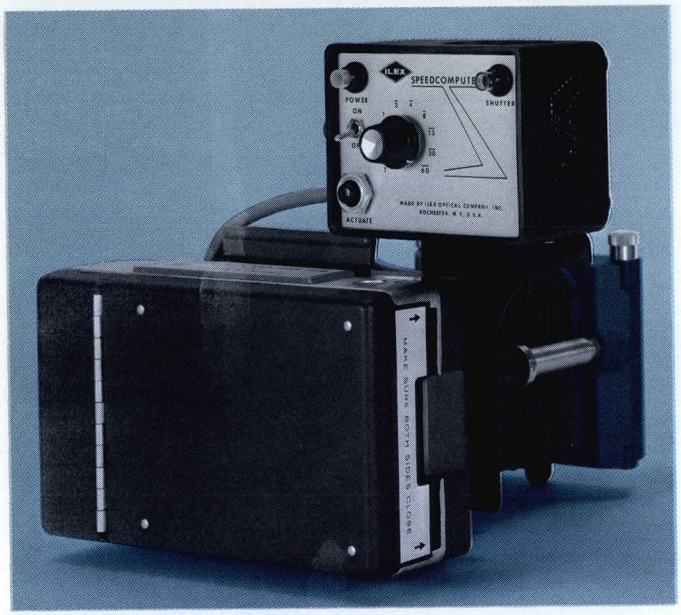
C-32-G CAMERA, Graflok Back **$590**

C-32-N CAMERA, No Back **$540**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.



ELECTRICALLY-ACTUATED CAMERAS

All C-30-Series Cameras are available with an electric shutter and speed computer, instead of the standard mechanical shutter. These cameras are useful in areas where a large number of cameras need to be remotely controlled, or where there is limited access to the oscilloscope and camera. Other features of the electrically-actuated cameras (designated by suffix "E") are identical to the standard cameras.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second (accurate within 20% from 0°C to +40°C) plus Bulb and Time.

SHUTTER LIGHT
The shutter light indicates that the shutter is open.

REMOTE ACTUATION
Remote actuation is obtained with a single ground closure.

LINE VOLTAGE
115 VAC ±10% or 230 VAC ±10%, 50 to 60 Hz.

C-30A-PE CAMERA, Pack-Film Back **$750**
C-30A-RE CAMERA, Roll-Film Back **$750**
C-30A-GE CAMERA, Graflok Back **$715**
C-31-PE CAMERA, Pack-Film Back **$855**
C-31-RE CAMERA, Roll-Film Back **$855**
C-31-GE CAMERA, Graflok Back **$820**
C-32-PE CAMERA, Pack-Film Back **$895**
C-32-RE CAMERA, Roll-Film Back **$895**
C-32-GE CAMERA, Graflok Back **$860**

CARRYING CASE

The carrying case holds the C-30A, C-31, or C-32 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16} \times 13\frac{3}{16} \times 15\frac{3}{16}$ inches.
Order 016-0126-00 ..... $38

CAMERA ADAPTERS
($16 each)

FOR OSCILLOSCOPE TYPE	PART NUMBER
321A	016-0242-00
Tektronix Oscilloscopes with 5-inch round CRT (except Type 519).	016-0243-00
Tektronix 560 Series with rectangular CRT, 529 and RM529.	016-0244-00
528, 601, 602, 7000 Series	016-0248-00

FILM BACKS

Three Film Backs provide flexibility of performance and films. Dark slides are included with all the film backs to permit changing backs without exposing any film.

Pack-Film Back accepts Polaroid $3\frac{1}{4} \times 4\frac{1}{4}$ 3000-speed pack film, order 122-0752-00 ..... $85
Focus Plate for above, order 387-0893-00 ..... $ 5

Roll-Film Back accepts Polaroid $3\frac{1}{4} \times 4\frac{1}{4}$ 10,000- or 3,000-speed roll film, order 122-0754-00 ..... $85
Focus Plate for above, order 387-0460-00 ..... $ 5

Graflok Back, $2\frac{1}{4} \times 3\frac{1}{4}$ with focusing screen. Accepts standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0755-00 ..... $50

X SYNC CABLE

Coiled cable has standard ASA connector which mates to the flash sync connectors on C-30-Series Cameras, C-12 and C-27 Cameras. Other end has 2-prong male plug. Order 175-0461-00 ..... $4.70

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

C-50, C-51 and C-52

NEW

- ***TRACE-BRIGHTNESS PHOTOMETER***
- ***ELECTRICALLY-CONTROLLED SHUTTER***
- ***RANGE-FINDER FOCUSING***
- ***ACCURATE EXPOSURE CONTROL***
- ***COMPACT, LIGHTWEIGHT***

The C-50, C-51 and C-52 are compact, light-weight, trace-recording cameras designed primarily for use with all Tektronix 7000-Series Oscilloscopes. With optional battery pack and appropriate mounting adapter, they may be used with most other full-size oscilloscopes. Differing only in the lens system, these cameras feature a trace-brightness photometer, range-finder focusing and accurate exposure control. The shutter is electrically actuated either remotely or by a push button on the control panel. Cameras may be ordered with either a Polaroid[1] Pack-Film Back or Roll-Film Back, or a Graflok[2] 4 x 5 Back. Optional film backs can be rapidly interchanged without refocusing the camera.

The C-50 is provided with an f/1.9, 1:0.7 lens for general-purpose trace recording. The C-51 uses an f/1.2, 1:0.5 lens providing the high-writing speed desired when the 7000-Series Oscilloscopes are operated single sweep at the fastest sweep rates. The C-52 features an f/1.4, 1:1 lens for full-size records (on 4 x 5 film with a Graflok Back). The three cameras mount directly to all 7000-Series Oscilloscopes. No additional adapter is required.

COMMON CHARACTERISTICS

MODES

A five-position switch turns the camera power on and selects normal, time, bulb or single-sweep operation. A power-on indicator lights when the mode switch is turned from the off position.

FOCUS

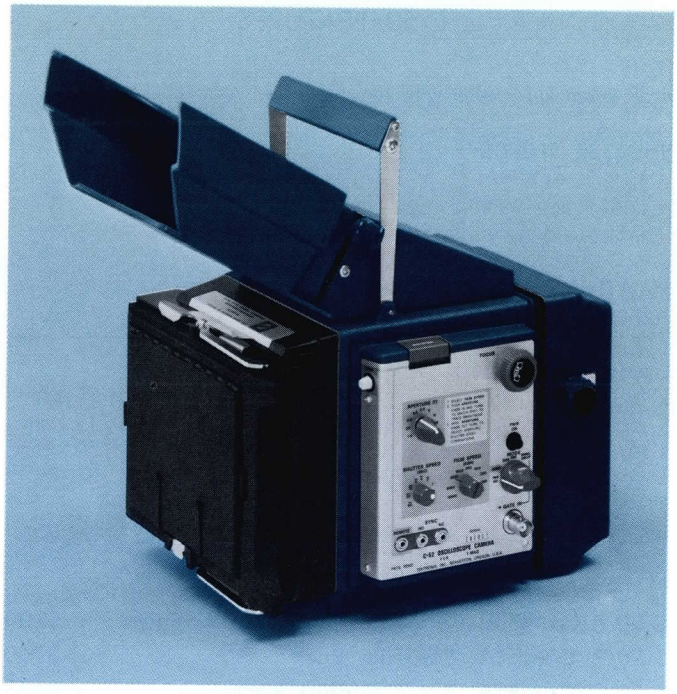
A spring-loaded knob is pushed in to project two vertical bars of light onto the CRT. By turning the focus control the light bars can be merged, indicating that the camera is properly focused. When the focus control is released, the camera is then locked in focus and the lamps are turned off.

EXPOSURE

The proper combination of shutter speed and f number is selected to match the ASA film index and trace brightness as measured by the photometer. A thumbwheel inside the camera housing selects absorption filters for making an approximate visual color match of the photometer spot to the particular color of phosphor in use. Four filters are provided: P1, P2, P11, and P31. The exposure setting is obtained as follows: The ASA index is set, then the f knob is pushed in and turned to match the spot brightness to the trace brightness. When the f knob is released, it locks into the proper relation with the shutter-speed knob. Thus, if either is changed, the other follows to maintain a proper ratio.

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.



SHUTTER

The shutter is electrically actuated in each operating mode. In the single-sweep mode, the shutter opens when the actuator button is depressed. Simultaneously the camera provides a pulse to reset the oscilloscope single sweep. The shutter remains open in this mode unless the camera is externally connected to the oscilloscope plus gate. When connected to the plus gate, the shutter is electronically closed approximately five seconds after the end of sweep (end of + gate).

SHUTTER CLOSURE DELAY

In bulb mode only—250 ms or less after release of shutter button.

In single-sweep only—5 seconds (within 20%) after sweep ends with + gate applied.

CAMERA POWER AND SWEEP RESET

A 3-pin connector on the bezel of the Tektronix 7000-Series Oscilloscopes provides +15 V, a ground connection to the camera and a sweep-reset pulse (in single-sweep function only) back to the oscilloscope. An optional battery pack is available for use with other oscilloscopes.

Optional battery pack installed on camera

NEW

C-50, C-51 and C-52

C-50 FEATURES

LENS
57.6-mm f/1.9 lens with magnification ratio of 1:0.7.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second plus Bulb and Time. Timing accuracy is within 10% from +20°C to +30°C, and within 20% from 0°C to +50°C.

RELATIVE APERTURE RANGE
f/1.9, 2.8, 4.0, 5.6, 8, 11 and 16.

DIMENSIONS AND WEIGHTS

Length	10¾ inches (with viewing tunnel)	27.3 cm
Width	7½ inches (with pack back)	19.1 cm
Height	11½ inches (with viewing tunnel)	29.2 cm
Weight	7.5 lb (with pack back)	3.4 kg

INCLUDED STANDARD ACCESSORY
Instruction manual (070-1011-01)

C-50-P CAMERA, Pack-Film Back (Recommended) . **$700**
C-50-R CAMERA, Roll-Film Back **$700**
C-50-G CAMERA, 4 x 5 Graflok Back **$665**
C-50-N CAMERA, No Back **$615**

C-51 FEATURES

LENS
57.6-mm f/1.2 lens with magnification ratio of 1:0.5.

PHOTOGRAPHIC WRITING SPEED (without film fogging, using 10,000-speed roll film).

OSCILLOSCOPE	P31 PHOSPHOR	P11 PHOSPHOR
7704	3300 cm/μs	7000 cm/μs
7504 7503	2250 cm/μs	3500 cm/μs

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second plus Bulb and Time. Timing accuracy is within 10% from +20°C to +30°C, and within 20% from 0°C to +50°C.

RELATIVE APERTURE RANGE
f/1.2, 1.4, 2.0, 2.8, 4.0, 5.6, 8 and 11.

DIMENSIONS AND WEIGHTS

Length	10¾ inches (with viewing tunnel)	27.3 cm
Width	9¾ inches (with roll back)	24.8 cm
Height	11½ inches (with viewing tunnel)	29.2 cm
Weight	9.5 lb (with roll back)	4.3 kg

INCLUDED STANDARD ACCESSORY
Instruction manual (070-1011-01)

C-51-R CAMERA, Roll-Film Back (Recommended) . **$900**
C-51-P CAMERA, Pack-Film Back **$900**
C-51-G CAMERA, 4 x 5 Graflok Back **$865**
C-51-N CAMERA, No Back **$815**

C-52 FEATURES

LENS
60-mm f/1.4 lens with magnification ratio of 1:1.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second plus Bulb and Time. Timing accuracy is within 10% from +20°C to +30°C and within 20% from 0°C to +50°C.

RELATIVE APERTURE RANGE
f/1.4, 2.0, 2.8, 4.0, 5.6, 8, 11, and 16.

DIMENSIONS AND WEIGHTS

Length	10¾ in (with viewing tunnel)	27.3 cm
Width	7¼ in (with Graflok back)	18.5 cm
Height	11½ in (with viewing tunnel)	29.3 cm
Weight	8 lb (with Graflok back)	3.6 kg

INCLUDED STANDARD ACCESSORY
Instruction manual (070-1011-01).

C-52-G CAMERA, 4 x 5 Graflok Back (Recommended) **$915**
C-52-R* CAMERA, Roll-Film Back **$950**
C-52-P* CAMERA, Pack-Film Back **$950**
C-52-N CAMERA, No Back **$865**

OPTIONAL ACCESSORIES

BATTERY PACK

The battery pack provides an auxiliary power source for the C-50-Series Cameras when using oscilloscopes without camera power outputs. In addition to its own power (12 AA size batteries) the battery pack has provisions to allow the camera to be powered from the oscilloscope camera power or an external DC voltage source. Net weight of pack, including batteries, is 1.2 pounds. Order 016-0270-00 . . . . . $85

CARRYING CASE

The carrying case holds a C-50, C-51, C-52, or C-70 Camera and all standard accessories including a battery pack, extra film, and adapters. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are 16 3/4 x 23 2/3 x 10 1/10 inches. Net weight is 8 pounds. Order 016-0177-00 . . . . . $80

FILM BACKS

Three Film Backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing any film.

Pack-Film Back accepts Polaroid 3¼ x 4¼ 3,000-speed pack film, order 122-0926-00 . . . . . $85

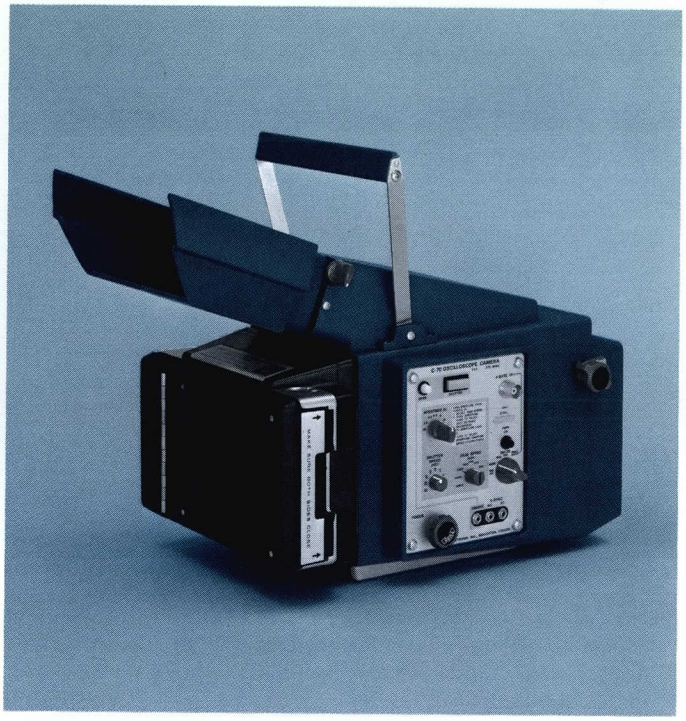
Roll-Film Back accepts Polaroid 3¼ x 4¼ 10,000 or 3,000-speed roll film, order 122-0929-00 . . . . . $85

Graflok Back, 4 x 5. Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0931-00 . . . . . $50

*These cameras use 3¼ x 4¼ film and will not record a full 8 x 10 cm graticule.

U.S. Sales Prices F O B Beaverton, Oregon
Please refer to General Information page

- ***TRACE-BRIGHTNESS PHOTOMETER***
- ***ELECTRICALLY-CONTROLLED SHUTTER***
- ***RANGE-FINDER FOCUSING***
- ***ACCURATE EXPOSURE CONTROL***
- ***COMPACT***



The C-70 is a compact trace-recording camera designed for use with Tektronix instruments which have 6½-inch CRT bezels and auto scale-factor readout (Types 576, 5030 and 5031). The C-70 has an f/1.9 lens and a camera housing that accommodates either a Polaroid[1] Pack-Film Back or Roll-Film Back, or a Graflok[2] 4 x 5 Back. An analog exposure photometer mechanically selects the proper shutter speed and f number for a wide range of ASA film ratings and display luminances. The camera shutter is electrically actuated by a push button or remotely through an input jack, both of which are on the control panel. A special power-signal cable connects power from the oscilloscope to the camera and connects a signal from the camera for resetting the oscilloscope single sweep. The camera mounts directly to the 5030 and 5031 Oscilloscopes and to the Type 576 Curve Tracer. No additional adapter is required.

MODES

A five-position switch turns the camera power on and selects normal, time, bulb, or single-sweep operation. A power-on indicator lights when the mode switch is turned from the off position.

FOCUS

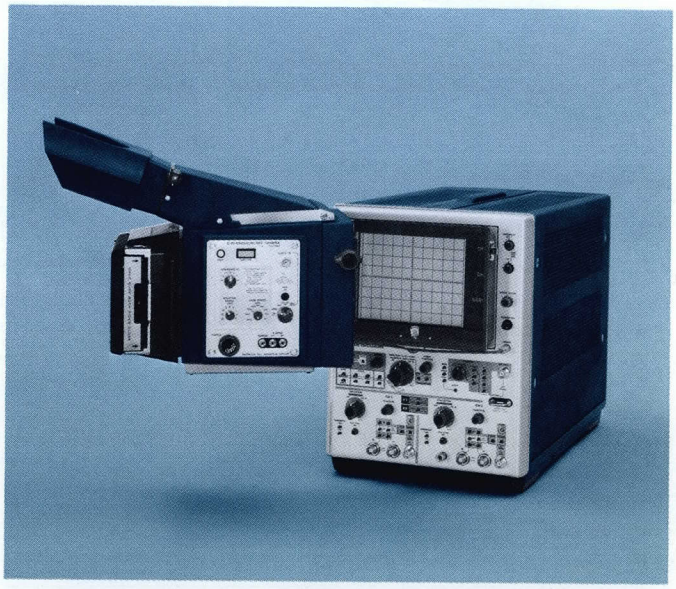
A spring-loaded knob is pushed in to project two vertical bars of light onto the CRT. By turning the focus control, the light bars can be merged, indicating that the camera is properly focused. When the focus control is released, the camera is then locked in focus and the lamps are turned off.

SHUTTER

The shutter is electrically actuated in each operating mode. In the single-sweep mode, the shutter opens when the actuator button is depressed. Simultaneously the camera provides a pulse to reset the oscilloscope single sweep. The shutter remains open in this mode unless the camera is externally connected to the oscilloscope plus gate. When connected to the plus gate, the shutter is electronically closed approximately five seconds after the end of sweep (end of plus gate).

EXPOSURE

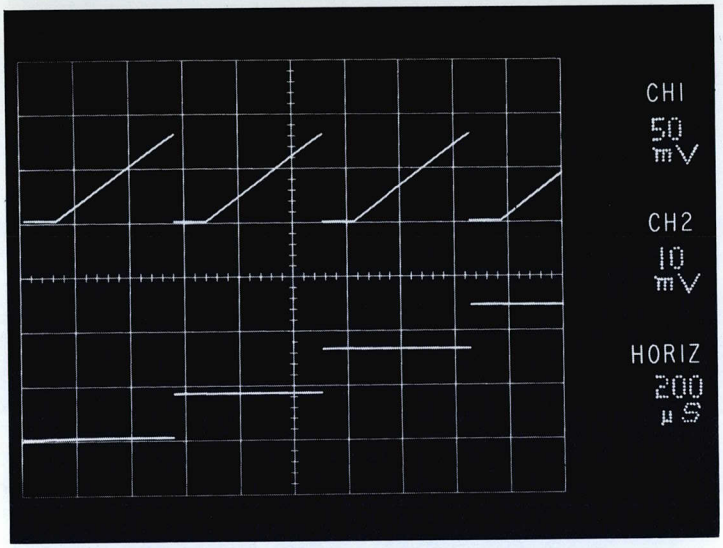
The proper combination of shutter speed and f number is selected to match the ASA film index and trace brightness as measured by the photometer. A thumbwheel inside the camera housing selects absorption filters for an approximate visual color match of the photometer spot to the particular color of phosphor in use. Four filters are provided: P1, P2, P11, and P31. The exposure setting is obtained as follows: The film speed (ASA) is selected and the aperture (f) knob is pushed in to project a spot of light onto the CRT. The aperture knob is then turned to match the spot brightness to the trace brightness. When the aperture knob is released, it locks with the shutter speed knob. Thus, if either is changed, the other follows to maintain a proper relationship.



Convenient mounting, Swing-away hinging

[1]Registered Trademark Polaroid Corporation

[2]Registered Trademark Graflex, Inc.



LENS
67-mm f/1.9 lens with magnification ratio of 1:0.575 records display and readout on 6½-inch CRTs. Above photo shown in actual print size.

RELATIVE APERTURE RANGE
f/1.9, 2.8, 4.0, 5.6, 8, 11 and 16.

SHUTTER SPEEDS
4, 2, 1, 1/2, 1/4, 1/8, 1/15, 1/30 and 1/60 second plus Bulb and Time. Timing accuracy is within 10% from +20°C to +30°C, and within 20% from 0°C to +50°C.

SHUTTER CLOSURE DELAY
In bulb mode only—250 ms or less after release of shutter button.

In single-sweep only—5 seconds (within 20%) after sweep ends with + gate applied.

CAMERA POWER AND SWEEP RESET
Supplied from the oscilloscope by a power-signal cable. Provides +15 V, a ground connection and a sweep reset signal connection from the camera. The sweep reset function does not apply to the Type 576.

DIMENSIONS AND WEIGHTS

Length	14.6 inches (with viewing tunnel)	37.1 cm
Width	8.2 inches (with pack back)	20.8 cm
Height	10.6 inches (with viewing tunnel)	26.9 cm
Weight	11 lb (with pack back)	5.0 kg

INCLUDED STANDARD ACCESSORY
Instruction manual (070-1025-00).

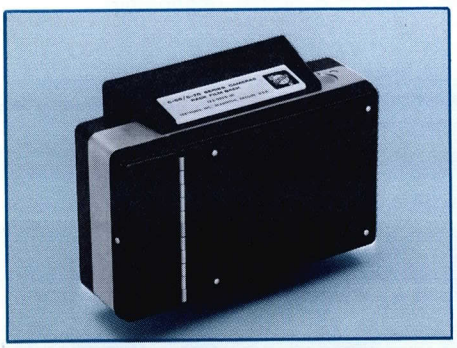
C-70-P CAMERA, Pack-Film Back **$785**
C-70-R CAMERA, Roll-Film Back **$785**
C-70-G CAMERA, 4 x 5 Graflok Back **$750**
C-70-N CAMERA, No Back **$700**

CARRYING CASE

The carrying case holds a C-50, C-51, C-52, or C-70 Camera and all standard accessories including a battery pack, extra film, and adapters. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are 16 3/4 x 23 2/3 x 10 1/10 inches. Net weight is 8 pounds. Order 016-0177-00 ..... $80

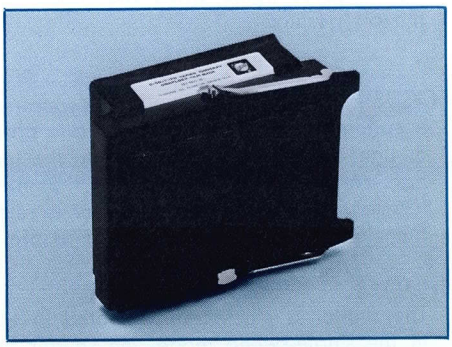
FILM BACKS

Three Film Backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing any film.



Pack-Film Back, Polaroid Land Film, 3¼ x 4¼, 8 exposure, order 122-0926-00 ..... $85

Roll-Film Back, Polaroid Land Film, 3¼ x 4¼, 8 exposure, order 122-0929-00 ..... $85



Graflok Back, 4 x 5. Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders, order 122-0931-00 ..... $50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

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Tektronix offers a choice of voltage and current probes designed to be compatible with circuit measurement requirements. The probes are designed to monitor the signal source with minimum circuit loading while maintaining waveform fidelity.

A prime consideration in selecting the proper probe is the circuit loading effect of the oscilloscope/probe combination. The probe with the highest input impedance (lowest input capacitance and highest input resistance) will provide the least circuit loading. Typically, as frequency increases and risetime decreases, the capacitive loading becomes most important; at low frequencies the resistive loading becomes most important.

Capacitive loading of voltage probes is an important consideration when measuring fast-risetime pulses. The time required to charge the input capacitance of the probe from 10% to 90% is $t_r = 2.2\ R_{source}\ C_{probe}$. Current probes have minimum capacitive loading (typically 1 pF). With current probes the stray capacitance loading can be reduced by inserting the current probe on the ground or B+ side of the load resistor.

Probe attenuation ratio is also an important consideration. The oscilloscope must have enough gain to allow viewing of the attenuated signal. In addition to attenuating high-amplitude signals, 10X probes: (A) reduce the low-frequency 3-dB point of the oscilloscope (when AC coupled) by a factor of ten (B) reduce the input capacitance of the oscilloscope.

When an attenuating probe is used with an oscilloscope, the input resistance and input capacitance of the oscilloscope represent R_2C_2, and the probe resistor and capacitor represent R_1C_1. When the probe is first connected to the oscilloscope, it must be compensated by applying a squarewave and adjusting the capacitor in the probe (C_1) until $R_1C_1 = R_2C_2$, which is indicated by the proper display on the oscilloscope. Improper compensation will result in either overshoot, roll-off, or incorrect signal amplitude when viewing a pulse of relatively narrow width.

If the probe is now removed from the oscilloscope on which it was compensated and connected to another one, THE PROBE MUST BE RECOMPENSATED. The input R and C of the second oscilloscope may be quite a bit different than the first, and C_1 would have to be readjusted so that R_1C_1 now equals the new R_2C_2.

To help you select the right probe for your application, the probe reference chart provides a quick comparison of Tektronix probe parameters. The following factors should be considered in making your selection:

1. Be sure the desired probe will match the input resistance and capacitance of the oscilloscope used, and is equipped with the proper connector.

2. Select a probe with adequate risetime and bandwidth for the oscilloscope and the application. Where risetime is stated in the chart it is for the probe only. From this figure the risetime of the probe/oscilloscope system may be calculated by using the formula: t_r^2 system $= t_r^2$ probe $+ t_r^2$ oscilloscope. The bandwidth (3-dB down) of the system may be calculated, knowing the system risetime and using the formula Bw (MHz) $= 350/t_r$ (ns).

3. When considering input impedance, the probe with the lowest input capacitance will generally provide the most accurate measurements.

4. The instrument descriptions in this catalog list standard and optional accessories, and should be consulted for specific probe recommendations.

5. If you desire help in selecting the right probe for your application, please consult your local Tektronix Field Engineer, Representative or Distributor.

VOLTAGE PROBES

FOR USE WITH OSCILLOSCOPES OR PLUG-INS WHICH HAVE 1-MΩ INPUTS AND BNC CONNECTORS

TYPE	PAGE	ATTEN-UATION	LENGTH IN FEET	INPUT RC	SIG SPEED[1] IN MHz	MAX ± DC	SCOPE C IN pF	PRICE
P6006	386	10X	3.5 6 9 12	10 MΩ 7.5 pF[2] 8.5 11 13	35 25 25 12	600 V	15 to 55	$29
P6007	386	100X	3.5 6 9 12	10 MΩ 2 pF[2] 2.2 2.4 2.6	25 20 15 13	1.5 kV	15 to 55	29
P6008	387	10X	3.5	10 MΩ 7.5 pF[2]	70	600 V	12 to 47	46.50
P6009	387	100X	9	10 MΩ 2.5 pF[2]	100	1.5 kV	12 to 47	66
P6011	388	1X	3.5 6 9	1 MΩ 48 pF[2] 68 95	12 10 7	600 V	ANY	21
P6012	388	10X	3.5 6 9	10 MΩ 11.5 pF 14.5 17.5	35 30 22	500 V	15 to 47	36
P6013A	389	1000X	10 25	100 MΩ 3 pF 3.5	25 13	12 kV	15 to 55	160
P6015	389	1000X	10	100 MΩ 3 pF	44	20 kV	12 to 47	250
P6028	390	1X	3.5 6 9 12	1 MΩ 50 pF[2] 67 90 112	14 10 7 4	600 V	ANY	16.50
P6048	396	10X	6	1 kΩ 1 pF	75	20 V	15 to 20	61
P6052	399	10X or 1X 10X or 1X	3.5 6	10 MΩ 14 pF 1 MΩ 113 10 MΩ 15.5 1 MΩ 134	20 3 15 2	500 V	15 to 55	55
P6053	399	10X	3.5 6	10 MΩ 9.5 pF 12	250 250	500 V	15 to 24	55
P6054	400	10X	3.5 6 9	10 MΩ 9.5 pF 12 13.5	250 250 88	500 V	15 to 24	50
P6055*	401	10X	3.5	1 MΩ 10 pF[2]	35	500 V	20 to 47	75

1. Approximately one octave below —3 dB frequency of probe alone.
2. Rating varies with oscilloscopes having other than 20 pF inputs.
*Designed for use with Tektronix differential amplifiers. The attenuation ratio is adjustable to 10X.

FOR USE WITH OSCILLOSCOPES OR PLUG-INS WHICH HAVE 50-Ω INPUTS OR 1-MΩ INPUTS SHUNTED BY 50 Ω

TYPE	PAGE	LENGTH IN FEET	ATTEN-UATION	INPUT RC	RISETIME IN ns	MAX ± DC	CONNECTOR	PRICE
P6034	391	1.5[3]	10X	500 Ω 0.7 pF	0.1	16 V	GR	$44
P6035	391	1.5[3]	100X	5 kΩ 0.7 pF	0.2	50 V	GR	44
P6045 FET	392	6.0	1X 10X 100X	10 MΩ 5.5 pF 2.5 1.8	1.5	1.5 V[4] 15 100	BNC	325
P6046 DIFF/AMP	394	6.0	1X 10X	1 MΩ 10 pF 10 MΩ 3	3.5	25 V 250	BNC	800[5]
P6051 FET	397	6.0[3]	5X 20X 100X 200X	1 MΩ 2.8 pF 3.3 2 1.8	0.35	7.5 V[4] 30 150 200	GR	375

3. May be extended with 50-ohm cable.
4. Using offset.
5. Probe and amplifier.

CURRENT PROBES

TYPE	PAGE	RECOMMENDED USE AREA	RISETIME IN ns	MINIMUM DEFL FACTOR	PRICE
P6021/Passive Termination	402	450 Hz to 60 MHz	5.8	2 mA/mV	$121
P6021/134 Amplifier	402	12 Hz to 40 MHz	9	1 mA/div	325
P6021/134 Amplifier/CT-5	407	12 Hz to 20 MHz	17.5	1000 A/div*	725
P6022/Passive Termination	403	8.5 kHz to 150 MHz	2.2	1 mA/mV	165
P6022/134 Amplifier	403	100 Hz to 70 MHz	5	1 mA/div	360
P6040/CT-1	405	34 kHz to 1 GHz	0.35	5 mV/mA	40
P6041/CT-2	406	1.2 kHz to 150 MHz	0.5	1 mV/mA	47.50
P6042/Amplifier	408	DC to 50 MHz	7	1 mA/div	690
P6042/CT-5	407	1 Hz to 20 MHz	17.5	1000 A/div*	1090

*Maximum deflection factor

Probing Considerations

Select the lowest impedance test point which provides a useful waveform. Although the input impedance of a probe is made as high as possible, it still will always have some finite effect on the circuit under test.

Be aware of the fact that the input impedance of a probe varies inversely with frequency. For example, a probe having a bandwidth of 50 MHz and an input resistance of 10 megohms (at DC), would only have an input resistance of approximately 1.5 kΩ at 50 MHz.

Probe loading effects can be minimized by selecting low-impedance test points. Usually, cathodes, emitters and sources should be chosen in preference to plates, collectors or drains; and inputs to high-impedance dividers in preference to mid-points. Circuits with low resistive peaking or compensation often produce displays which are difficult to evaluate properly in high-speed pulse work. It's often preferable to make current measurements than to attempt an accurate evaluation of inductive circuit voltage waveforms because of the effect of the probe input capacitance.

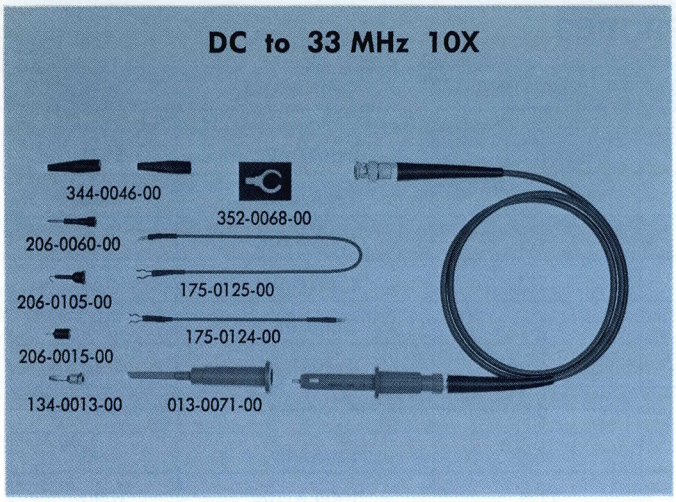
Time-delay differences must be considered, particularly in phase and time coincidence measurements, and differential applications. Low-impedance probes minimize these problems and high-speed differential probes are capable of matching probe characteristics to a high degree.

When using low-impedance probes keep in mind the resistive loading of the probe. For example, if observing the 1-volt 1%, 250-Ω 1% calibrator output of the 454A with the 1-kΩ P6048, correct calibration is indicated by a CRT display of 0.8 volts.

Grounding practices should always be kept in mind, particularly in high-impedance probe applications. Using as short a ground path as possible (preferably coaxial adapter or short bayonet connector) will minimize the effect of series inductance to the probe input. And, of course, in all probes that have variable compensation adjustments, check your compensation!

For a complete understanding of probe specifications and measurements, consult the measurement concept book entitled "Probe Measurements". An in-depth discussion of the mechanical and electrical make-up of probes is contained in a companion volume, "Oscilloscope Probe Circuits". Both of these books are available through your Tektronix Field Engineer or Representative.

DC to 33 MHz 10X



The P6006 is a general-purpose probe designed for use with Tektronix DC-to-33 MHz oscilloscopes. The probe can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

ATTENUATION is 10X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for standard length probe is approximately 7 pF when used with an instrument having a 20-pF input capacitance; 8.5 pF for the 6-ft version, 11 pF for the 9-ft version, 13 pF for the 12-ft version.

PROBE RISETIME is approximately 5 ns.

TYPICAL RISETIME of the 3.5-ft probe, Type 1A2 Plug-In Unit, and Type 545B Oscilloscope is 12 ns.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

NET WEIGHT is approx 8 ounces.

P6006 3.5-FT PROBE, order 010-0127-00 BNC or 010-0125-00 UHF **$29**

P6006 6-FT PROBE, order 010-0160-00 BNC or 010-0158-00 UHF **$29**

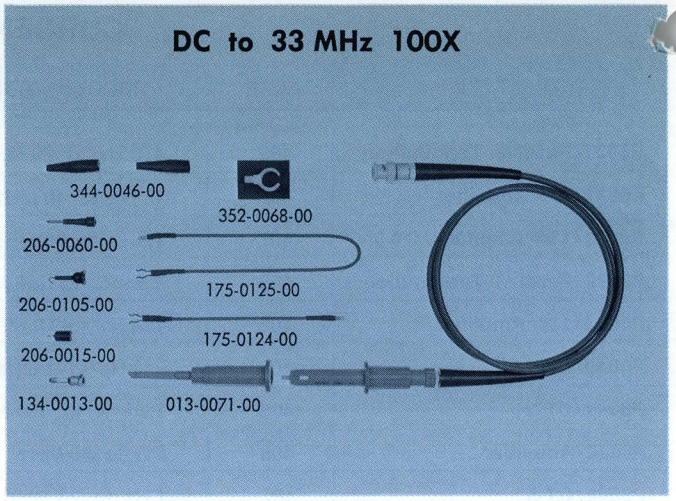
P6006 9-FT PROBE, order 010-0146-00 BNC or 010-0142-00 UHF **$29**

P6006 12-FT PROBE, order 010-0148-00 BNC or 010-0144-00 UHF **$29**

Includes: straight tip (206-0015-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); instruction manual (070-0381-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 5.7 MHz when working into a 20-pF input, or higher than 3.6 MHz when working into a 47-pF input.

DC to 33 MHz 100X



The P6007 low input-capacitance, high-voltage (1.5-kV) probe is designed for use with Tektronix DC-to-33 MHz oscilloscopes. The probe can be compensated to match all Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

ATTENUATION is 100X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE for a standard length probe is approximately 2.0 pF when used with an instrument having a 20 pF input capacitance; 2.2 pF for the 6-ft version, 2.4 pF for the 9-ft version, 2.6 pF for the 12-ft version.

PROBE RISETIME is approximately 7 ns.

TYPICAL RISETIME of the 3.5-ft probe, Type 1A2 Plug-In Unit, and Type 545B Oscilloscope is approx 12.5 ns.

VOLTAGE RATING is 1.5 kV DC or AC RMS, 4.2 kV AC peak to peak.*

NET WEIGHT is approx 16 ounces.

P6007 3.5-FT PROBE, order 010-0150-00 BNC or 010-0134-00 UHF **$29**

P6007 6-FT PROBE, order 010-0165-00 BNC or 010-0162-00 UHF **$29**

P6007 9-FT PROBE, order 010-0152-00 BNC or 010-0136-00 UHF **$29**

P6007 12-FT PROBE, order 010-0154-00 BNC or 010-0138-00 UHF **$29**

Includes: straight tip (206-0015-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); instruction manual (070-0388-01).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 200 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

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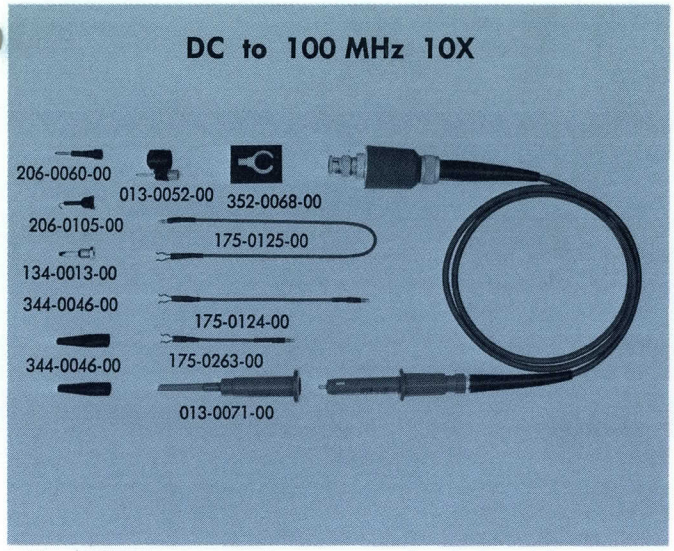
DC to 100 MHz 10X



The P6008 is a general purpose probe designed for use with Tektronix DC-to-100 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

ATTENUATION is 10X

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is approximately 7.5 pF when used with an instrument having a 20 pF input capacitance.

PROBE RISETIME is less than 3 ns.

TYPICAL RISETIME of probe, Type 1A1 Plug-In Unit, and Type 547 Oscilloscope is 7.6 ns.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

CABLE is 3.5 ft long, terminated with a BNC connector.

NET WEIGHT is approx 8 ounces.

P6008 PROBE, order 010-0129-00 . . . . . **$46.50**
Includes: bayonet adapter (013-0052-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); straight tip (206-0015-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 3.5-inch ground lead (175-0263-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); instruction manual (070-0362-01).

ENVIRONMENTALIZED PROBE

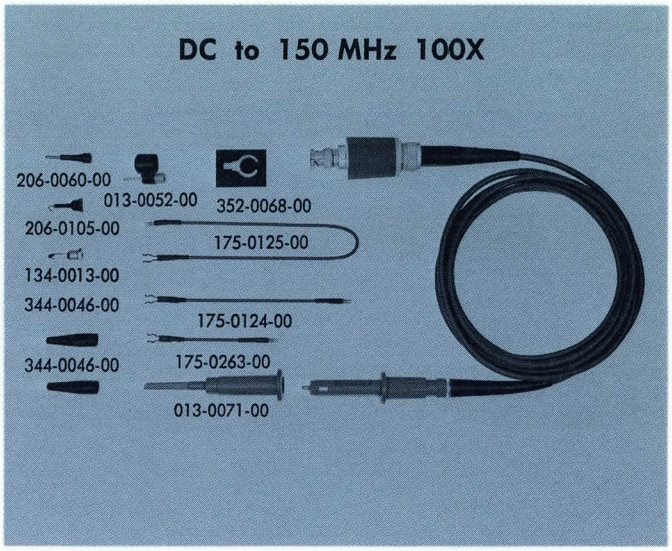
A version of the P6008 is available that is designed to operate over a temperature range of −50°C to +150°C. Input capacitance is 9.0 pF when used with an instrument having a 15 pF input capacitance. Probe risetime is less than 4 ns, all other characteristics are the same as for the standard probe.

P6008 6-FT ENVIRONMENTALIZED PROBE,
order 010-0129-01 . . . . . **$80**
Includes: banana plug (134-0013-00); minigator clip (344-0045-00); 12.5-inch ground lead (175-0925-00); probe holder (352-0068-00); retractable hook tip (013-0071-01); instruction manual (070-0362-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 20 MHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 300 V.

DC to 150 MHz 100X



The P6009 low input capacitance, high-voltage (1.5-kV) probe is designed for use with Tektronix DC-to-150 MHz oscilloscopes. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

ATTENUATION is 100X.

INPUT RESISTANCE is 10 megohms.

INPUT CAPACITANCE is approximately 2.5 pF when used with an instrument having a 20 pF input capacitance.

PROBE RISETIME is approximately 2 ns.

TYPICAL RISETIME of probe, Type 1A1 Plug-In Unit, and Type 547 Oscilloscope is 7.1 ns.

VOLTAGE RATING is 1.5 kV DC or AC RMS, 4 kV AC peak to peak.*

CABLE is 9 ft long, terminated with a BNC connector.

NET WEIGHT is approx 16 ounces.

P6009 PROBE, order 010-0140-00 . . . . . **$66**

P6009 PROBE, for the Type 10A2A,
order 010-0170-00 . . . . . **$66**
Includes: bayonet adapter (013-0052-00); hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); straight tip (206-0015-00); banana plug (134-0013-00); two minigator clips (344-0046-00); probe holder (352-0068-00); 3.5-inch ground lead (175-0263-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); instruction manual (070-0401-00).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 300 kHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 575 V.

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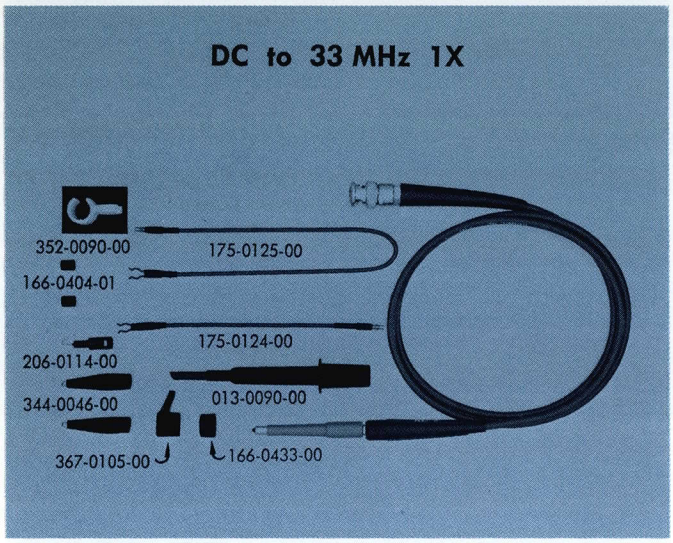
DC to 33 MHz 1X



The P6011 1X Passive Probe can be used with all Tektronix general-purpose oscilloscopes. The small size of the probe body makes it ideal for working on compact circuitry.

The probe cable utilizes a resistive center conductor for damping critical reflections, insuring maximum bandwidth. In addition to the standard 3.5-ft length, the probe is available with a 6-ft or 9-ft cable.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is approx 28 pF; 48 pF for the 6-ft version, instrument excluded.

PROBE RISETIME for the 3.5-ft length is less than 12 ns working into a plug-in with an input capacitance of 15 pF; less than 15 ns working into a plug-in with an input capacitance of 20 pF. The probe risetime of the 6-ft version is less than 15 ns into 15 pF or less than 17 ns into 20 pF. The probe risetime of the 9-ft version is less than 23 ns into 15 pF or less than 25 ns into 20 pF.

TYPICAL RISETIME of the 3.5-pF probe, Type 1A1 Plug-in Unit, and Type 545B Oscilloscope is 16 ns.

VOLTAGE RATING is 600 V DC, AC peak, or DC and AC peak combined.*

STANDARD CABLE is 3.5 ft long with a BNC connector.

NET WEIGHT is approx 12 ounces.

P6011 3.5-FT PROBE, order 010-0193-00 . . . . . $21

P6011 6-FT PROBE, order 010-0190-00 . . . . . $21

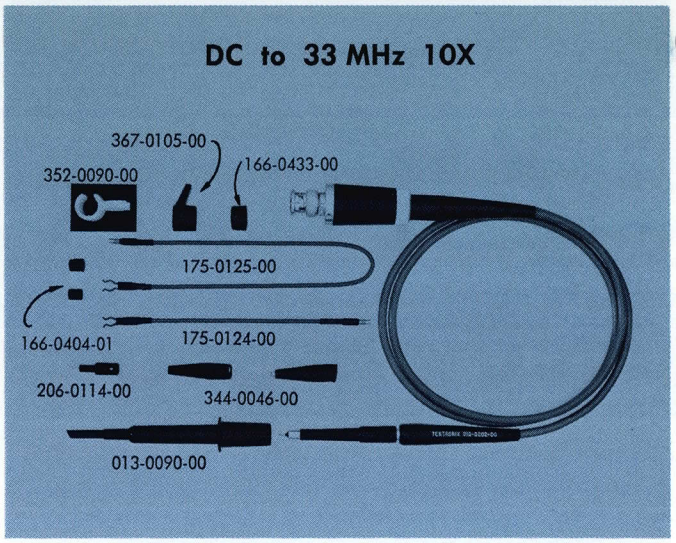
P6011 9-FT PROBE, order 010-0229-00 . . . . . $21

Includes: hook tip (206-0114-00); retractable hook tip (013-0090-00); two minigator clips (344-0046-00); probe holder (352-0090-00); two insulating tubes (166-0404-01); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); insulating sleeve (166-0433-00); hook tip handle (367-0105-00); instruction manual (070-0512-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak voltage derating is necessary for CW frequencies higher than 0.5 MHz. When the probe is used with a plug-in having an input C of 20 pF, the maximum allowable peak voltage at 1 MHz is 510 V. At 5 MHz, the maximum is 100 V; 46 V at 10 MHz. When the probe is used with a plug-in having a 47-pF input, the allowable voltage will be lower by a ratio of 1:3.

DC to 33 MHz 10X



The P6012 is a miniature general-purpose probe designed for use with Tektronix oscilloscopes having bandwidths up to 33 MHz. The probe can be compensated to match Tektronix plug-ins and oscilloscopes with nominal input capacitances of 15 to 47 pF and input resistance of 1 MΩ.

Very small in size, the P6012 is well suited for applications involving subminiature circuitry. The probe is available with a 3.5-ft, 6-ft, or 9-ft cable.

ATTENUATION is 10X.

INPUT RESISTANCE is approximately 10 megohms.

INPUT CAPACITANCE of probe with 3.5-ft cable is 11.5 pF or less; 14.5 pF or less for the 6-ft version; 17.5 pF or less for the 9-ft version.

PROBE RISETIME is 5 ns or less with 3.5-ft cable, 6 ns or less with 6-ft cable, 6.5 ns or less with the 9-ft cable.

TYPICAL RISETIME of the 3.5-ft probe and Type 422 is 24 ns.

VOLTAGE RATING is 500 V DC and AC peak combined.*

PROBE CABLE is terminated with a BNC connector.

NET WEIGHT is approx 15 ounces.

P6012 3.5-FT PROBE, order 010-0203-00 . . . . . **$36**

P6012 6-FT PROBE, order 010-0209-00 . . . . . **$36**

P6012 9-FT PROBE, order 010-0231-00 . . . . . **$36**

Includes: hook tip (206-0114-00); retractable hook tip (013-0090-00); two minigator clips (344-0046-00); probe holder (352-0090-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); two insulating tubes (166-0404-01); insulating sleeve (166-0433-00); hook tip handle (367-0105-00); instruction manual (070-0601-02).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak voltage derating is necessary for CW frequencies higher than 4 MHz. At 15 MHz the maximum allowable peak voltage is 210 V; 95 V at 33 MHz.

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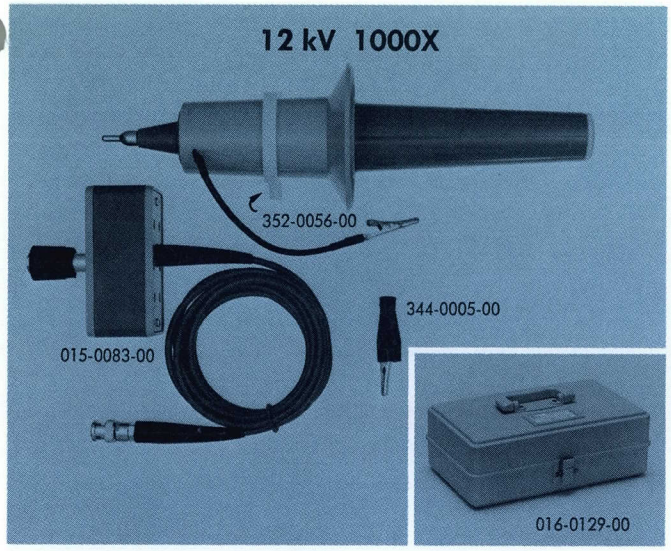


The P6013A provides 1000X attenuation for oscilloscope measurements of high amplitude waveforms or DC potentials up to 12 kV. Pulse frequency can be up to 100 kHz at 12 kV.

The probe can be compensated for oscilloscope input capacitance up to 60 pF and input resistance of 1 MΩ.

ATTENUATION is 1000X.

INPUT RESISTANCE is 100 megohms.

INPUT CAPACITANCE of probe with 10-ft cable is 3 pF; 3.5 pF with 25-ft cable.

PROBE RISETIME is 7 ns or less with 10-ft cable, 13.5 ns or less with 25-ft cable.

TYPICAL RISETIME of 10-ft probe, Type 1A1 Plug-In Unit, and Type 545B Oscilloscope is 13 ns.

VOLTAGE RATING is 12 kV DC, peak pulse, or peak AC.*

CABLES are 10-ft or 25-ft long, terminated with a LOCKING BNC or UHF connector.

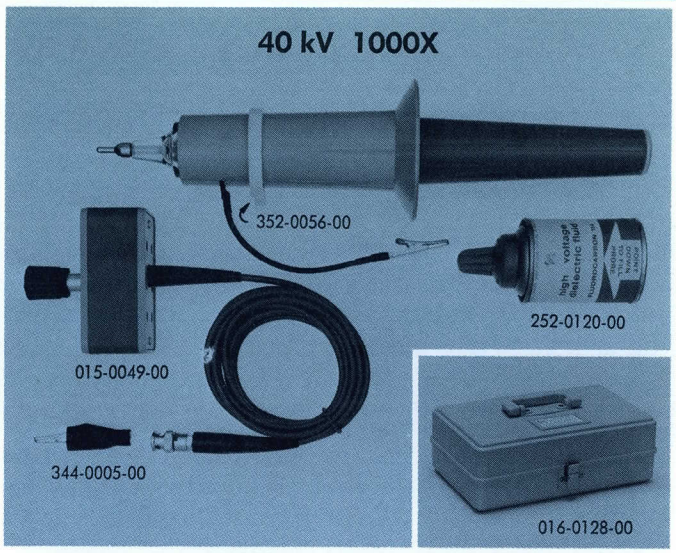
NET WEIGHT is approx 5½ pounds.

P6013A 10-FT PROBE, order 010-0177-01 LOCKING BNC or 010-0181-01 UHF **$160**
Includes: compensating box (015-0083-00 BNC) or (015-0081-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00); instruction manual (070-0603-00).

P6013A 25-FT PROBE, order 010-0175-01 LOCKING BNC or 010-0179-01 UHF **$160**
Includes: compensating box (015-0084-00 BNC) or (015-0082-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00); instruction manual (070-0603-00).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 1 MHz, the maximum allowable peak-to-peak voltage is 5.5 kV.



The P6015 provides 1000X attenuation for oscilloscope measurements up to 40-kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in environmental temperatures above 25°C.

The probe time constant can be adjusted to equal the oscilloscope input time constant for instruments with nominal input capacitance of 12-pF to 47-pF.

ATTENUATION is 1000X.

INPUT RESISTANCE is 100 megohms.

INPUT CAPACITANCE is approximately 2.7 pF.

PROBE RISETIME is approximately 4 ns.

TYPICAL RISETIME of the probe, Type 1A1 Plug-In Unit, and Type 547 Oscilloscope is 8 ns.

TEMPERATURE RANGE is 10° C to 55° C environmental temperature. Approximate temperature coefficient of the nose resistor is —0.03% per degree centigrade. Calibration adjustments are necessary when environmental or nose resistor temperature changes.

VOLTAGE RATING is 40 kV peak AC or pulse, 20 kV DC or RMS continuous at 25°C environmental temperature.*

CABLE is 10 ft long, terminated with a locking BNC or UHF connector.

NET WEIGHT is approx 6 pounds, 5 ounces.

P6015 PROBE, order 010-0172-00 LOCKING BNC or 010-0132-00 UHF **$250**
Includes: compensating box (015-0049-00 BNC) or (015-0039-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); can of high-voltage dielectric fluid (252-0120-00); silica-gel† (256-0570-00); carrying case (016-0128-00); instruction manual (070-0373-01).

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

†not shown.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 13 kV.

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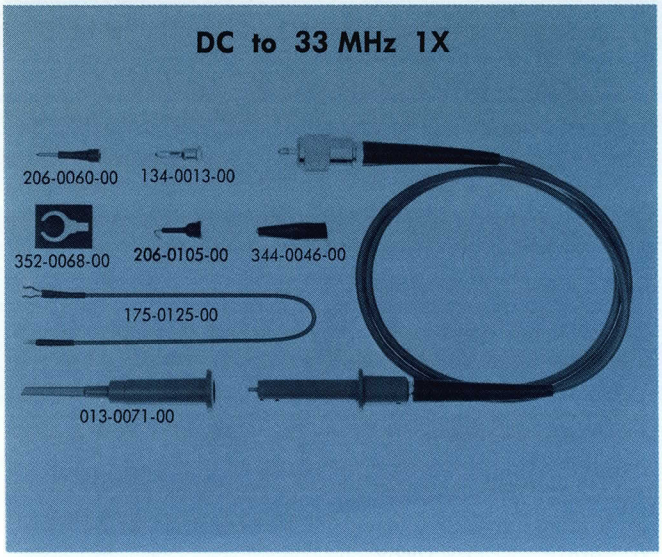


The P6027 is a general-purpose 1X voltage probe designed for use with Tektronix DC-to-33 MHz oscilloscopes that have UHF input connectors.

In addition to the standard 3.5-ft cable length, the P6027 is available in cable lengths of 6 ft, 9 ft and 12 ft. Insertion loss increases with probe cable length.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument.

PROBE RISETIME is approximately 10 ns.

TYPICAL RISETIME of the 3.5-ft probe, Type 1A1 Plug-In Unit and Type 545B Oscilloscope is 15 ns.

VOLTAGE RATING is 600 V DC or AC peak to peak.*

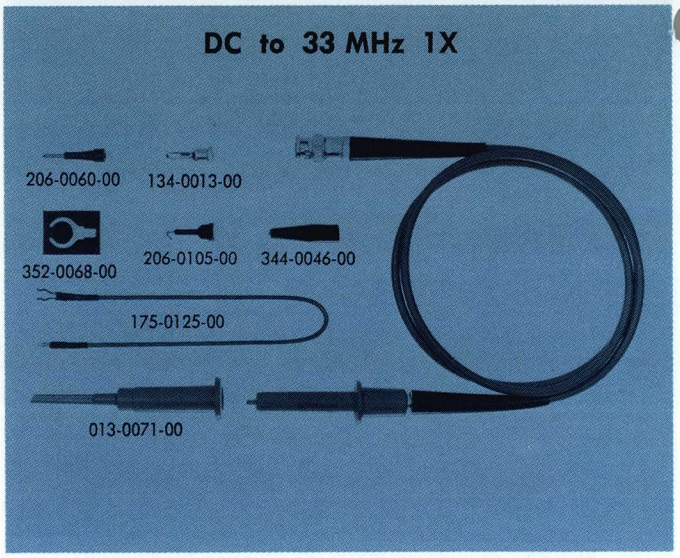
NET WEIGHT is approx 5 ounces.

STANDARD CABLE is 3.5 ft long, terminated with a UHF connector.

P6027 3.5-FT PROBE, order 010-0070-00 . . . . . **$16.50**
P6027 6-FT PROBE, order 010-0071-00 . . . . . **$16.50**
P6027 9-FT PROBE, order 010-0072-00 . . . . . **$16.50**
P6027 12-FT PROBE, order 010-0073-00 . . . . . **$16.50**
Includes: hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); minigator clip (344-0046-00); probe holder (352-0068-00); 12.5-inch ground lead (175-0125-00); parts list.

OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.



The P6028 is a general-purpose 1X voltage probe designed for use with Tektronix DC-to-33 MHz oscilloscopes that have BNC input connectors.

In addition to the standard 3.5-ft cable length, the P6028 is available in cable lengths of 6 ft, 9 ft and 12 ft. Insertion loss increases with probe cable length.

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, instrument input R included.

INPUT CAPACITANCE for standard length probe is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument.

PROBE RISETIME is approximately 10 ns.

TYPICAL RISETIME of the 3.5-ft probe, Type 1A1 Plug-In Unit and Type 545B Oscilloscope is 15 ns.

VOLTAGE RATING is 600 V DC or AC peak to peak.*

NET WEIGHT is approx 5 ounces.

STANDARD CABLE is 3.5 ft long, terminated with a BNC connector.

P6028 3.5-FT PROBE, order 010-0074-00 . . . . . **$16.50**
P6028 6-FT PROBE, order 010-0075-00 . . . . . **$16.50**
P6028 9-FT PROBE, order 010-0076-00 . . . . . **$16.50**
P6028 12-FT PROBE, order 010-0077-00 . . . . . **$16.50**
Includes: hook tip (206-0105-00); retractable hook tip (013-0071-00); spring tip (206-0060-00); banana plug (134-0013-00); minigator clip (344-0046-00); probe holder (352-0068-00); 12.5-inch ground lead (175-0125-00); parts list.
OPTIONAL ACCESSORIES—see probe accessories at the rear of probe section.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.

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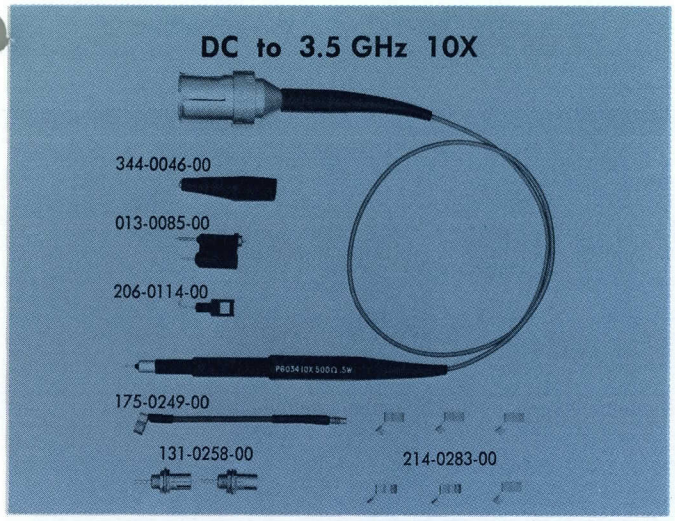
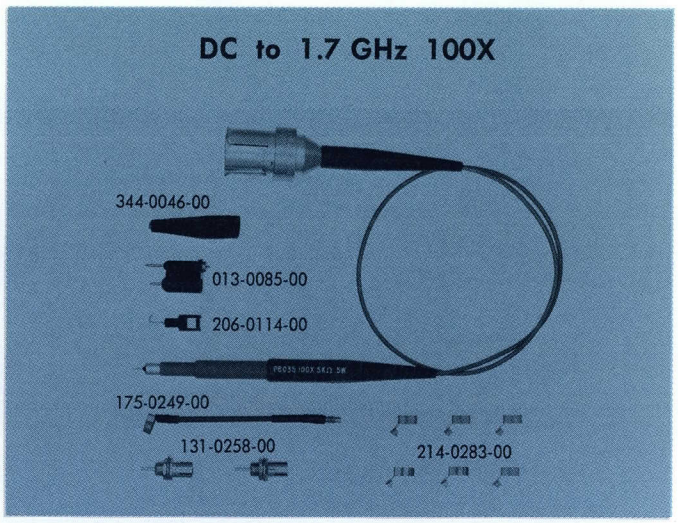




The P6034 and P6035 are low-capacitance miniature probes designed for use with Tektronix 50-Ω sampling units such as the Tektronix Type 1S1, 1S2, 3S2/S-1 and 7S11/S-1 Sampling Plug-In Units. With the use of a 50-Ω termination, they can be used with wideband, non-sampling oscilloscopes when an extremely low input capacitance is required.

ATTENUATION is 10X.

INPUT RESISTANCE is 500 ohms ±1.5%, approximately 300 ohms at 1 GHz.

INPUT CAPACITANCE is 0.7 pF.

PROBE RISETIME is less than 100 ps.

BANDWIDTH is DC to 3.5 GHz (3-dB down).

VOLTAGE RATING is 16 V DC or 45 V peak to peak.*

CABLE is 18 inches long with GR connector.

NET WEIGHT is approx 10 ounces.

P6034 PROBE, order 010-0110-00 . . . . . **$44**
Includes: hook tip (206-0114-00); six ground clips (214-0283-00); minigator clip (344-0046-00); two test jacks (131-0258-00); 2.5-inch ground lead (175-0249-00); bayonet-ground adapter (013-0085-00); instruction manual (070-0368-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 800 MHz. At 1 GHz, the maximum allowable peak-to-peak voltage is 25 V.

ATTENUATION is 100X.

INPUT RESISTANCE is 5 kilohms ±1.5%, approximately 1.5 kilohms at 1 GHz.

INPUT CAPACITANCE is 0.6 pF.

PROBE RISETIME is less than 200 ps.

BANDWIDTH is DC to 1.7 GHz (3-dB down).

VOLTAGE RATING is 50 V DC or 140 V peak to peak.*

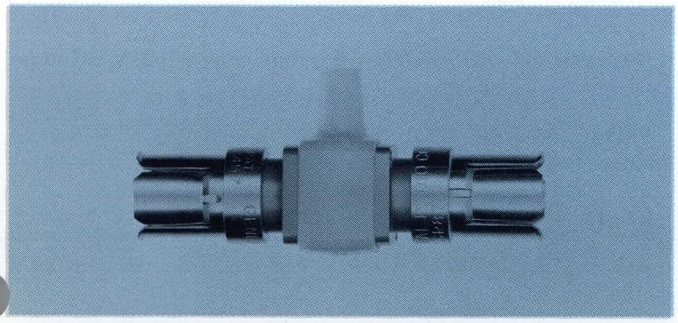
CABLE is 18 inches long with GR connector.

NET WEIGHT is approx 9 ounces.

P6035 PROBE, order 010-0111-00 . . . . . **$44**
Includes: hook tip (206-0114-00); six ground clips (214-0283-00); minigator clip (344-0046-00); two test jacks (131-0258-00); 2.5-inch ground lead (175-0249-00); bayonet-ground adapter (013-0085-00); instruction manual (070-0369-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 500 MHz. At 1 GHz, the maximum allowable peak-to-peak voltage is 60 V.

OPTIONAL ACCESSORIES



The VP-1 50-ohm "T" type pickoff allows signal pickoff from a closed 50-ohm system with minimum disturbance of the system's characteristics. The VP-1 is designed for use with the P6034 or P6035 Miniature Passive Probes. Using a Type 1S1 Sampling Plug-In Unit and a Type 281 Time-Domain Reflectometer Pulser having a system risetime of 0.75 ns, the reflection coefficient of the VP-1 is approximately 0.03. With the P6034 or P6035 inserted, it is typically 0.02. The resistive reflection of the VP-1 is 0.005 when used with the P6035, 0.05 when used with the P6034.

Order 017-0073-01 . . . . . **$28.00**

GR to BNC 50-Ω thru-line termination, order 017-0083-00 $33.50

Probe Tip to GR Adapter, order 017-0076-00 . . . . . $8.30

Probe Tip to BNC Adapter, order 013-0084-01 . . . . . $5.30

Coupling Capacitor, GR874-K*, order 017-0028-00.

*Registered Trademark General Radio Company

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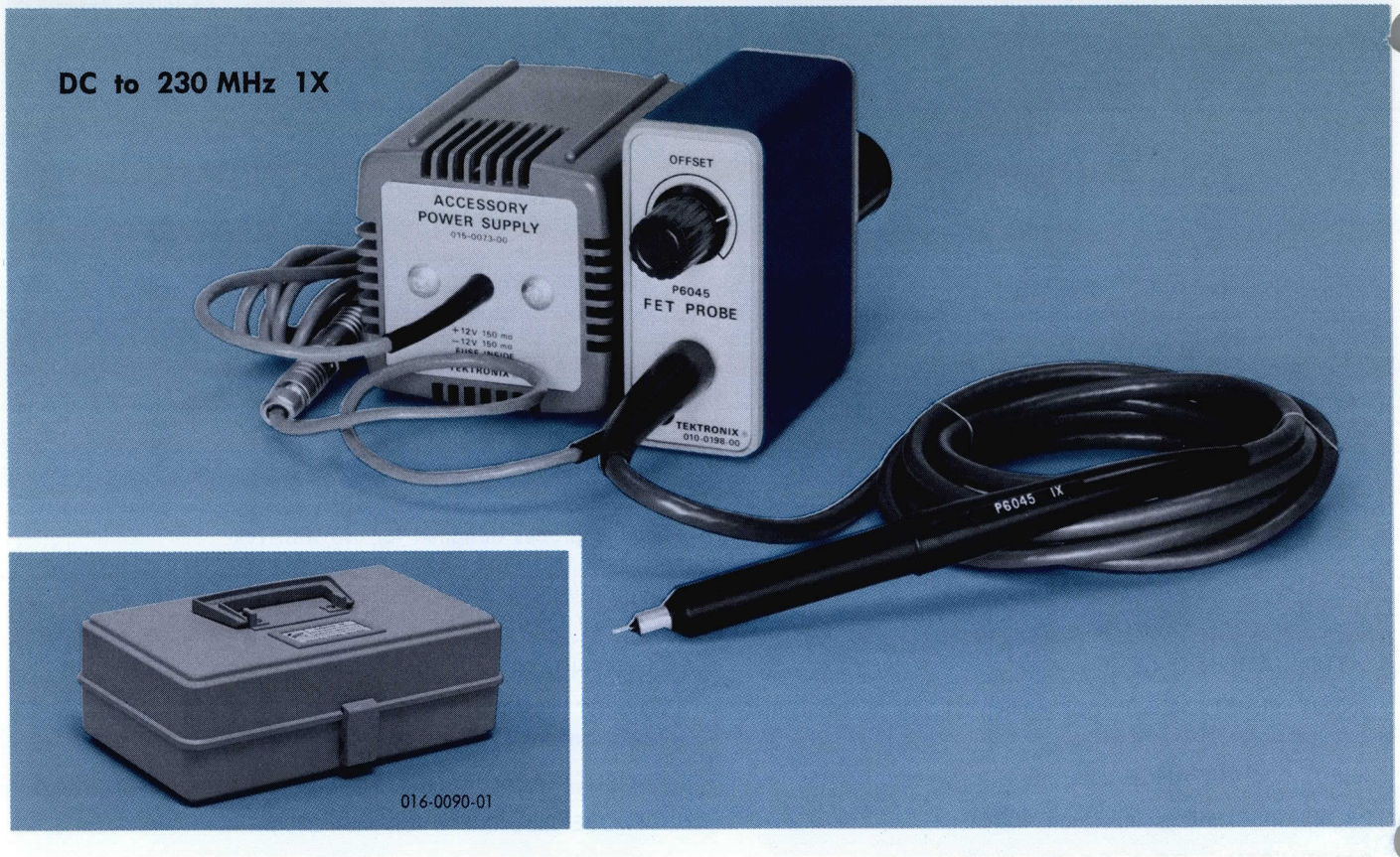
Please refer to General Information Page

P6045 FET Probe



The P6045 FET Probe offers capabilities for measuring small, high-frequency signals. Unlike many general-purpose probes which require built-in attenuation to reduce circuit loading, the P6045 utilizes a field effect transistor, resulting in reduced loading without sacrificing the gain of the measurement system.

This DC-to-230 MHz probe can be used with Tektronix conventional oscilloscopes (1-MΩ inputs) and 50-Ω sampling oscilloscopes. Its small size makes it easy to use, particularly for applications involving compact circuitry. The probe also features a DC-offset control for measuring very small AC signals with DC potentials up to one volt.

Accessories supplied with the probe include 10X and 100X attenuator heads and an AC-coupling capacitor. Optional accessories include a probe power supply, and a tunnel diode pulser for checking the response of the probe.

The Accessory Power Supply permits the P6045 to be used with all Tektronix conventional oscilloscopes and 50-Ω sampling oscilloscopes. It provides the power required to operate one P6045. The Tektronix 454A oscilloscope provides two P6045 probe power connectors.

CHARACTERISTICS

PROBE GAIN is adjustable to 1X.

RISETIME is 1.5 ns or less.

BANDWIDTH is DC to 230 MHz. Low-frequency 3-dB point with AC-coupling capacitor is less than 16 Hz.

INPUT RESISTANCE is 10 megohms with or without attenuators.

INPUT CAPACITANCE is approximately 5.5 pF.

OUTPUT LOAD IMPEDANCE is 50 Ω. A switch on the compensating amplifier provides internal 50-Ω termination, or the probe can be terminated externally. This switching provision allows the P6045 to be used with either 50-ohm or 1-megohm systems. The probe may require recompensation when the termination is changed. Compensation is adjusted at the factory for 1-megohm systems.

DC-OFFSET RANGE is ±1 V, selected by variable front-panel control.

OUTPUT DYNAMIC RANGE is ±0.5-V peak.

INPUT DYNAMIC RANGE is ±0.5-V peak around a reference voltage which can be offset by 0 to ±1 V DC.

NOISE (tangentially measured) is 600 μV or less at probe tip.

MAXIMUM INPUT VOLTAGE (Probe Only) is 12 V (DC + peak-to-peak AC)*.

MAXIMUM SURGE VOLTAGE (probe only) ±100 V DC surge for 1 minute maximum.

PROBE POWER REQUIREMENTS are +12.5 V, ±5% at approx 50 mA; −12.5 V, ±5% at approx 100 mA.

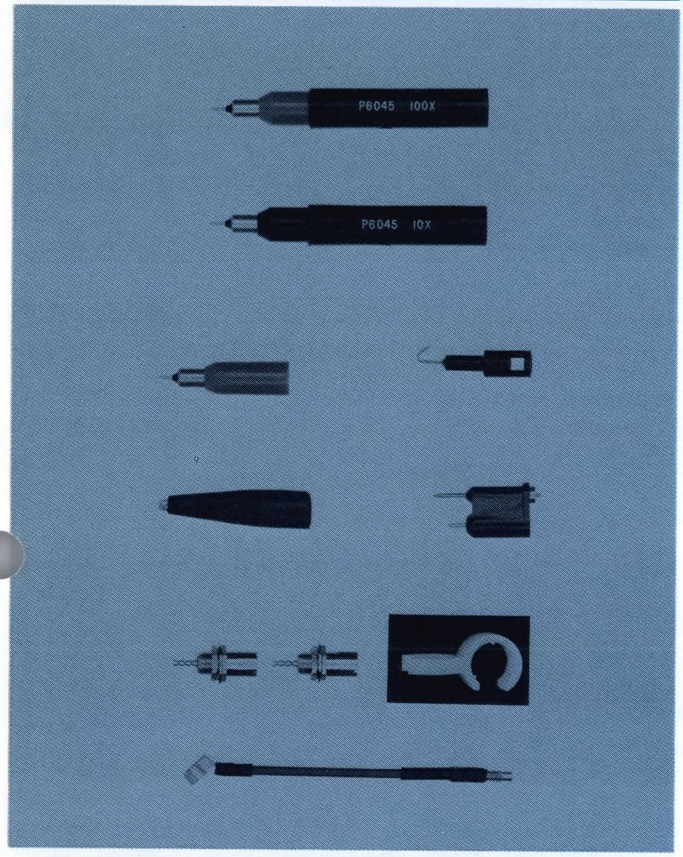
CABLE is 6 ft long. Output connector is locking BNC.

ACCESSORY POWER SUPPLY operates from 93 V-to-140 V or 186 V-to-280 V line.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 9.5 MHz. Maximum input voltage at 230 MHz is 2 V.

PROBE CHARACTERISTICS WITH ACCESSORY HEADS

	Max-Voltage Input (DC + Peak AC)	*Attenuator Accuracy*	*Input C*
10X Attenuator	±100 V*	±3.5%	2.5 pF ±15%
100X Attenuator	±100 V	±3.5%	1.8 pF ±15%
AC-Coupling Capacitor	±200 V		Add 2.0 pF



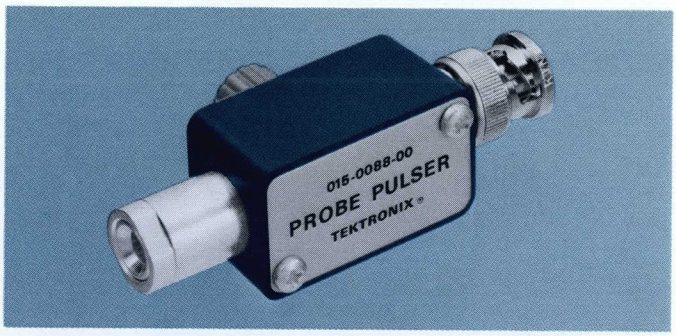
P6045 PROBE WITH ACCESSORY POWER SUPPLY, order 010-0205-00 ..... **$435**

P6045 PROBE, order 010-0204-00 ..... **$325**
Includes: 10X attenuator head (010-0357-02); 100X attenuator head (010-0358-01); AC-coupling capacitor head (010-0360-00); 2.5-inch ground lead (175-0249-00); bayonet ground adapter (013-0085-00); hook tip (206-0114-00); alligator clip (344-0046-00); two test jacks (131-0258-00); probe holder (352-0090-00); carrying case (016-0090-01); instruction manual (070-0597-00).

POWER SUPPLY, order 015-0073-00 ..... **$110**
Power Supply includes: power cord (161-0025-01); instruction manual (070-0636-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 18 MHz. Maximum input voltage at 230 MHz is 20 V.

OPTIONAL ACCESSORIES



The tunnel-diode pulser is used to adjust the P6045 FET Probe for optimum response. The pulser is designed to be driven by the 100-V output of the oscilloscope calibrator. Risetime of the probe pulser is less than 0.5 ns.

Probe Pulser, order 015-0088-00 ..... $31.00

Probe Tip to GR Adapter, order 017-0076-00 ..... 8.30

Probe Tip to BNC Adapter, order 013-0084-01 ..... 5.30

Probe Tip to GR Termination Adapter, order 017-0088-00 ..... 25.00

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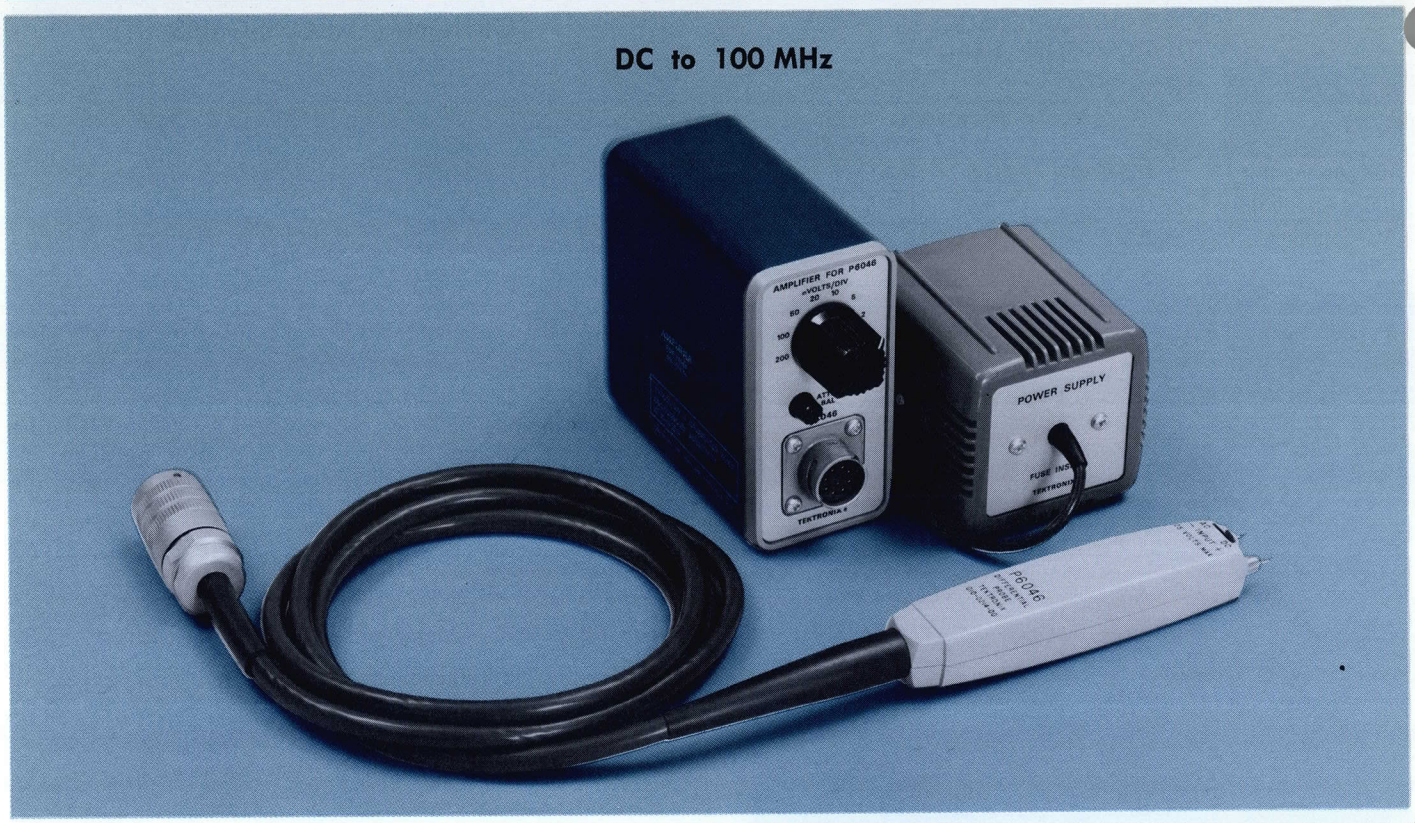
Please refer to General Information page

P6046 Differential Probe



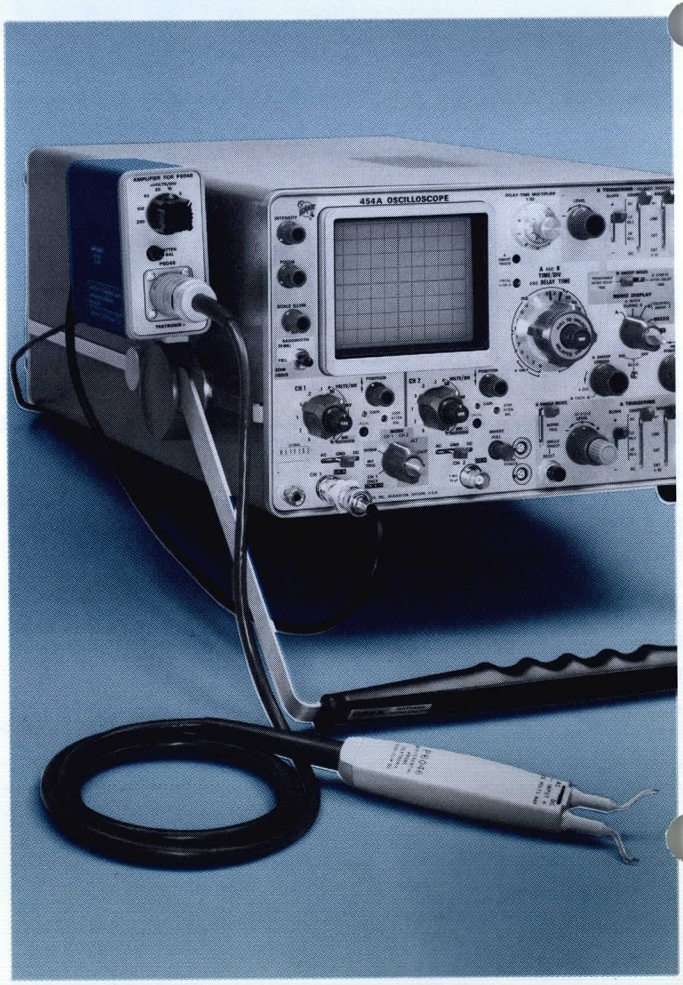
- ***1,000:1 CMRR at 50 MHz***

The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities when used with all Tektronix oscilloscopes. With this probe system, the differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 Probe and Amplifier provides DC-to-100 MHz single-ended and differential measurements.

The probe circuitry utilizes 13 semiconductors including dual FET's for the balanced input. A switch on the probe selects AC or DC input coupling. Accessories include a plug-on 10X attenuator for extending the differential input voltage range, and a ground tip for applications requiring single-ended input. Unique swivel tips provide variable spacing to accommodate varying distance between test points.

The P6046 Amplifier mounts conveniently on the side of the oscilloscope and features a calibrated 1-mV/div to 200-mV/div (2 V/div with 10X attenuator) deflection factor (oscilloscope deflection factor set at 10 mV/div). The output impedance of the amplifier is 50 Ω. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems.

The P6046 Differential Probe may be used with the Type 1A5 Differential Amplifier with Tektronix Type 530, 540, 550, and 580-Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the Type 1A5 to 50 MHz. (CMRR is 1,000:1 at 50 MHz). The Type 1A5 supplies both probe power and amplification.



CHARACTERISTICS

Probe and Amplifier

DEFLECTION FACTOR is 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div).

BANDWIDTH is DC-to-100 MHz at 3-dB down.

RISETIME is 3.5 ns or less.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/div to 20 mV/div are at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz and 1,000:1 from 10 MHz to 50 MHz.

COMMON-MODE LINEAR DYNAMIC RANGE is ±5 V.

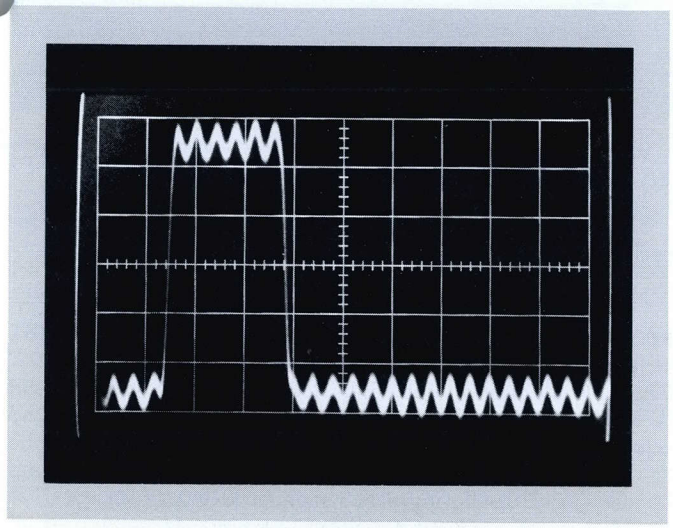
INPUT RC is 1 MΩ paralleled by ≤10 pF.

INPUT COUPLING is AC or DC, selected by a switch on the probe. Low-frequency response AC-coupled is 3-dB down at 20 Hz, 2 Hz with 10X attenuator.

DISPLAYED NOISE is 280 μV or less (tangentially measured).

MAXIMUM INPUT VOLTAGE is ±25 V (DC + peak AC), ±250 V with 10X attenuator.

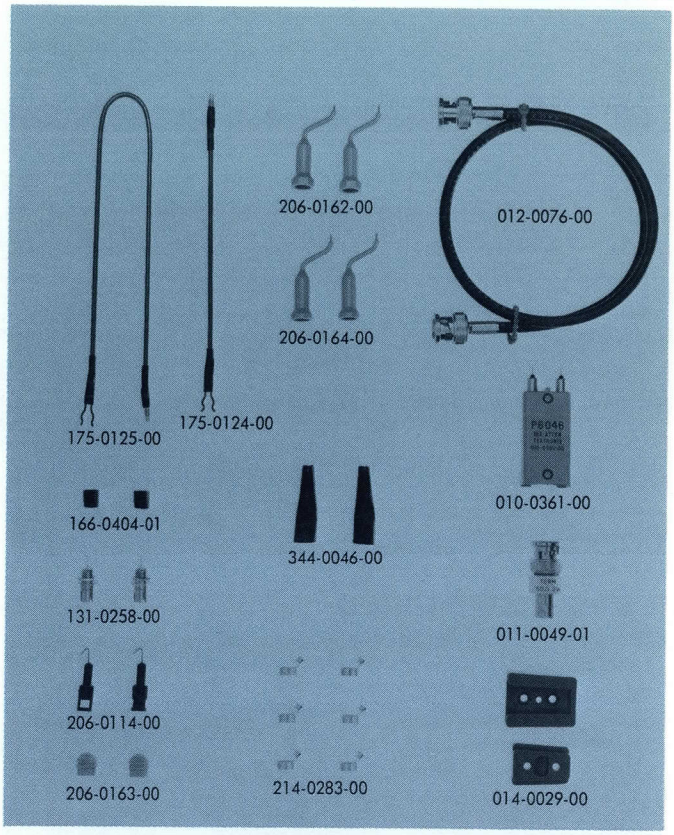
OUTPUT IMPEDANCE is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the amplifier for use with 1-megohm systems.



The photograph shows a 5-mV pulse with a 1-volt, 50-MHz common-mode signal (Vertical - 1 mV/div; Horizontal - 50 ns/div). It demonstrates the ≥1,000:1 common-mode rejection ratio of the P6046 Probe and Amplifier.

PROBE CABLE is 6 feet long, terminated with a special nine-pin connector.

AMPLIFIER POWER REQUIREMENTS are 10 watts maximum, 48 to 400 Hz. Factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V-to-250 V (234 V nominal). Instrument can be ordered factory wired for 210 V-to-250 V operation.



P6046 Probe and Amplifier, order 010-0232-00 . . **$800**
Includes: P6046 Probe Package (010-0213-00); Amplifier for P6046 and Power Supply (015-0106-00).

Amplifier for P6046, order 015-0106-00 . . . . . **$330**
Includes: Amplifier for P6046 and Power Supply; hanger assembly (014-0029-00); 50-Ω cable (012-0076-00); 50-Ω termination (011-0049-01); instruction manual (070-0756-00).

P6046 Probe, order 010-0213-00 . . . . . **$470**
Includes: P6046 Probe (010-0214-00); dual 10X attenuator head (010-0361-00); two swivel tip assemblies (206-0162-00); two swivel tip assemblies (206-0164-00); two ground tips (206-0163-00); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); two alligator clips (344-0046-00); two hook tips (206-0114-00); two test jacks (131-0258-00); two insulating tubes (166-0404-01); six ground clips (214-0283-00); carrying case (016-0111-00); instruction manual (070-0756-00).

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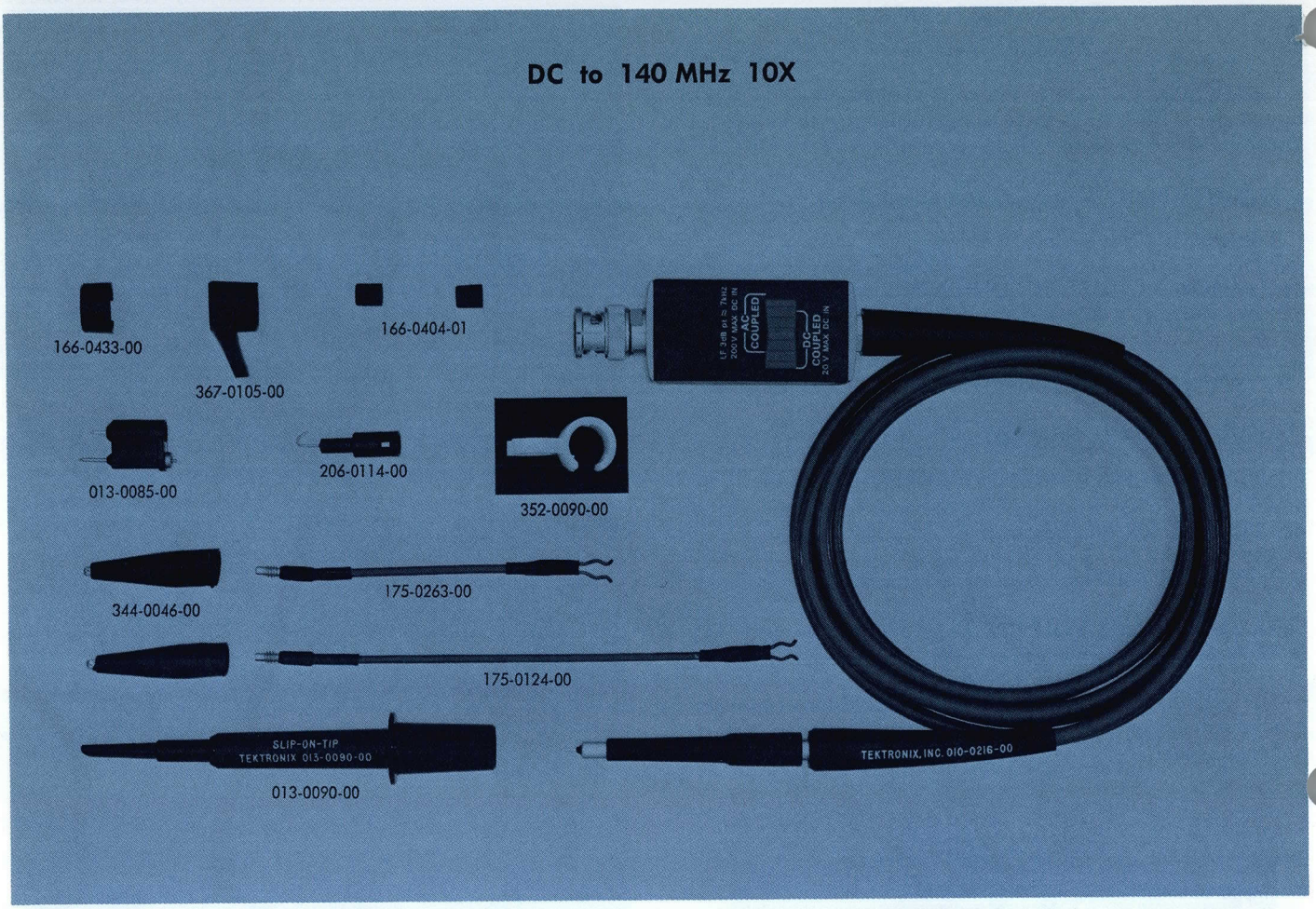
P6048 Voltage Probe



The P6048 is a low-capacitance, miniature probe designed for use with Tektronix high-frequency oscilloscopes such as the Tektronix 454A and Type 647A. It can also be compensated for use with other instruments that have a nominal input capacitance of 15 to 20 pF and input resistance of 1 MΩ.

The P6048 offers a new level of high-frequency measurement performance with its low 1-pF input capacitance. Its small size makes it easy to use, particularly for applications involving compact circuitry.

ATTENUATION is 10X.

INPUT RESISTANCE is 1 kΩ.

INPUT CAPACITANCE is 1 pF or less.

BANDWIDTH/RISETIME when used with 454A Oscilloscope.

Oscilloscope Deflection Factor	Minimum Bandwidth	Maximum Risetime
2 mV/div	45 MHz	7.8 ns
5 mV/div	75 MHz	4.7 ns
10 mV/div to 5 V/div	100 MHz	3.5 ns

AC-coupled low-frequency response is 7 kHz or less.

VOLTAGE RATING DC coupled is 20 V (DC plus peak AC); AC coupled is 200 V DC.

STANDARD CABLE is 6 ft long, terminated with a BNC connector.

NET WEIGHT is approx 13 ounces.

P6048 PROBE, order 010-0215-00 . . . . . **$61**
Includes: hook tip (206-0114-00); retractable-hook tip (013-0090-00); 3.5-inch ground lead (175-0263-00); 5.5-inch ground lead (175-0124-00); two minigator clips (344-0046-00); bayonet-ground adpater (013-0085-00); two insulator tubes (166-0404-01); probe holder (352-0090-00); insulating sleeve (166-0433-00); hook-tip handle (367-0105-00); instruction manual (070-0675-00).

OPTIONAL ACCESSORIES

Probe Tip to GR Adapter, order 017-0076-00 . . . . . $8.30
Probe Tip to BNC Adapter, order 013-0084-01 . . . . . $5.30

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DC to 1 GHz 5X

The P6051 FET Probe offers new capabilities for measuring low-amplitude, very high-frequency signals. Its relatively low input capacitance and high input resistance result in reduced loading on the circuit under test.

This new DC-to-1 GHz probe can be used with Tektronix conventional oscilloscopes (1-MΩ inputs, optional 50 Ω termination mandatory) and 50-Ω sampling oscilloscopes. The probe also features a DC-offset control for measuring small AC signals with DC potentials up to 5 volts (200 V with the 40X attenuator).

The P6051 can be powered from the probe power out of the 7500 and 7700-Series mainframes or by the Accessory Power Supply Type 1101. Among the optional accessories is an adapter which allows the probe to be powered from the 454A probe power out or from the accessory power supply, 015-0073-00.

CHARACTERISTICS

PROBE ATTENUATION—5X within 4%. Attenuator heads are accurate within 1%.

RISETIME—0.35 ns or less.

BANDWIDTH—DC to 1 GHz at 3-dB down. Low frequency 3-dB point with AC-coupling capacitor is approximately 175 Hz.

INPUT RESISTANCE—1 megohm with or without attenuators.

INPUT CAPACITANCE—approximately 2.8 pF.

OUTPUT LOAD IMPEDANCE—50 Ω. A 50-Ω termination is required when the probe is used with oscilloscopes having 1-MΩ input.

DC OFFSET RANGE— ±5 V (excluding attenuators), continuously variable coarse and fine controls select the amount of offset desired. Three-position switch turns offset function OFF or selects + or — polarity.

SIGNAL RANGE—(Probe terminated in 50 Ω)

Probe Input—At least ±2.5 V.

Probe Output—At least ±0.5 V.

Compression—5% or less with an input signal of 50 mV (over signal ranges specified).

NOISE (tangentially measured)—700 μV or less at probe tip.

MAXIMUM PROBE INPUT VOLTAGE—200 V (DC + peak AC). Voltage derating is necessary for CW frequencies higher than 500 kHz. At 1 GHz the maximum allowable peak voltage is 20 V.

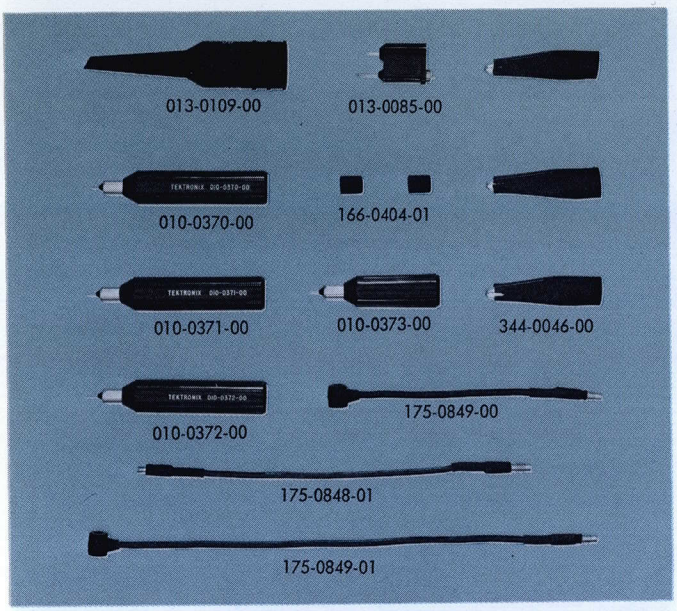
CABLE—6 feet long. Output connector is GR-Type.

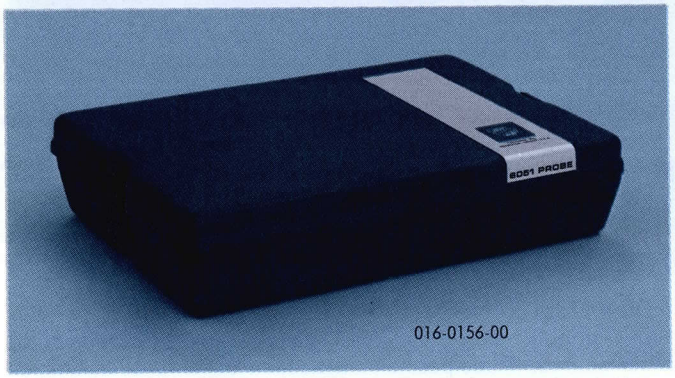
PROBE CHARACTERISTICS WITH ATTENUATOR HEADS

	Input C	DC Offset	Max-Voltage Input	Max-Voltage Input at 1 GHz
4X Attenuator	3.25 pF	±20 V	±200 V*	7.5 V
20X Attenuator	2.0 pF	±100 V	±200 V*	17 V
40X Attenuator	1.8 pF	±200 V	±200 V*	22 V

AC coupler adds 2.0 pF within 10% to input capacitance of either the probe or its attenuators.

*Voltage derating is necessary for CW frequencies higher than 2 MHz for the 4X attenuator, 75 MHz for the 20X attenuator, and 100 MHz for the 40X attenuator.





P6051 PROBE WITH ACCESSORIES,
order 010-0227-00 ..... $375
Includes: P6051 probe (010-0226-00); 4X attenuator head (010-0370-00); 20X attenuator head (010-0371-00); 40X attenuator head (010-0372-00); AC-coupling capacitor head (010-0373-00); retractable hook tip (013-0109-00); 5-inch ground lead (175-0848-01); bayonet ground adapter (013-0085-00); 3-inch nose ground lead (175-0849-00); 6-inch nose ground lead (175-0849-01); three minigator clips (344-0046-00); four end caps (200-1062-00); two insulating tubes (166-0404-01); carrying case (016-0156-00); instruction manual (070-1009-00).

OPTIONAL ACCESSORIES

For powering only one P6051 Probe (adapter cable 012-0187-00 is required) order Accessory Power Supply, 015-0073-00 ..... $110
Includes: power cord (161-0025-01); instruction manual (070-0636-00).

Adapter cable, order 012-0187-00 ..... $20
Adapts P6051 power connector to the "Probe Power Out" of the 454A and also required for use with the Power Supply, 015-0073-00.

Probe tip to GR Termination Adapter,
order 017-0088-00 ..... $25

50-Ω termination, thru-line (GR to BNC Male), order 017-0083-00.

The Type 1101 Accessory Power Supply is designed to power active probes, such as the Type P6051, when used with oscilloscopes that do not have a probe power provision.

The Type 1101 will power up to four probes with outputs featuring short-circuit protection. A platform base provides storage for the power cord.

CHARACTERISTICS

POWER OUTPUT

+15 V supply (adjustable). Accuracy: ±0.75% (after initial setting).

−15 V supply. Accuracy: ±1.5%.
+5 V supply. Accuracy: ±2.0%.

Output Current: 400 mA from each supply, short-circuit protected.

Ripple Content: 1 mV or less, each supply with a 400 mA load.

OUTPUT CONNECTORS

Four special Lemo four-pin connectors, connected in parallel internally, provide the output facility.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz; 39 watts, 390 mA maximum at 115 VAC and 60 Hz, high range; 47 watts, 455 mA maximum at 115 VAC and 60 Hz, low range. Side panel selector switches provide rapid accommodation for 115 V or 230 V line operation and high or low line-voltage ranges.

DIMENSIONS AND WEIGHTS

Height	3⅛ in	7.9 cm
Width	5¼ in	13.2 cm
Depth	8¼ in	20.9 cm
Net weight	3½ lb	1.6 kg

INCLUDED STANDARD ACCESSORIES

Instruction manual (070-0949-00); ≈6 foot power cord attached.

TYPE 1101 POWER SUPPLY $225

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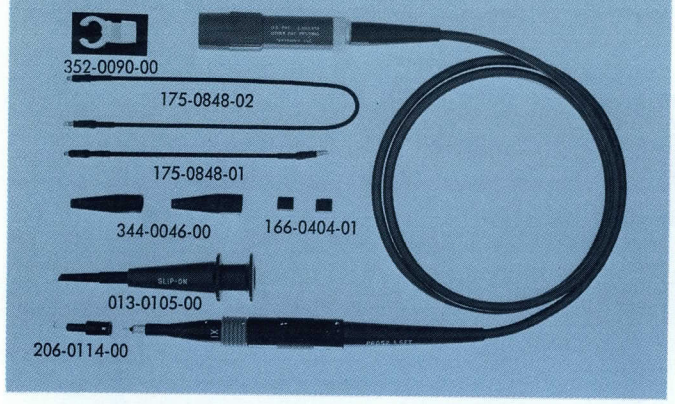
P6052

Voltage Probes

P6053

DC to 40 MHz
1X, 10X SELECTABLE ATTENUATION



The P6052 is a passive dual-attenuation probe designed for Tektronix low-frequency oscilloscopes that feature CRT readout and trace-identification functions. A sliding collar on the barrel of the probe selects 1X or 10X attenuation; a push button actuates the trace-identify function. A coding ring on the probe BNC output connector couples the control signals to the main frame. The P6052 can be compensated for use with instruments having a nominal input capacitance of 15 to 55 pF.

ATTENUATION 10X within 3%.

INPUT RESISTANCE: 1X position, 1 megohm within 2%; 10X position, 10 megohms within 1.5%.

INPUT CAPACITANCE for the 3.5-foot probe is 113 pF in the 1X position, 14 pF within 1 pF in the 10X position. For the six-foot version the input capacitance in the 1X position is 134 pF within 6 pF, the 10X position 16 pF within 1 pF.

PROBE RISETIME for the 3.5-foot probe is $\leq$60 ns in the 1X position, $\leq$9 ns in the 10X position. For the six-foot version: 1X position $\leq$75 ns, 10X position $\leq$11 ns.

TYPICAL RISETIME of the 3.5-ft probe, 7403 Oscilloscope, and 7A18 Amplifier is 11 ns.

VOLTAGE RATING is 500 V (DC + Peak AC)*.

PROBE CABLE is terminated with a BNC connector having a coding ring.

NET WEIGHT is approx 1 pound.

P6052 3.5-FT PROBE, order 010-0241-00 ..... **$55**

P6052 6-FT PROBE, order 010-0243-00 ..... **$55**

Includes: retractable hook tip, (013-0105-00); hook tip, (206-0114-00); 5-inch ground lead, (175-0848-01); 12-inch ground lead, (175-0848-02); two minigator clips, (344-0046-00); two insulating tubes, (166-0404-01); probe holder, (352-0090-00); instruction manual, (070-0973-00).

The P6052 is available without the readout and trace-identification functions.

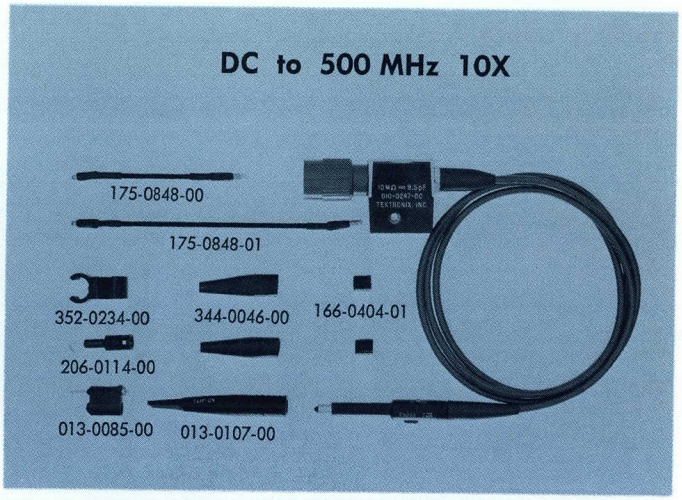
P6052 3.5-FT PROBE, (without readout function) order 010-0241-01 ..... **$55**

P6052 6-FT PROBE, (without readout function) order 010-0243-01 ..... **$55**

Includes: same accessories as standard P6052 Probe.

*Peak voltage derating is necessary for CW frequencies higher than 500 kHz in the 1X position and above 5 MHz in the 10X position. At 44 MHz the maximum allowable peak voltage is approximately 35 V in the 1X position and approximately 60 V in the 10X position.

DC to 500 MHz 10X



The P6053 is a miniature fast-rise 10X probe designed for Tektronix 7-Series vertical plug-in units having a nominal input capacitance of 15 to 24 pF. The probe has a push button for actuating the trace-identify function of the oscilloscope main frame.

ATTENUATION is 10X within 3%.

INPUT RESISTANCE is 10 megohms within 2%.

INPUT CAPACITANCE for the 3.5-foot probe is 9.5 pF within 0.5 pF; 12 pF within 0.5 pF for the six-foot version.

PROBE RISETIME is 0.7 ns† or less.

TYPICAL RISETIME of the 3.5-ft probe, 7704 Oscilloscope, and 7A16 Amplifier is 2.4 ns.

VOLTAGE RATING is 500 V (DC + Peak AC).*

PROBE CABLE is terminated with a BNC connector having a coding ring.

NET WEIGHT is approx 1 pound.

P6053 3.5-FT PROBE, order 010-0248-00 ..... **$55**

P6053 6-FT PROBE, order 010-0250-00 ..... **$55**

Includes: hook tip (206-0114-00); retractable-hook tip (013-0107-00); bayonet-ground adapter (013-0085-00); minigator clip (344-0046-00); probe holder (352-0234-00); 3-inch ground lead (175-0848-00); 5-inch ground lead (175-0848-01); two insulating tubes (166-0404-01); instruction manual (070-1001-00).

OPTIONAL ACCESSORIES

Probe Tip to GR Adapter, order 017-0076-00 ..... $8.30

Probe Tip to BNC Adapter, order 013-0084-01 ..... $5.30

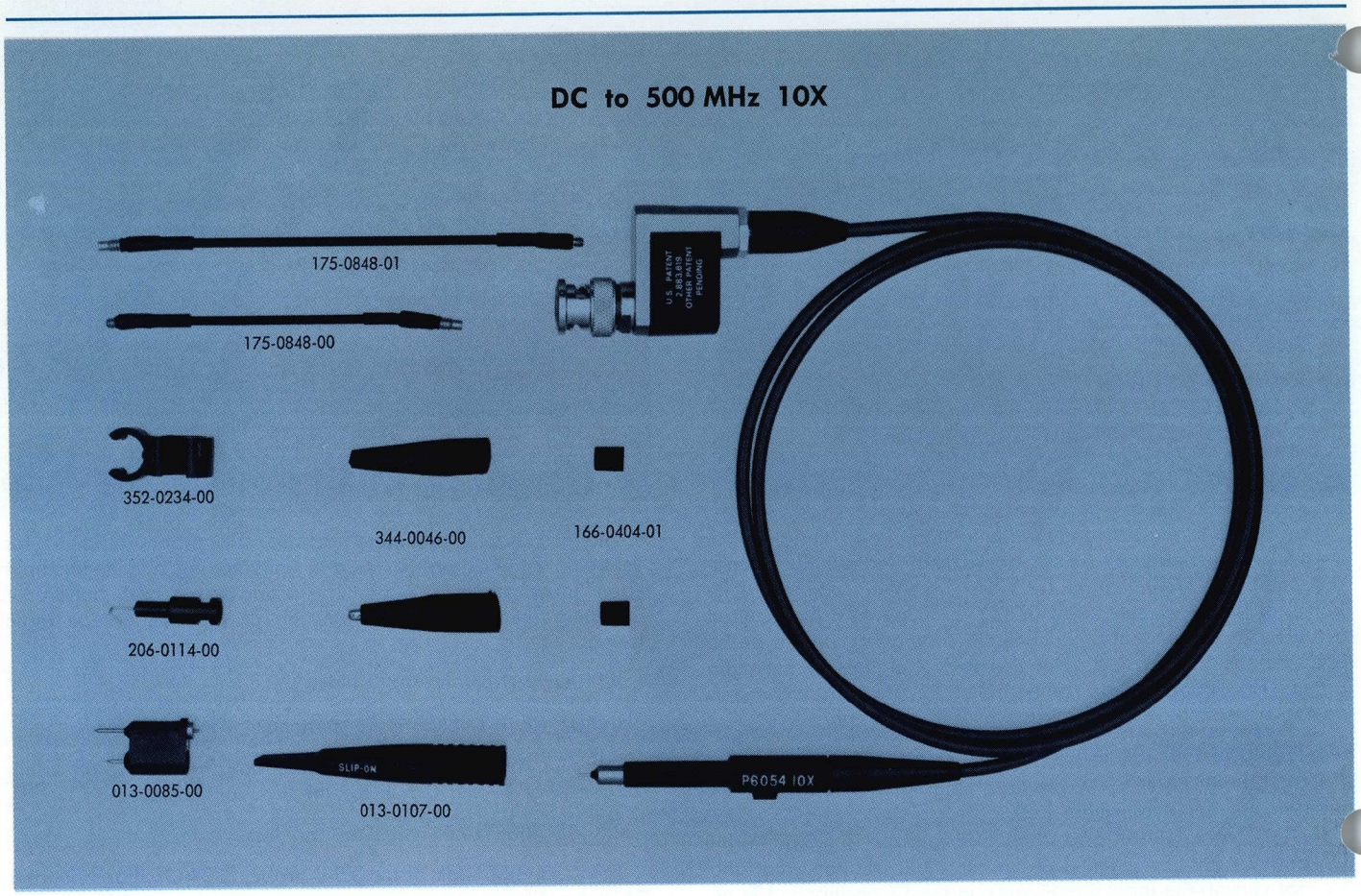
†Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system.

*Peak voltage derating is necessary for CW frequencies higher than 5.5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

NEW

P6054 Voltage Probe



The P6054 is a miniature, fast-rise, 10X probe designed for use in conjunction with Tektronix oscilloscopes having a nominal input capacitance of 15 to 24 pF. The probe does not incorporate CRT readout/trace-identify functions.

ATTENUATION is 10X within 3%.

INPUT RESISTANCE is 10 megohms within 2%.

INPUT CAPACITANCE for the 3.5-foot probe is 9.5 pF within 0.5 pF; for the 6-foot version 12 pF within 0.5 pF; for the 9-foot version 13.5 pF within 0.5 pF.

PROBE RISETIME for 3.5-ft or 6-ft probe is 0.7 ns* or less, the 9-ft probe is 2 ns or less.

TYPICAL RISETIME of 3.5-ft probe with 454A oscilloscope is 2.4 ns.

VOLTAGE RATING is 500 V (DC + Peak AC).†

PROBE CABLE is terminated with a BNC connector, it does not provide readout/trace-identify functions.

NET WEIGHT is approx 10 ounces.

P6054 3.5-FT PROBE, order 010-6054-01 ..... **$50**
P6054 6-FT PROBE, order 010-6054-03 ..... **$50**
P6054 9-FT PROBE, order 010-6054-05 ..... **$50**

Includes: hook tip (206-0114-00); retractable-hook tip (013-0107-00); bayonet-ground adapter (013-0085-00); two minigator clips (344-0046-00); probe holder (352-0234-00); 3-inch ground lead (175-0848-00); 5-inch ground lead (175-0848-01); two insulating tubes (166-0404-01); instruction manual (070-1110-00).

OPTIONAL ACCESSORIES

Probe Tip to GR Adapter, order 017-0076-00 ..... $8.30
Probe Tip to BNC Adapter, order 013-0084-01 ..... $5.30

*Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system.

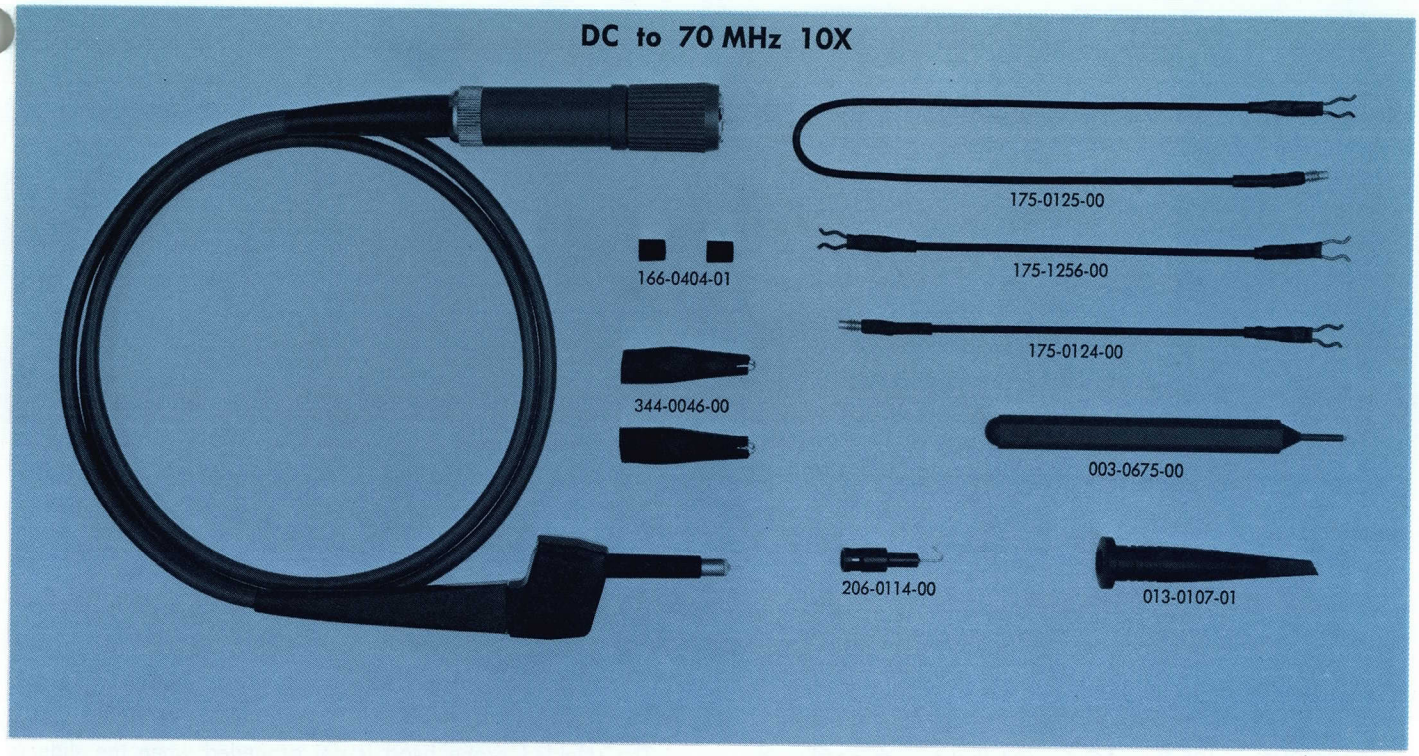
†Peak voltage derating is necessary for CW frequencies higher than 6 MHz. At 10 MHz the maximum allowable peak voltage is 300 V; 25 V at 100 MHz, 22 V at 150 MHz. Values for 3.5-ft probe only.

U.S. Sales Prices FOB Beaverton, Oregon

Please refer to general information page

NEW

DC to 70 MHz 10X



The P6055 is a miniature low-capacitance, 10X Probe designed for use with Tektronix differential amplifiers having nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system. Another feature of this probe is the special cable used to prevent loss of CMRR, if the probes are moved.

ATTENUATION is adjustable to 10X.

INPUT RESISTANCE is 1 MΩ ±0.5%.

INPUT CAPACITANCE is approx 10 pF when used with an instrument having 20 pF input capacitance; 12.5 pF when used with an instrument having 47 pF input capacitance.

TYPICAL RISETIME of probe with 7A13 and 7704 Oscilloscopes is 5.4 ns.

VOLTAGE RATING is 500 V (DC + peak AC).*

CMRR is 20,000:1 from DC to 1 kHz derating to 100:1 at 20 MHz, measured at probe tip using probe pair with 7A13 or 1A5.

CABLE is 3.5 ft long, terminated in a BNC locking readout connector.

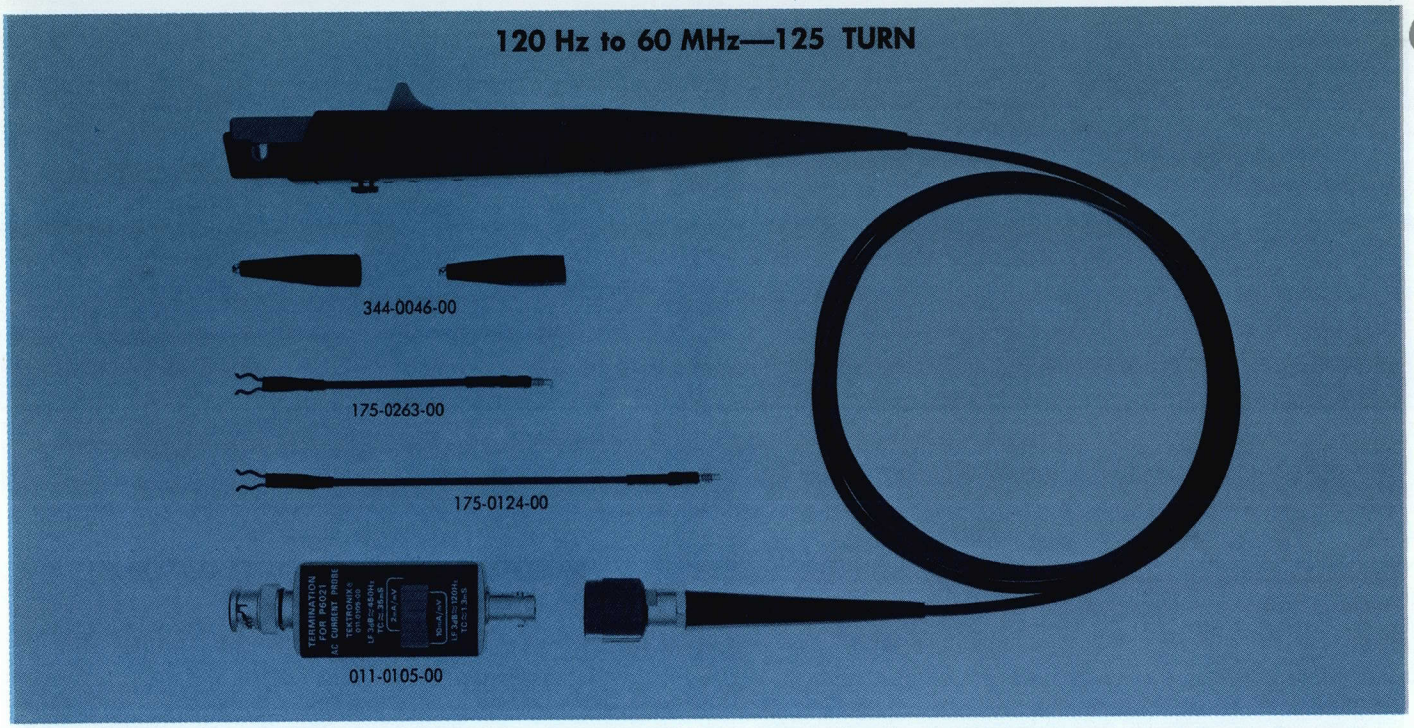
NET WEIGHT is approx 5 ounces.

P6055 PROBE, order 010-6055-01 . . . . . **$75**
Includes: input compensation adjusting tool (003-0675-00); retractable hook tip (013-0107-01); 5.5-inch ground lead (175-0124-00); 12.5-inch ground lead (175-0125-00); 6-inch probe-to-probe ground strap (175-1256-00); hook tip (206-0114-00); two minigator clips (344-0046-00); two insulating tubes (166-0404-01); instruction manual (070-1115-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 12 MHz. At 70 MHz, the maximum allowable peak-to-peak voltage is 100 V.

U.S. Sales Price FOB Beaverton, Oregon
Please refer to General Information page

P6021 AC Current Probe



The P6021 is a 125-Turn AC Current Probe, with passive termination or Type 134 Amplifier, designed for use with real-time oscilloscopes. Neither the termination nor the amplifier is required to use the probe with the Tektronix 5030 and 5031 Oscilloscopes, 3A9 and 7A14 plug-in amplifiers. The P6021 provides the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Simply open the spring-loaded slide, place the conductor (up to 0.150-inch diameter) in the probe slot, and release the slide . . . no electrical connection required.

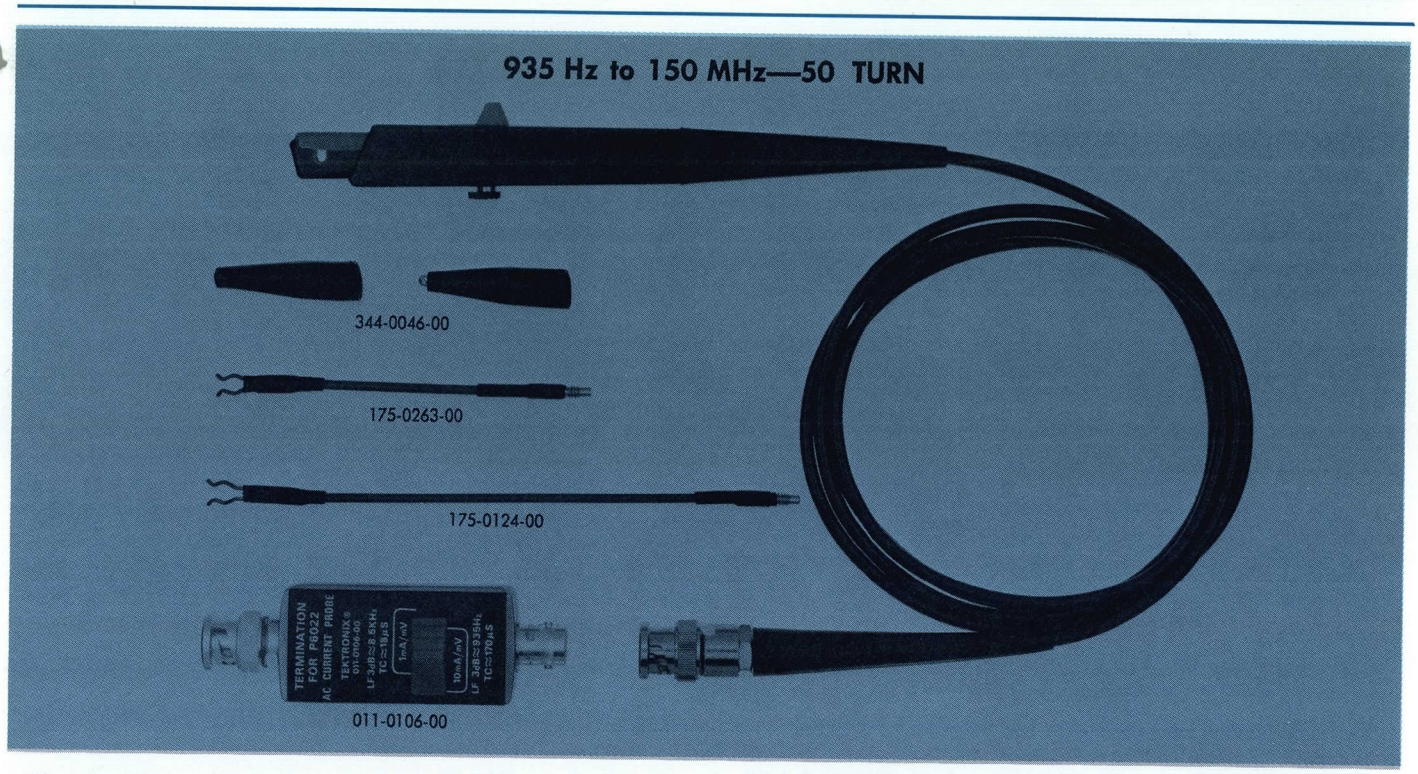
The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. For general-purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The probe's low-frequency capabilities and sensitivity can be expanded using the Type 134 Current Probe Amplifier. The P6021, with passive termination or with the amplifier, can be used with oscilloscopes having input resistances of 1-megohm or greater. Please turn to page 404 for ordering information.

PERFORMANCE CHARACTERISTICS

	P6021 PROBE WITH PASSIVE TERMINATION	P6021 PROBE WITH TYPE 134 AMPLIFIER
SENSITIVITY	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.
SYSTEM BANDWIDTH†/RISETIME Oscilloscope Bandwidth 50 MHz 75 MHz 100 MHz	Bandwidth / Risetime 39 MHz / 9.0 ns 48 MHz / 7.3 ns 52 MHz / 6.7 ns	Bandwidth / Risetime 30 MHz / 11.6 ns 35 MHz / 10.0 ns 36 MHz / 9.6 ns
LOW-FREQUENCY RESPONSE	≤450 Hz at 2 mA/mV ≤120 Hz at 10 mA/mV	≤12 Hz
NOISE		≤150 μA
MAXIMUM CURRENT (CW)*	15 A peak-to-peak sinewave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV	15 A peak-to-peak sinewave between 230 Hz and 5 MHz
MAXIMUM CURRENT (PULSE)*	250 A Peak, not to exceed 500 A-μs or 5 A RMS	10 A Peak, not to exceed 500 A-μs or 5 A RMS
MAXIMUM VOLTAGE	600 V (DC + peak AC)	600 V (DC + peak AC)
NET WEIGHT	≈1 lb	≈5 lb
PRICE	$121	$325

*Decrease oscilloscope sensitivity to make these measurements.

†All bandwidths stated are at —3 dB.



The P6022 is a 50-Turn AC Current Probe, with passive termination or Type 134 Amplifier, designed for use with real-time oscilloscopes. The termination or amplifier is not required to use the probe with the Tektronix 7A14 plug-in amplifier. The P6022 provides the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Simply open the spring-loaded slide, place the conductor (up to 0.100-inch diameter) in the probe slot, and release the slide . . . no electrical connection required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. The extra-small size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits. The probe's low-frequency capabilities and sensitivity can be expanded using the Type 134 Current Probe Amplifier. The P6022, with passive termination or with the amplifier, can be used with oscilloscopes having input resistances of 1-megohm or greater. Please turn to page 404 for ordering information.

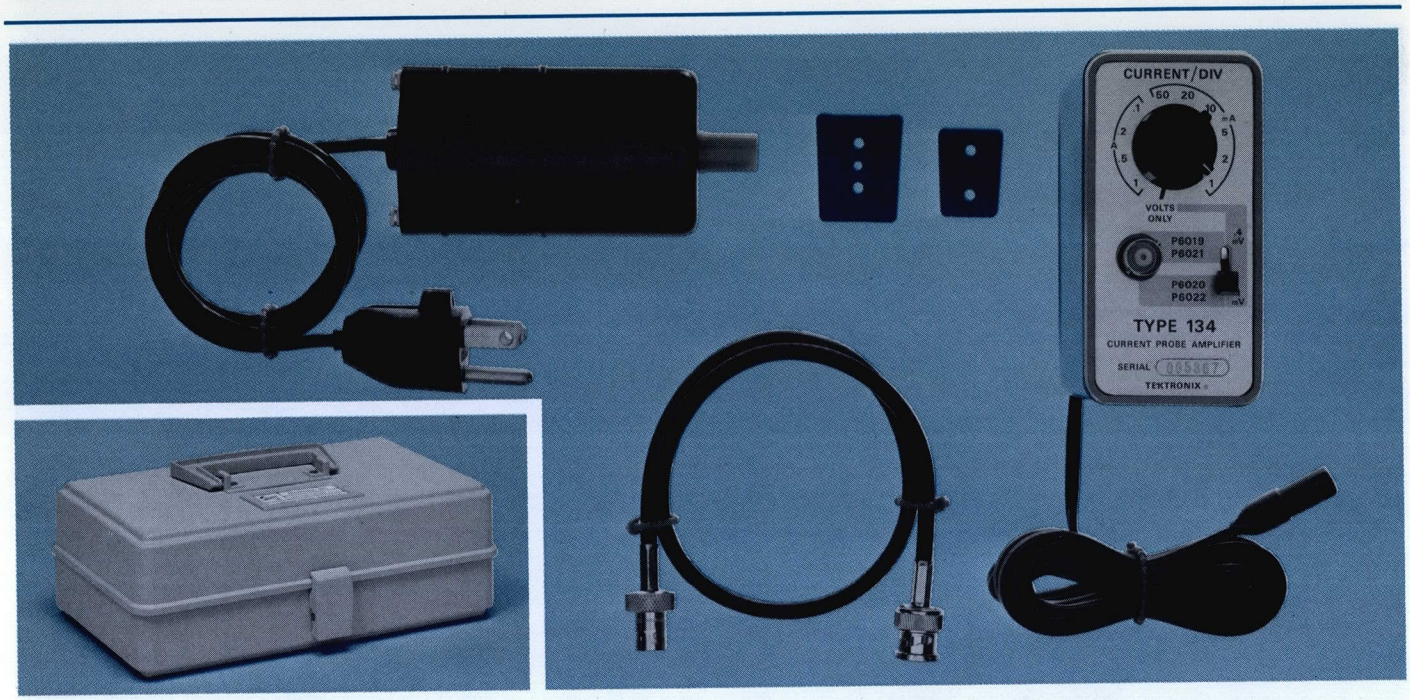
PERFORMANCE CHARACTERISTICS

	P6022 PROBE WITH PASSIVE TERMINATION				P6022 PROBE WITH TYPE 134 AMPLIFIER	
SENSITIVITY	1 mA/mV or 10 mA/mV, selected by termination switch. Accuracy ±3%.				Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.	
SYSTEM BANDWIDTH†/RISETIME	Bandwidth		Risetime			
Oscilloscope Bandwidth	1 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	Bandwidth	Risetime
50 MHz	47 MHz	48 MHz	7.45 ns	7.2 ns	40 MHz	8.8 ns
75 MHz	65 MHz	70 MHz	5.35 ns	5.0 ns	50 MHz	7.0 ns
100 MHz	80 MHz	90 MHz	4.36 ns	3.9 ns	54 MHz	6.4 ns
150 MHz	100 MHz	120 MHz	3.50 ns	2.9 ns	59 MHz	5.9 ns
LOW FREQUENCY RESPONSE	≤8.5 kHz at 1 mA/mV ≤935 Hz at 10 mA/mV				≤100 Hz	
NOISE					≤150 μA	
MAXIMUM CURRENT (CW)*	6 A peak-to-peak sinewave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV				6 A peak-to-peak sinewave between 1.3 kHz and 10 MHz	
MAXIMUM CURRENT (PULSE)*	100 A Peak, not to exceed 9 A-μs or 2 A RMS				10 A Peak, not to exceed 9 A-μs or 2 A RMS	
MAXIMUM VOLTAGE	600 V (DC + peak AC)				600 V (DC + peak AC)	
NET WEIGHT	≈1 lb				≈5 lb	
PRICE	$165				$360	

*Decrease oscilloscope sensitivity to make these measurements.

†All bandwidths stated are at —3 dB.

134 AC Current Probe Amplifier



The Type 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div).

The Type 134 can also be used as an auxiliary voltage amplifier by placing the current/div switch in the VOLTS position.

DEFLECTION FACTOR: (with 50 mV/div oscilloscope input setting) 1 mV/div (P6022) or 0.4 mV/div (P6021).

LINEAR DEFLECTION: ± 10 A Peak at 1 A/div.

GAIN: 50 (P6022) or 125 (P6021), ±3%. Selected by lever switch.

IMPEDANCE: (input and output) approx 50 Ω, AC-coupled.

BANDWIDTH: 8 Hz to 54 MHz at a gain of 50; 10 Hz to 30 MHz at a gain of ..5 (3-dB down).

NET WEIGHT: approx 4 pounds.

TYPE 134 AMPLIFIER ONLY (015-0057-01) $209
Includes instruction manual (070-0990-00).

POWER SUPPLY ONLY, 115 V (015-0058-01) $33

POWER SUPPLY ONLY, 230 V (015-0059-01) $33

ORDERING INFORMATION

P6021

P6021 5-FT PROBE WITH PASSIVE TERMINATION (015-0140-02) $121

P6021 9-FT PROBE WITH PASSIVE TERMINATION (015-0140-03) $121

P6021 5-FT PROBE (010-0237-02) $94

P6021 9-FT PROBE (010-0244-02) $94

Probe includes: 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00); two alligator clips (344-0046-00); instruction manual (070-0947-00).

P6021 PASSIVE TERMINATION (011-0105-00) $33

P6021 5-FT PROBE, TYPE 134 AMPLIFIER WITH 115-V POWER SUPPLY (015-0141-01) $325

P6021 9-FT PROBE, TYPE 134 AMPLIFIER WITH 115-V POWER SUPPLY (015-0141-02) $325

P6021 5-FT PROBE, TYPE 134 AMPLIFIER WITH 230-V POWER SUPPLY (015-0142-01) $325

P6021 9-FT PROBE, TYPE 134 AMPLIFIER WITH 230-V POWER SUPPLY (015-0142-02) $325

Probe/amplifier includes: hanger assembly (014-0029-00); cable, coax, 18 inches (012-0104-00); carrying case (016-0087-00); 5.5-inch ground lead (175-0124-00); 3.5-inch ground lead (175-0263-00); two alligator clips (344-0046-00); one each instruction manual (070-0947-00) and (070-0990-00).

P6022

P6022 5-FT PROBE WITH PASSIVE TERMINATION (015-0135-00) $165

P6022 PROBE (010-0238-00) $127

Probe includes: 5-inch ground lead (175-0124-00); 3-inch ground lead (175-0263-00); two alligator clips (344-0046-00); instruction manual (070-0948-00).

P6022 PASSIVE TERMINATION (011-0106-00) $44

P6022 PROBE, TYPE 134 AMPLIFIER WITH 115-V POWER SUPPLY (015-0136-00) $360

P6022 PROBE, TYPE 134 AMPLIFIER WITH 230-V POWER SUPPLY (015-0137-00) $360

Probe/amplifier includes: hanger assembly (014-0029-00); cable, coax, 18 inches (012-0104-00); carrying case (016-0087-00); 5.5-inch ground lead (175-0124-00); 3.5-inch ground lead (175-0263-00); two alligator clips (344-0046-00); one each instruction manual (070-0948-00) and (070-0990-00).

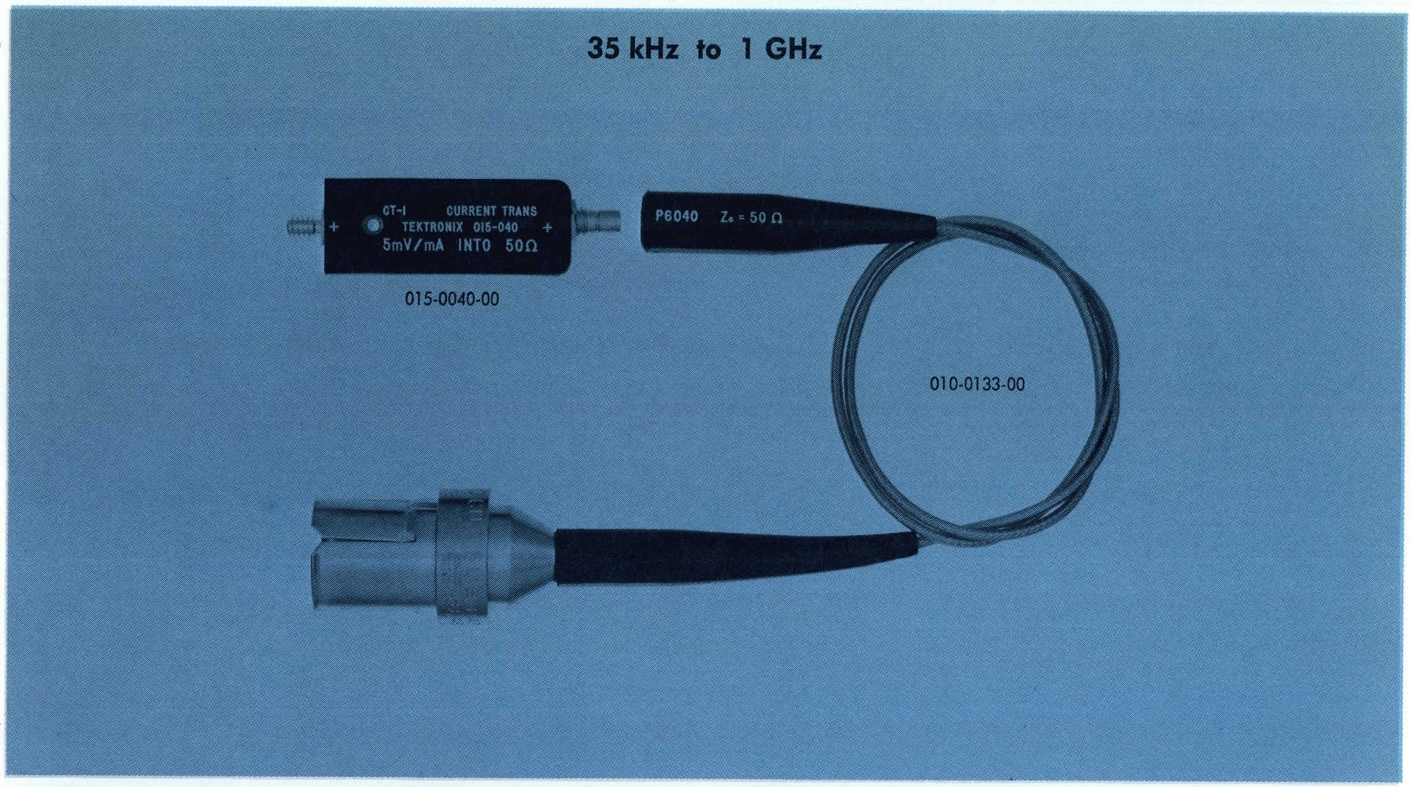
OPTIONAL ACCESSORIES for P6021 and P6022

CALIBRATOR ADAPTER, BNC (013-0092-00) $5.00

ADAPTER, BNC to UHF (103-0015-00) $2.25

U. S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

35 kHz to 1 GHz



The P6040/CT-1 Current Probe is designed for use with Tektronix 50-Ω sampling units such as the Tektronix 1S1, 1S2, 3S1, 3S2, 3S5, 3S6 and 7S11 Sampling Plug-In Units. With the use of a 50-Ω termination the P6040/CT-1 can be used with wideband, non-sampling oscilloscopes for making fast-risetime current measurements.

Several CT-1 current transformers may be placed throughout the circuit and monitored by one or more P6040 Probes. For a longer length probe, additional 50-Ω cable can be used in series with the probe. Conductor sizes up to 0.065 inches in diameter can be monitored.

P6040 PROBE

The P6040 Probe is an inter-connecting cable for the CT-1, used between the transformer and oscilloscope input.

If several CT-1 Transformers are in a circuit, the P6040 Probe can be used to monitor any one of them.

The P6040 can be used with other test-point connectors, such as Amphenol series 27 Sub-Minax or Sealectro Sub-Miniature RF.

IMPEDANCE is 50 ohms.

ATTENUATION is 1X.

OUTPUT CONNECTOR is a GR type.

CABLE LENGTH is 18 inches. Additional 50-Ω cable can be used in series with the probe. RG8/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

CT-1 CURRENT TRANSFORMER

SENSITIVITY is 5 mV/mA into a 50-ohm load. Accuracy is better than ±3%.

DECAY TIME CONSTANT is 5 μs, approximated by 1% per 50 ns; limit, 1 μs.

RISETIME is less than 350 ps.

FREQUENCY RESPONSE is 35 kHz to 1 GHz (30% down points).

INSERTION IMPEDANCE with a 50-ohm termination is 1 ohm shunted by approximately 5 μH; 2 ohms shunted by approximately 5 μH without a 50-ohm termination.

CAPACITIVE LOADING to a bare wire passing through the CT-1 transformer is typically 1.5 pF for #14 gauge, 0.6 pF for #20 gauge.

MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 1000 V DC.

DIRECT CURRENT reduces the L/R time constant by a factor of 2 at 0.6 A.

PULSE CURRENT RATING is 100 A peak, with an amp-second product of 1 A-μs. When the A-s product is exceeded, the core saturates reducing the CT-1 output to zero.

RMS CURRENT RATING is 500 mA maximum.

TEMPERATURE RATING is −25° C to +65° C.

PHYSICAL DIMENSIONS are $\frac{3}{8}$ x $\frac{9}{16}$ x $1\frac{13}{16}$ inches plus #6-32 x $\frac{1}{4}$-inch mounting stud. Net weight is approx 8 ounces.

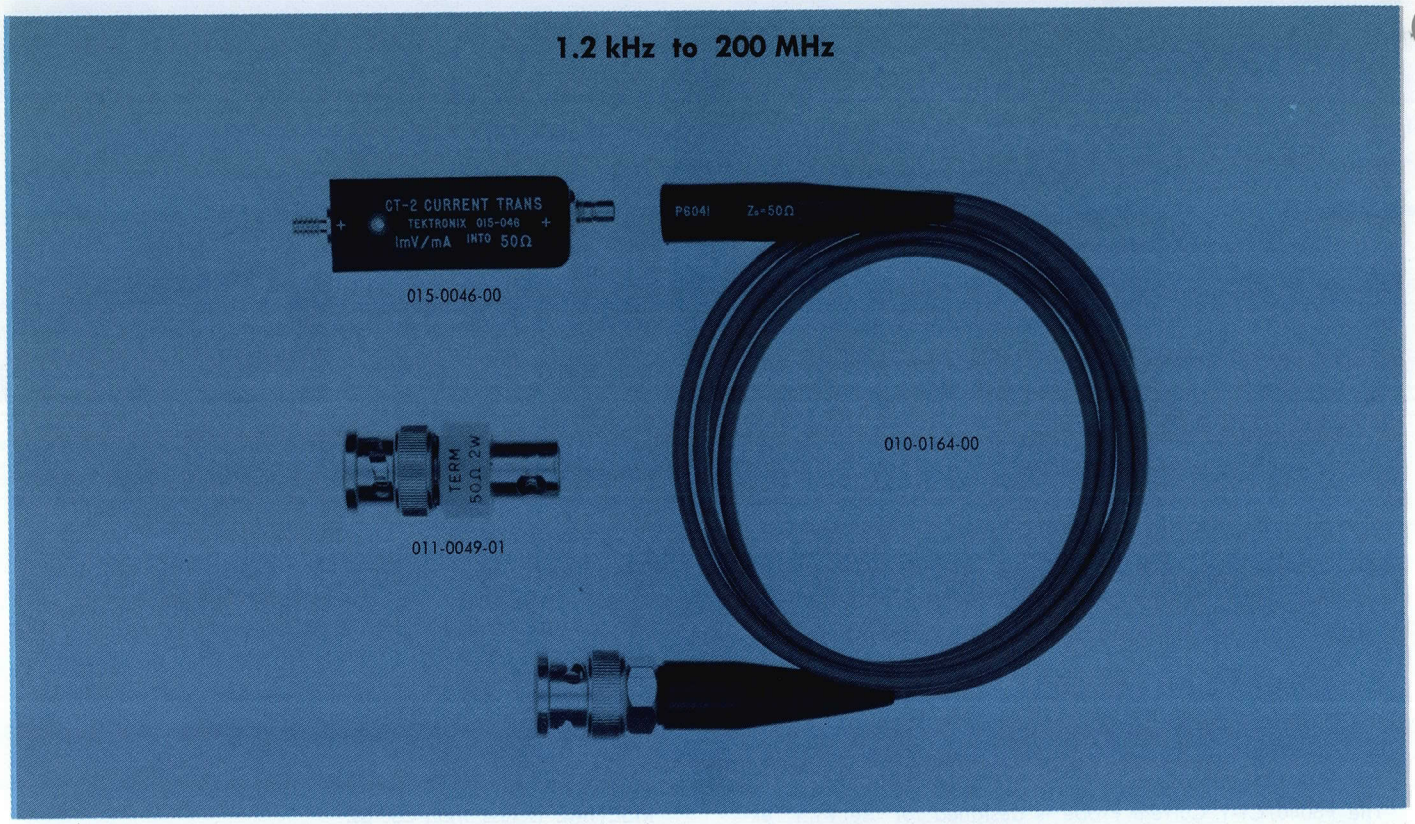
P6040/CT-1 CURRENT PROBE, order 015-0041-00 . . **$40**
Includes instruction manual (070-0375-01).
CT-1 CURRENT TRANSFORMER, order 015-0040-00 . **$21**
P6040 PROBE, order 010-0133-00 . . . . . **$19**

OPTIONAL ACCESSORY

GR to BNC, 50-Ω thru-line termination, order 017-0083-00.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

P6041/CT-2 AC Current Probe



The P6041/CT-2 Current Probe is designed for use with Tektronix DC-to-150 MHz oscilloscopes. A 50-Ω termination is used in conjunction with the P6041/CT-2 for terminating the probe at the input of the oscilloscope.

The insulated case of the CT-2 Current Transformer is convenient to use in applications where limited circuit space exists. Several CT-2 Transformers may be placed throughout the circuit and monitored by one or more P6041 Probes. Conductor sizes up to 0.050 inches in diameter can be monitored.

P6041 PROBE

The P6041 Probe serves as an interconnecting cable between the CT-2 Transformer and the oscilloscope input. A 50-ohm termination is used in conjunction with the P6041 for terminating the probe at the high impedance input of the oscilloscope used.

Although designed for use with the CT-2, the P6041 Probe can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

IMPEDANCE is 50 ohms.

ATTENUATION is 1X.

OUTPUT CONNECTOR is BNC type.

CABLE LENGTH is 42 inches. Additional 50-ohm cable can be used in series with the probe. RG8/U or RG58A/U cable is recommended to preserve the high-frequency response.

CT-2 CURRENT TRANSFORMER

SENSITIVITY is 1 mV/mA into a 50-ohm load. Accuracy is better than ±3%.

DECAY TIME CONSTANT is 125 μs, approximated by 1% per 1.25 μs; limit, 25 μs.

RISETIME is approximately 0.5 ns.

FREQUENCY RESPONSE is 30% down at 1.2 kHz, 7% down at 200 MHz.

INSERTION IMPEDANCE with a 50-ohm termination is 0.04 ohms shunted by approximately 5 μH; 0.08 ohms shunted by approximately 5 μH without a 50-ohm termination.

CAPACITIVE LOADING to a bare wire passing through the CT-2 Transformer is typically 2.1 pF for #16 gauge, 0.7 pF for #22 gauge.

MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 1000 V DC.

DIRECT CURRENT reduces the L/R time constant by a factor of 2 at 0.5 A.

PULSE CURRENT RATING is 100 A peak, with an amp-second product of 50 A-μs. When the A-s product is exceeded, the core saturates reducing the CT-2 output to zero.

RMS CURRENT RATING is 2.5 A maximum.

TEMPERATURE RATING is —25° C to +65° C.

PHYSICAL DIMENSIONS are $\frac{3}{8}$ x $\frac{9}{16}$ x $1\frac{13}{16}$ inches plus #6-32 x $\frac{1}{4}$-inch mounting stud. Net weight is approx 8 ounces.

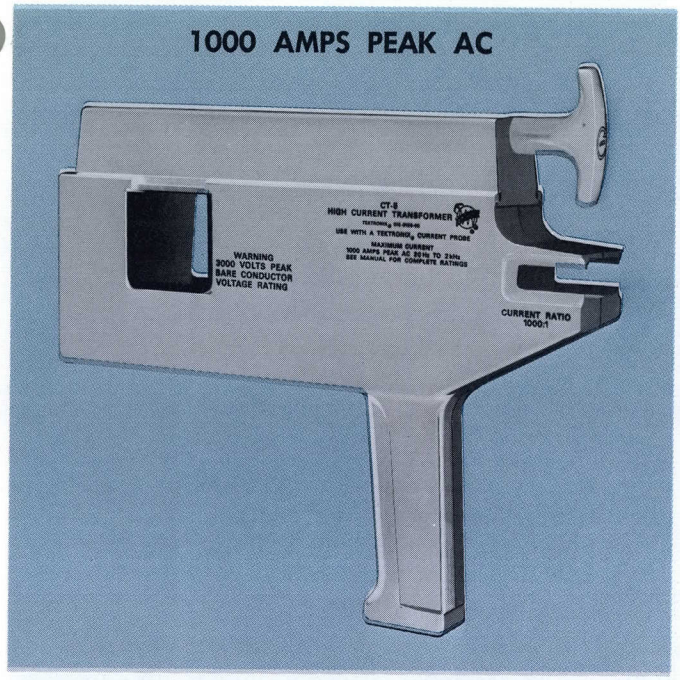
P6041/CT-2 CURRENT PROBE, order 015-0047-00. **$47.50**
Includes: 50-Ω termination (011-0049-01); instruction manual (070-0406-01).

CT-2 CURRENT TRANSFORMER, order 015-0046-00 . . **$21**

P6041 PROBE, order 010-0164-00 . . . . . **$16.50**

50-OHM TERMINATION, order 011-0049-01 . . . . . **$10**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page



The CT-5 is a clip-on High-Current Transformer designed to extend the measurement capability of Tektronix clip-on current probes. Maximum low-frequency performance is obtained using the P6042 DC Current Probe. It may also be used with the P6021 (not compatible with P6022) in conjunction with a current probe amplifier for measurements at normal power line frequency and above.

The CT-5 has receptacles for insertion of a current probe in either 20:1 or 1000:1 step-down ratios. The 1.5-inch square opening makes it possible to clip onto large conductors to make current measurements without breaking the circuit under test.

The core and shield assembly is insulated from the windings and the handle. This allows measurements to be made on bare conductors to 3000 volts, and to 10 kV RMS on insulated conductors or by use of a high-voltage bushing.

Use of an optional DC bucking coil assembly, which slips over the front of the CT-5, allows up to 300 amps of DC to be tolerated without appreciably degrading the measurements to be made. This is very useful for measuring AC signals riding on top of DC.

CHARACTERISTICS

BANDWIDTH

	CT-5 with P6042	CT-5 with P6021/134
Upper —3 dB	At least 20 MHz	At least 20 MHz
Lower —3 dB	1 Hz or less	12 Hz or less

The following are characteristics of the CT-5 using either the P6042 or P6021/134 combination.

RISETIME is 17.5 ns or less.

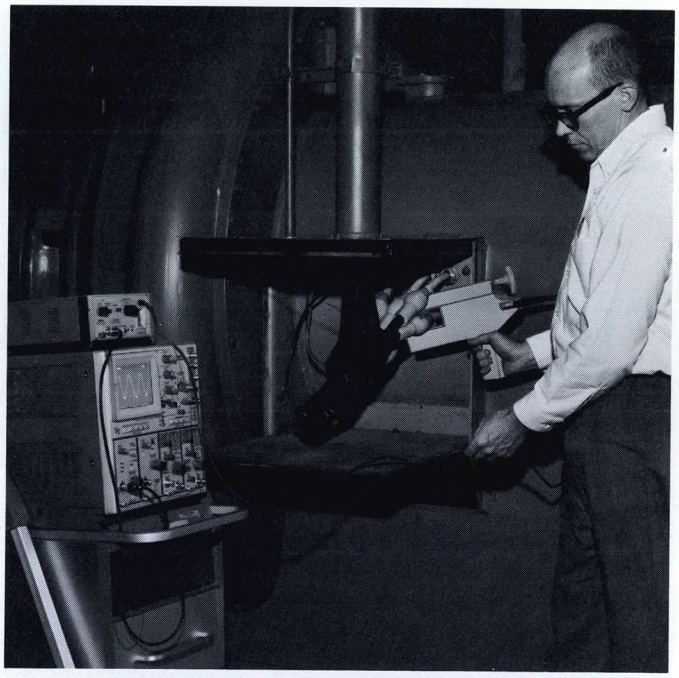
INSERTION IMPEDANCE is 20 $\mu\Omega$ or less at 60 Hz, increasing to 20 mΩ at 1 MHz.

CURRENT RANGE is 20 mA/div to 20 A/div (20:1 step-down ratio); 1 A/div to 1000 A/div (1000:1 step-down ratio). Accuracy is within 4%.

MAXIMUM CURRENT is 1000 A Peak.*

AMP-SECOND PRODUCT is 8 A-s.

*Maximum continuous current 1000 A peak from 20 Hz to 2 kHz derating to 100 A peak at 250 kHz.

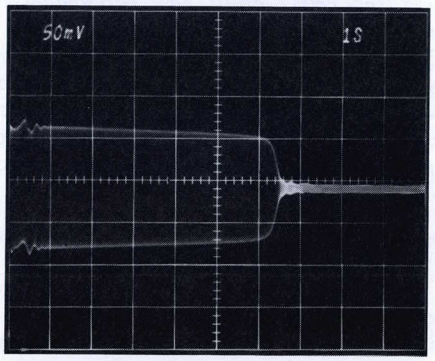


Typical application of CT-5 clip-on High Current Transformer, P6042 DC Current Probe and 7504 Oscilloscope measuring the running current of a 1500 hp delta-connected induction motor.

MAXIMUM VOLTAGE of circuit under test is 3000 V (bare conductor).

MAXIMUM DC BUCKING CURRENT is 300 mA to buck out 300 A DC (using optional DC bucking coil).

DIMENSIONS AND WEIGHT—the length is 10½ inches, width is 2¼ inches, height is 9½ inches; net weight is approx 4 pounds.



Starting current of motor shown in photograph displayed at 1000 A/div vertical deflection and 1 s/div horizontal deflection. The measurement was made using a CT-5 High Current Transformer, P6042 Current Probe and 7000-Series Oscilloscope system.

CT-5 HIGH-CURRENT TRANSFORMER, order 015-0189-00 . . . . . **$400**
Includes instruction manual (070-1130-00); carrying case (016-0191-00); high-voltage bushing, 10-inch (015-0194-00).

OPTIONAL ACCESSORIES

DC Bucking Coil, order 015-0190-00 . . . . . $125
High-Voltage Bushing, 4-feet long, inside dia 1 inch, order 015-0194-01 . . . . . $8

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

P6042 DC Current Probe

DC to 50 MHz 1-mA/DIV

The P6042 is a DC-to-50 MHz current probe designed for use with all Tektronix oscilloscopes. Utilizing a variation of the Hall effect, the P6042 offers new capabilities for making both high-frequency and DC current measurements. AC Signals with DC components can be displayed on the oscilloscope with true waveform presentation. The probe is particularly useful for evaluating the performance of semiconductor circuits where a wide range of parameters exist. Fast switching transients, low-frequency response, and DC level can all be displayed simultaneously.

The probe can also be used to measure the sums or differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, the sum is displayed. By reversing one of the wires, the difference is displayed. For increased sensitivity, several loops can be placed through the probe, increasing the sensitivity by the number of loops.

The P6042 consists of an amplifier with built-in power supply, 6-foot probe cable, and probe head. The probe is easy to use. Simply place the conductor (Up to 0.150-inch diameter) in the slot of the probe head and close the spring-loaded slide . . . no need to break the circuit under test. A warning light on the front panel of the amplifier indicates when the slide is in the unlocked position. A compartment is provided in the front panel for use in degaussing, and for convenient storage of the probe head when the system is not in use.

CHARACTERISTICS

Probe and Amplifier

SENSITIVITY is 1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 50 mV/div).

BANDWIDTH is DC to 50 MHz at 3-dB down.

RISETIME is 7 ns or less.

DYNAMIC RANGE is + and — 10 divisions of display.

NOISE (periodic and random deviation) is 0.5 mA or less, plus 0.2 or less major divisions of display. Random trace shift is 1.5 mA or less.

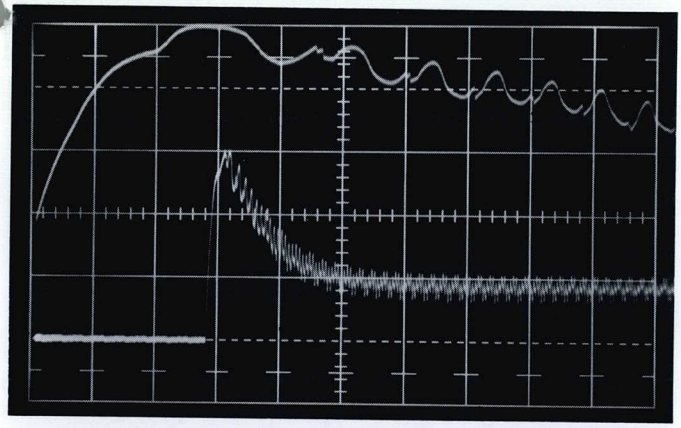
THERMAL DRIFT is 2 mA/°C or less, plus 0.2 or less major division of display per °C.

MAXIMUM INPUT CURRENT is 10 A (DC plus Peak AC).*

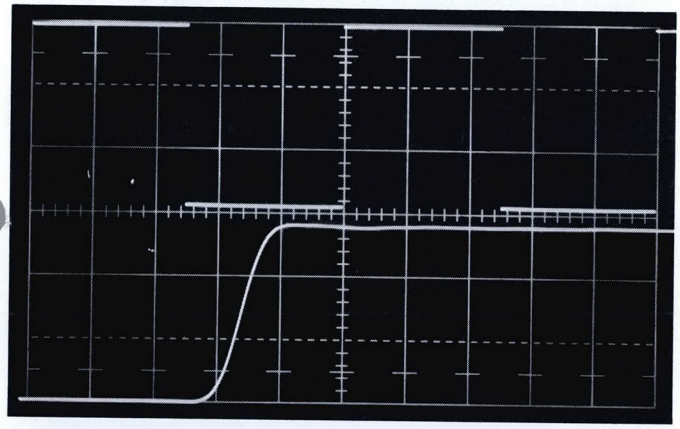
MAXIMUM VOLTAGE OF CIRCUIT UNDER TEST is 600 V (DC plus Peak AC).

OUTPUT IMPEDANCE is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the probe for use with 1-megohm systems.

*Peak-to-peak current derating is necessary for CW frequencies higher than 10 MHz. At 50 MHz, the maximum allowable current is 2 A.

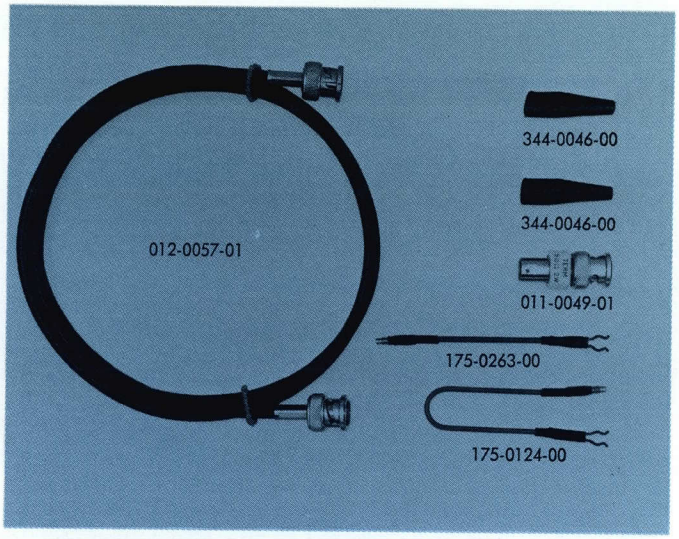


Double exposure photograph using the P6042 and a Type 547/1A5 Oscilloscope to display the current characteristics of a small DC motor. Lower display shows the zero current level, starting current, and running current. Current/div setting is 0.2 A/div with a sweep rate of 50 ms/cm. In the upper display, the sweep rate is increased to 5 ms/cm to show the current change as the commutator bars pass the brushes.



Upper display is a 60-Hz squarewave demonstrating the DC response of the P6042. The lower display is the same waveform at 10 ns/div. Double exposure photograph.

Typical application of CT-5 clip-on High Current Transformer, P6042 DC Current Probe and 7504 Oscilloscope measuring the running current of a 1500 hp delta-connected induction motor.



AMPLIFIER POWER REQUIREMENT is approximately 20 W, 50 Hz to 400 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

DIMENSIONS AND WEIGHT of the amplifier are 4½ inches (11.4 cm) high by 7½ inches (19.2 cm) wide by 9¾ inches (24.8 cm) deep; 6½ lbs. (3.1 kg).

PROBE CABLE is 6 feet long, permanently connected between the probe head and amplifier.

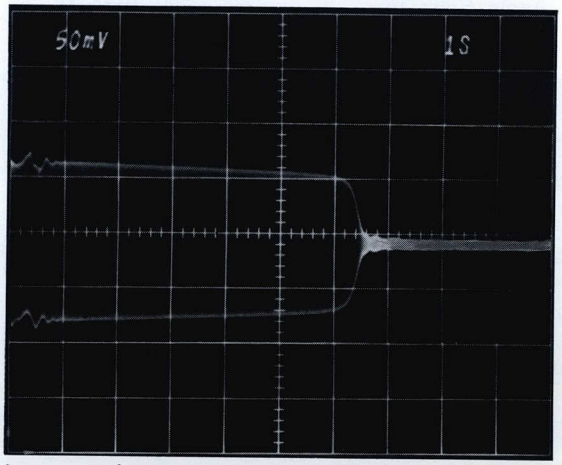
P6042 DC CURRENT PROBE, order 010-0207-00 . . . **$690**
Includes: 50-Ω BNC cable (012-0057-01); 50-Ω BNC termination (011-0049-01); 3.5-inch ground lead (175-0263-00); 5.5-inch ground lead (175-0124-00); two alligator clips (344-0046-00); instruction manual (070-0629-00).

OPTIONAL ACCESSORIES

The CT-5 High Current Transformer extends the maximum measurement capability of the P6042 at bandwidths from 1 Hz to 20 MHz.

Order 015-0189-00 ..... $400

BNC-to-GR Adapter, order 017-0063-00.



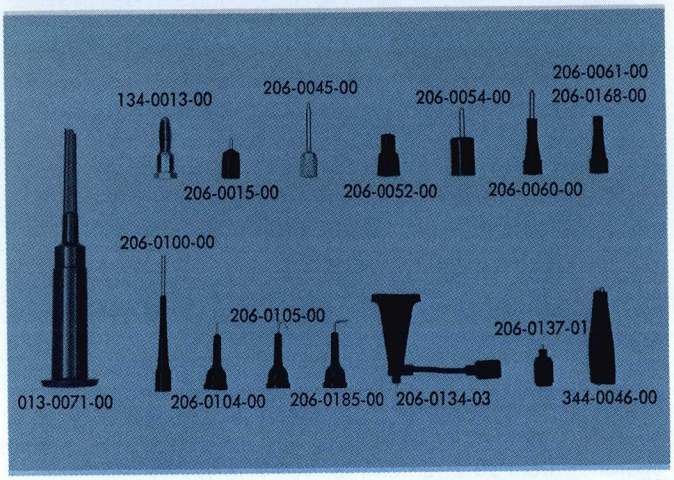
Starting current of motor shown in photograph displayed at 1000 A/div vertical deflection and 1 s/div horizontal deflection. The measurement was made using a CT-5 High Current Transformer, P6042 Current Probe and 7000-Series Oscilloscope system.

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

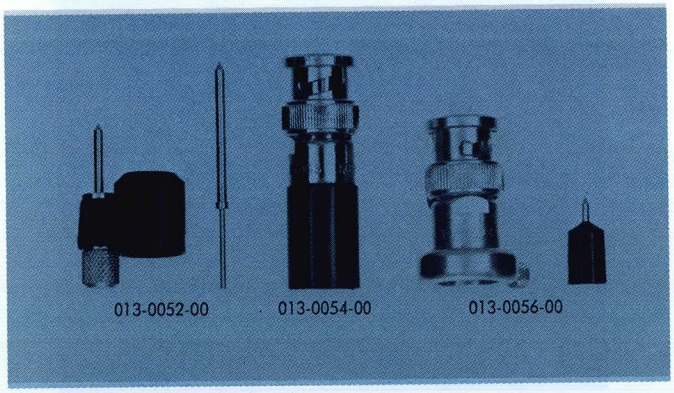
Probe Accessories

#6-32 PROBE TIPS AND ADAPTERS

The following tips and adapters can be used on all Tektronix Probes that accept a #6-32 screw-on tip including the P6006, P6007, P6008, P6009, P6027 and P6028 Probes.

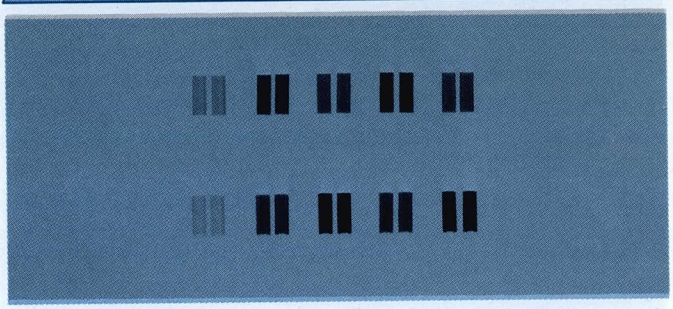


DESCRIPTION	PART NUMBER	PRICE
Calibration Tip (0.063 in dia)	206-0100-00	$1.00
Straight Tip (0.080 in dia)	206-0045-00	.85
Straight Tip (0.086 in dia)	206-0054-00	.85
Long Straight Tip (0.032 in dia)	206-0104-00	.30
Spring Tip (0.080 in dia)	206-0060-00	.55
Spring Tip (accepts 0.065 in dia pin)	206-0061-00	.50
Spring Tip (accepts 0.068 in dia pin)	206-0168-00	.50
Recessed Tip (accepts 0.065 in dia recessed pin)	206-0052-00	.30
Short Straight Tip (0.055 in dia)	206-0015-00	.30
Banana Tip	134-0013-00	.20
Minigator Tip	344-0046-00	.25
Hook Tip	206-0105-00	.30
Retractable Hook Tip (for P6006, P6007, P6008, P6009, P6027, P6028)	013-0071-00	2.20
Probe Tip (accepts 0.025 in x 0.025 in dia pin)	206-0134-03	1.75
Ground Lead Adapter (#6-32 to 0.025 in x 0.025 in dia pin)	206-0137-01	.60
Right Angle Hook Tip	206-0185-00	.30



Probe Tip to BNC Adapter (for P6006, P6007, P6008, P6009)	013-0054-00	$3.00
Probe Tip to BNC Adapter (for P6027, P6028)	013-0056-00	3.50
Bayonet Ground Assembly (for P6006, P6007, P6008, P6009)	013-0052-00	2.50

IDENTIFICATION TAGS



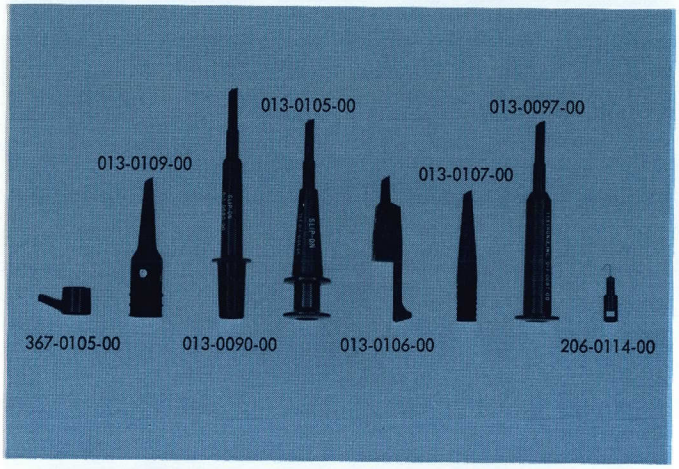
Probe identification tags for multi-probe applications help locate correlating probe ends quickly. One package contains 2 each of 10 colors.

DESCRIPTION	PART NUMBER	PRICE
For $\frac{1}{8}$ inch dia cable	016-0130-00	$1.10
For $\frac{3}{16}$ inch dia cable	016-0127-00	1.10

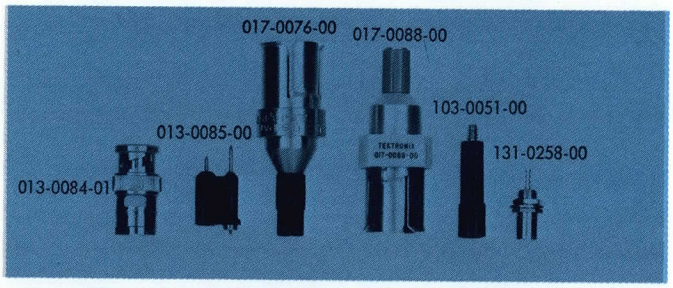
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

SLIP-ON PROBE TIPS AND ADAPTERS

The following tips and adapters are designed for use with Tektronix Miniature Probes that accept a slip-on tip.

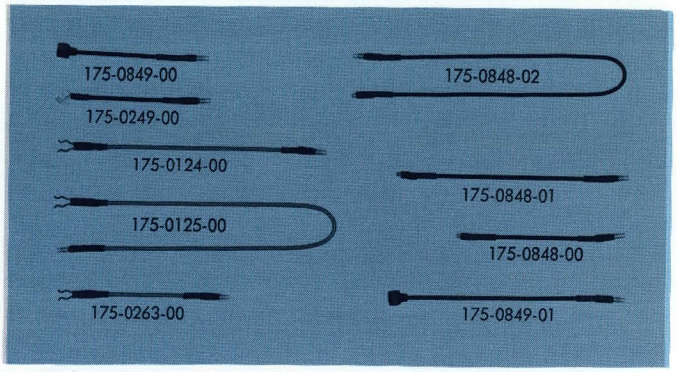


DESCRIPTION	PART NUMBER	PRICE
Retractable Hook Tip (for P6010, P6011, P6012, P6048, P6049)	013-0090-00	$2.20
Retractable Hook Tip (for S-3A, P6045)	013-0097-00	2.20
Retractable Hook Tip (for P6051)	013-0109-00	4.50
Retractable Hook Tip (for P6052)	013-0105-00	2.20
Retractable Hook Tip (for P6053, P6054)	013-0107-00	2.20
Retractable Hook Tip (for P6055) not shown	013-0107-01	2.20
Retractable Hook Tip (for 7A11)	013-0106-00	3.25
Retractable Hook Tip Handle	367-0105-00	.15
Hook Tip	206-0114-00	.90



Probe Tip to GR 50-Ω Termination Adapter	017-0088-00	$25.00
Miniature Probe to #6-32 Adapter (adapts miniature probes for use with all #6-32 screw-on tips)	103-0051-00	1.25
Probe Tip to GR Adapter	017-0076-00	8.30
Probe Tip to BNC Adapter	013-0084-01	5.30
Bayonet Ground Assembly	013-0085-00	2.75
Chassis Mount Test Jack	131-0258-00	1.50

PROBE GROUND LEADS



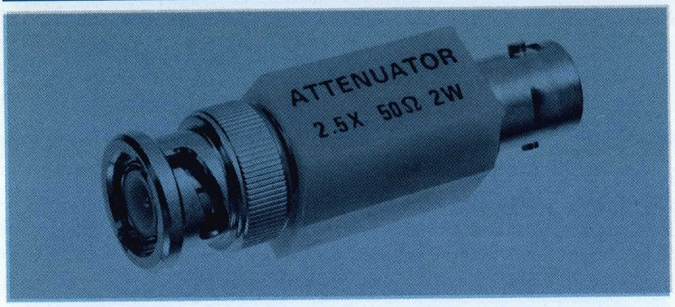
The following Ground Leads have a #6-32 thread size.

DESCRIPTION		PART NUMBER	PRICE
Ground Lead for P6034, P6035, P6045, S-3A:	2.5-inch	175-0249-00	$1.10
Ground Lead	3.5-inch	175-0263-00	.60
Ground Lead	5.5-inch	175-0124-00	.60
Ground Lead	12.5-inch	175-0125-00	.60
Ground Leads for P6051, P6052, P6053, P6054:	3-inch	175-0848-00	.60
	5-inch	175-0848-01	.60
	12-inch	175-0848-02	.60
Nose Ground Leads for P6051:	3-inch	175-0849-00	.60
	6-inch	175-0849-01	.60

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Accessories With BNC Connectors

ATTENUATORS—TERMINATIONS



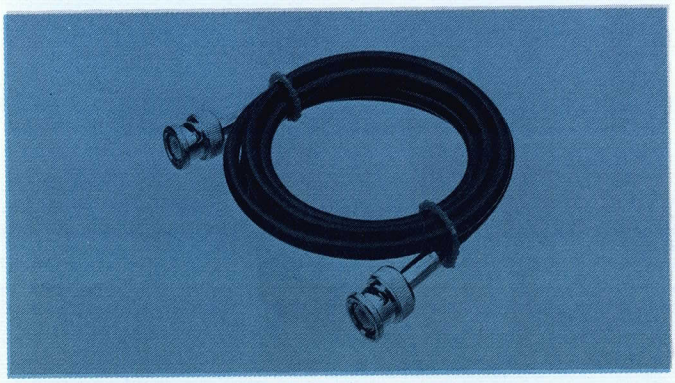
DESCRIPTION	PART NUMBER	PRICE
50-Ω feedthrough termination	011-0049-01	$10.00
50-Ω feedthrough termination (5 watt)*	011-0099-00	18.50
50-Ω 2X attenuator	011-0069-01	16.50
50-Ω 2.5X attenuator	011-0076-01	16.50
50-Ω 5X attenuator	011-0060-01	16.50
50-Ω 10X attenuator	011-0059-01	16.50

CHARACTERISTICS (for 50-Ω termination and attenuators above)
Accuracy of Indicated Attenuation Ratio is ±2% at DC; ±3% at 500 MHz. Power Rating is 2 watts.
Voltage Standing Wave Ratio (VSWR) is less than 1.1 up to 250 MHz. *VSWR less than 1.1 up to 100 MHz.

50-Ω to 75-Ω min loss attenuator	011-0057-00	$13.25
75-Ω to 50-Ω min loss attenuator (AC coupled)	011-0112-00	25.00
50-Ω to 93-Ω min loss attenuator	011-0058-00	13.25
75-Ω feedthrough termination	011-0055-00	10.00
75-Ω 10X attenuator	011-0061-00	12.00
93-Ω feedthrough termination	011-0056-00	10.00
93-Ω 10X attenuator	011-0062-00	12.00
600-Ω feedthrough termination (1 watt, DC to 1 MHz)	011-0092-00	18.00

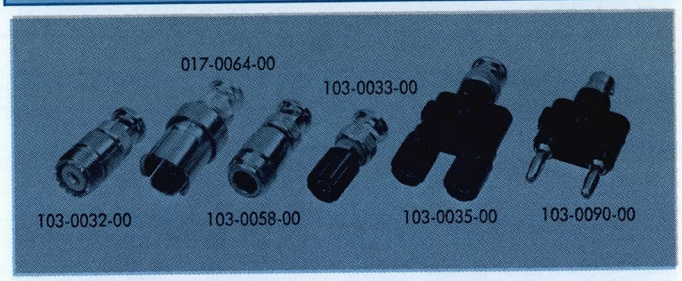
CHARACTERISTICS
Accuracy of Indicated Attenuation Ratio is ±2% at DC.
Power Rating of attenuators is ½ watt and terminations 1 watt.
Voltage Standing Wave Ratio (VSWR) not specified.

CABLES

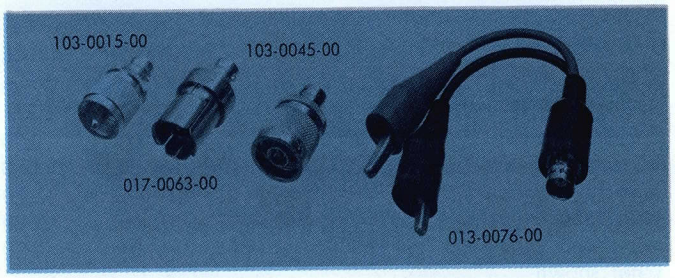


Coaxial, 50 Ω, 18 in	012-0076-00	$6.00
Coaxial, 50 Ω, 42 in	012-0057-01	6.00
Coaxial, 75 Ω, 42 in	012-0074-00	6.00
Coaxial, 93 Ω, 42 in	012-0075-00	6.00

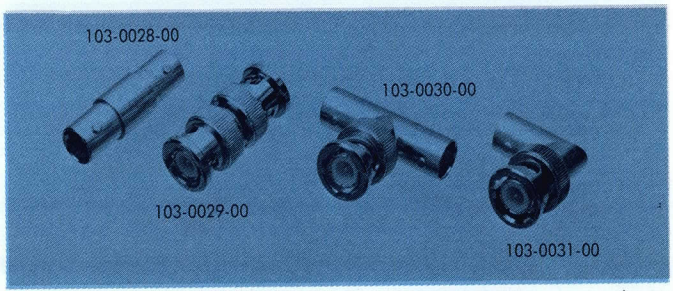
ADAPTERS



DESCRIPTION	PART NUMBER	PRICE
BNC Male to GR	017-0064-00	$10.50
BNC Male to N Female	103-0058-00	2.75
BNC Male to Binding Post	103-0033-00	2.20
BNC Male to Dual Binding Post	103-0035-00	6.50
BNC Female to Dual Banana	103-0090-00	3.50
BNC Male to UHF Female	103-0032-00	2.00



BNC Female to UHF Male	103-0015-00	$2.25
BNC Female to GR	017-0063-00	7.50
BNC Female to N Male	103-0045-00	2.40
BNC Female to clip leads	013-0076-00	5.50

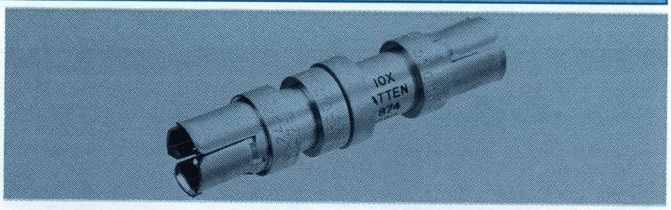


BNC Female to BNC Female	103-0028-00	$2.10
BNC Male to BNC Male	103-0029-00	4.00
BNC T	103-0030-00	3.70
BNC Elbow Male to Female	103-0031-00	3.00

Accessory housing without electrical components is useful for applications requiring special circuitry.
Order 011-0081-00 ..... $8.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

ATTENUATORS—TERMINATIONS

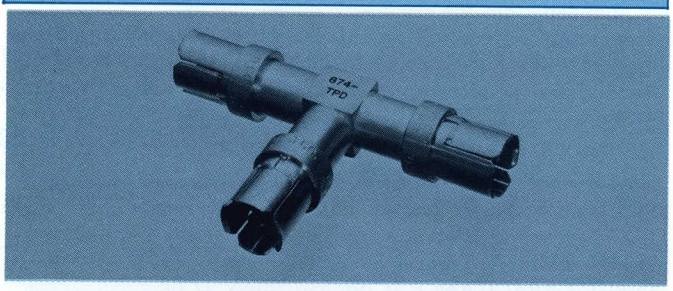


DESCRIPTION	PART NUMBER	PRICE
50-Ω termination, end-line	017-0081-00	$35.75
50-Ω 2X attenuator	017-0080-00	44.00
50-Ω 5X attenuator	017-0079-00	44.00
50-Ω 10X attenuator	017-0078-00	44.00
125-Ω min loss	017-0052-00	33.00

CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at DC, ±3% at 1 GHz. Voltage standing wave ratio (VSWR) is less than 1.1 up to 1 GHz. Power Rating is 1 watt.

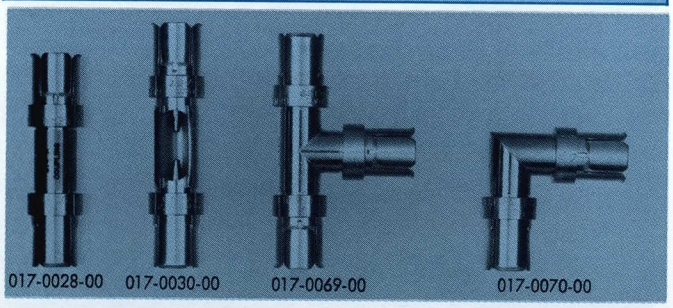
50-OHM POWER DIVIDER



This coaxial tee has a 16.67-ohm resistor in each leg, connected so that the tee looks like 50 ohm if two legs are terminated in 50 ohm. It is designed for use in broad-band 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Order 017-0082-00 ..... **$95.00**

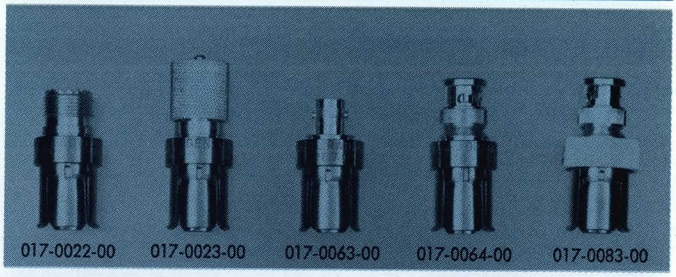
COUPLING CAPACITOR—ADAPTERS



The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflections, but DC and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor	017-0028-00	$17.00
GR Insertion Unit	017-0030-00	20.00
GR T	017-0069-00	20.00
GR Elbow	017-0070-00	17.50

ADAPTERS

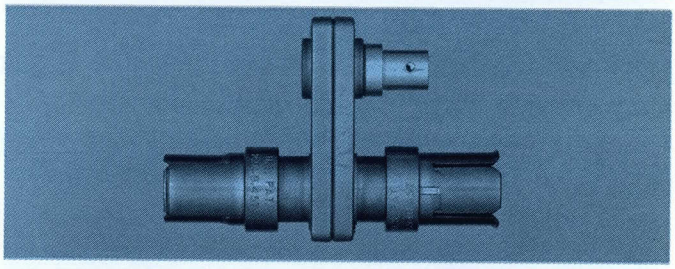


DESCRIPTION	PART NUMBER	PRICE
50-Ω termination, thru-line *(GR to BNC Male)	017-0083-00	$33.50
GR to BNC Male	017-0064-00	10.50
GR to BNC Female	017-0063-00	7.50
GR to UHF Male	017-0023-00	8.00
GR to UHF Female	017-0022-00	7.00

*Upper frequency limit 100 MHz

GR to N Male	017-0021-00	$ 8.00
GR to N Female	017-0062-00	7.00
GR to C Male	017-0027-00	10.00
GR to C Female	017-0065-00	10.00

CT-3 SIGNAL PICKOFF



Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50-ohm system. Used with any of the Tektronix sampling instruments, the CT-3 provides the link for use as a trigger source.

SENSITIVITY is 10% of the voltage under test, into a 50-ohm load.

DECAY TIME CONSTANT is 4.5 μs at 0 DC current.

RISETIME is less than 0.4 ns.

FREQUENCY RESPONSE is 50 kHz to 875 MHz at 0 DC current.

INSERTION IMPEDANCE with a 50-ohm termination is 1 ohm shunted by 4.5 μH; 2 ohms shunted by 4.5 μH without a 50-ohm termination.

VSWR is less than 1.2 at 1.5 GHz.

VOLTAGE RATING at 0 V DC is 25 V RMS, 1-kV pulse peak. The volts-second product is 100 V μs. If exceeded, the L/R decay will decay rapidly toward zero.

Order 017-0061-00 ..... **$38.00**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Accessories With GR Connectors

281 TDR PULSER

The Type 281 Time-Domain Reflectometer Pulser is designed for use with Tektronix Type 1S1 and 3S1 Sampling Plug-Ins. It converts these general-purpose sampling plug-ins to an easy-to-use TDR system. Power is obtained from their probe power connector.

FEED-THROUGH OUTPUT allows Type 281 to be connected directly between oscilloscope input and TDR test-line. Pulse injection is from non-loading current source ($\leq$10% capacitive reflection of 750-ps step).

RISETIME is less than or equal to 750 ps at negative transition.

AMPLITUDE is approximately 460 mV (both connectors terminated in 50 Ω).

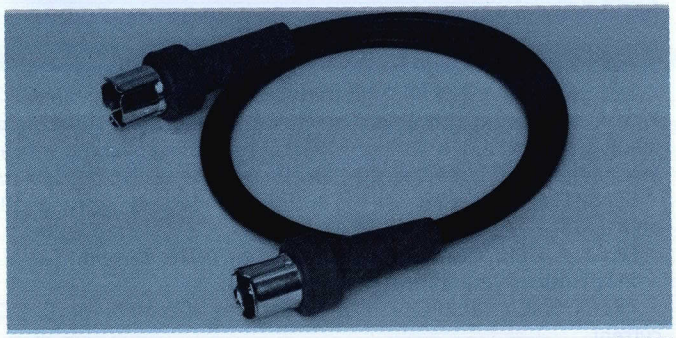
WIDTH is greater than or equal to 5 μs from negative-going edge to positive-going edge, at 50% amplitude points.

ABERRATIONS are ±2% or less in first 10 ns following the negative transition, ±0.5% after 10 ns.

NET WEIGHT is approx 1 pound.

TYPE 281 TDR PULSER, order 015-0060-00 .... **$95.00**
Includes an instruction manual (070-0515-00).

50-OHM CABLES



DESCRIPTION	PART NUMBER	PRICE
Coaxial 5-ns Type RG58C/U	017-0512-00	$20.00
Coaxial 10-ns Type RG58C/U	017-0501-00	17.00
Coaxial 1-ns Type RG58C/U*	017-0503-00	9.00
Coaxial 2-ns Type RG58C/U	017-0505-00	17.00
Coaxial 5-ns Type RG213/U	017-0502-00	17.00
Coaxial 20-ns Type RG213/U	017-0504-00	18.00
Coaxial 10-in Type RG213/U	017-0513-00	14.50
Coaxial 20-in Type RG213/U	017-0515-00	15.00

*Connector on one end only.

282 PROBE ADAPTER

The Type 282 permits the use of conventional high-impedance probes with 50-Ω sampling plug-in units, such as Types 1S1 and 3S1. Power is obtained from their probe power connector. The Type 282 Mod 125D is a similar unit for use with the Types S-1 and S-2 in Type 3S2, 3S5 and 7S11 sampling plug-ins. Power is obtained from the accessory power supply.

Features of sampling such as DC offset, smoothing and overload recovery not normally available with a conventional oscilloscope are combined with the convenience of a high-impedance probe.

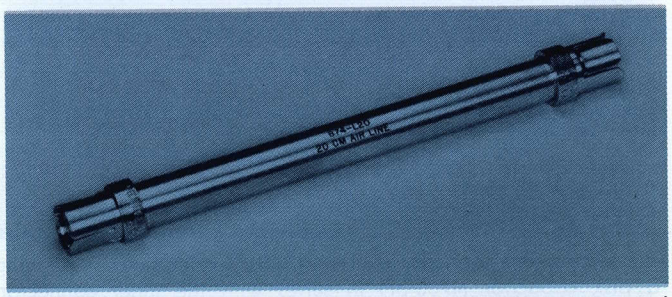
The Type 282 is intended for use with P6008, P6009, P6010, P6011, P6048, P6053 and P6054 probes.

RISETIME is 3 ns or less.
GAIN is unit ±3%, non-inverting.
INPUT RESISTANCE is 1 megohm.
INPUT CAPACITANCE is approximately 17 pF.
DYNAMIC RANGE is +750 mV to −750 mV into 50 Ω.
MAXIMUM INPUT is ±5 V (DC + peak AC).
NET WEIGHT is approx 2 lb.

TYPE 282, order 015-0074-00 ..... **$95**
TYPE 282 MOD 125D, order 015-0146-00 ..... **$100**
Each instrument includes an instruction manual (070-0544-00).

For powering two Type 282 Mod 125D probe adapters from one accessory power supply.
Accessory Power Supply, order 015-0073-00 ..... $110
Tee Connector, order 015-0147-00 ..... $35

50-OHM AIR LINE



The 20-cm 50-Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.
Order 017-0084-00 ..... **$18.75**

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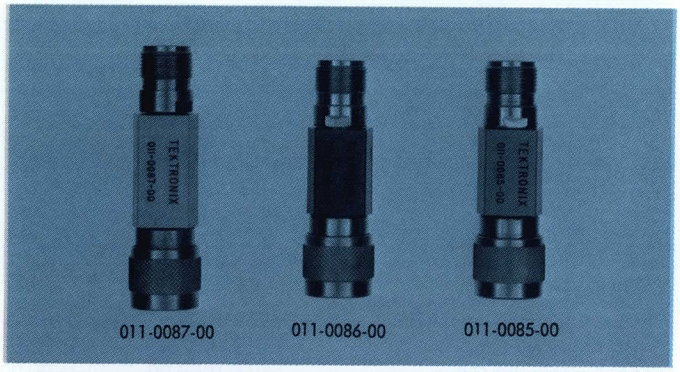
Please refer to General Information page

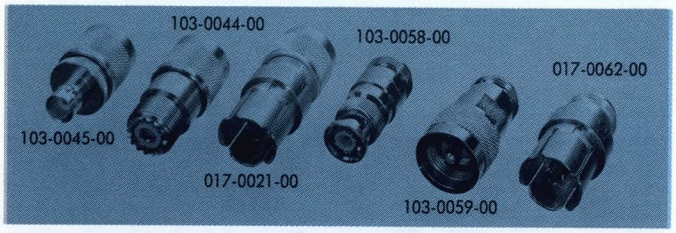
50-OHM ATTENUATORS



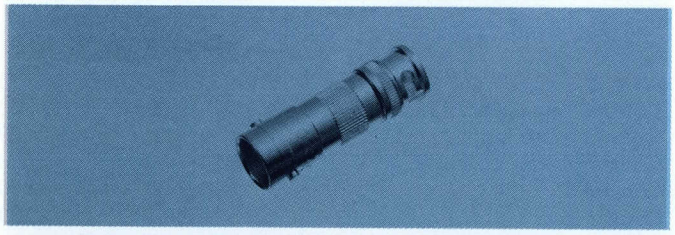
Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

DESCRIPTION	PART NUMBER	PRICE
10-dB attenuator	011-0085-00	$45.00
20-dB attenuator	011-0086-00	45.00
40-dB attenuator	011-0087-00	55.00

ADAPTERS

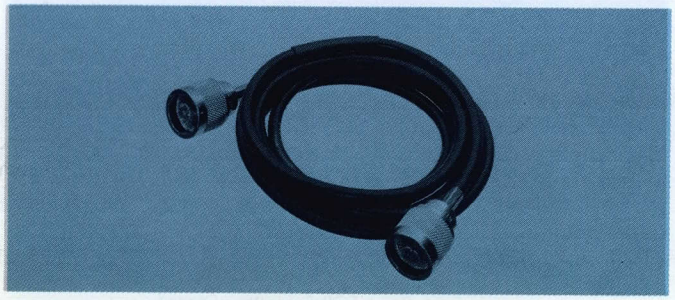


N Male to BNC Female	103-0045-00	$2.40
N Male to UHF Female	103-0044-00	4.25
N Male to GR	017-0021-00	8.00
N Female to BNC Male	103-0058-00	2.75
N Female to UHF Male	103-0059-00	2.50
N Female to GR	017-0062-00	7.00



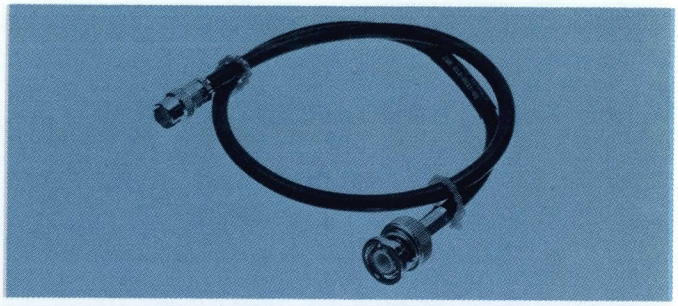
BSM Male to BNC Female	103-0036-00	$5.50

50-OHM CABLE



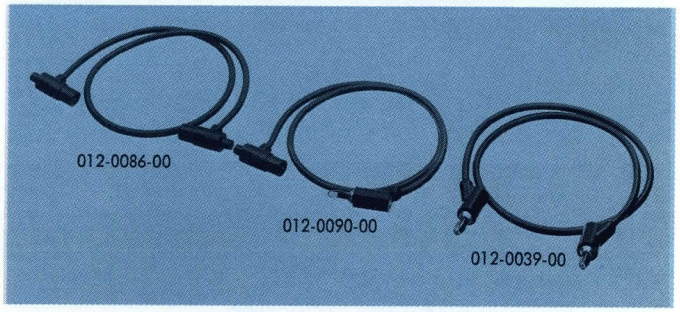
Coaxial Type N connectors, 6 feet	012-0114-00	$10.00

50-OHM CABLES

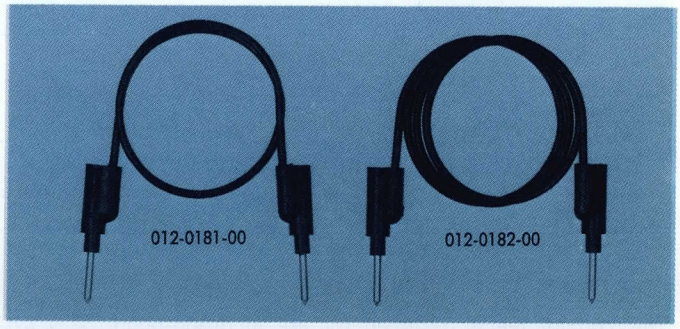


DESCRIPTION	PART NUMBER	PRICE
Coaxial, 10 inch, RG58 BSM Female to BNC Male	012-0128-00	$7.50
Coaxial, 18 inch, RG58 BSM Female to BNC Male	012-0127-00	7.50

PATCH CORDS



BNC to BNC, 18 inch		
Red	012-0087-00	$1.65
Black	012-0086-00	1.65
BNC to banana plug-jack, 18 inch		
Red	012-0091-00	1.65
Black	012-0090-00	1.65
Banana plug-jack to banana plug-jack, 18 inch		
Red	012-0031-00	1.65
Black	012-0039-00	1.65



Pin-jack to pin-jack, 0.08 inch dia pin.		
Red, 8 inch	012-0179-00	$1.95
Red, 18 inch	012-0180-00	1.95
Black, 8 inch	012-0181-00	1.95
Black, 18 inch	012-0182-00	1.95

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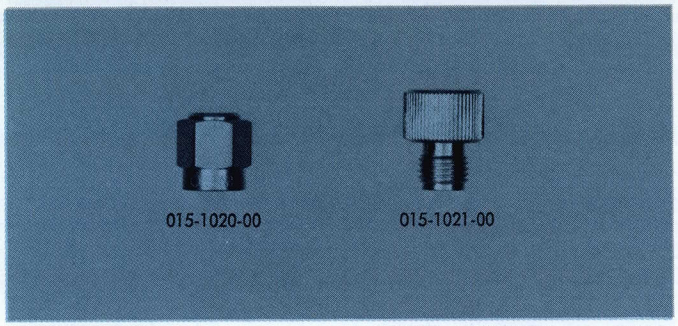
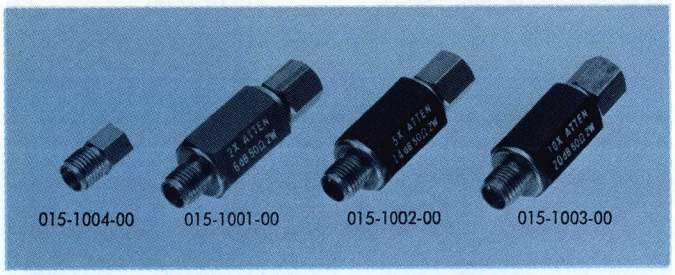
Please refer to General Information page

Accessories With SMA (3-mm) Connectors

ATTENUATORS — TERMINATORS



DESCRIPTION	PART NUMBER	PRICE
50-Ω termination Male (Not Pictured)	015-1022-00	$27.50
Short-Circuit termination Male	015-1020-00	6.60
Short-Circuit termination Female	015-1021-00	6.60

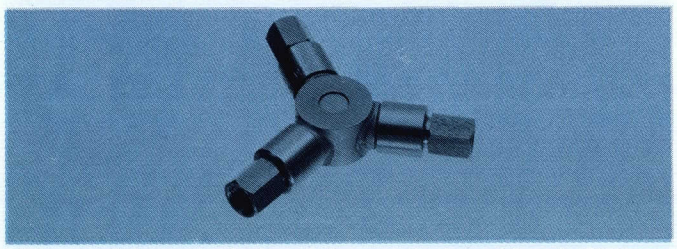


50-Ω termination Female	015-1004-00	$40.00
50-Ω 2X attenuator	015-1001-00	66.00
50-Ω 5X attenuator	015-1002-00	77.00
50-Ω 10X attenuator	015-1003-00	72.00

CHARACTERISTICS

	DC — 12.40 GHz		12.41 — 18.00 GHz		Power
	Attenuation Accuracy	VSWR	Attenuation Accuracy	VSWR	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	± .75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W

50-Ω POWER DIVIDER

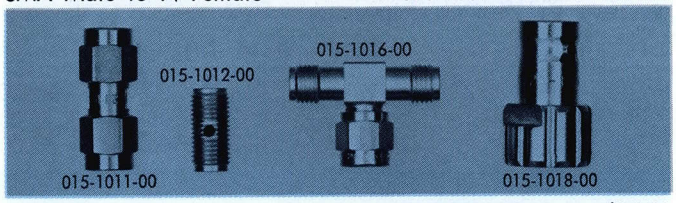


This coaxial tee is designed for use in broad-band, 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50-Ω termination). Maximum VSWR is 1.50 from DC to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Order 015-1014-00 ..... $94.00

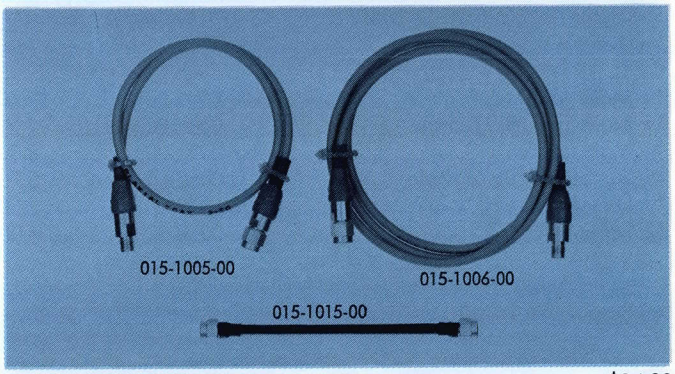
ADAPTERS

DESCRIPTION	PART NUMBER	PRICE
SMA Male to 7-mm APC	015-1010-00	$105.00
SMA Male to GR	015-1007-00	20.00
SMA Female to GR	015-1008-00	20.00
SMA Male to N Female	015-1009-00	40.00



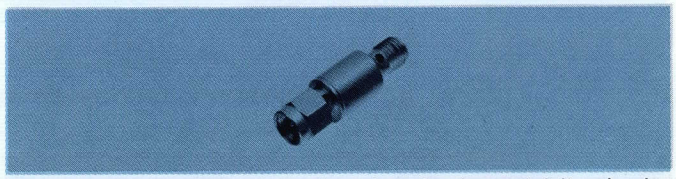
SMA T	015-1016-00	$18.00
SMA Male to Male	015-1011-00	9.00
SMA Female to Female	015-1012-00	7.00
SMA Male to BNC Female	015-1018-00	4.50

50-Ω CABLES



Coaxial semirigid 750 ps	015-1017-00	$24.00
Coaxial semirigid 500 ps	015-1015-00	24.00
Coaxial 1 ns	015-1019-00	22.00
Coaxial 2 ns	015-1005-00	40.00
Coaxial 5 ns	015-1006-00	40.00

50-Ω COUPLING CAPACITOR



The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150-ps TDR system), maximum is 0.03. Voltage rating is 200 Volts.

Order 015-1013-00 ..... $75.00

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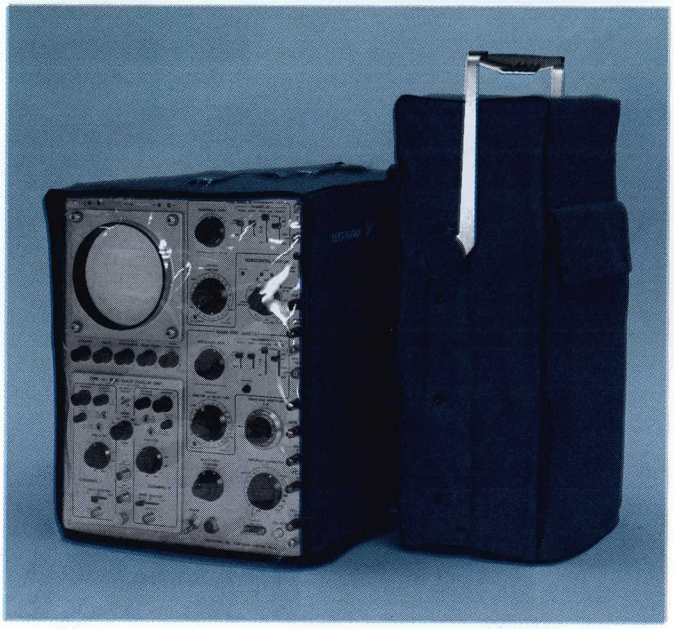
Please refer to General Information page

OSCILLOSCOPE PROTECTIVE COVERS



The cover provides protection for the oscilloscope during transport or storage. Made of water-proof blue vinyl, the covers are available for both laboratory and portable instruments. The laboratory version features a clear frontal area for easy identification of the instrument. The cover for all portable instruments except the Type 323 and 324 has a pocket for carrying the manual.

INSTRUMENT	PART NUMBER	PRICE
Type 323, 324	016-0112-00	$10.00
Type 422 (with battery pack)	016-0075-00	10.00
Type 422 (without battery pack)	016-0076-00	10.00
Type 453A, 454A, 491	016-0074-01	10.00
Type 502A	016-0070-00	10.00
Type 529 (with field case)	016-0085-00	10.00
Type 503, 504, 647A, 560-Series (except Type 565, 567, 568)	016-0067-00	10.00
Type 565, 567, 568	016-0069-00	10.00
Type 540-Series	016-0068-00	10.00

PLUG-IN UNIT CARRYING CASES

CARRYING CASE FOR 7000-SERIES PLUG-IN UNITS
Order 437-0106-00 ..... $30.00

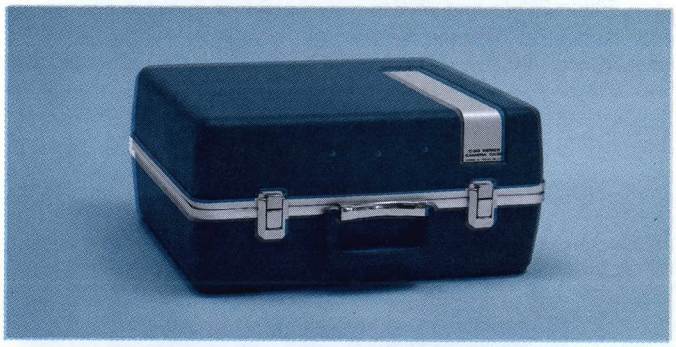
CARRYING CASE FOR 2, 3, 10 and 11-SERIES PLUG-IN UNITS—accommodates two plug-in units.
Order 437-0070-00 ..... $30.00

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 ..... $22.00

OSCILLOSCOPE CARRYING CASES

CARRYING CASE—For Type 321A Portable Oscilloscope. The net weight is approx 6 lb.
Order 016-0026-00 ..... $50.00

CAMERA CARRYING CASES



C-30A/C-31/C-32 CARRYING CASE—The carrying case holds the C-30A, C-31 or C-32 Camera and all standard accessories including up to three Film Backs, extra bezels and extra film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are $7\frac{3}{16}$ x $13\frac{3}{16}$ x $15\frac{3}{16}$ inches, net weight is approx $6\frac{1}{2}$ lb.

Order 016-0126-00 ..... $38.00

C-12/C-27 CARRYING CASE—C-12/C-27 Camera Carrying Case holds either the C-12 or C-27 Camera and all the standard accessories plus extra film. The case is constructed of heavy-gage, high-impact plastic and has a foam-rubber liner. Dimensions are $20\frac{1}{2}$ by 20 by 8 inches. Net weight is $15\frac{1}{2}$ lb; domestic shipping weight is $\approx$22 lb.

Order 016-0208-01 ..... $85.00

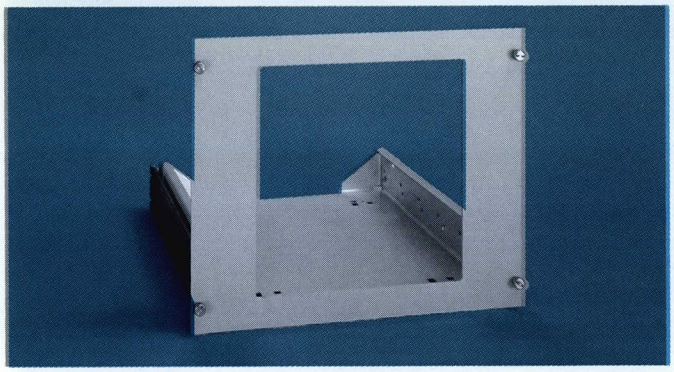
C-50 Series/C-70 CARRYING CASE—The carrying case will hold a C-50, C-51, C-52, or C-70 Camera and all standard accessories including a battery pack, extra film, and adapters. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are 16 3/4 x 23 2/3 x 10 1/10 inches. Net weight is approx 8 pounds.

Order 016-0177-00 ..... $80.00

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Mounting Accessories

RACK ADAPTERS

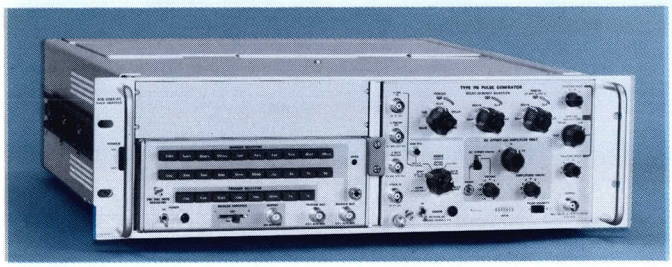


For rackmounting the 7500 and 7700-Series Oscilloscopes and 611 in a standard 19-inch wide rack. Rack adapter includes slide-out assemblies. 7500 and 7700-Series mask finish is light gray, 611 mask finish is black.

For 7503, rack height is 15¾ inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0555-00 ..... $95.00

For 7504, 7514, and 7704, rack height is 15¾ inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0554-00 ..... $95.00

For 611, rack height is 14 inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0551-00 ..... $95.00



For rackmounting most Tektronix generators in a standard 19-inch wide rack. The rack height is 5¼ inches, rack depth is 19¾ inches. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

Two half-rack width generators such as the 106 Squarewave Generator and 2101 Pulse Generator can be mounted side by side. Two quarter-rack width generators such as the 284 Pulse Generator can be mounted side by side. One quarter-rack width instrument may be mounted with a half-rack width instrument.

The adapter provides forced air ventilation and blank panels are provided to cover the unused openings. Mounting kits must be ordered separately for each instrument to be mounted.

Rack Adapter includes half-rack width blank panel (333-1384-00).
Order 016-0268-00 ..... $225.00

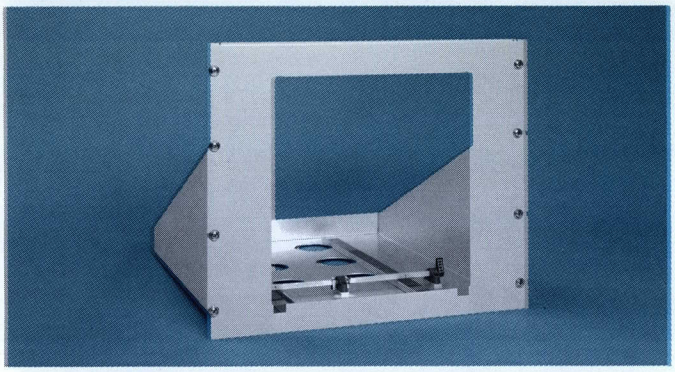
284 Mounting Kit includes quarter-rack width blank panel (016-0109-00).
Order 016-0187-00 ..... $15.00

106, 114, 115, and 191 Mounting Kits.
Order 016-0186-00 ..... $10.00

2101 and 2901 Mounting Kits.
Order 016-0188-00 ..... $5.00

286 Mounting Kit
Order 016-0190-00 ..... $10.00

CRADLE MOUNTS



For rackmounting 500, 7500 and 7700-Series cabinet-type oscilloscopes in a standard 19-inch wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, 7500 and 7700-Series mask finish is light gray.

For 7503, rack height is 15¾ inches, rack depth is 22 inches, shipping weight is approx 16 lb.
Order 040-0559-00 ..... $34.50

For 7504, 7514, and 7704, rack height is 15¾ inches, rack depth is 22 inches, shipping weight is approx 16 lb.
Order 040-0560-00 ..... $34.50

For 540 Series and 575, rack height is 17½ inches, rack depth is 21⁹⁄₁₆ inches, shipping weight is approx 16 lb.
Order 040-0281-00 ..... $34.50

For 502A, rack height is 17½ inches, rack depth is 21⁹⁄₁₆ inches, shipping weight is approx 16 lb.
Order 040-0278-00 ..... $34.50

For 503, 504, 561B, and 564B, rack height is 15¾ inches, rack depth is 21⁹⁄₁₆ inches, shipping weight is approx 17 lb.
Order 040-0321-01 ..... $34.50

REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19-inch backless rack. Shipping weight is approx 3 lb.

For Types R561B, R564B, and R647A.
Order 040-0344-00 ..... $10.00

For Types RM565 and R567.
Order 040-0346-00 ..... $10.00

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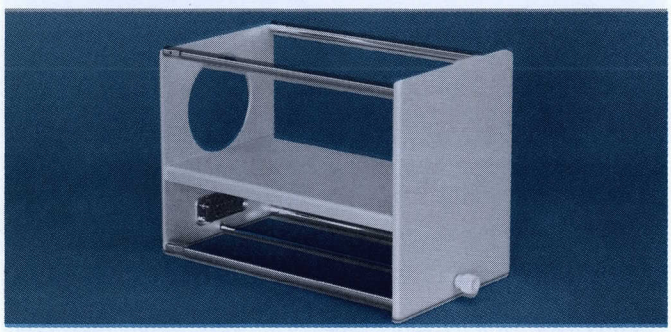
STORAGE CABINETS

PLUG-IN PREAMPLIFIER STORAGE CABINET mounts in standard 19-inch rack, available in two types:

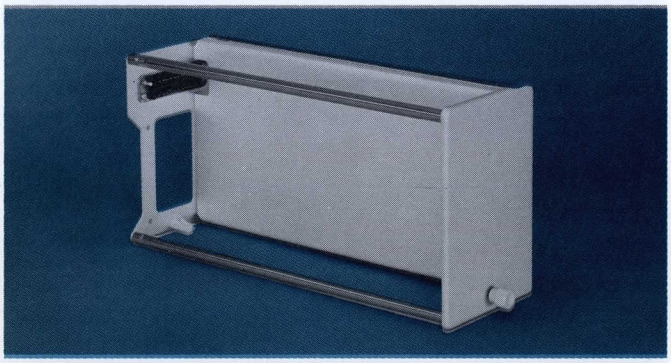
FOR 1-SERIES AND LETTER-SERIES PLUG-IN UNITS—holds 3 plug-in units. Measures 19 inches wide, 8¾ inches high, 9⅜ inches deep. Net weight is approx 9 lb.
Order 437-0031-00 ..... **$27.50**

FOR 2 AND 3-SERIES PLUG-IN UNITS—holds 4 plug-in units. Measures 19 inches wide, 7 inches high, 13 5/16 inches deep. Net weight is approx 10 lb.
Order 437-0071-00 ..... **$33.00**

BLANK PLUG-IN CHASSIS

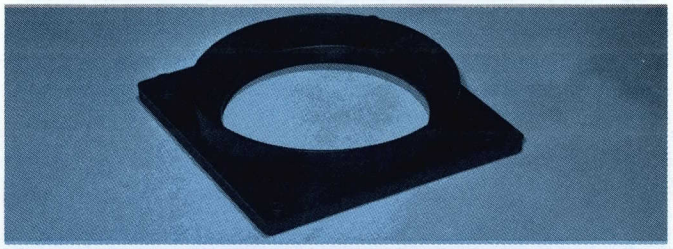


BLANK 1-SERIES AND LETTER-SERIES PLUG-IN CHASSIS—Useful for constructing your own special circuits. Net weight is approx 2 lb.
Order 040-0065-00 ..... **$27.50**



BLANK TYPE 560-SERIES PLUG-IN CHASSIS—For special circuit construction of sweep or vertical amplifier. Net weight is approx 2½ lb.
Order 040-0245-00 ..... **$27.50**

CAMERA MOUNTING ADAPTERS

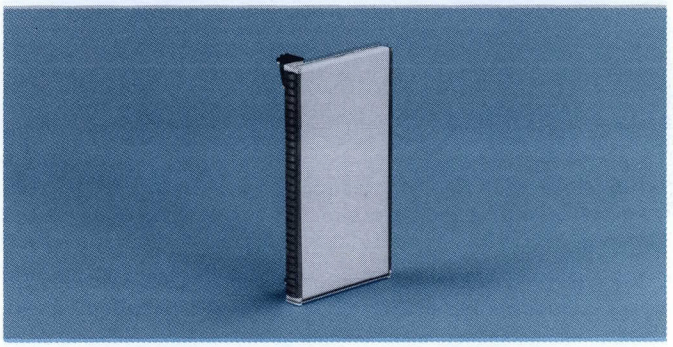


Bezels for mounting commercially available cameras on Tektronix Oscilloscopes. Mounting ring measures 5⅝-inches outside diameter. Die-cast construction. Net weight of each is approx 1 lb.

INSTRUMENT*	PART NUMBER	PRICE
Type 502A, 503, 504, 540-, 550-Series, 565 and 575	014-0018-00	$10.00
Type 561B, 564B, 567 and 568	014-0016-00	$10.00
Type 647A	014-0017-00	$10.00
Type 529	014-0031-00	$8.50

*Also rackmount version.

BLANK PLUG-IN PANEL



7000-SERIES BLANK PLUG-IN PANEL—When operating the 7000-Series instruments with less than the full complement of plug-ins, the blank plug-in panel may be used to cover unused channels.
Order 016-0155-00 ..... **$6.00**

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Please refer to General Information page

VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.

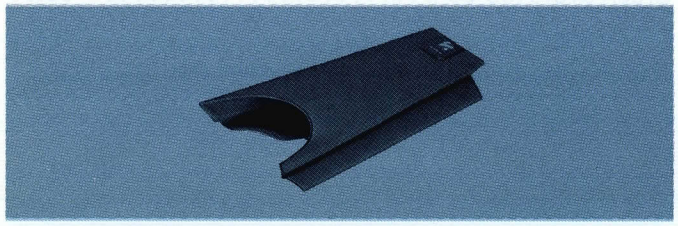
POLARIZED VIEWERS—For Tektronix 5-inch Oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

RECTANGULAR VIEWER, order 016-0039-00 . . . $12.00
PLASTIC ROUND VIEWER, order 016-0053-00 . . . $12.00

VIEWING HOOD—For Tektronix 5-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0001-01 ..... $9.00

VIEWING HOOD—For Tektronix 3-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0002-00 ..... $9.00

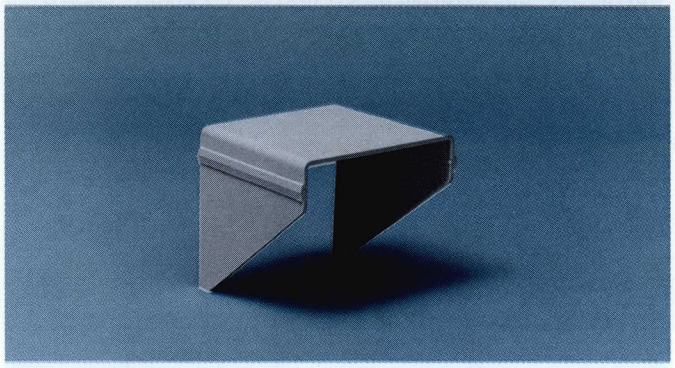
COLLAPSIBLE VIEWING HOOD—For Tektronix 3-inch Oscilloscopes. It is made of black acrylic plastic with handy fastening arrangement.
Order 016-0010-00 ..... $6.00



COLLAPSIBLE VIEWING HOOD—For portable instruments with rectangular CRT's. Blue-vinyl material, folds flat for convenient storage.

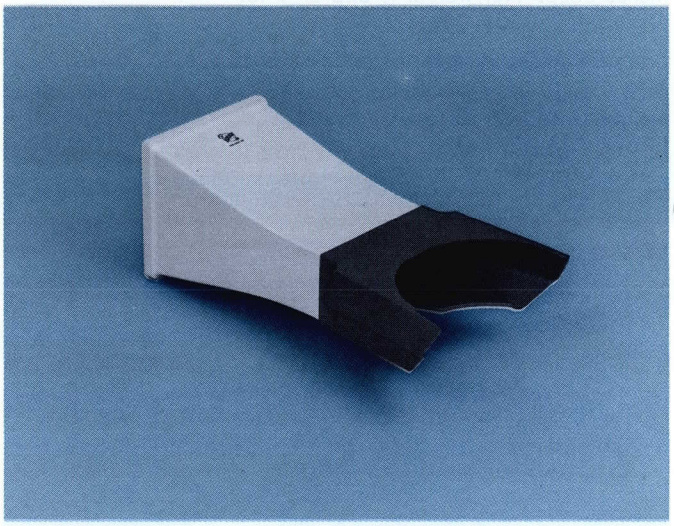
For Types 422, 491, 453A, 454A, order 016-0082-00 ..... $9.00
For Types 549, 561B, 564B, 567, 568, order 016-0103-00 .. $9.00

VIEWING ACCESSORIES



VIEWING HOOD (folding)—for Types 576, 5000, 7500, and 7700-Series Oscilloscopes. Molded gray polycarbonate with non-reflective finish.

For Types 576, 5030 and 5031, order 016-0259-00 ..... $8.00
For 7000 Series, order 016-0260-00 ..... $8.00



VIEWING HOOD—for Type 576, 5000, 7500, and 7700-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

For Type 576, 5030 and 5301, order 016-0153-00 ..... $9.50
For 7000 Series, can also be used with Types 601, 602 and 528, order 016-0154-00 ..... $9.50

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
Type 321A	Smoke-gray	378-0547-00	$1.15
	Green	378-0554-00	1.15
	Blue†	378-0555-00	1.15
	Amber	378-0556-00	1.15
Type 323, 324	Smoke-gray	426-0403-00	2.10
	Blue†	426-0512-00	2.10
	Amber	426-0513-00	2.10
Type 422, 491, 453A, 454A	Smoke-gray	378-0549-00	.90
	Green	378-0557-00	.90
	Blue†	378-0558-00	.90
	Amber	378-0559-00	.90
Type 540-, 550-Series, 565, 575	Smoke-gray†	378-0567-00	1.60
	Green	378-0568-00	1.60
	Blue	378-0569-00	1.60
	Amber	378-0570-00	1.60
Type 502A, 503, 504	Smoke-gray	378-0567-00	1.60
	Green	378-0568-00	1.60
	Blue†	378-0569-00	1.60
	Amber	378-0570-00	1.60
Type 529, 561B, 567, 568	Smoke-gray†	378-0560-00	1.35
	Green	378-0561-00	1.35
	Blue	378-0562-00	1.35
	Amber	378-0563-00	1.35
Type 576	Blue†	378-0616-00	1.60
Type 602	Smoke-gray†	378-0586-00	1.50
	Amber	378-0595-00	4.10
Type 647A	Smoke-gray†	378-0548-00	1.15
	Green	378-0564-00	1.15
	Blue	378-0565-00	1.15
	Amber	378-0566-00	1.15
Type 5030	Blue†	378-0626-00	1.60
Type 5031	Clear†	378-0667-00	1.00
Type 7500, 7700-Series	Blue†	378-0625-00	1.60

*For both cabinet and rackmount instruments unless rackmount version is listed.

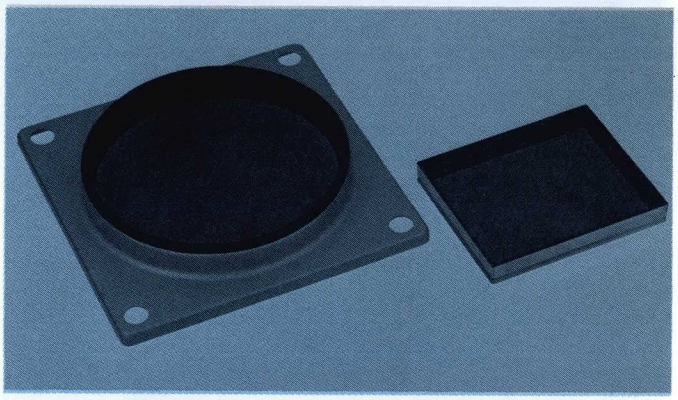
†Standard filter supplied with instrument.

UNSCRIBED GRATICULES

INSTRUMENT*	PART NUMBER	PRICE
575	331-0093-00	$2.50
502A, 503, 504	331-0105-00	2.50
549	386-0451-00	2.20

*For both cabinet and rackmount instruments.

CRT MESH FILTERS



The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions. The filter is a direct replacement for the existing graticule cover on most Tektronix instruments, or, in the case of the new portable oscilloscopes, snaps in the CRT opening on the front panel.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the CRT is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

The mesh filter also serves as an EMI filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the EMI spectrum.

INSTRUMENT*	PART NUMBER	PRICE
Type 321A	378-0577-00	$15.00
Type 323, 324	378-0596-00	15.00
Type 422, 491, 453A, 454A	378-0648-00	15.00
Type 502A, 503, 504, 540-Series, 565	378-0572-00	18.00
Type 529, 561B, 564B, 567, 568	378-0575-00	18.00
Type 647A	378-0574-00	18.00
7500, 7700-Series	378-0603-00	18.00

*For both cabinet and rackmount instruments.

U.S. Sales Prices FOB Beaverton, Oregon
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Scope-Mobile® Carts

The Type 200-1 Scope-Mobile® Cart is specifically designed for the Types 453A and 454A Portable Oscilloscopes, and the Type 491 Spectrum Analyzer. A separate version, the Type 200-2, is designed for use with the Type 422 Portable Oscilloscope.

These oscilloscope carts occupy less than 18 inches of aisle space. With their large wheels and unique design, they can easily be moved up and down stairs. Friction locks on the oscilloscope tray permit the instrument to be positioned at any angle for convenient viewing. Storage space is provided at the base of the cart for accessories or associated instruments.

ADJUSTABLE TRAY friction-locks in any position from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting.

MECHANICAL FEATURES include cast-aluminum construction with six-inch rubber wheels in the rear and two-inch swivel castors in front.

OVERALL DIMENSIONS are approximately 29 inches high by 17 inches wide by 19 inches deep. Storage area in the base measures 12 inches by 12 inches, and ¾ inches deep.

NET WEIGHT is 19 lb.

TYPE 200-1 SCOPE-MOBILE® CART
for Types 453A, 454A, 491 ..... **$95**

TYPE 200-2 SCOPE-MOBILE® CART
for Type 422 ..... **$95**

The Type 204-2 (for 7000 Series) and 204-3 (for 5030 and 5031) Scope-Mobile® Carts feature tilt-locking in any of nine tray positions. The 204-2 is equipped with a large storage drawer for holding accessory items and a plug-in carrier for storing plug-ins. Three AC receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments. The 204-3 does not have a storage drawer or a plug-in carrier. Both carts come equipped with front-wheel brakes.

ADJUSTABLE TRAY tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

MECHANICAL FEATURES include aluminum construction, 5-inch rubber wheels with front wheel brakes, and linoleum-topped steel shelf at the bottom. A latch-operated hold-down device insures that the oscilloscope is firmly secured to the adjustable tray.

NET WEIGHT is 48 lb for 204-2, 45 lb for 204-3.

OVERALL DIMENSIONS are approximately 36 inches high by 19-½ inches wide by 29 inches deep.

TYPE 204-2 includes plug-in carrier and storage drawer **$155**

TYPE 204-3 without plug-in carrier and storage drawer **$125**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Eight models comprise the 201 through 205-Series Scope-Mobile® Carts featuring tilt locking in one of nine tray positions. These tilt-lock models include the Types 201-1, 201-2, 201-3, 202-1, 202-2, 205-1, 205-2, 205-3. The three models ending with -1 have a storage drawer for holding accessory items. The models ending with -2 and -3 have a storage drawer and a plug-in carrier for housing plug-in units. Three AC-receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments. All tilt-lock models come equipped with front-wheel brakes.

ADJUSTABLE TRAY tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

MECHANICAL FEATURES include aluminum construction, 5-inch rubber wheels with front wheel brakes, and linoleum-topped steel shelf at the bottom.

OVERALL DIMENSIONS are approximately 36 inches high by 19½ inches wide by 29 inches deep for the 201-1, -2, -3 and 202-1, -2; 36 inches high by 23½ inches wide by 29 inches deep for the 205-1, -2 and -3.

An optional strap assembly is available for securing various auxiliary instrument/oscilloscope combinations to the Scope-Mobile® upper tray.

Strap assembly, order 346-0070-01 ..... $8.50

Either the storage drawer or the storage drawer and plug-in carrier combination can be ordered separately to modernize older Scope-Mobile® Carts.

014-0012-00 drawer for 201-1 ..... $45
014-0013-00 drawer/plug-in carrier combination for 201-2 . $50
014-0014-00 drawer for 202-1 ..... $45
014-0015-00 drawer/plug-in carrier combination for 202-2 . $50
014-0032-00 drawer/1-, letter-series plug-in carrier combination for 205-2 ..... $50
014-0033-00 drawer/2-, 3-, 10-, 11-series plug-in carrier combination for 205-3 ..... $50

MODEL	PLUG-IN CARRIER	TRAY WIDTH	TRAY DESIGNED FOR TEKTRONIX OSCILLOSCOPE TYPE	BOTTOM TRAY DIMENSIONS**	NET WEIGHT	PRICE
201-1	NO	10½ in	503, 504, 561B, 564B, 647A 5100 Series	15½ in x 25 in	≈37 lb	$145
201-2	Holds two 2-, 3-, 10-, or 11-series plug-ins				≈38½ lb	$155
201-3	Holds three 5-series plug-ins				≈38½ lb	$155
202-1 MOD 52	NO	14¾ in	519	18½ in x 25 in	≈43¾ lb	$185
202-1	NO	14 in	502A*, 540-Series, 575, 576	15½ in x 25 in	≈40¾ lb	$145
202-2	Holds two 1-, or letter-series plug-ins				≈42¾ lb	$155
205-1	NO	17¾ in	520, 521, 522, 556, 565, 568, and rackmount instruments	18½ in x 25 in	≈45¾ lb	$150
205-2	Holds three 1- or letter-series plug-ins				≈48¾ lb	$160
205-3	Holds four 2-, or 3-series plug-ins				≈48¾ lb	$160

**Requires special adapter, order 040-0365-00 .... $3.00.*

***Usable dimensions may be limited by height required.*

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

Limited-Demand Instruments

The instruments described on these pages are in limited demand, but represent a desirable choice in a few specialized cases. As such, they are available for you who have a need for them. Consult your Tektronix Field Engineer for information on other instruments in the Tektronix product line that generally give greater value in application areas presently filled by these instruments.

TYPE 310A OSCILLOSCOPE

The Type 321A or 323 is recommended as a replacement for the Type 310A.

The Type 310A is a portable oscilloscope that features a bandwidth of DC to 4 MHz with calibrated deflection factors of 10 mV/div to 50 V/div. The time base is calibrated from 0.5 μs/div to 0.2 s/div; the X5 magnifier extends the time base to 0.1 μs/div. The CRT display area is 8 x 10 divisions; each division is ¼ inch.

TYPE 310A OSCILLOSCOPE **$960**

TYPE 317 AND RM17 OSCILLOSCOPES

The 324 or R422 is recommended as a replacement for the Type 317 or RM17.

The Type 317 and its rackmount counterpart Type RM17 are DC-to-10 MHz oscilloscopes with calibrated deflection factors from 0.1 V/div (DC) or 10 mV/div (AC) to 50 V/div, and a calibrated time base from 0.2 μs/div to 2 s/div. The X5 magnifier extends the time base to 40 ns/div. The CRT has a display area of 8 x 10, ¼-inch divisions, and features a 9-kV accelerating voltage. A vertical delay line permits viewing the leading edge of the triggering waveform.

TYPE 317 OSCILLOSCOPE **$1250**
TYPE RM17 OSCILLOSCOPE **$1325**

RM502A DUAL-BEAM OSCILLOSCOPE

The 5103N Oscilloscope System is recommended as a replacement for the RM502A.

The RM502A is a mechanically-rearranged model of the 502A; its specifications are the same. The RM502A requires 12¼ inches of rack height.

RM502A DUAL-BEAM OSCILLOSCOPE **$1650**

TYPE 507 OSCILLOSCOPE

The Tektronix Type 507 is a specialized oscilloscope, designed primarily for high-voltage surge testing of power transformers, high-voltage insulators, lightning arrestors, etc. Careful design of circuitry grounding points ensures minimum sensitivity to extraneous disturbances caused by large voltage transients often introduced into the grounding system.

TYPE 507 OSCILLOSCOPE **$4000**

TYPE 515A AND RM15 OSCILLOSCOPES

The Type 422 is recommended as a replacement for the Type 515A or RM15.

The Type 515A and its rackmount counterpart Type RM15 have bandwidths of DC to 15 MHz and a risetime of 24 ns. The calibrated deflection factors are 50 mV/cm to 20 V/cm. The time-base range is 0.2 μs/cm to 2 s/cm; the X5 magnifier extends the fastest sweep rate to 40 ns/cm. The CRT display area is 6 x 10 cm. A vertical delay line permits viewing the leading edge of the triggering waveform.

TYPE 515A OSCILLOSCOPE **$1250**
TYPE RM15 OSCILLOSCOPE **$1325**

TYPE 516 DUAL-TRACE OSCILLOSCOPE

The Type 422 is recommended as a replacement for the Type 516.

The Type 516 differs from the 515A only in its vertical amplifier. Two input channels permit dual-trace capability with either chopped or alternate switching between channels.

TYPE 516 DUAL-TRACE OSCILLOSCOPE **$1525**

TYPE 531A, 533A, and 543B OSCILLOSCOPES

The Type 544 is recommended as a replacement for the Type 531A, 533A, and 543B.

The Type 531A, 533A, and 543B all have 6 x 10 cm graticules and will accept all Tektronix Letter-Series and 1-Series Plug-In Units. Time bases are calibrated from 0.1 μs/cm to 5 s/cm. The Type 531A has a X5 sweep magnifier and 15-MHz bandwidth. The Type 533A has a X100 sweep magnifier, single sweep, and 15-MHz bandwidth. The Type 543B and RM543B (rackmount) have a X100 sweep magnifier, single sweep, and 33-MHz bandwidth.

TYPE 531A OSCILLOSCOPE, without plug-in units . **$1350**
TYPE 533A OSCILLOSCOPE, without plug-in units . **$1525**
TYPE 543B OSCILLOSCOPE, without plug-in units . **$1750**
TYPE RM543B OSCILLOSCOPE, without plug-in units **$1850**

TYPE 535A AND RM35A OSCILLOSCOPES

The Type 545B, 546, or 547 is recommended as a replacement for the Type 535A.

The vertical and time-base characteristics of the Type 535A and Type RM35A are the same as described for the 531A above. The Types 535A and RM35A have, in addition, a second, delaying-sweep time base that permits calibrated sweep delays of 0.2 μs to 10 s. The horizontal display modes are: 'A' single sweep, 'A' normal, 'A' delayed by 'B', 'B' intensified by 'A', and 'B' normal.

TYPE 535A OSCILLOSCOPE **$1825**
TYPE RM35A OSCILLOSCOPE **$1925**

TYPE 536 (X-Y) OSCILLOSCOPE
TYPE T TIME-BASE UNIT

The Type 561B with any matched pair of 560-Series vertical plug-ins is recommended as a replacement for the Type 536 in X-Y applications.

The Type 536 is used primarily for X-Y displays, its accuracy obtained with the use of an Amplifier Phasing control. Relative phase shift is less than 1° to 15 MHz with two Type K Units at 50 mV/div. Front-panel control adjusts amplifier phasing to 30 MHz, with signals not overdriving Type K units. Using identical wideband Plug-In Units, horizontal and vertical deflection systems are almost identical. It is also a 11-MHz general purpose oscilloscope when used with the Type T Time-Base Generator.

TYPE 536 OSCILLOSCOPE, without plug-in units .. **$1650**
TYPE T TIME-BASE GENERATOR **$400**

TYPE RM544 AND RM546 OSCILLOSCOPES

The Type 544 or 546 are recommended as replacements for the RM544 or RM546. They can be rackmounted with Cradle-Mount Kit 040-0281-00. When rack space is at a premium, the Type RM547 is recommended.

The Types RM544 and RM546 are mechanically-rearranged models of the Types 544 and 546; their specifications are the same.

TYPE RM544 OSCILLOSCOPE **$2075**
TYPE RM546 OSCILLOSCOPE **$2325**

TYPE 551 DUAL-BEAM OSCILLOSCOPE

The Type 556 is recommended as a replacement for the Type 551.

The Type 551 is a dual-beam oscilloscope; its vertical amplifiers have a bandwidth of DC to 27 MHz and a risetime of 13 ns, depending on the plug-in unit. The single time base provides sweep rates from 0.1 μs/cm to 5 s/cm; the X5 magnifier increases the fastest rate to 20 ns/cm. CRT display area is 4 x 10 cm for each beam; total area is 6 x 10 cm. All Tektronix Letter-Series and 1-Series Plug-In Units can be used. The Type 551 Power Supply is a separate unit, cable-connected to the oscilloscope unit.

TYPE 551 DUAL-BEAM OSCILLOSCOPE **$2650**

TYPE CA PLUG-IN UNIT

The Type 1A2 Plug-In Unit is recommended as a replacement for Type CA.

The Tektronix Type CA Plug-In Unit contains two identical input channels. Either channel can be operated separately. The two channels can be electronically switched, either at a chopped rate of about 100 kHz, or triggered by the oscilloscope sweep. In addition, both channels can be combined at the output, adding or subtracting according to the settings of the polarity switches. Bandwidth is DC to 24 MHz when used with current-production Type 540-Series, Type 556, and (with Type 81A Adapter) 580 Series Oscilloscopes.

TYPE CA PLUG-IN UNIT **$410**

TYPE L SINGLE-TRACE AMPLIFIER

The Type 1A1 is recommended as a replacement for the Type L.

The Type L is a fast-rise, plug-in unit for use in Type 530-40-50-80-Series Oscilloscopes. It offers deflection factors of 50 mV/cm to 20 V/cm, DC-coupled; up to 5 mV/cm, AC-coupled. Bandwidth in a Type 540-Series Oscilloscope is up to DC to 30 MHz; risetime, 12 ns.

TYPE L SINGLE-TRACE AMPLIFIER **$310**

TYPE M PLUG-IN UNIT

The Type 1A4 Plug-In Unit is recommended as a replacement for Type M Unit.

The Type M Unit provides four-trace displays in Type 530-, 540-, 550- and (with Type 81A Adapter) 580-Series Oscilloscopes. The four input channels are identical. Each has separate controls for coupling, attenuating, inverting and positioning the signal. Chopped (successive 1-μs, approx, segments displayed) or alternate electronic switching can be used for multi-channel displays. Bandwidth is DC to 20 MHz with current production Type 540-Series, 556, and (with 81A adapter), the 585A Oscilloscopes.

TYPE M PLUG-IN UNIT **$775**

TYPE Q TRANSDUCER AND STRAIN GAGE AMPLIFIER

The Type 3C66 or 3A10 is recommended as a replacement for the Type Q. The 3C66 or 3A10 must be used in a 560-Series Oscilloscope.

The Type Q, used in a Type 530-40-50-80-Series Oscilloscope, is used to measure mechanical quantities through the use of strain gages and other transducers. Calibrated deflection factors are 10 μstrain/div to 10,000 μstrain/div when used with a single strain gage having a gage factor of 2. Capacitive or inductive transducers can also be used.

TYPE Q TRANSDUCER AND STRAIN GAGE AMPLIFIER **$500**

TYPES 1L10 AND 3L10 SPECTRUM ANALYZERS

The 1401 or the 1L20 is recommended as a replacement for the Type 1L10 or 3L10.

These plug-in units provide spectrum analysis in the 1-to-36 MHz region: the Type 1L10, when used in any 530-40-50-80-Series Oscilloscope; the Type 3L10, when used with a Type 561B or 564B Oscilloscope with an appropriate time-base unit. Both units feature calibrated dispersion from 0.01 kHz/div to 2 kHz/div, resolution from 10 Hz to 1 kHz, and maximum 50 Ω input sensitivity of —100 dBm.

TYPE 1L10 SPECTRUM ANALYZER **$1400**
TYPE 3L10 SPECTRUM ANALYZER **$1500**

TYPE 3A5 PROGRAMMABLE AMPLIFIER

The Type 3A5 is an automatic plug-in unit designed for use in the Type 561B and 564B Oscilloscopes. When the "seek" button is pressed, the instrument selects the deflection factor for a convenient display size. The bandwidth is DC to at least 15 MHz; risetime is at least 24 ns. Deflection factors are 10 mV/div to 50 V/div, automatically; to 1 mV/div, manually. Readout is provided by ½-inch bulb-and-film digits.

TYPE 3A5 PROGRAMMABLE AMPLIFIER **$1150**

TYPE 3B5 PROGRAMMABLE TIME BASE

Used with the Type 3A5, the Type 3B5 provides automatic time-base "seeking" of sweep speeds between 0.1 μs/div and 5 s/div. Manual operation extends the sweep speed to 10 ns/div. A sweep magnifier expands the display X10 or X100; a calibrated control selects the magnified sweep start point.

TYPE 3B5 PROGRAMMABLE TIME BASE **$1300**

TYPE 263 PROGRAMMER

The Type 263 provides up to six 3A5/3B5 programs which can be push-button selected. Used for production-line testing, the chances for oscilloscope/operator error are practically eliminated. Type 263's can be cascaded for applications requiring more than six measurements.

TYPE 263 PROGRAMMER **$450**

TYPE 567/6R1A/262 DIGITAL MEASUREMENT SYSTEM

The Type 568/230/241 Digital Instruments are recommended as replacement units for the Type 567/6R1A/262 Units.

The Type 567/6R1A Digital Readout Oscilloscope provides digital readout of the waveform displayed on the cathode-ray tube when used with suitable vertical and horizontal plug-in units. Digital readout provides greater accuracy, speed, and convenience of measurement over conventional CRT displays.

The Type 262 Programmer makes it possible to remotely control the measurement and readout capabilities of the Type 6R1A Digital Unit. Any set of up to 8 different preselected time or voltage measurements can be made with each Type 262 used.

TYPE 567 OSCILLOSCOPE, without plug-in units .. **$1050**
TYPE RM567 OSCILLOSCOPE, without plug-in units **$1150**
TYPE 6R1A DIGITAL UNIT **$3800**
TYPE 262 PROGRAMMER **$2125**

TYPE 581A OSCILLOSCOPE TYPE 86 AMPLIFIER

The 7503 with a 7B50 Time Base and a 7A16 Amplifier is recommended as a replacement for the 581A/86.

The Type 581A Oscilloscope is a general-purpose laboratory instrument featuring bandwidth to 80 MHz (at 3-dB down) when used with the Type 82 or Type 86 Plug-In Unit. Tunnel-diode triggering to 150 MHz and HF Sync to 250 MHz makes the instrument useful beyond the specified bandwidth. The horizontal consists of a calibrated (3%) time base from 50 ns/cm to 2 s/cm, a X5 magnifier, single sweep, and external horizontal input.

The Type 86 Single Trace Plug-In Unit provides fast-rise capability, a calibrated deflection-factor range of 100 mV/cm to 50 V/cm (within 3%) and a built-in X10 amplifier which extends the deflection-factor range to 10 mV/cm at 75 MHz. Input RC is 1 megohm paralleled by approx 15 pF. A P6008 Probe is supplied with the Type 86.

TYPE 581A OSCILLOSCOPE, without plug-in units . **$2050**
TYPE 86 PLUG-IN UNIT **$550**

TYPE 585A AND RM585A OSCILLOSCOPES

A 7503 with a 7B52 Dual Time Base is recommended as a replacement for the Types 585A and RM585A.

The Type 585A and its rackmount equivalent RM585A are delaying-sweep oscilloscopes with DC-to-80 MHz bandwidth, full-bandwidth triggering ('A' sweep only), and a 4 x 10-cm display area. The delayed sweep ('A') has sweep rates of 50 ns/cm to 2 s/cm; the delaying sweep ('B') has sweep rates of 2 μs/cm to 1 s/cm. The X5 magnifier increases the fastest 'A' sweep rate to 10 ns/cm; the fastest 'B' rate to 0.4 μs/cm.

TYPE 585A OSCILLOSCOPE **$2400**
TYPE RM585A OSCILLOSCOPE **$2500**

TYPE 81A PLUG-IN ADAPTER

The Type 81A Plug-In Adapter allows use of all 1-Series and Letter-Series Plug-Ins with 580-Series Oscilloscopes. The full-bandwidth capabilities of the plug-in units are realized.

TYPE 81A PLUG-IN ADAPTER **$210**

TYPE 82 DUAL-TRACE AMPLIFIER

Used in the 580-Series Oscilloscopes, the Type 82 features a bandwidth of DC to 80 MHz at 100 mV/cm; DC to 75 MHz at 10 mV/cm. The two input channels permit dual-trace capability with chopped or alternate switching.

TYPE 82 DUAL-TRACE AMPLIFIER **$925**

TYPE 122, FM122, AND RM122 LOW-LEVEL PREAMPLIFIERS

The Type 122, frame-mounted FM122, and rackmounted RM122 are low-frequency, low-level preamplifiers with a voltage gain of 100 or 1000, single-ended or differential inputs, and a bandwidth of 0.2 Hz to 40 kHz. Common-mode rejection ratio is better than 10,000:1 between 5 Hz and 40 kHz, with a maximum common-mode input signal of 4 V. High- and low-frequency —3 dB points can be set by front-panel switches. Power is supplied by the Type 125 supply or by batteries (not included).

TYPE 122 LOW-LEVEL PREAMPLIFIER **$200**
TYPE FM122 LOW-LEVEL PREAMPLIFIER **$205**
TYPE RM122 LOW-LEVEL PREAMPLIFIER **$205**

TYPE 125, FM125 AND RM125 POWER SUPPLIES

The Type 125, frame-mounted FM125, and rackmounted RM125 supply electronically-regulated power for up to four Type 122 Preamplifiers.

TYPE 125 POWER SUPPLY **$400**
TYPE FM125 POWER SUPPLY **$405**
TYPE RM125 POWER SUPPLY **$405**

TYPE 127 POWER SUPPLY

The Type 127 Provides power to one or two 1-Series or Letter-Series Plug-In Units. Rear Connectors allow alternate trace trigger-signal inputs; push-pull outputs are available on the front as well as the rear. A squarewave calibration voltage is available on the front panel.

TYPE 127 POWER SUPPLY **$925**

TYPE 175 HIGH-CURRENT ADAPTER

The 176 is recommended as a replacement for the Type 175. The 176 is used in the 576 Curve Tracer.

The Type 175 adapts the Type 575 to plot and display characteristic curves of high-current semiconductors. Its collector sweep generator is continuously variable from zero to ±20 V with 200-A capability and zero to ±100 V with 40-A capability. The base or emitter step generator has voltage increments from 20 mV/step to 0.5 V/step with 12 A capability and current increments from 1 mA/step to 1 A/step.

TYPE 175 HIGH-CURRENT ADAPTER **$2125**

160-SERIES MODULAR INSTRUMENTS

The 2600 Modular Instrument Series is recommended as a replacement for the 160-Series Instruments.

TYPE 160A POWER SUPPLY

The Type 160A provides electronically-regulated power for one Type 360 Indicator unit with up to six 160-Series Generators.

TYPE 160A POWER SUPPLY **$300**

TYPE 161 PULSE GENERATOR

The Type 161 generates rectangular pulses from zero to ±50 V amplitude and 10 μs to 100 ms duration when an external trigger is received. Output pulse delay is achieved by triggering at a selectable point on a negative-going sawtooth.

TYPE 161 PULSE GENERATOR **$200**

TYPE 162 WAVEFORM GENERATOR

The Type 162 produces pulse, gate, and sawtooth output waveforms which can be externally triggered or gated, recurrent, or manually triggered or gated. The unit will serve as a delay generator in conjunction with the Type 161 or 163, and will supply a sweep voltage to the Type 360 Indicator. Pulse duration range is 10 μs to 0.05 s; gate and sawtooth duration range is 100 μs to 10 s. Repetition rate is 0.1 Hz to 10 kHz. Pulse and gate amplitudes are at least 50 V; negative-going sawtooth runs from at least 145 V to less than 25 V.

TYPE 162 WAVEFORM GENERATOR **$200**

TYPE 163 PULSE GENERATOR

The Type 163 generates rectangular pulses from zero to +25 V amplitude and 1 μs to 10 ms duration when an external trigger is received. Output pulse delay is achieved by triggering at a selectable point on a negative-going sawtooth.

TYPE 163 PULSE GENERATOR **$200**

TYPE 360 INDICATOR UNIT

The Type 360 provides a CRT display when externally provided with X, Y, and Z input voltages. Bandwidth is DC to 500 kHz; vertical deflection factor is 0.05 V/div to 50 V/div. Time-base requirement is compatible with the Type 162.

TYPE 360 INDICATOR UNIT **$415**

MOUNTING FRAME

Mounts up to 4 units in 12 ¼-inch rack space.

Order 014-0002-00 ..... $8.00

BLANK PANEL

Same size as one unit. Order 333-0157-00 ..... $4.40

TYPE 184 TIME-MARK GENERATOR

The Type 2901 is recommended as a replacement for the Type 184 Time-Mark Generator.

The Type 184 provides 16 marker intervals, 5 sinewave frequencies, and 7 trigger-pulse intervals. More than one marker interval (up to two decades apart) can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The Type 184 is transistorized (plus 6 nuvistors) and is frequency controlled by a temperature-stabilized 10-MHz crystal oscillator.

TYPE 184 TIME-MARK GENERATOR ..... **$ 760**

TYPE R293 PROGRAMMABLE PULSE GENERATOR and POWER SUPPLY

The Type R293 is a combination pulse generator and power supply which may be used in testing time and charge parameters of semiconductor devices, testing switching and propagation times of micro-logic circuits, or applications which require fast-rise and fast-fall pulses.

As an example, programmable parameters can be remotely controlled (automatic sequence optional) with the Type 262 Programmer. The Type 567 Readout Oscilloscope and Type 6R1A Digital Unit may be used to display the results of each measurement and indicate whether results are within, above, or below predetermined limits. The pulse amplitude may be varied from 6 V to 12 V with a pulse width from 2 ns to 250 ns (into 50 Ω) and a pulse repetition rate from <10 kHz to ≈100 kHz.

TYPE R293 PROGRAMMABLE PULSE GENERATOR AND POWER SUPPLY **$1400**

P6023 VOLTAGE PROBE

The P6055 is recommended as a replacement for the P6023.

The P6023 is a low-capacitance, 10X voltage probe that can be adjusted to input capacitances from 20 pF to 55 pF. The 10X attenuation ratio is adjustable over a ±2.5% range to facilitate use with differential amplifiers. The probe risetime is less than 7 ns; it can be used over a DC-to-33 MHz bandwidth.

P6023 VOLTAGE PROBE **$52**

RACK ADAPTER

The 016-0268-00 Rack Adapter is recommended as a replacement for the 016-0086-01 Adapter.

The 016-0086-01 Rack Adapter permits rackmounting of two 106, 114, 115, or 191 Generators; or one generator with one or two 284 Generators; or up to four 284 Generators. Blank panels cover unused openings. A divider kit is used between instruments and/or panels.

016-0086-01 Rack Adapter **$170**
¾-width blank panel (016-0133-00) **$9**
½-width blank panel (016-0081-00) **$8**
¼-width blank panel (016-0109-00) **$5.50**
Divider Kit (016-0089-00) **$15**

U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

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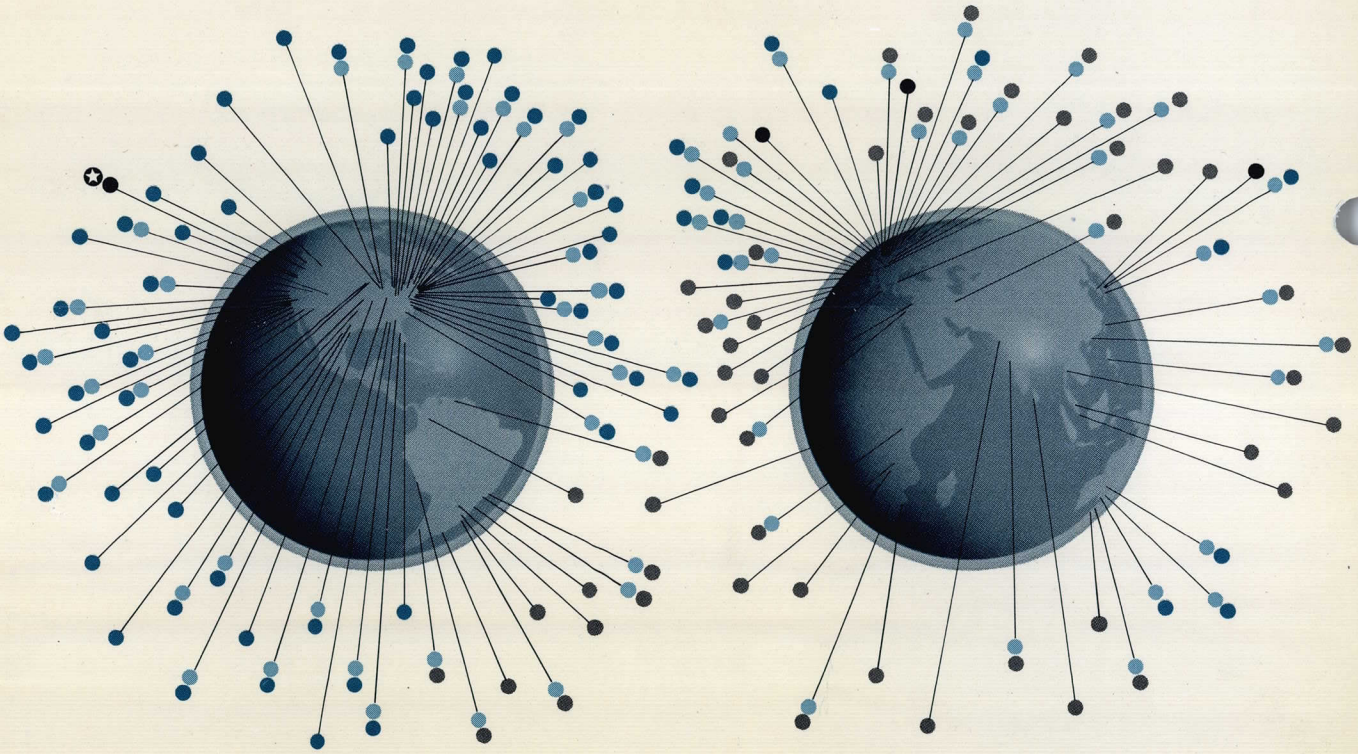
committed to technical excellence



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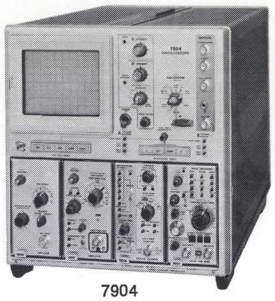
NEW PRODUCTS

JULY 1971

SUPPLEMENT NO. 1 to the MARCH '71 CATALOG

NEW 7000-SERIES PRODUCTS

500-MHz Real-Time Oscilloscope System


7904

7904 Oscilloscope—The 7904 is the world's most advanced oscilloscope measurement system. It is the latest extension of the versatile TEKTRONIX 7000 Series. Coupled with the broad functional versatility of the established 7000-Series plug-ins, the 7904 offers the highest mainframe and CRT bandwidth available today in a general-purpose oscilloscope. In addition, the 7B92 time base plug-in offers a sweep rate of 500 picoseconds per cm and a delaying sweep format to provide optimum usability of the mainframe performance. With the 7A19 Amplifier plug-in the bandwidth is 500 MHz at a deflection factor of 10 mV/div. A separate option is available enabling direct access to the CRT providing 1-GHz bandwidth at a deflection factor of 5 V/div.

The 7904 CRT has a full 8 x 10 cm viewing area and offers excellent visual brightness and photographic writing speed. 24-kV accelerating potential and a new CRT design provide a writing speed of 10 cm/ns with C-51-R Camera, P-11 phosphor and 10,000 ASA film (20 cm/ns with the optional Writing Speed Enhancer). An optional CRT (4 x 5 cm display area) and the writing speed enhancement of TEKTRONIX' new film fogging technique extends writing speed to the speed of light (30 cm/ns). Most photographic requirements can now be met with 3000 ASA film. The writing speed reserve means reduced intensity settings and improved trace definition. With P31 phosphor, the optional CRT provides an outstanding method of viewing low rep rate signals even in high ambient light.

7904 Oscilloscope **$2900**

7A19

7A19 Amplifier—The 7A19 provides a 50-Ω input for optimum signal fidelity and also offers as an option, an internal variable (front-panel) delay line to permit matching the transit time of two preamps and probes to better than 50 picoseconds. The range of this variable delay function is ±500 picoseconds. Bandwidth is 500 MHz over a deflection factor range from 10 mV/div to 2 V/div.

7A19 Amplifier **$500**

7B92

7B92 Dual Time Base—The 7B92 delaying sweep time base offers sweep rates from 500 picoseconds per division to 0.2 seconds per division. Triggering capability is 600 MHz or greater. The external trigger inputs offer either 50-Ω or 1-MΩ input impedance, switch selected. The 7B92 features four display modes: normal sweep, intensified delaying sweep (controllable contrast), delayed sweep and alternate.

7B92 Dual Time Base **$1400**

NEW PORTABLE OSCILLOSCOPES

434

434 Storage Oscilloscope—Tektronix introduces an important new feature in portable oscilloscopes: Storage. The new 434 Storage Oscilloscope is virtually two instruments in one. It offers all of the advantages of Bistable Split-Screen Storage, plus those of a conventional oscilloscope in a portable instrument with a large 8 x 10 cm CRT.

Bandwidth is DC to 25 MHz and deflection factors are 1 mV/div to 10 V/div. A wide range, direct-reading magnifier expands the horizontal display up to a maximum of 50 times in six steps. 20 ns/div is the fastest magnified sweep. To save operator time and reduce errors, lighted knob skirts read out scale factors even when using the recommended 10X probe.

Field uses for storage continue to expand as electronic equipment uses and costs place strong demands upon quick isolation and solution of problems. Signals normally difficult to view (single events, low rep rate, aperiodic or random) are clearly displayed on the 434 Storage Oscilloscope. Single sweep writing speed is 100 cm/ms (400 cm/ms with enhancement).

434 Storage Oscilloscope **$2150**

432

432 Portable Oscilloscope—The 432, a portable oscilloscope with a conventional CRT, is introduced with the 434. Both have identical performance characteristics except for the storage feature of the 434. Cabinet and rack height is 5-3/4 inches for easy carrying or rackmounting.

432 Oscilloscope **$1585**

453A-1,-2,-3,-4 Portable Oscilloscopes

453A-4

Each of these new portable oscilloscopes has a 60-MHz dual-trace vertical amplifier system. Deflection factors are 5 mV/div to 10 V/div dual trace and 1 mV/div single trace (both channels cascaded).

The differences among these oscilloscopes are in the horizontal system. The 453A-1 has normal and uncalibrated delayed sweep; the 453A-2 has normal and calibrated delayed sweep; the 453A-3 has normal, calibrated delayed sweep and calibrated mixed sweep; the 453A-4 has normal sweep. In the calibrated mixed sweep mode, a feature new to portable oscilloscopes, the main sweep is displayed at a selected rate for a time adjusted by a front panel control. At the end of this time, the sweep continues at a faster rate as selected by the second time/div control. This permits the operator to display high density pulse trains in one sweep, magnify the extreme right hand portion of the display by a selectable ratio, and "unwind" each pulse from right to left. This provides for detailed examination of the pulse train and is a feature which is needed for many field service applications.

For further information on these products, contact your local Tektronix Field Office or return the enclosed inquiry card.

The CRT has an 8 x 10 division (0.8 cm/div) internal non-illuminated graticule. 14-kV accelerating potential provides bright displays both visually and photographically. The display brightness of these instruments is evident in a side-by-side comparison with other portable oscilloscopes, especially when compared to the high writing rate of the TEKTRONIX 454A Oscilloscope.

These four oscilloscopes, plus the standard 453A, give the user a wide choice in selecting a 60-MHz portable oscilloscope with performance and cost compatible with his measurement needs, either in the lab or in the field.

453A-1 Oscilloscope **$1850**
453A-2 Oscilloscope **$1875**
453A-3 Oscilloscope **$1900**
453A-4 Oscilloscope **$1700**

NEW SPECTRUM ANALYZER SYSTEM

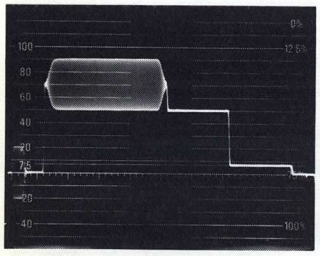
1401A/323

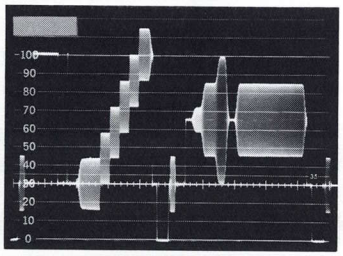
1401A (50 Ω)/1401A-1 (75 Ω) 1 MHz to 500 MHz Spectrum Analyzer Modules—Spectrum analysis in the 1 MHz to 500 MHz frequency range is easily performed anywhere with the 1401A or 1401A-1 when combined with the SONY/TEKTRONIX 323 or 324. Amplitude and frequency calibration with intermodulation distortion of less than 60 dB of full screen is featured. A gated mode allows the 1401A or the 1401A-1 Spectrum Analyzer to be used in viewing time related signals. A built-in calibrator furnishes both frequency and amplitude references for calibrating the associated oscilloscope.

AC line, 6 to 16 VDC, or internal rechargeable batteries can be used for power. While the 1401A or 1401A-1 is specifically designed to combine with the 323 or 324, each can also be used with other oscilloscopes having a 0.2 V/div vertical deflection factor and a 0.5 V/div horizontal deflection factor.

1401A Spectrum Analyzer (50 Ω) **$2400**
1401A-1 Spectrum Analyzer (75 Ω) **$2450**

NEW TELEVISION PRODUCTS


VIRS


EBU VITS 331

Both the 147 and 148 Television Test Signal Generators are state-of-the-art products employing digital and function generator techniques to produce outstanding signal quality.

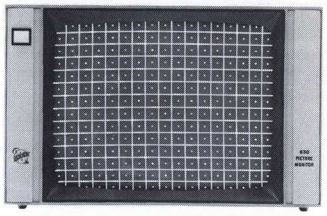
147 NTSC Test Signal Generator—The 147 is an NTSC television signal generator that supplies all the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full-field composite-video test signals and as Vertical Interval Test Signals (VITS) inserted into the vertical blanking interval of an incoming composite-video signal.

147 NTSC Test Signal Generator **$2700**

148 EBU Insertion Test Signal Generator—The 148 is a PAL television signal generator developed using EBU performance specifications for equipment for international insertion signals as a guide. The 148 supplies all the test signals commonly used for test and measurement of video transmission systems. The signals generated are available as full-field composite-video test signals and as Vertical Interval Test Signals (VITS) inserted into the vertical blanking interval of an incoming composite-video signal.

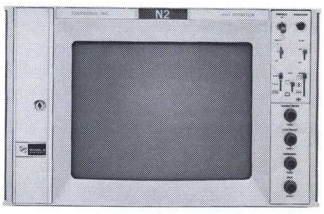
In-service test signal timing information for the 147 and 148 is derived from the incoming composite-video signal. There are extensive provisions within the instruments to modify test signal parameters and their location within the vertical blanking interval. This flexibility is provided through the use of easily-changeable pin connectors. All time locations of test signals as to position within the line and field are derived by digital counting from a master clock which in turn is genlocked to the incoming synchronizing pulses; however, in the absence of incoming composite video (or sync), the 147 and 148 will operate in the full-field test signal mode, deriving timing information from its own internal oscillator (clock).

148 EBU Insertion Test Signal Generator **$3500**


630

630 Monochrome Picture Monitor—The TEKTRONIX 630 is a 15-inch Television Picture Monitor for 50-field, 625-line or 60-field, 525-line television. The monitor is designed for both measurement and qualitative evaluation of TV signals. The monitor uses all solid-state circuitry and requires only 10-1/2 inches in both its rackmount version and cabinet version. The 630 uses a rectangular picture tube with a choice of two phosphors including D6500°. High resolution at full drive along with a no-bounce raster when added to the features of calibrated brightness and contrast make the 630 an excellent standard for display quality.

630 Monochrome Picture Monitor **$1050**


650

650 Color TV Picture Monitor — The TEKTRONIX 650 Color Television Picture Monitor is a compact, NTSC, instrument using a 12″ Trinitron* picture display tube. The 650 design as a measuring instrument enables it to display true pictures with minimal adjustment and maximum stability.

The Trinitron has many advantages over available shadow-mask color picture tubes since the simplicity of its convergence adjustment is outstanding. Only four front-panel controls control convergence. Other convergence controls are located internally and are only adjusted during major servicing. Not only are there far fewer controls, but control operation is much simpler. Convergence is primarily a matter of modulating the horizontal deflection component of the red and blue beams. The green beam, centered in the tube, is only slightly affected by the convergence adjustments. As the eye perceives green most accurately, the green beam is centered to produce the best focus.

650 Color TV Picture Monitor **$2500**

*Registered Trademark SONY Corporation

For further information on these products, contact your local Tektronix Field Office or return the enclosed inquiry card.

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NEW 2600 MODULAR INSTRUMENTS

2620 Stimulus Isolator—The 2620 Stimulus Isolator is a tristable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from ground-referenced generators connected to the input, thus permitting true differential tissue stimulation.

2620

Pulse polarity and timing are determined by the input signal via an optical coupler and may be supplied from a 2600-Series pulse generator or other suitable source. The output pulse amplitudes are controlled independently at the Isolator control panel. Power is provided by two nickel-cadmium "D" cells, operating a DC-to-DC converter. Recharging is provided by an external charger.

2620 Stimulus Isolator **$450**

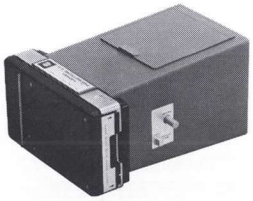
26A2 Differential Amplifier—The 26A2 is a DC-coupled differential amplifier with up to 1 X 10^6 gain designed for use in the 2600-Series modular instrument system. Excellent common-mode rejection, high gain, and selectable high- and low-frequency —3 dB points, make the 26A2 suitable for low-frequency, low-level applications. Frequency response is DC up to 1 MHz with selectable upper and lower —3 dB points.

26A2

26A2 Differential Amplifier **$550**

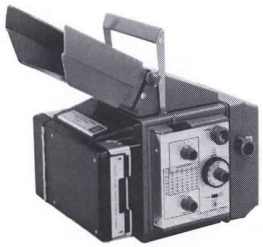
NEW CAMERAS AND ACCESSORIES

C-5 Camera—The C-5 Camera is specifically designed for use with TEKTRONIX 5100-Series Oscilloscopes. A fixed focus f/16 (1:0.68) lens together with three shutter speeds of 1/10, 1/25 and 1/50 second (plus Bulb and Time) and a permanently attached pack-film back make this inexpensive camera easy to use.



C-5

C-5 Camera **$185**



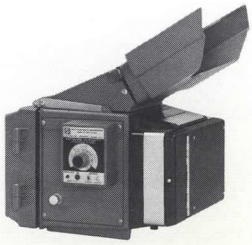
C-59-P

C-59 Camera—The C-59 Camera, designed primarily for the TEKTRONIX 7400 Series, features many qualities of other C-50 Series Cameras, but at a much lower cost. C-59 has a mechanically actuated shutter with speeds ranging from 1 to 1/50 second (plus Bulb and Time). Aperture ranges are from f/2.8 to f/16 and magnification ratio is 1:0.67. Camera is available with Pack, Roll or Graflok* Back or no back at all.

C-59-P Camera **$450**

*Registered Trademark Graflex, Inc.

Writing Speed Enhancer—The TEKTRONIX Writing Speed Enhancer makes possible, for the first time, accurately controlled oscilloscope camera film fogging. The ability to accurately control film fogging is the key to writing speed improvement. Dependent upon the type of film used, this device will increase writing speeds approximately four times. Enhancer is available for use with the C-50 or C-51 Cameras.



C-50 Camera with Writing Speed Enhancer

Writing Speed Enhancer **$125**

NEW CALCULATOR PRODUCTS

Scientist 909

TEKTRONIX Scientist 909—The 909 is a programmable desktop calculator for solving mathematical problems quickly, easily and accurately without learning a machine language. The Scientist 909 speaks the universal language of mathematics, bypassing the need for computer languages in scientific calculators. Operating the 909 is a simple, straightforward procedure which requires fewer operations than machines with thumbwheels, toggle switches or key notations. Many mathematical expressions are keyed directly onto the keyboard just the way they would be written on paper.

Significantly more powerful than contemporary calculators, the Scientist 909 quickly evaluates many functions that are solved through complicated programming on other machines. The basic machine has 26 storage registers and 85 program steps. This can be expanded in the same mainframe to 100 storage registers and 256 program steps.

Scientist 909 ..... **$3780**

TEKTRONIX Statistician 911—The 911 is a programmable calculator capable of performing complex statistical calculations simply and quickly. The 911 closely parallels the design, operation and mathematical computation capabilities of the 909. The only difference is in the function of four keys.

Statistician 911 ..... **$3780**

CALCULATOR PERIPHERALS

TEKTRONIX Programmer 926—Organizes and stores programs utilizing the capabilities of the TEKTRONIX calculators. Adds the capability of looping, branching, program editing, and subroutining to the calculator's capabilities. Stores up to 512 steps internally and up to 5120 on a removable tape.

Programmer 926 ..... **$1495**

TEKTRONIX Instructor 928—Stores data on a conventional cassette recorder, and plays back a sequence of program steps which automatically operates the calculator. When used with a dual channel recorder the 928 can also provide audio instruction to the calculator user.

Instructor 928 ..... **$245**

TEKTRONIX Printer 941—Provides a reliable way to permanently record data produced by the calculator. Print-out is on standard 3-1/2 inch paper tape, A two-digit line-identify number is assigned to each line of print-out.

Printer 941 ..... **$995**

TEKTRONIX Card Reader 923—Programs all keys of the calculators and programmer through punched 32-column cards.

Card Reader 923 ..... **$495**

TEKTRONIX f(x) Repeater 920—A hand-held device, permits manually controllable "looping" to be performed on TEKTRONIX calculators.

f(x) Repeater 920 ..... **$95**

TEKTRONIX Junction Box 905—Provides connection for up to four peripherals.

Junction Box 905 ..... **$75**

For further information on these products, contact your local Tektronix Field Office or return the enclosed inquiry card.

NEW PROBES

The P6060 Probe—The P6060 is a precision passive probe with 10X attenuation, designed for use in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 MΩ. The BNC-Type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5100-Series Oscilloscopes. The connector is also compatible with all BNC connectors used on TEKTRONIX products.

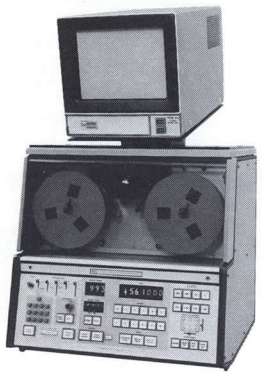
P6060 Probe **$35**

The P6061 Probe—The P6061 is a miniature 10X attenuation probe designed specifically for use with the 453A, or the 7A18 when used with the 7403. The probe does not incorporate CRT readout/trace-identify functions. The P6061 can be compensated for use with instruments having a nominal input capacitance of 15 to 24 pF.

P6061 Probe **$35**

NEW NUMERICAL CONTROL PRODUCTS

1791 N/C Program Verifier—The 1791 is a unique and versatile tool for the numerical control programmer. The 1791 Program Verifier with a 611 Storage CRT Display Unit make up the complete package necessary to check machine control programs on standard one-inch numerical control tapes. The display will graphically reveal most tool path program errors. Both point-to-point and contouring control tapes can be verified. The 1791 can show both positive and negative directions of the three major axes of a Cartesian system. For a three-axis control program, the CRT display will show the oblique view of any of three orthographic views as selected. For two-axis programs, an othographic view will be plotted.



1791 with 611 Storage Display Unit

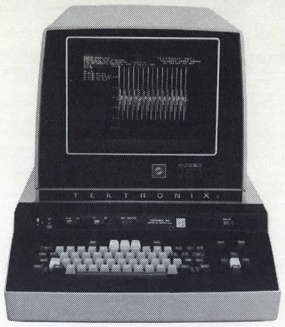
1791 N/C Program Verifier ... **$10,500**

1711 Point-To-Point Two-Axis Machine Control Unit—The 1711 is a two-axis point-to-point, closed-loop numerical control device incorporating automatic backlash take-up. Noise immunity is excellent. Resolution at a 400 i.p.s. feedrate is 0.0001 inches.

1711 Point-to-Point Two-Axis Machine Control Unit **$5300**

NEW INFORMATION DISPLAY PRODUCTS

4002A Graphic Computer Terminal—The 4002A is an interactive high-density alphanumeric and complex graphic computer terminal with a bright 11-inch split-screen CRT display.



4002A

Data can be entered at the keyboard which accommodates all 128 ASCII codes or at the plug-in auxiliary port which accepts interactive graphic units.

The split-screen design offers users the benefits of both storage and refreshed displays. The Computer-Addressable Scratch Pad is a refreshed area at the bottom of the display, 85 characters long and 1 line high. The computer and the operator can address the scratch pad without disturbing previously-stored information on the main portion of the CRT. Data can be composed, edited and viewed on the scratch pad and then the contents or selected portions sent to the computer, or main display area, or both. High-resolution, non-flickering displays are stored on the main portion of the split-screen CRT. The direct-view storage tube eliminates the need for a separate expensive refreshed memory for the main storage display and minimizes the information requirements of the data source. In total, 39 lines with 85 vertical or italic characters per line can be displayed. Any point on a 1024 x 1024 coordinate matrix can be addressed in three different graphic modes, and any point on a 761 by 1024 coordinate matrix can be viewed.

Software supporting the 4002A includes TEKPLOT, a FORTRAN package for data communication interfaces, also an assembly language package for mini-computers and the new TEKTRONIX Graphics Software/360 System.

The 4002A may be interfaced with data communication systems, dedicated computers and computers with Teletype Ports.

The Terminal is hard-copy compatible with the TEKTRONIX 4601, thus significantly enhancing the flexibility of the CRT-type display and providing 8-1/2 x 11-inch copies of the information stored on the CRT for convenient records, storage and communications.

4002A Graphic Computer Terminal without interface **$8800**

Interfaces range from $600 to $750

For further information on these products, contact your local Tektronix Field Office or return the enclosed inquiry card.

Tektronix, Inc.

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