Tektronix®

COMMITTED TO EXCELLENCE

1979

Tektronix®
COMMITTED TO EXCELLENCE

Our Company — Now in our 33rd year, Tektronix has established a reputation as an innovator and leader—first in oscilloscopes, then in areas including professional studio television equipment, graphic display devices and numerous other electronic products.

Our corporate offices and main manufacturing operations are located at the 300-acre Tektronix Industrial Park, just west of Portland, Oregon. Two nearby industrial parks are the sites of our Systems Division and Information Display Group. Another site in Vancouver, Washington allows for further growth. Within the United States, we maintain 47 field offices staffed by sales, service and support personnel trained and dedicated to meeting customer needs.

International manufacturing plants are located near London; on the English Channel Isle of Guernsey; at Heerenveen, The Netherlands; and in Tokyo and Gotemba, Japan, (occupied by Sony/Tektronix Corporation, our equally-owned Japanese affiliate).

Worldwide, the manufacturing, engineering, warehousing and related space owned by Tektronix totals about 3.4 million square feet. Sales during calandar year 1978 exceeded $600 million.

Our Products — Tektronix products encompass virtually all aspects of human endeavor in research, design, manufacturing, and testing. This catalog includes complete specification for some products, and a summary of others. If you would like additional specification or application information, use the return card at the rear of the catalog, or contact our nearest office directly. It is listed on the page facing the return card.

To find out more about our products and our company, contact your local Tektronix office.

CORPORATE OFFICES AND PRINCIPAL PLANT LOCATED AT
TEKTRONIX INDUSTRIAL PARK
14150 S.W. KARL BRAUN DRIVE,
BEAVERTON, OREGON

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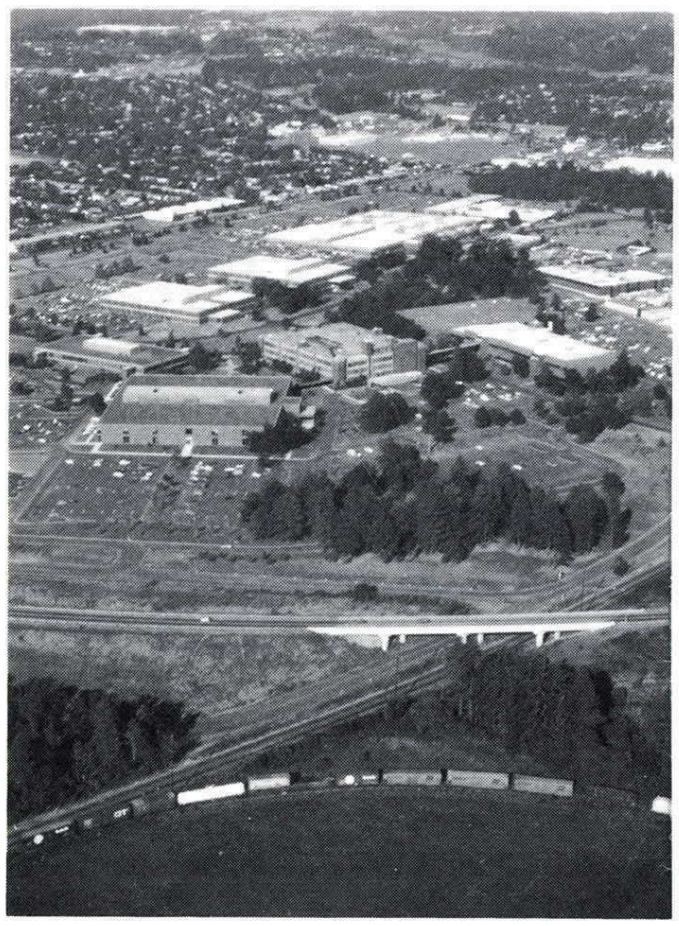

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7L18 60-GHz Spectrum Analyzer
GMA Series Graphic Displays
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TM 515 Modular Instrument System

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A complete family of test and measurement instruments.

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Compact, reliable physiological monitors. Portable and versatile for bedside, transport, intensive care, operating room or nursery. Options include hard copy and multiple digital readout.

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For both OEM and end-users, we offer a wide range of display monitors for direct viewing or photography; bistable or variable persistence storage; and X-Y, raster scan (video), random dot scan or vector displays. UL 544 Listing and Component Recognition is available on most instruments.

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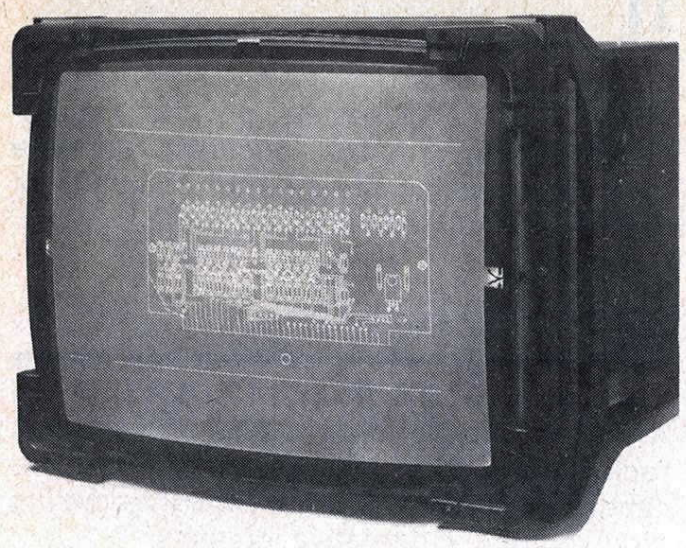
Details about ordering, training, calibration, maintenance, repairs, parts service, terms of sale and warranty.

OUR NEWEST PRODUCTS

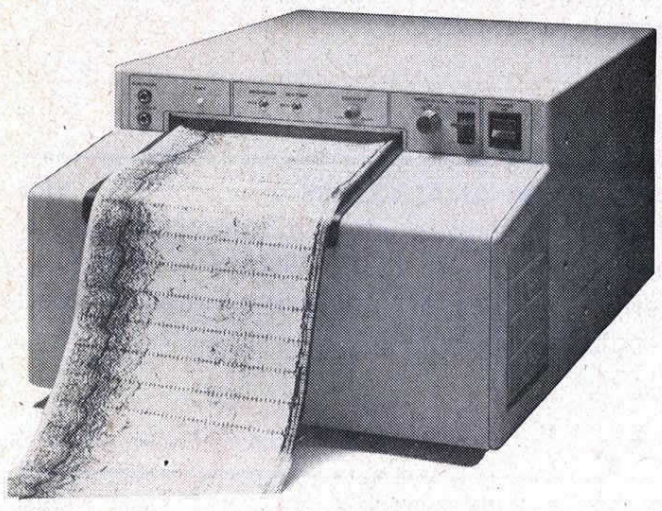
INFORMATION DISPLAY PRODUCTS

GMA125 Computer Display



Modular Construction
High Performance 25-inch Graphics and Alphanumerics
Combined Refresh and Storage Capability

4633A Continuous Recorder



High Resolution Gray Scale
Continuous Dry Silver Paper Images of M-Mode Ultrasound Systems
Fiber Optics Technology

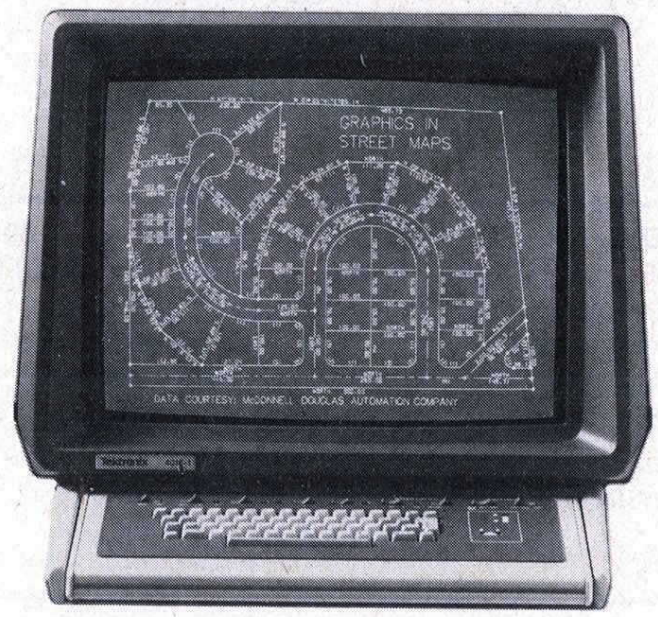
4634 Image Forming Module

High Resolution Gray Scale
Dry Silver Paper Records of Raster Scan Video Signals
Fiber Optics Technology

4027 Color Graphics Terminal

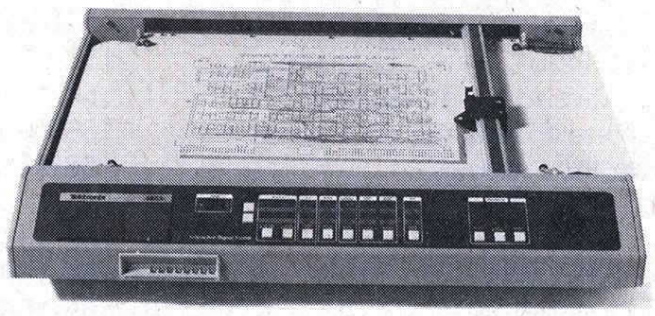
Color Graphics and Alphanumerics
PLOT 10 Software Support

4016-1 Computer Display Terminal



25″ Graphics Display for more Information Capacity
Detachable Keyboard and Display
Local Digitizing Capabilities
PLOT 10 Compatible

4663 Interactive Digital Plotter

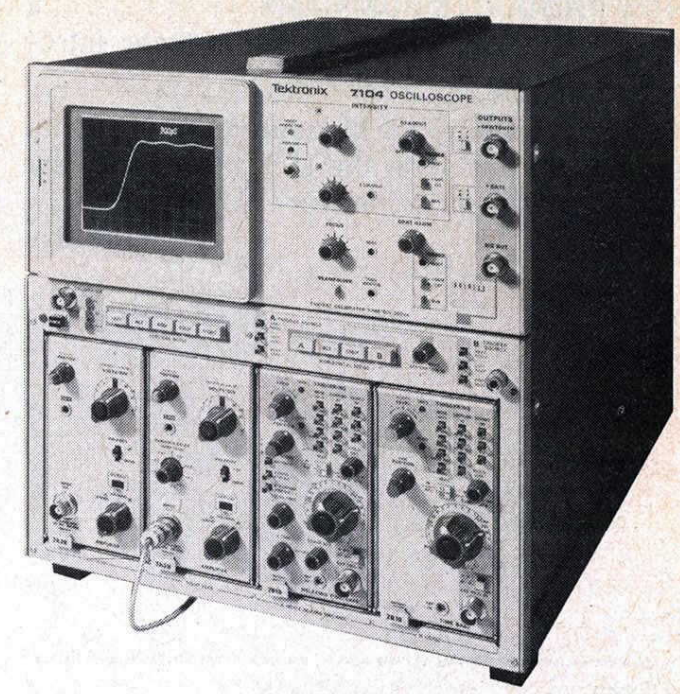


C-size Plotter Convenience
Microprocessor-based Local Intelligence
Unique Parameter Entry Device
Automatic Media Advance

See page 11 for more information on these and all other IDG products.

7000 SERIES OSCILLOSCOPES

7104 1 GHz Oscilloscope



The new 7104 non-storage, plug-in oscilloscope offers a 1 GHz bandwidth, a rise-time of 350 ps (our fastest) and a writing speed of 20 cm/ns. This newest addition to the 7000 Series is used to observe or photograph very fast single-shot waveforms.

The 7104 is compatible with standard 7000 Series plug-in units, including three new ones designed to take the instrument to its specification limits. They are:

7A29 Vertical Amplifier—1 GHz bandwidth; 10 mV/div—1 V/div calibrated vertical deflection factors; 50Ω input.

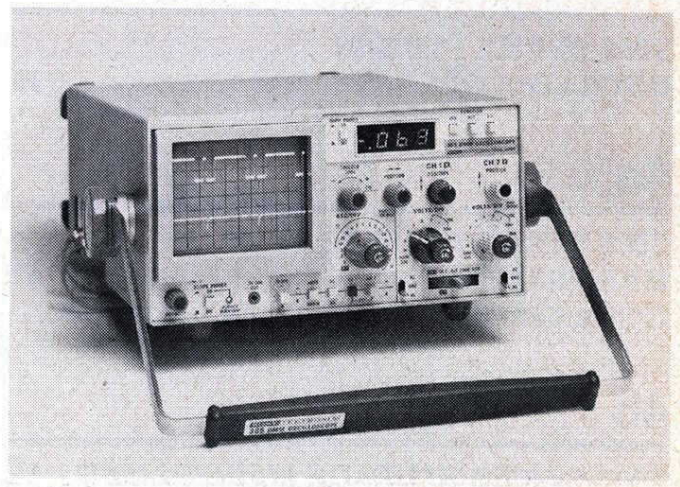
7B10 Delayed Time Base—200 ps/div maximum sweep rate; 1 GHz triggering; extremely low jitter (0.02%).

7B15 Delaying Time Base—Same performance as 7B10 plus delay time and Δ time measurement capabilities when used with the 7B10 or equivalent time base.

For more information on the 7104 Oscilloscope, turn to page 48.

PORTABLE OSCILLOSCOPES

305 Portable Oscilloscope/DMM

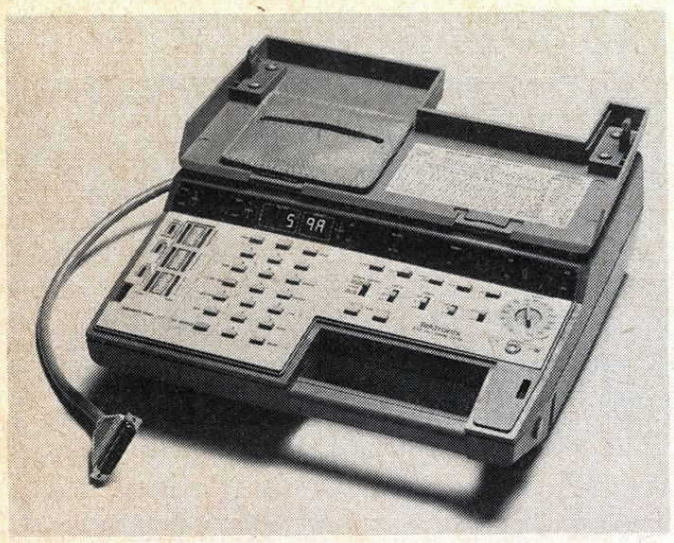


The new SONY/TEKTRONIX 305 Oscilloscope DMM is a 5 MHz portable scope with an integral auto-ranging DMM and built-in, rechargeable battery power. It also offers full X-Y and Dual Trace in a compact, lightweight package.

See page 118 for more information.

DIGITAL SERVICE INSTRUMENTS

832 Data Comm Tester

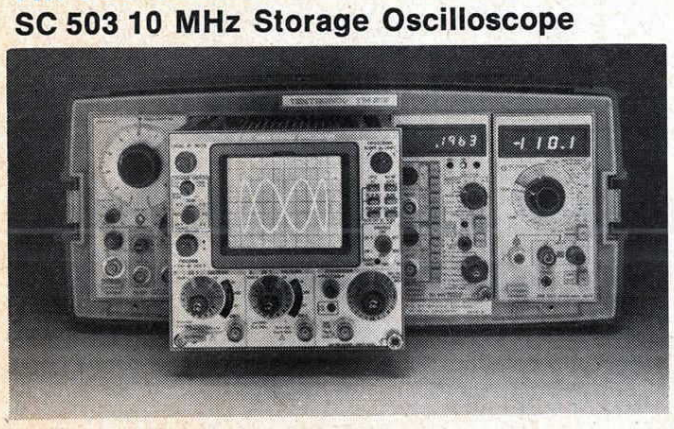


New this year to the Digital Service Instrument group is the 832 Data Comm Tester, a portable digital service instrument that guides the user towards possible problems in data communication systems.

The 832 can monitor, analyze, test and troubleshoot data communications interfaces. For further information, see page 132.

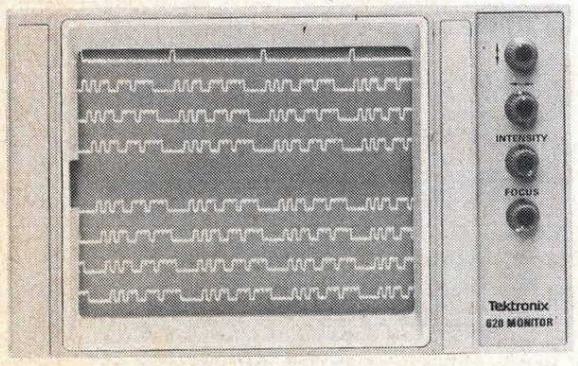
TM 500 SERIES PRODUCTS

SC 503 10 MHz Storage Oscilloscope



TM 500 Plug-in 10 MHz Oscilloscope
Bistable Storage Auto-erase
Variable Enhancement and Integration to Increase Writing Speed
Trigger View
Variable Holdoff
Switchable Front/Rear X and Y Inputs, Rear Z Axis Input
True X-Y Capability
See page 159 for more information

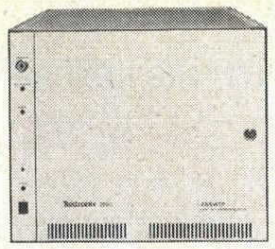
MEASUREMENT DISPLAY PRODUCTS



620 Low Cost Display Monitor

The new TEKTRONIX 620 Display Monitor is a very low cost electrostatically-deflected display that offers small spot size, a 10 x 12 cm screen and medium brightness. Modular packaging and other options make the 620 an excellent value in price/performance situations where good system/display interface is also required.
Special pricing, terms and conditions are available to qualified OEMs. For more information see page 205.

TELEVISION PRODUCTS



ANSWER™ System

The ANSWER™ System is a new, all digital, software-programmable, automated video signal measurement set. It is factory programmed to make over 30 amplitude, phase, and timing measurements using the NTC 7 and FCC VIT signals. See page 187 for more information.

SEMICONDUCTOR TEST SYSTEMS

S-3280 Automated Semiconductor Test System

- Tests ECL (Emitter Coupled Logic) devices
- Sub-nanosecond measurement capability
- 50 Ohm Environment
- Full graphics and data reduction package
- Interfaces to various handlers and probers
- Easy to program and edit
- Uses TEKTEST III, a device-oriented test language
- Tests high-speed logic
- Individual drivers per device pin

S-3270 Automated Semiconductor Test System

- Device characterization for microprocessors, RAMs, ROMs, LSI devices, hybrids
- Uninterrupted Error Storage at 20 MHz
- Multiple Pattern Sources
- Versatile driver formats
- 14 programmable channels of timing information
- Single-shot timing
- Advanced graphics and data reduction
- Uses TEKTEST III, a device-oriented test language
- Easy to program and edit
- True foreground/background timesharing

S-3250 Automated Semiconductor Test System

- Fast, efficient high-volume device testing
- Interfaces with various handlers and probers
- 20 MHz clock rate
- Minimum operator interface
- High through-put
- Uses TEKTEST III, a device-oriented test language
- Easy to program and edit
- Tests microprocessors, LSI devices, RAMS, ROMS, hybrids and more

See page 171 for more information on TEXTRONIX Automated Test Systems.

CABLE TESTER PRODUCTS

The PA1 Cable Comparator is used with the 1503 Cable Tester to amplify the test pulse and test two lines at the same time. This gives the user a clear picture of faults on noisy or lossy lines, the ability to see crosstalk and the advantage of instant comparison of a bad line with a good one. See page 183 for more information.

TELEQUIPMENT

Test & Measurement Products

Telequipment Instruments are now available through the new U.S. stocking distributor network offering:

- More products (Previously unavailable in the U.S.)
- New products
- Local stock
- Local sales and warranty
- Local service and support
- Credit card purchasing in selected areas

For low-priced oscilloscopes that meet your measurement needs day-in and day-out, consider our Telequipment line.

PORTABLE SCOPES

- D32 - 10 MHz Dual Trace

New

- S22 - 5 MHz Single Trace
- D34 - 15 MHz Dual Trace

BENCH SCOPES

- S61 - 5 MHz Single Trace
- D61A - 10 MHz Dual Trace

New

- D66A - 25 MHz Dual Trace

New

- D67A - 25 MHz Dual Trace Delayed Sweep

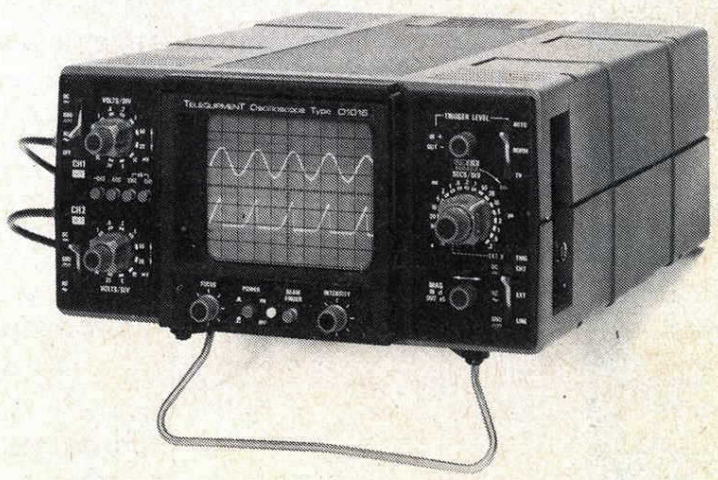
STORAGE SCOPE

- DM64 - 10 MHz Dual Trace

CURVE TRACER

- CT71

Four new products for 2nd quarter 1979:



D1010, D1011
- 10 MHz

D1015, D1016
- 15 MHz

For Telequipment distributor addresses, see Page 248 or use the catalog reply card, or write: Telequipment U.S. Sales
P.O. Box 500 Beaverton, OR 97077
Phone: (503) 644-0161, Ext. 6205
or (503) 644-0143

1

Reference Information

USING THIS REFERENCE SECTION

The products in this catalog cover a range of capabilities in a number of areas. In many cases you'll have several products from which to choose. These introductory notes are intended to help you review some of the factors involved in making a selection.

Of course this reference section can only outline some of the major factors involved. If you need more information, contact your local Tektronix Field Office, Representative, or Distributor — we're ready and eager to help.

REFERENCE SECTION CONTENTS

INSTRUMENT CONFIGURATION

Two Basic Approaches 5
A discussion of plug-in and monolithic designs for oscilloscopes and other types of electronic equipment. Includes charts.

Portability 6
Discusses what factors make an instrument a portable. A chart of TEKTRONIX portable instruments is provided.

Environmental Factors 6
Information about how to interpret environmental specifications.

Power Source Considerations 6
Material on what kind of power sources TEKTRONIX instruments can handle.

CRT DISPLAY OPTIONS

Storage 7
Many TEKTRONIX products which use crts for a display come in storage models. Advantages of storage and the characteristics of various techniques are presented. Accompanied by a chart of TEKTRONIX products using crt storage.

Display Monitors 8
Factors which influence image characteristics, the advantages of crt storage, and associated amplifiers are mentioned.

Cathode-Ray Tube Phosphor Data 8
A section on phosphors and human eye response, and one on phosphor protection. Chart of common phosphor types and their characteristics.

KEY SPECIFICATIONS AND FEATURES

Oscilloscopes and Related Equipment . . . 9

Amplifier Considerations 9
Rise Time and Bandwidth
Sensitivity (Deflection Factor)
Differential, Balanced, or Push-Pull Inputs
Multiple Inputs
Two Techniques: Dual-Beam and Dual-Trace

Time Bases 10
Sweep Rates, and Sweep Types
Relating Fast Sweep, High Frequencies, and Rise Times
Delaying/Delayed Time Bases
Digital Time Displays

Sampling 10

All products identified with this phrase

GPIB Products

incorporate the IEEE STD. 488-1975 Digital Interface for Programmable Instrumentation. This same interface has also been adopted by the American National Standards Institute as ANSI MC 1.1-1975. The interfacing scheme set forth in these standards is commonly known as the "GPIB" — General Purpose Interface Bus. It is a byte serial, eight bit parallel interface designed specifically for connecting together test and measurement instruments, controllers and peripherals into systems for automatic testing, monitoring, controlling and computation. In selecting equipment to incorporate into a GPIB system, the user must be aware that a wide latitude of interface capability is permitted within the scope of the IEEE-488-1975 standard. This latitude may allow devices which fully comply with the standard to be operationally incompatible with each other. It is therefore recommended that specific information on each GPIB product be obtained from the vendor in order to determine the operational capability which may be realized in the interconnection of these products into a system.

CONFIGURATION

TWO BASIC APPROACHES

There are two basic configurations for test and measurement instruments. Modular instruments, more often called plug-in or laboratory models when referring to oscilloscopes, combine a mainframe and one or more interchangeable plug-in subassemblies. Integrated instruments, such as monolithic oscilloscopes, are one-piece units.

Although portable instruments are traditionally designed as integrated units, not all monolithic instruments meet all the objectives of portability. On the other hand, some modular systems, such as the TEKTRONIX TM 500 Modular Test and Measurement Line, are designed for easy transport right into the field—See the reference section on portability for more details.

Modular Design

Versatility is the primary advantage of a modular instrument. Many more functions than could be economically or practically combined in a single unit can be made available in separate plug-ins. You the user, can then choose the ones that serve you best.

Because a modular instrument is so versatile, it can also make use of advances in instrument design. New plug-ins or mainframes can be added that, within the basic limitations of the other units, add new functions or higher performance.

Modularity also allows plug-ins and mainframes to be shared between various uses. For example, with the TM 500 Line, the same general test and measurement plug-ins used in the lab for design work can be quickly inserted into a portable mainframe and easily carried to a service problem. Alternately, where demand warrants it, the identical model plug-ins can be supplied to both field service and laboratory personnel, assuring the repeatability of measurements and minimizing training time.

Plug-ins can also extend the original instrument range to other functions. Digital multimeters, curve tracers, spectrum analyzers and logic analyzers are just a few examples of the many specialized plug-ins Tektronix offers for modular oscilloscopes.

Oscilloscopes

There are two lines of TEKTRONIX modular oscilloscopes to choose from. The TEKTRONIX 5000 Series uses two amplifier plug-ins plus one time base. The TEKTRONIX 7000 Series, which offers higher performance in a number of areas, can accept up to two vertical-channel plug-ins and two time bases or other horizontal units simultaneously. In-depth coverage begins on page 39.

MODULAR NON-STORAGE OSCILLOSCOPES

Model Number	Bandwidth**	Minimum Deflection Factor	Number of Traces	Maximum Sweep Rate	Delayed Sweep	Page	Price*
7104	1 GHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	200 ps/div	X	48	$14400
7904 R7903	500 MHz†	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	50	5695 5150
7844	400 MHz†	20 mV/div at BW 10 μV/div 1 mA/div	up to 4 Dual-Beam	1 ns/div	X	52	8295
7704A Opt 09	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	55	+200
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	54	3635
7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	56	2260
5440	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	5 ns/div	X	91	1640
5112	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual-Beam	100 ns/div	X	97	1360
5110	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	X	96	795
7603N11S	Ruggedized oscilloscope system [meets or exceeds MIL-0-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	57	4895

*Price does not include plug-ins.

†1 GHz with 7A21N direct-access plug-in.

**Bandwidths are real time.
Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

Test and Measurement Instruments

In the general test and measurement field the TEKTRONIX TM 500 Test and Measurement Line is our modular system. One, three, four, five, and six-compartment mainframes accept a broad selection of plug-in units. The mainframe unit provides a common primary power supply, keeping total instrument weight, size, and cost down. Just as importantly, TM 500 Mainframes also provide a signal control and data interface between modules. This allows TM 500 units to work either individually or together as integrated measuring systems. The TEKTRONIX TM 500 Modular Test and Measurement Line is extensive: more than 30 units, including power supplies, signal sources, oscilloscope modules, a logic analyzer, digital multimeters, counter/timers, and more. Custom plug-in kits allow you to add your own unique circuits. With this feature, you can also apply TM 500's capability to unusual applications. In-depth coverage begins on page 133.

Other Modular Devices

Logic Analyzers page 21
Waveform Digitizing Instruments and Systems page 169
Spectrum Analyzers page 188
Curve Tracers page 176

Integrated and Monolithic Devices

Taking the other design approach to instrument design, integrated instrument are optimized for a single range of functions. One-piece instrument design provides reduction in weight, increased ease of use, smaller size, and usually lower power requirements when a definite function is required.

Many oscilloscopes of this type are particularly designed for portable use, with rugged cases, environmental protection, and internal or external battery power. In-depth coverage begins on page 103.

Tektronix also offers many other one-piece products designed to be used alone or as elements of larger systems. Each performs its specialized task economically yet fully because it is designed for a specific type of use:

Graphic Terminals page 11
Digital Service Instruments page 129
Tv Products page 186
Display Monitors page 201

To sum up, modular instruments feature versatility, opportunities for tailor-made selection of functions, and a wide range of measurement capability. Integrated designs are strongest in economy for single functions, ruggedness, and portability.

PORTABILITY

Any instrument not actually permanently bolted down is in some sense portable, but by "portable" we mean something more.

Portable Oscilloscopes

For oscilloscopes, a combination of factors must be considered. Small size and light weight are obviously important, but the degree depends on the application and the uses. Similarly, ruggedized cases or dust covers may be required. The TEKTRONIX 200-Series Oscilloscopes, for example, are less than 8 x 14 x 23 cm (3 x 6 x 9 in), weigh less than 2 kg (3½ lb) and are specifically designed and packaged for field use. The 300-Series all weigh less than 5 kg (11 lb). The high-performance TEKTRONIX 400-Series models, 10.5 to 11.8 kg (21 to 26 lb), are designed as portables, too.

For many applications, internal battery power is often essential. On the other hand, the weight of internal batteries can be a disadvantage if they are rarely needed. In some applications power is always available, since it must be provided to the equipment being tested. TEKTRONIX Portable Oscilloscopes cover the full range of power options. The 200-Series has internal batteries. The 300-Series models and high performance portables, such as the TEKTRONIX 400-Series, are line operated. However, external battery packs are available as accessories for both the 300-Series and the 400-Series.

Portable Test and Measurement Instruments

Many of these same factors apply to other instruments besides oscilloscopes. The TM 500 Modular Test and Measurement Line, for example, has several configurations designed for portability. The TM 515 Traveller Mainframe travels like luggage but works like a lab bench set-up. Although it is attractive and convenient enough to treat as carry-on luggage (it will even go beneath your seat in most airplanes), the TM 515 is designed to take rugged travel. It carries up to five TM 500 plug-in instruments. Again, relatively light weight, rugged construction, and convenient size are the key to portability.

Plug-ins include: pulse generators, function generators, other signal generators, amplifiers and filters, oscilloscopes and monitors, lab power supplies, digital counter/timers, digital multimeters, special plug-ins, and custom plug-ins.

All of the more than 30 TM 500 plug-ins are portable when used with portable TM 500 Mainframes: TM 515 5-compartment Traveller Mainframe, TM 503 3-compartment Mainframe with carrying case or protective cover, TM 504 4-compartment Mainframe with carrying case or protective cover.

In-depth coverage of TM 500 products begins on page 133.

Our Other Portables

Still other TEKTRONIX portable instruments meet special requirements far above simple movability. The 1502 and 1503 TDR Cable Testers, for example, are designed to work outdoors in any weather, including pouring rain.

TEKTRONIX Portable Patient Monitors provide hours of battery-powered operation so they can keep on providing data on vital functions not only during surgery but right through patient transport.

For movement within limited areas, TEKTRONIX SCOPE-MOBILE® Carts and Lab Carts are available in several configurations. A typical setup might include a 400-Series Oscilloscope on the top shelf with two TM 503 Mainframes underneath. These carts are particularly useful for in-plant servicing, school and research laboratories, and similar applications.

For more information, see the following pages:

Logic Analyzer	page 21
Cable Testers	page 183
Spectrum Analyzers	page 188
Portable Patient Monitors	page 199
SCOPE-MOBILE® Carts	page 234

PORTABLE NON-STORAGE OSCILLOSCOPES

Model Number	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed SWEEP	Page	Price
485	350 MHz	5 mV/div at BW	X	1 ns/div	X	106	$5725
475A	250 MHz	5 mV/div at BW	X	1 ns/div	X	108	3800
475	200 MHz	2 mV/div at BW	X	1 ns/div	X	108	3435
465	100 MHz	5 mV/div at BW	X	5 ns/div	X	108	2495
465M	100 MHz	5 mV/div at BW	X	5 ns/div	X	110	2620
455	50 MHz	5 mV/div at BW	X	5 ns/div	X	113	2055
335	35 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div	X	116	2175
305	5 MHz	5 mV/div at BW	X	0.1 μs/div		118	1725
221	5 MHz	5 mV/div at BW	X	100 ns/div		119	1190
213	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div		120	1595
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		122	1190
T935A	35 MHz	2 mV/div at BW	X	10 ns/div	X	125	1535
T932A	35 MHz	2 mV/div at BW	X	10 ns/div		125	1245
T922	15 MHz	2 mV/div at BW	X	20 ns/div		123	975
T921	15 MHz	2 mV/div at BW 1 mV/div		20 ns/div		123	795
D67A*	25 MHz	10 mV/div at BW 1 mV/div	X	40 ns/div	X	3	
D66A*	25 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div		3	
D34*	15 MHz	2 mV/div at BW	X	40 ns/div		3	
D32*	10 MHz	10 mV/div at BW	X	100 ns/div		3	
D1010* D1011*	10 MHz	5 mV/div at BW	X	40 ns/div		3	
D1015* D1016*	15 MHz	5 mV/div at BW	X	40 ns/div		3	
S22*	5 MHz	10 mV/div at BW 1 mV/div		100 ns/div		3	
SC 504†	80 MHz	5 mV/div at BW	X	5 ns/div		158	1900
SC 502†	15 MHz	5 mV/div at BW 1 mV/div	X	20 ns/div		160	1500

*TELEQUIPMENT

†The SC 502 and SC 504 are TM 500 Oscilloscopes that must be plugged into a TM 500 Mainframe for operation.

Please turn to page 164 for more information on TM 500 Mainframes.

ENVIRONMENTAL CHARACTERISTICS

The environmental characteristics listed in instrument specifications may include some or all of the following: temperature, altitude, humidity, vibration, shock, and electromagnetic compatibility (emc, previously rfi or emi).

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 physicial deterioration. Such operation, however, should not cause electrical performance to deteriorate 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 longterm reliability and should be avoided if possible. The emc test is completely nondestructive.

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.

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

POWER SOURCE CONSIDERATIONS

In general, instruments are factory wired for the nominal voltage of the country of manufacture. Most TEKTRONIX instruments provide wide-range regulated supplies, or 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.

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).

Except for some double-insulated instruments, most 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 chassis to protect operating personnel.

Power-cord coding follows one of the two following schemes:

	Scheme 1	Scheme 2
Line	Black	Brown
Neutral	White	Light blue
Ground (safety earth)	Green-yellow	Green-yellow

STORAGE

Storage crts continue to display a waveform after the input signal ceases. The period of image retention runs from a few seconds to several hours depending on several factors mentioned below. The stored display may be erased to make way for storage of a later waveform. Storage tubes may also be operated as conventional (nonstorage) tubes.

Storage oscilloscopes allow easy, accurate evaluations of slowly changing phenomena that would appear only as slow moving dots. They are also needed for viewing rapidly changing nonrepetitive waveforms whose images would otherwise flash across the crt too quickly to be evaluated. Storage can reduce the time to photograph scope traces by allowing you to "compose" the picture. Unwanted displays can be erased as many times as necessary before the photograph is taken.

Storage crts are used in other TEKTRONIX products, too. For terminals, crt storage provides an economical means of retaining graphic and alphanumeric display without requiring refresh circuitry. Curve tracers with a storage crt show a wider range of waveforms. And monitors with storage find a wide variety of applications.

TYPES OF STORAGE

TEKTRONIX products use three types of storage crts — the TEKTRONIX proprietary bistable phosphor storage tube, a variable persistence tube (sometimes called halftone storage), and a fast transfer tube. The last device can also provide operating modes similar to the simpler bistable and variable persistence types.

Although storage writing speeds are not quite as fast as conventional crt speeds yet, they are catching up: recent developments in transmission storage tubes at Tektronix have resulted in a fast stored writing speed of 2500 cm/μs.

BISTABLE

The bistable-phosphor crt utilizes a special phosphor with two stable states: written and unwritten.

The storage mode allows waveforms to be stored and displayed a minimum of several hours (in some cases much longer) or until erased by operator.

Bistable storage is often the easiest kind of storage to use. It is also usually the most inexpensive. Some principal applications include mechanical measurements, signal comparisons, and data recording. Most bistable phosphor crts have a split-screen viewing area which allows each half to be used independently for storage displays. The split-screen feature provides many unique advantages. With this system, a reference waveform can be stored on one half of the screen and the other half can be used to store the effect that calibration adjustments or the insertion of filters, etc, have on circuit operation. If desired, this technique can be used where the reference portion operates in the stored mode and the other half of the display, operating in the nonstored mode, monitors an external input.

CRT STORAGE OSCILLOSCOPES
(in order of Stored Writing Rate)

Model Number	Stored Writing Speed	View Time	Type of Storage	Bandwidth**	Minimum Deflection Factor	Number of Traces	Delayed Sweep	Plug-in	Page	Price
7834	5500 div/μs	30 s ††	Fast Variable Persistence	400 MHz	20 mV/div at BW 10 mV/div at 325 MHz	up to 4	X	X	60	$7695
	776 div/μs	30 min minimum	Fast Bistable							
	12 div/μs	30 s ††	Variable Persistence							
	0.2 div/μs	30 min minimum	Bistable							
466	3000 div/μs	15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	X		111	5355
	3 div/μs	15 s ††	Variable persistence							
7633	2200 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	62	5615
	400 div/μs	30 min minimum	Fast bistable							
	3 div/μs	30 s ††	Variable persistence							
	2 div/μs	30 min minimum	Bistable							
7623A	150 div/μs	30 s ††	Fast variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	62	4295
	50 div/μs	30 min minimum	Fast bistable							
	0.5 div/μs	30 s ††	Variable persistence							
	0.03 div/μs	30 min minimum	Bistable							
464	110 div/μs 0.5 div/μs	15 s †† 15 s ††	Fast variable persistence	100 MHz	5 mV/div at BW	up to 2	X		111	4375
7613	5 div/μs	1 hr	Variable persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	64	3430
5441	5 div/μs	1 hr	Variable persistence	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	92	2775
7313	5 div/μs	30 min minimum	Bistable split screen	25 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	65	3535
434	5 div/μs	4 hrs	Bistable split screen	25 MHz	10 mV/div at BW 1 mV/div	up to 2			115	3480
5115	0.8 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	97	1565
5113	0.2 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 dual-beam	X	X	97	2025
5111	0.02 div/μs	10 hrs	Bistable split screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	96	1490
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			122	1595
314	0.25 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	up to 2			117	2645
DM 64*	0.25 div/μs	1 hr	Bistable	10 MHz	1 mV/div at BW	up to 2			3	
SC 503†	80 div/ms	4 hrs	Bistable	10 MHz	1 mV/div at BW	up to 2			159	2200

*TELEQUIPMENT
**Bandwidths are real time. Sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.
†The SC 503 is a TM 500 Oscilloscope that must be pugged into a TM 500 Mainframe for operation.
Please turn to page 164 for more information on TM 500 Mainframes.
††View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.

An example of the usefulness of the split-screen feature is in speech therapy. The normal speech pattern is recorded on the upper half of the storage screen and the patient's attempts to match this pattern are recorded on the lower half. With split-screen operation, the lower half showing the trial waveform can be erased as many times as desired without affecting the stored information on the upper screen.

VARIABLE PERSISTENCE

Variable persistence storage allows a continuous gradation between the bright written level and the dark reference.

The variable persistence mode also allows for the selection of the time a stored image will be retained. The storage persistence can be adjusted so the entire waveform can be viewed, yet the stored trace fades from view just as the new waveform is being plotted. With the save feature, an entire display can be stored for further analysis if desired.

Applications for variable persistence storage include real time, spectrum analysis, time-domain reflectometry, sampling and other measurements which require slow sweep displays. For fast repetitive sweeps, the storage persistence can be set so multiple traces are displayed before the first trace fades from view. Then you can view changes in signal response with changes in circuit conditions, time, or adjustments. This method can also be used to provide display integration so that only the coincident portions of a repetitive signal are displayed. Any aberration or jitter not common to all repetitive traces will not be stored or displayed. Low-repetition rate, fast-rise-time signals that are not discernible on conventional crts can be easily viewed.

This type of storage provides the best display when storing displays with varying intensities, such as delayed sweep or with Z-axis intensity modulation. Variable persistence storage provides very good displays for photographs due to the high contrast between dark background and bright waveforms.

(Continued on following page)

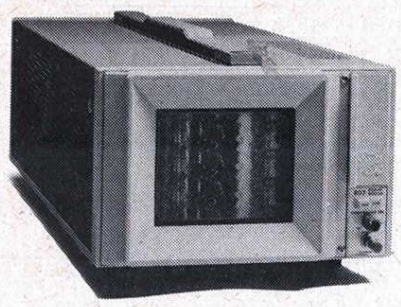
FAST TRANSFER

Fast transfer storage uses a tube with a special intermediate mesh target. This target, which is optimized for speed, captures the waveform and then transfers it to a slower, longer-storing electrode. The second target can be designed to offer bistable or variable persistence modes, in combination with the transfer mesh or by itself.

Several TEKTRONIX Oscilloscopes use this combination of capability to provide unique multimode storage. By front-panel controls, users of these instruments can select the operating mode suited to the specific measurement situation.

DIGITAL STORAGE

Although not directly comparable in some respects, digital storage is also a useful technology for waveform retention. More information is given in the sections on digital oscilloscopes, logic analyzers and signal processing systems products.



DISPLAY MONITORS

Image Characteristics

Elements that may be important to you in obtaining the best image from a display monitor include the brightness of the image, the resolution or spot diameter, the size of the image and the phosphor type used and its characteristics.

Brightness depends on the type of crt used, the phosphor and the accelerating voltage. In general, higher brightnesses can only be obtained at the cost of lower resolution or slower writing speed. On some monitors, a separate intensity or Z-axis input is available to modulate the brightness of the beam. Resolution is specified either by spot size or by number of line pairs in a given distance. Smaller spot sizes or greater numbers of line pairs in general mean a more detailed image can be displayed.

Screen size and the size of the graticule on conventional monitors is normally comparable to that offered on laboratory oscilloscopes (up to 8 by 10 cm). Tektronix also offers a series of displays with screen sizes of 19 and 25 inches (see page 18). Phosphor characteristics can be selected to optimize viewing or photography and to match desired image decay rates. See the phosphor chart and following information.

Storage

Storage is an essential feature on monitors when the information to be presented is transitory or the image to be built up is too complex for the source to communicate all at one time. Tektronix offers both bistable storage monitors and variable persistence models. See page 203 for application information.

Vertical and Horizontal Amplifiers

The amplifiers in display monitors must faithfully translate the input signal to a deflection on the crt screen. Two important characteristics are the bandwidth of the amplifier and the linearity, each of which contributes to how faithfully the signal will be reproduced on the screen. The phase difference and the common-mode rejection ratio determine how closely two signals can be graphed against one another and how well they can be extracted from extraneous background noise. See the amplifier considerations section on the next page for further details.

CATHODE-RAY TUBE PHOSPHOR DATA

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 wavelength from deep red to violet. The human eye is most sensitive to the yellow-green region; however, its responsiveness diminishes 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. It is based on measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The SI (international metric standard) units for luminance are candelas per meter squared, but the English footlamberts are still used extensively in the U.S. One footlambert = 0.2919 candelas/m². The term **luminance** implies that data has been measured or 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.

PHOSPHOR PROTECTION

When a phosphor is excited by an electron beam with 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

PHOSPHOR DATA CHART

Phosphor	Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance[1]	Relative Photographic Writing Speed[2]	Decay to 10%	Decay to 1%	Decay to 0.1% (in ms)	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	—	50%	20%	24 ms	48 ms	95	Medium	Replaced by P31 in most applications	Special order
P2	Bluish-green	Yellowish-green	55%	40%	75 μs	—	120[3]	Medium high	Good compromise for high- and low-speed applications. Replaced by P31 in most applications	Special order
P4	White	—	50%	40%	60 μs	470 μs	20	Medium high	Television displays	74
P7	Blue	Yellowish-green	35%	75%	0.3 s	3 s	8 sec	Medium	Long decay, double-layer screen	76
P11	Purplish-blue	—	15%	100%	80 μs	—	20	Medium	For photographic applications	78
P31	Yellowish-green	—	100%	50%	38 μs	250 μs	32	High	General purposes, brightest available phosphor	80
P39	Yellowish green	—	27%	NA[4]	36	203	1250	NA[4]	Photographic applications	40
P45	White	—	32%	NA[4]	7	1.9	5	NA[4]	Monochrome TV displays	

[1]Measured with TEKTRONIX J16 photometer and J6523 luminance probe which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.

[2]P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.

[3]Low level lasts over one minute under conditions of low ambient illumination.

[4]Not available.

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). 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 like any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping the intensity down or the time short will save the screen.

SELECTING A PHOSPHOR

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option. Special phosphors are available for applications which require different characteristics. 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. For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Sales Engineer, Representative or Distributor. They know the factors that must be considered in selection of a phosphor for any given application.

Phosphors are rated in several parameters, such as color of fluorescence or phosphorescience, decay, etc. The table on page 8 describes the more commonly used phosphors.

KEY SPECIFICATIONS AND FEATURES

for oscilloscopes and related equipment

AMPLIFIER CONSIDERATIONS

RISE TIME AND BANDWIDTH

One vital capability generally sought in an oscilloscope is sufficient bandwidth and adequate rise time.

Although rise time is usually the more important parameter when working with faster waveforms, signal bandwidth is commonly specified for lower speeds. Constraints make the two numerically related in well-designed general-purpose oscilloscopes. Bandwidth in megahertz multiplied by rise time in nanoseconds is approximately 0.35. Therefore, if your needs are defined in terms of one factor, dividing it into 0.35 will produce the other.

Bandwidth is of course defined as the frequency range in which signals are handled with less than a 3-dB loss compared to midband performance. Since modern oscilloscopes work well at low frequencies down to dc, bandwidth here commonly refers to the highest frequency which can be displayed with a 3-dB or less error.

Most oscilloscope designs make use of gradual roll-offs at the high-frequency end, so in many cases a scope will be useful far beyond its specified bandwidth. Waveshapes may be altered and amplitudes reduced somewhat.

In terms of rise time, scopes ideally should have a vertical system capable of responding at least five times as fast as the fastest applied step signal (thus having a rise time less than 1/5 as great). In such a case, the rise time of the signal indicated on the scope will be in error by less than 2 percent.

Using the 1/5 and 0.35 factors together, the minimal requirements for scope bandwidth for accurate rise time measurements can be estimated using the following rule of thumb:

$$\text{Bandwidth (minimal)} \approx \frac{1.70}{\text{Fastest Rise Time}}$$

Very accurate absolute rise time measurements are not always important. When simply comparing the rise times of two signals, scopes with a rise time equal to the rise time of the signals applied are usually considered adequate.

Besides indicating bandwidth for the vertical channel, many oscilloscope specifications also include a bandwidth figure for the horizontal and trigger channels.

Bandwidth and rise time figures also apply to many other TEKTRONIX instruments. Signal sources, probes, amplifiers, TDR systems and many other test instruments are characterized in part by rise time. Frequency response figures are given for portable patient monitors, spectrum analyzers and many tv products. The specifications will indicate values where these figures are relevant.

SENSITIVITY (DEFLECTION FACTORS)

Although sensitivity specifications are most often associated with oscilloscope vertical channels, specifications can also be provided for horizontal channels and trigger circuits with external inputs. Similarly, various other instruments may have a sensitivity specification relating minimum input level to some function or output level.

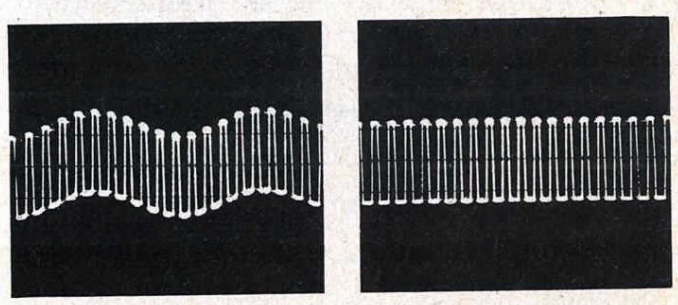
Sensitivity, in the case of oscilloscopes, refers to the input needed to produce a stated deflection of the spot on the crt. Specifications typically are given in millivolts per centimeter or division.

At a given state of the art, sensitivity is a tradeoff with bandwidth. The small amount of noise in even the best input circuit will mask signals which are too weak. Raising the bandwidth increases the noise picked up by the amplifiers, requiring more of a signal to create a clear display.

As a consequence of this relationship, many high-sensitivity scopes provide bandwidth-limiting controls to allow you to make better low-level, moderate frequency measurements. For these and other models, a set of sensitivity specifications may be given for limited frequencies as well as over the full range.

Many times, external noise will be the problem. Differential amplifiers are often used to lessen the effects of external noise and common-mode signals, thus improving the useful measurement sensitivity range.

DIFFERENTIAL, BALANCED, OR PUSH-PULL INPUTS



Differential or balanced amplifiers 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. Such amplifiers provide a simple and accurate means of measuring the difference between two signals. They also provide a means of rejecting most unwanted signal components common to both inputs, such as power line "hum."

MULTIPLE INPUTS

It is quite often useful to be able to view any one or several of a number of input signals without disturbing connections to the oscilloscope. Several types of multiple-input amplifiers which display more than one signal on the same crt display are available.

Common applications include input-output comparisons, checking a signal against a standard or working with complex circuits.

Two Techniques: Dual-Beam and Dual-Trace

Two techniques, dual-trace or dual-beam circuitry, are commonly used for creating two traces on a single crt. The dual-trace scope incorporates electronic switching to alternately connect two input signals to a single deflection system. The dual-beam scope, however, has two independent deflection systems within its crt. (Some models do share horizontal systems, though.) There are distinct advantages to both dual-beam and dual-trace scopes. A dual-beam scope can display two input signals separately and **simultaneously**. Therefore, it can show two nonrecurrent signals of short duration. Also, models with independent horizontal deflection can display nonrecurrent signals on different time bases.

The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities. This comes from using a single horizontal amplifier and one set of deflection plates. On the other hand, since a transient event might occur on one input channel while the beam is tracing the other, dual-trace scopes are not recommended for viewing fast one-shot phenomena.

Extension of the dual-trace principles has produced newer multiple-trace oscilloscopes capable of displaying up to eight traces.

TIME BASES

SWEEP RATES AND SWEEP TYPES

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 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."

This technique permits:

1. Direct measurement of time between events.
2. Viewing and measuring small portions of pulse trains.
3. Viewing and measuring random or aperiodic events.
4. Viewing and measuring single nonrecurrent events.

Distances representing time are measured on the scope's graticule, the ruled scale built into the display. The internal graticule built inside the crt face on modern scopes is preferable, as it eliminates parallax.

A major graticule division may be an inch, centimeter or some other length. Some instruments have different distance-units for the vertical and horizontal 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.

Strictly speaking, sweep specifications are rates properly expressed as time/length. However, the term **sweep speed** (implying length/time) is often used synonymously.

RELATING SWEEP RATES, HIGH FREQUENCIES AND RISE TIMES

The appropriate sweep rate for frequency-specified measurements is based on the nature of the test. Given a moderate frequency, a sweep is usually considered adequate if it is capable of displaying one cycle across the full horizontal scale. At high frequencies, however, scopes seldom have sweeps that fast. To measure rise time as accurately as possible, a step signal (square wave, rectangular pulse, etc) should occupy most of the full vertical scale, and the rising portion of the signal should be displayed at nearly a 45° slope. This objective 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 rise time of the vertical deflection system. Because of the compounding difficulties and cost of providing extremely fast sweeps which are both linear and accurate, this goal must be tempered somewhat in scopes having the very best vertical deflection system rise time capabilities.

In some cases rise time measurements are not made to determine actual rise time, but are done to decide whether certain limits are met or exceeded. In such cases, an adequate comparison with a standard signal of known rise time can usually be made even with a sweep that provides a fairly steep display, given that the vertical deflection system rise time is good enough.

DELAYING/DELAYED TIME BASES

Delaying-sweep measurements use two linear calibrated time bases. The first time base, commonly called the delaying sweep, allows the operator to select a specific delay time. When this time is reached, the second time base, called the delayed sweep, starts. The delayed sweep is typically set a decade or two faster than the delaying sweep and therefore offers additional resolution. The combination of these two time bases also offers increased accuracy of time interval measurement.

DIGITAL TIME DISPLAYS

You can make delay and interval time measurements with digital ease on several TEKTRONIX oscilloscopes. The DM44 option for the 400 Series allows you to read the delay time, interval frequency, or temperature right from an LED readout, with no calculation or interpolation required. The 7B10, 7B15, 7B85 and 7B80 Plug-ins for 7000-Series Oscillosccopes provide Δ time (dual-delayed sweep) measurements. With this feature, both ends of the selected interval which can be independently positioned on the trace are shown by intensified regions. The time interval between those points is shown on the screen using the 7000-Series crt-readout capability.

SAMPLING

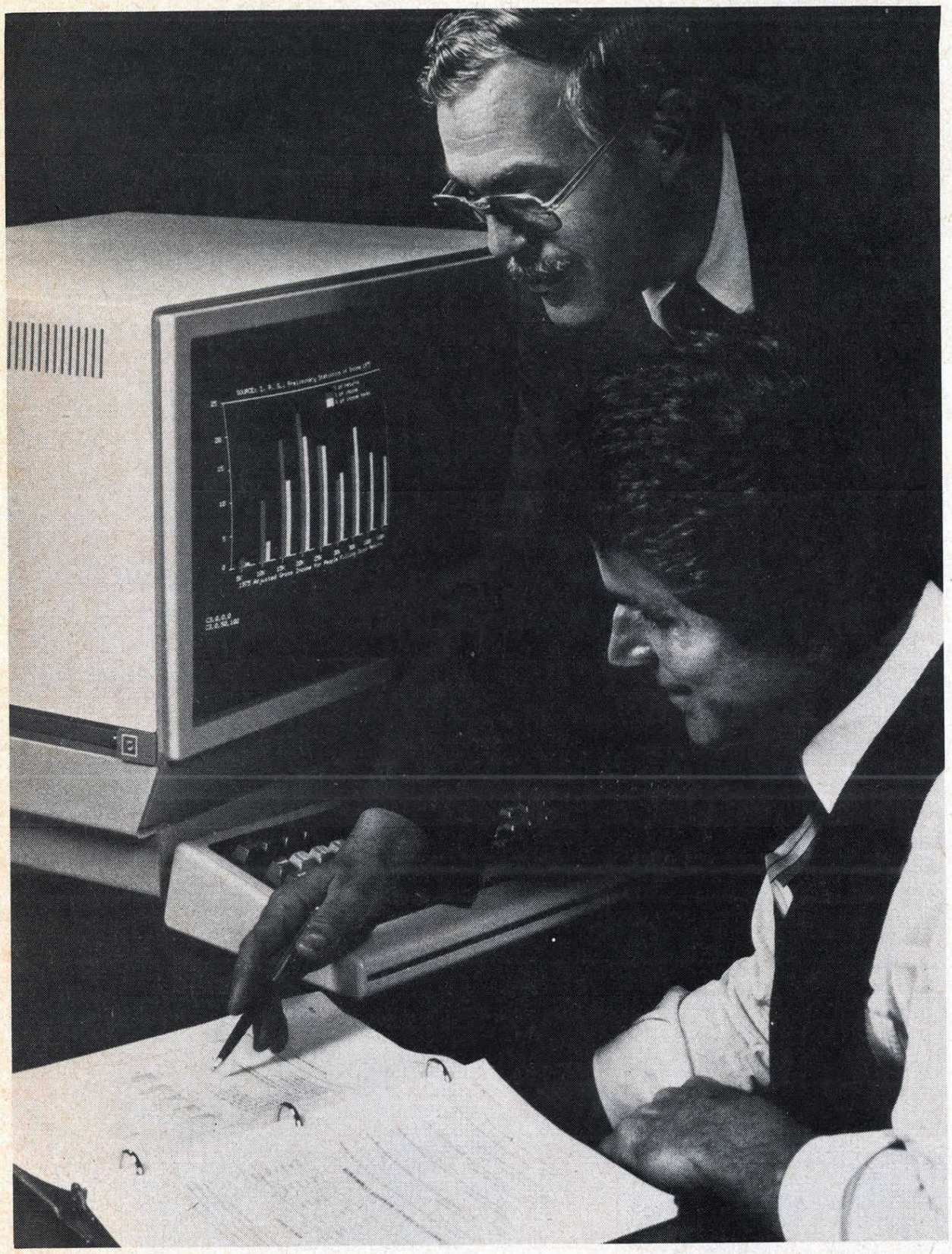
Sampling is a powerful technique for examining very fast repetitive signals. It is similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers, and finally shown, all seemingly at one time, on the screen of a cathode-ray tube. The graph thus produces 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 a portion of the signal is captured and displayed each time the signal recurs.

The sampling method, however, provides a means of 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 30 picoseconds on an "equivalent" time base of less than 20 picoseconds per division and less than 5 mV of peak amplitude.

Tektronix uses the random sampling technique which differs from conventional sampling because it does not require a delay line or pretrigger for lead time to be visible in the display. The benefits afforded by this feature are:

1. Signals with no source of pretrigger can be observed.
2. The inherent rise time limitation of signal delay lines is eliminated.
3. It is no longer necessary to work into the 50 Ω characteristic impedance of a delay line, so high impedance can be retained.
4. External triggers may occur before, coincident with, or after the displayed signal, with lead time still visible in the display.
5. Display time jitter otherwise caused by pretrigger-to-signal jitter is eliminated.

Information Display Group Products



As the world's computer graphics leader, Tektronix Information Display Group enters each market with a commitment to the best solution in the industry. You'll see that commitment demonstrated here in low cost graphics. High information density. Alphanumerics and forms ruling. Local intelligence. Color. Software. Peripheral support and service. From business and scientific graphing to complete graphic computer systems, our product development is a mutual process: As our customers demonstrate new needs, we continue to develop solutions. On the following pages you'll see where the graphics market, and thus the graphics leader, are heading.

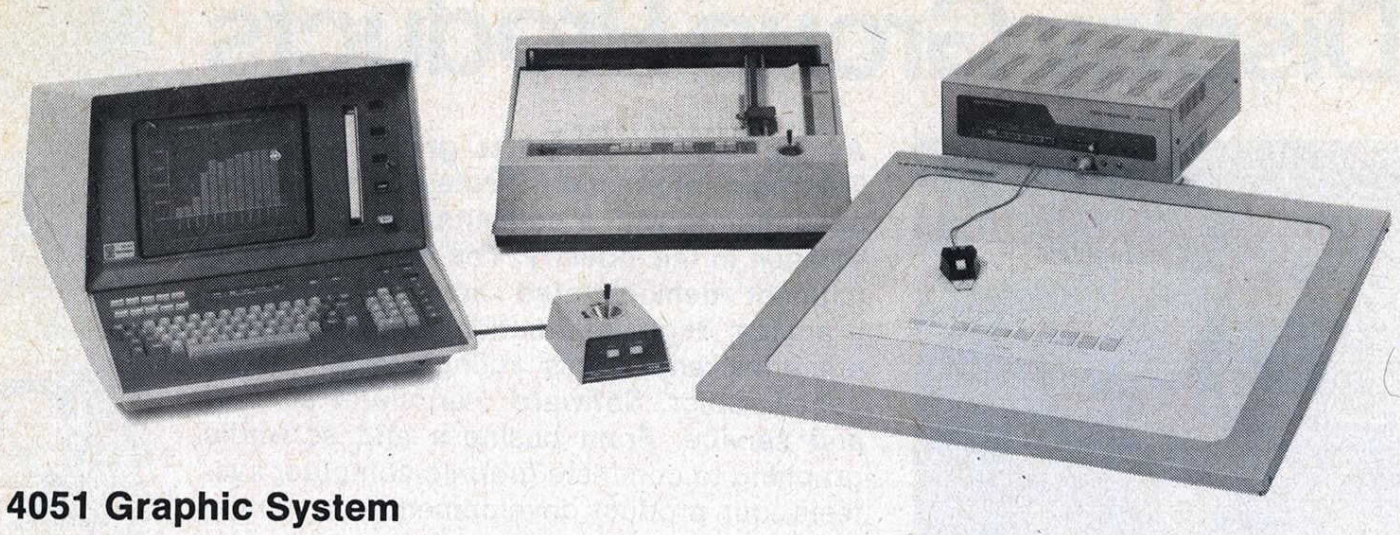
For additional product information and details on interfacing, software, and accessory support, please indicate your interest on the postcard at the back of the catalog.

The Graphic Computing Systems Division (GCS) of Tektronix provides computing products and associated peripherals to serve the growing need for stand-alone graphics, desktop computing systems and intelligent graphics terminals.

Simple to use, high technology GCS products have been used in business, medicine, education engineering, and scientific research and development applications.

The nucleus of the GCS product line is the 4051, a proven product with friendly graphics and extended BASIC, interfacing flexibility and a wide range of options and peripherals providing affordable and expandable computing power. A choice of mass storage devices, line printers, graphic input and output devices, plug-in functions (ROM Packs), and applications software packages further extends 4051 versatility.

The 4051 is an integrated system providing approachable computing and graphics technology for efficient and meaningful display of information. With 4051 systems, computing and graphics become friendly, useful tools, whether your expertise is in education, mathematics, the sciences, business, engineering or some other field. GCS products are supplied with a commitment to high quality, worldwide service and support synonymous with Tektronix.



4051 Graphic System

The 4051 is an integrated desktop computer with Extended Basic programming language, a graphics-alphanumeric display, keyboard, magnetic tape cartridge drive and IEEE (Std-488-1975) interface built-in. Extensions of the language make it simple for the beginning programmer, but powerful for advanced problem solving. Built-in peripherals and IEEE interface are easy to handle; the language commands accommodate built-in or expanded peripherals through device independent keywords.

The keyboard contains full 128 character ASCII encoding plus user definable function keys, program editing keys, numeric and calculator function keys.

Numeric results are accurate over a wide range. Accurate results are provided to 14 decimal digits from $\pm 1 \times 10^{-308}$ to $\pm 10^{308}$.

The CRT display, using storage tube technology, is 20.3 cm x 15.2 cm (8 inches wide by 7 inches) high. There is capacity for 35 lines of 72 characters; 2520 characters total. High resolution graphics—1024 x 780 points—means smooth plots of data or functions.

Screen copies are possible with a 4631 Hard Copy Unit plugged into the built-in interface.

File structured storage is readily accessible via the built-in language and 3M® DC300 cartridge drive. Up to 300k bytes of program or data may be stored on the cartridge. Direct access memory of 8k bytes is standard. Optionally it may be extended to 32k bytes.

The General-Purpose Interface Bus (488-1975) provides byte serial, bit parallel data and control for a broad range of peripherals and instruments. Language extentions give program control over interrupt handling polling, and data transfer.

RS-232 Interfaces:

An RS-232-C printer interface (Option 10) permits connecting the 4051 to any RS-232-C compatible printer.

An asynchronous communications interface (Option 01) permits the 4051 to share data with a host computer. Option 01 gives the 4051 a terminal mode making it look like a 4012 terminal with 300k bytes of local storage. You may send and receive in batch mode directly to or from your host computer and 4051 tape cartridge.

PHYSICAL CHARACTERISTICS

Height — 34.5 cm (13.6 in).

Width — 46.5 cm (18.3 in).

Length — 82.6 cm (32.5 in).

Net Weight — 29.5 kg (65 lb).

Shipping Weight — 36.8 kg (81 lb).

GPIB Product

ORDERING INFORMATION

4051 Graphic System **$5995**
Option 01
Data Communications Interface . **Add $1500**
Option 10
RS-232 Printer Interface . . . . . **Add $550**
Option 20
4051 with 16k byte memory . . . . **Add $1400**
Option 21
4051 with 24k byte memory . . . . **Add $2600**
Option 22
4051 with 32k byte memory . . . . **Add $3800**

4907 File Manager

The 4907 File Manager is a high capacity, highly reliable mass storage device with a built-in file manager and controller. Its ease of operation and compact design make it a natural companion to the 4051. It is compact enough to fit on a desktop or in a rack mount.

The 4907 is a direct access, flexible disc device for the storage and retrieval of ASCII and Binary data and programs. A GPIB (IEEE 488-1975) cable is used to connect the 4907 to the 4051 and provides data and command communication. Data and program integrity is assured by the use of CRC (Cyclic Redundancy Checking) and automatic recovery from erroneous disc reads. A special 4051 File Manager ROM Pack is included to extend the BASIC language to include file management and access commands. None of the 4051 read/write memory is required by the 4907 or ROM Pack. No overhead is added to the 4051 because the 4907's built-in controller assumes the functional tasks.

The flexible disc provides a capacity of 630 kilobytes of user accessible storage using a double density recording technique. As an option, up to two additional disc drives can be connected to one 4907 providing a total of 1.89 megabytes of storage capacity.

The 4907 File Manager offers many features available only on large computer systems. A real-time clock providing date and time of file activities, up to 9 simultaneously open files, file security (passwording and execute only) and dynamic allocation of file space are examples of these enhancements. No bootstrapping of system software is ever required. An advanced multiple level file-by name system includes a directory that maintains user files, passwords, and available space.

GPIB Product

ORDERING INFORMATION

4907 File Manager **$4400**

4641 MATRIX PRINTER

180 Characters Per Second

132 Column Printout

Form Versatility

The 4641 is a 180 character per second matrix printer offering reliable performance with complete form versatility for a variety of output applications. A selectable form feature lets you handle a variety of format sizes, from labels to legal. A format control will adjust machine operation to 11 different form lengths.

A servo controlled carriage assures precise placement of characters, upper and lower case on a 7 x 7 dot matrix, 132 characters per line, six lines to the vertical inch. A tractor-driven paper feed system provides dependable feeding of multipart forms. The printer will adjust for forms up to 6 parts (.020 maximum thickness) and in varying widths. An alarm signals when paper is exhausted.

ORDERING INFORMATION

4641 Matrix Printer $4315

4050C01 SYNCHRONOUS COMMUNICATION INTERFACE

9600 Baud

IBM Binary Synchronous 2780 RJE Protocol

The 4050C01 Synchronous Communications Interface allows up to 9600 baud, error free communications between IBM computer systems and TEKTRONIX 4051 Graphic Systems.

The 4050C01 connects through a ROM backpack slot and is a firmware implementation of IBM Binary Synchronous 2780 remove job entry protocol in a microprocessor based intelligent peripheral interface.

Compatible modems which are supported include Bell 201A, 201B or C, 208 or 209 which support baud rates from 2000 to 9600.

ORDERING INFORMATION

4050C01 Synchronous Communications I/F $3200

4924 DIGITAL CARTRIDGE TAPE DRIVE

300k Bytes of Storage

GPIB Product

The 4924 auxiliary tape drive provides inexpensive storage and enhances the built-in storage capacity of 4051 Graphic Systems. 300k bytes of information can be stored on each tape cartridge and the 4924 can be addressed by the same commands used to control a 4051 built-in tape unit.

The 4924 can also be placed on-line to another controller which follows the IEEE 488-1975 standard protocol or off-line in talk only or listen only mode, which allows limited data logging capability.

ORDERING INFORMATION

4924 Digital Cartridge Tape Drive . . . $2495

4642 PRINTER

60 Characters Per Second

80 and 132 Column Output

The 4642 is a 60 character per second, low cost printer which utilizes standard RS232 interfacing. Regular and elongated characters are available in 80 column and condsensed 132 column output, using a 5 x 7 dot matrix.

The 4642 is a compact, table top unit which supports inexpensive roll paper, or with the optional tractor feed paper drive, can be used with both fan-fold paper and multi-part forms.

ORDERING INFORMATION

4642 Printer $2250

4051E01 ROM EXPANDER

The 4051E01 ROM Expander Unit is a desktop accessory for the 4051 Graphic System and provides 8 additional slots for connecting ROM packs.

The ROM Expander Unit is interfaced using an Expander Interface ROM Pack and allows any combination of special functions or interface ROM packs to be inserted into the remaining backpack slot or any of the 8 slots provided by the expander.

ORDERING INFORMATION

4051E01 ROM Expander $795

4952/Opt. 02 Joystick

The 4952 Option 02 Joystick provides increased interactive graphics input power to users of 4051 Graphic Systems.

The 4952 utilizes a vertical lever which can be moved in the direction you want to move the cursor; speed is controlled by the angle or distance of the lever from the center position.

When activated by the BASIC command, POINTER, the joystick returns an X, Y coordinate accurate to .1% for percise input. The joystick provides the perfect combination of free form and guided direction needed for interactive graphics.

ORDERING INFORMATION

4952/Option 02 Joystick $595

4956 GRAPHIC TABLET

GPIB Interface

Resolution: 0.1 mm (0.005″)

Available In Two Sizes

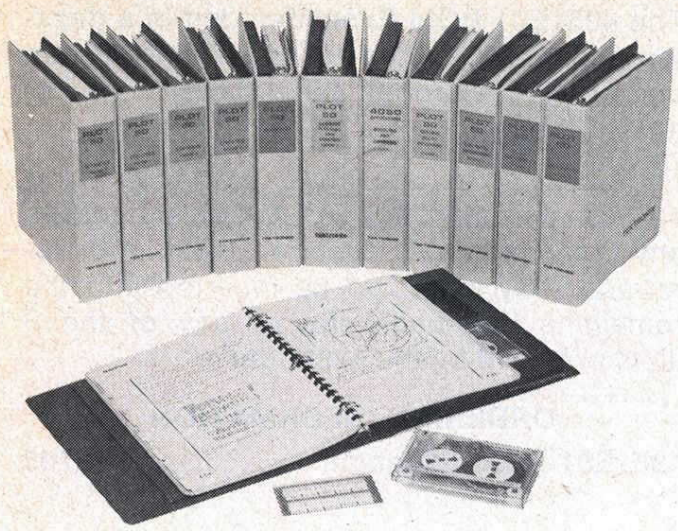
The 4956 Graphic Tablet provides users of 4051 Graphic Systems with digitizing, tracing, and free-hand graphics capability. Available in two sizes, 20″ x 20″ x 48″, the 4956 offers exceptional resolution and accuracy with a choice of stylus or cursor input. The tablet uses the IEEE 488-1975 standard interface and has four digitizing modes which allows one or more data points to be input at a user selectable rate.

ORDERING INFORMATION

4956 Graphic Tablet 20″ x 20″ $4900

4956 Option 33
36″ x 48″ Graphic Surface . . . . . Add $2600

SOFTWARE:



4051 software provides flexible, interactive programs that aid the user in business, scientific, and general purpose applications. High quality graphics are an integral part of the software. Each package comes complete with a binder, program tape(s), instruction manual, and any required key overlays.

Plot 50: Mathematics Vols. 1 and 2 can be purchased individually, or together as the **Plot 50: Mathematics Program Library. Plot 50: Mathematics Vol. 1** contains 23 programs and subroutines that provide fast solutions to frequently encountered mathematical probelms. Included are conversions, function analysis and plotting, integration, differentiation, and solutions to linear and differential equations. **Plot 50: Mathematics Vol. 2** consists of 16 programs and subroutines for solving more advanced mathematical probelms, such as linear programming, data fitting, and fast fourier transforms. The package also provides sophisticated techniques for advanced matrix operations, integration, and solutions to linear or differential equations.

Plot 50: Statistics Vols. 1, 2, 3, and 4 may be purchased separately, or together as the **Plot 50: Statistics Program Library. Plot 50: Statistics Vol. 1** contains 24 programs that generate tabled values for many common statistical distributions, allow testing of various hypotheses, and provide several data plotting and regression techniques. **Plot 50: Statistics Vol. 2** provides six sophisticated programs for one, two, and three-way analysis of variance and covariance; and Latin squares. **PLOT 50: Statistics Vol. 3** contains two large, highly interactive programs for performing polynomial and multiple linear regression. **Plot 50: Statistics Vol. 4** is a comprehensive package that provides 9 sophisticated non-linear regression techniques.

The Plot 50 Mathematics, Statistics, and Graph Plot packages may be purchased together as the **Plot 50: Scientific Library.**

Plot 50: Graph Plot helps either the novice or the sophisticated user prepare data representation graphics on the display or the 4662 Plotter. The package allows convenient data entry from keyboard or tape, then lets the user create a "presentation" of his data; arranging combinations of graphs, tables, and text together on one page.

The data and the completed presentation can be stored on tape. The format of the presentation can also be saved, and used again with different sets of data.

Plot: 50 General Utility Programs Vol. 1 contains fifteen subroutines and programs that aid the user in everyday 4051 tasks. Included are routines to edit BASIC programs quickly and easily, sort strings or data, duplicate tapes, and name tape files. Also included is a program that generates easy-to-read formatted listings of any BASIC program.

Plot 50: Business Planning and Analysis Vol. 1 is a collection of interactive programs for business decision-making and problem solving. The programs perform 1) general financial analysis, 2) quantitative decision analysis, and 3) recordkeeping and sorted data report generation. Problem solutions are presented graphically, on the display or the 4662 Plotter. Data reports can be shown on the display or the 4641/2 Printer.

Plot 50: Electrical Engineering Vol. 1 is a set of programs for modeling and analyzing audio, high frequency, VHF, UHF, and microwave circuits and systems. The programs are highly interactive and allow the user complete control over the circuit model, the method of analysis, and the type of graphic or tabular output.

Modeling and Reporting Software is a general-purpose modeling and reporting system that allow the user to automate his analysis and reporting processes. The package is optimized for user convenience, and requires no previous computer experience. Using simple English-like statements, the user can enter, manipulate, and store his data in matrix format. Once the desired calculations and format are saved in the form of a model, reports and graphics can be produced simply by revising the data and running the model. Report-quality tabular and graphic output are available from the display, the 4641 Printer, or the 4662 Plotter. The model and the reporting structure can be saved on tape or disc for future use.

ORDERING INFORMATION

4050A01 PLOT 50: Statistics, Vol. 1 . . . $350
4050A02 PLOT 50: Statistics, Vol. 2 . . . $350
4050A03 PLOT 50: Statistics, Vol. 3 . . . $600
4050A10 PLOT 50: Statistics, Vol. 4 . . . $600
4050A13 Statistics Library $1550
4050A04 PLOT 50: Mathematics, Vol. 1 . $300
4050A05 PLOT 50: Mathematics, Vol. 2 . $400
4050A14 Mathematics Library $600
4050A15 Scientific Library $2400
4050A06 PLOT 50:
Electrical Eng., Vol. 1 . . . . . $300
4050A07 PLOT 50: Graph Plot $350
4050A08 PLOT 50:
Gen. Util. Prgm., Vol. 2 . . . . . $275
4050A09 PLOT 50:
Business Planning & Analysis, Vol. 1 . $350
4050B01 Modeling and Reporting Software $2000
Option 05 (Flexible Disc Version) . . . . . N C

THE 4051 APPLICATIONS LIBRARY:

4051 owner and users are encouraged to join tht 4051 Applciation Libarary. A library of contributed software is maintained which provides a central resource of existing programs. A free newsletter, **TEKniques,** informs members of other users' applications, programming tips, new programs in the library and new 4051-related products.

4051 APPLICATIONS LIBRARY MEMBERSHIP write to: Group 451, P.O. Box 500, Beaverton, Oregon 97077.

SPECIAL FUNCTION ROM PACKS

Special function ROM packs are accessories that plug into the 4051 backpack or into the 4051E01 ROM Expander Unit. The ROM packs provide additional 4051 commands, without using any read/write memory.

The **4051R01 matrix functions** ROM pack supplements the 4051 with five commonly used matrix operations: matrix multiplication, matrix inversion, transpose, identity, and determinant. The operations are 2 to 8 times faster than functionally equivalent BASIC programs.

The **4051R05 Binary Program Loader** ROM pack provides four commands that allow fast program loading and storing in binary format. Program file saving, recalling, overlaying and appending are 3 to 10 times faster using the Binary Loader ROM pack.

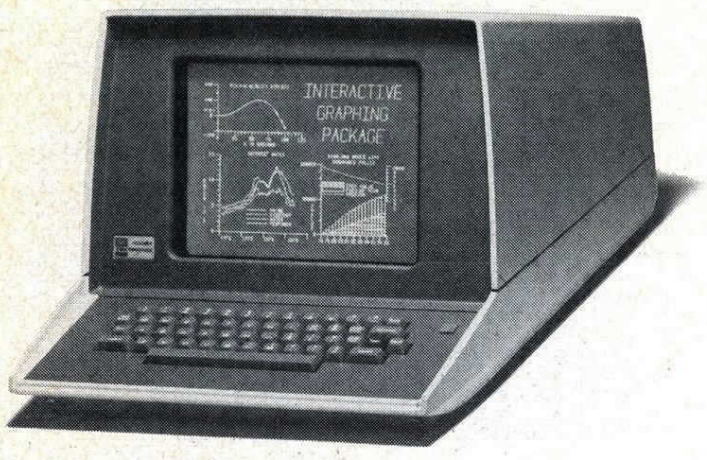
The **4051R06 EDITOR** ROM pack is a general-purpose text editor that can be used to create, edit, and store ACSII text of any kind. Twenty-nine commands are provided for quickly rearranging and modifying text. The text can be any set of ASCII characters: programs, data, or free-form text.

The EDITOR lets you use the 4051 to write or update programs in FORTRAN, COBAL, and other programming languages. This greatly enhances the 4051's capabilities as an intelligent terminal. You can develop programs off-line using the EDITOR, then use the 4051 Option 01 Data Communications Interface to send them to a host computer for processing.

ORDERING INFORMATION

ROM PACKS
4051R01 Matrix Function ROM Pack . . $350
4051R05 Binary Program Loader ROM Pack $200
4051R06 Editor ROM Pack $600

4006-1



Low Cost

High Resolution

Graphic and Alphanumerics

SPECIFICATIONS

Display Size — The screen is a direct-view storage crt, 19.1 cm wide x 14.2 cm high, (7-1/2 in wide x 5-3/5 in high).

Alphanumeric Mode Format — 35 lines, 74 characters per line, 2590 characters full screen.

Character Set — 63 printing characters (TTY ASCII Code).

Graphic Display Mode
Vectors Only.
Vector drawing time 3.6 ±.2 ms.

Information Density — 1024 X by 1024 Y Addressable points. 1024 X by 780 Y viewable points.

Baud Rate — Transmit and receive independently selectable from 75 to 4800 baud.

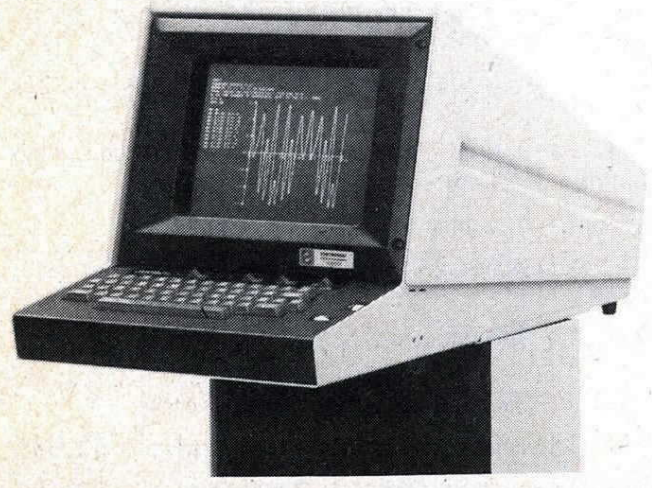
Interfacing — The 4006-1 is shipped with a Standard Data Communication Interface, with inputs and outputs conforming with EIA RS-232-C.

ORDERING INFORMATION

4006-1 Computer Display Terminal . . $2,995

Option 01, Data Communication Interface . . . . . Add $350

4010-1



Supports Alphanumerics Plus Low-Cost Computer Graphics

Graphic Input

Convenient Bus Structure for Peripheral add-on

Complete PLOT 10 Software Support

SPECIFICATIONS

Display Size — The screen is a direct view storage crt, 19.1 cm wide x 14.2 cm high, (7-1/2 in wide x 5-3/5 in high).

Alphanumeric Mode Format — 35 lines, 74 characters per line, 2590 characters full screen.

Character Set — 63 printing characters (TTY ASCII Code).

Character Generation — 5 x 7 dot matrix. Up to 1200 characters per second.

Graphic Display Mode — Vectors only. There are 1024 X by 1024 Y addressable points, and 1024 X by 780 Y viewable points.

Graphics Input Mode — A thumb-wheel controlled cross-hair cursor for 3 through 1023 X and 0 through 780 Y addressable points.

ORDERING INFORMATION

4010-1 Computer Display Terminal with Standard Data Communication Interface $4,950

4012

High Resolution Flicker-Free Graphics

Full Upper and Lower Case ASCII character set

Convenient bus structure for peripheral add-on

SPECIFICATIONS

Display Size — The screen is a direct-view storage crt 21 cm wide x 16.2 cm high, (8¼ in wide by 6⅜ in high).

Character Set — The 4012 has 96 printing characters and a 7 x 9 dot matrix. (Full ASCII code).

Graphic Display Mode — There are 1024 X by 1024 Y addressable points, and 1024 X by 780 Y viewable points.

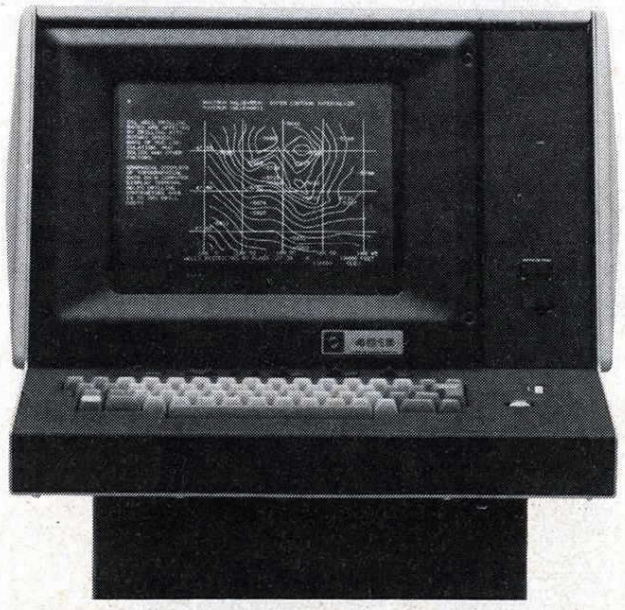
Graphic Input Mode — A thumb-wheel controlled cross-haired cursor for 3 through 1023 X and 0 through 780 Y addressable points.

ORDERING INFORMATION

4012 Computer Display Terminal with Standard Data Communication Interface $6,495

R4012 Computer Display Terminal with Standard Data Communication Interface (Rackmount) $6,895

4013



4012 High Performance plus APL Character Set

ORDERING INFORMATION

4013 Computer Display Terminal with Standard Data Communication Interface $6,995

R4013 Computer Display Terminal with Standard Data Communications Interface (Rackmount) $7,395

4014-1

48.3 cm (19 in), Direct-View Storage Display

Selectable Formats in Alphanumeric and Graphic Modes

Plug-in Intelligence Options

High-Resolution, Attractive, Flicker-Free Interactive Graphics

The 4014-1's 19-inch, high resolution and interactive graphics capabilities have made it the leading graphics device in a growing number of graphic applications.

SPECIFICATIONS

Display Size — The screen is a direct-view storage crt, 38.1 cm wide x 28 cm high; 48.3 cm diagonal (15 in wide x 11 in high; 19 in diagonal).

Character Set — Includes 96 characters (full ASCII upper and lower case, plus a TTY subset).

Vector Mode — There are 1024 X by 1024 Y addressable points, and 1024 X by 780 Y viewable points.

Graphic Input Mode — Thumb-wheel controlled cross-hair cursor for 3 through 1024 X and 0 through 780 Y addressable points.

4014-1 Enhanced Graphics Module, Option 34 — With this extra-cost option, capacity is extended to 4096 X by 4096 Y addressable points and 4096 X by 3120 Y displayable points. Dotted and dashed line vectors (five variables).

ORDERING INFORMATION

4014-1 Computer Display Terminal with Standard Data Communications Interface $12,195

Option 34, Enhanced Graphics Module (Factory Installed Only) . . . . . Add $795

4015-1

Full APL and ASCII Character Sets

4014-1 High Performance plus APL Character Set

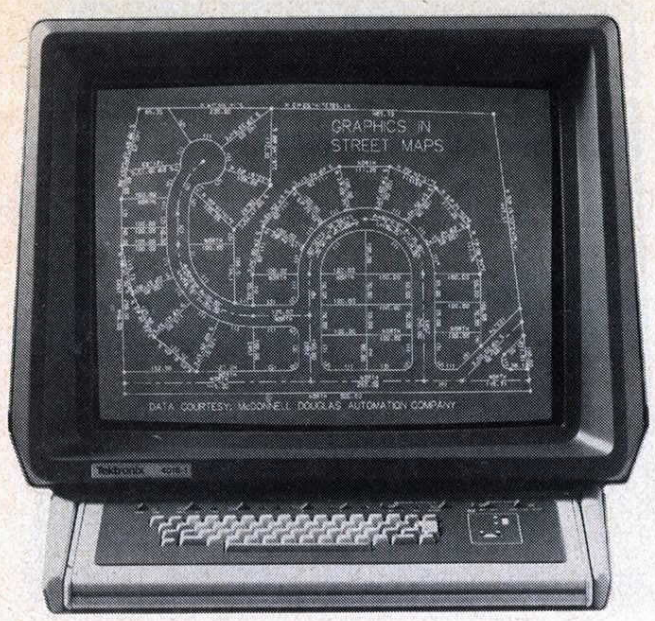
Interactive Graphics Capability

ORDERING INFORMATION

4015-1 Computer Display Terminal with Standard Data Communications Interface $13,245

Option 34, Enhanced Graphics Module (Factory Installed Only) . . . . . Add $795

4016-1



63.6 cm (25 inch) Direct-View Storage Display

High Resolution Flicker-free Graphics

Selectable Formats in Graphic and Alphanumeric Modes

Plug-in Intelligence Options

The Tektronix 25 inch Computer Display Terminal is the most effective way to display a large data base. It features a big 63.6 cm (25 inch), diagonal screen.

The 63.6 cm (25 inch), direct-view storage display tube allows over 15,000 characters on the screen in 179 characters per line columns, or in 3 other format sizes. A variety of vector types, point plot modes, and interactive modes are provided.

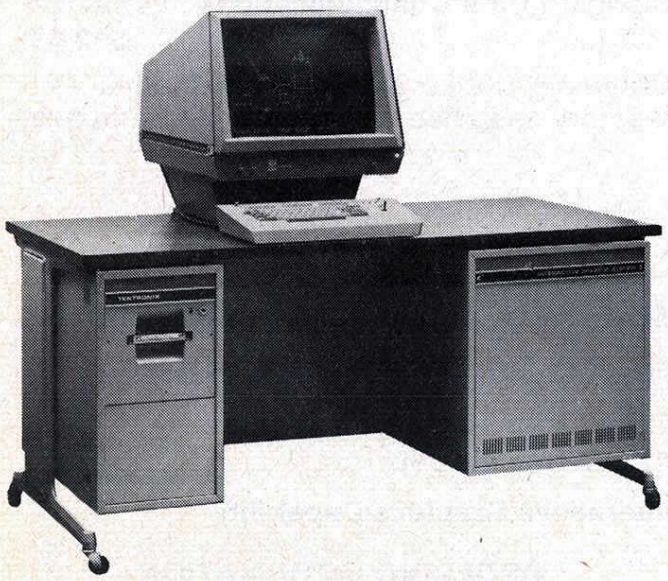
Complete TEKTRONIX 4014-1 Compatibility

The 4016-1 was designed for complete compatibility with all PLOT 10 Software, peripherals, communications support, and the series of intelligent plug-in options.

ORDERING INFORMATION

4016-1 Computer Display Terminal with Standard Data Communications Interface $19,500

4081



Interactive Graphics Terminal

Merging Storage and Refresh Graphics to Create a Technological First

Standard Features:

Local Graphics Editor
4014 Terminal Emulator
Graphics File Transfer
Local Storage of Graphics Information
Host Control of Terminal Functions
Command Language
Service Independence
Hard Copy Compatible
Host-terminal Data Error Detection

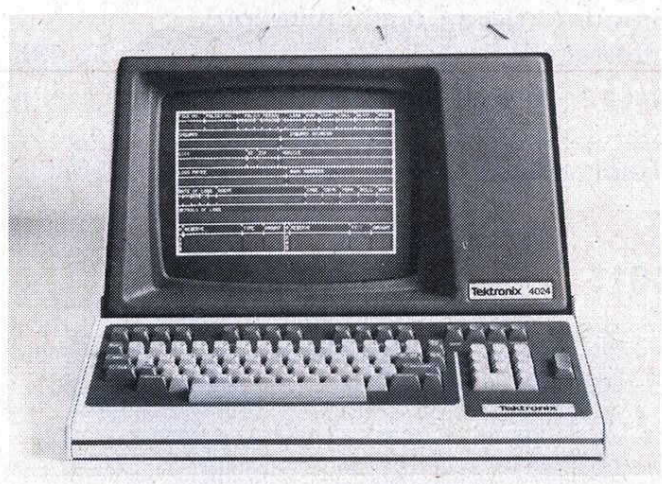
ORDERING INFORMATION*

4081 Interactive Graphics Terminal . $27,000
Option 06 CDC Synchronous Interface . . . . . Add $3,995
Option 22 64K Byte Total Memory . . . . . Add $3,950
Option 31 Expansion Package . . Add $1,800
4905 Mass Storage Module $635
Option 31 Dual Flexible Disc $5,725
Option 32 Two Dual Flexible Discs . $11,450
Option 33 Single Hard Disc $12,000
Option 34 Dual Hard Disc $21,000
4080A04 PLOT 80 Programming Support Package $2,000
4080A05 PLOT 80 Fortran IV and Distributed Graphics Support Subroutines $3,000

*The 4081 and 4905 may not be available in some areas of the world. Consult your local Tektronix Representative or Distributor.

4020 Series

Computer Display Terminals



4024 — The Complete Alphanumerics Terminal Data Entry, Program Writing, Editing, and Forms Fill Out with optional forms ruling.

4025 — Expandable from full alphanumerics, to forms rulings, and then into graphics.

Rolling & Scrolling both alphanumerics and graphics.

4027 — Full Color Graphics and Alphanumerics rolling and scrolling of alphanumerics and graphics Multi-paged graphing. With the added dimension of color Graphics Input.

4025 SPECIFICATIONS

Display Medium — Video Monitor.

Display Size — 22.9 cm wide x 16.3 cm high. (9 in wide x 6.4 in high).

Raster Line — Standard 525 line scan, with 480 lines displayed.

Character Set — 64/96 Upper and Lower Case ASCII (Optional character sets available).

ALPHANUMERIC

Mode Format — 34 lines, 80 charactears per line, 2720 characters full screen.

CHARACTER

Generation — 7 x 9 in a 8 x 14 dot matrix (graphic cells are 8 x 14 matrix).

Cursor — Wide underscore.

Baud Rate — Selectable to 9600 baud.

Graphics — Optional.

4027 SPECIFICATIONS

Display Size — 25.4 cm wide x 19.1 cm high, (10 in wide x 7.5 in high).

Graphics — Standard with Full Screen cross-hair cursor.

Color — 8 colors displayable, colors selected from a pallette of 64 colors.

Patterns — 120 user definable color patterns.

Local Functions — Circle and pie generation, polygon fill.

Other 4027 Specification — Same as 4025.

ORDERING INFORMATION

4024 Computer Display Terminal . . . $2,995
4025 Computer Display Terminal . . . $3,595
4027 Color Graphics Terminal $8,695

PLOT 10 SOFTWARE

For 4010-Series Terminals. 4006-1, 4025 and 4027 color display.

Tools for easy use of graphic and alpha-numeric capabilities of TEKTRONIX Terminals.

4010A01 PLOT 10 Terminal Control System $850

4010A10 PLOT 10 Terminal Control System, Implementation for IBM with TSO . . $1,095

4010A11 PLOT 10 Terminal Control System, Implementation CDC SCOPE/Intercom with Option 20 Interface $895

4010A12 PLOT 10 Terminal Control System, Implementation for PDP-11 with DOS . $895

Versatile software to graph your data using a powerful set of FORTRAN IV subroutines.

4010A02 PLOT 10 Advance Graphing II $950

Complete Support for TEKTRONIX 4013 and 4015 with self documenting commands, for the APL Programmer.

4010A09 PLOT 10 APL GRAPH II $850

4010A13 PLOT 10 APL GRAPH II, Implementation for APL/360 . . . . . $1,095

Office machine simplicity for the production of the most popular formats in graphing.

4010B01-5 PLOT 10 Easy Graphing . . . $875

4010B01 Plot 10 Easy Graphing Punch Paper Tape $875

4010B02 Plot 10 Easy Graphing 026 Format Punched Cards $875

4010B03 Plot 1 Easy Graphing Magnetic Tape $1250

4010R04 Plot 10 Easy Graphing Dec RK-05 Hard Disc $1000

410B05 Easy Graphing 029 Format Punch Cards $875

4010C01 PLOT 10 Interactive Graphics Library.

Powerful graphing through English language commands for the non-programmer

4010A03 PLOT 10 Interactive Graphing Package $1,300

Correct your graphics easily with a TEKTRONIX Terminal before plotting.

4010A04 PLOT 10 Preview Routines for CalComp Plotters $350

Provides complete flexibility of character definition, including rotation, scaling, and special characters.

4010A05 PLOT 10 Character Generation System $175

Point by point TEKTRONIX 4953 and 4954 support plus pencil and paper input ease for many computer systems.

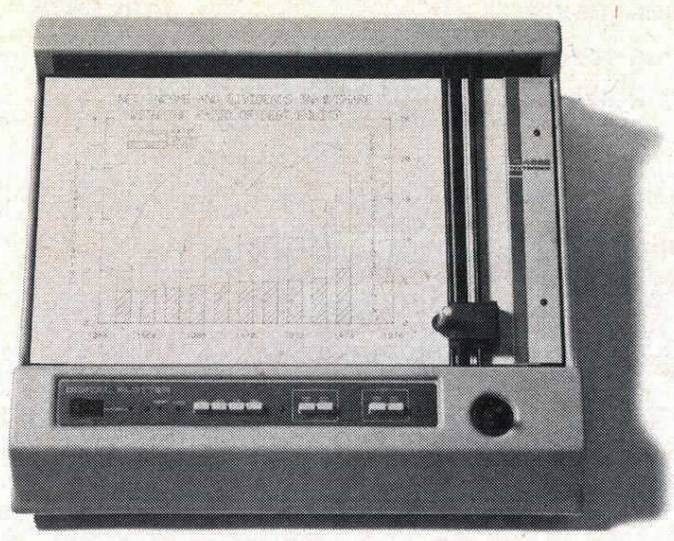
4010A06 PLOT 10 Graphic Tablet Utility Routines $125

Individual addressing of up to 12 Tektronix displays.

4010A08 PLOT 10 Display Multiplexer Utility Routines $110

Designed for device independent control of DVST, raster scan displays, and plotters. Offers a growing array of graphics control functions such as commands for color, 3-D, line smoothing, and multi font text manipulation.

4662



Microprocessor Based

7-Character Fonts

RS-232-C and GPIB Compatible

GPIB Product

The Tektronix 4662 Interactive Digital Plotter is microprocessor based, interactive, flexible in capabilities and easy to use.

25.5 mm x 38.1 mm, (10 in x 15 in), drawing area.

0.005 inch resolution ±0.0025 inch repeatability.

1:1 reproduction of crt displays up to 19 in diagonal.

Convenient, electrostatic positioning. Pen speed is 16 to 22 ips.

It is plug compatible with many Data Communications Systems (RS-232-C Full Duplex) and with the TEKTRONIX 4051 and IEEE 488-1975 interface standard.

The Fully Internal Character Generator Easy Labeling from Terminal Keyboard Exact Sizing to "Fit" only Graph or Plot.

1600 byte buffer.

Accommodation of Formatted Media.

Joystick Positioning.

Allowance for up-dating or changes on back of acetate.

90 watts maximum, 60 watts typical power requirement.

30 lb 13.8 kg Approx Weight.

UL Listed, CSA Approved.

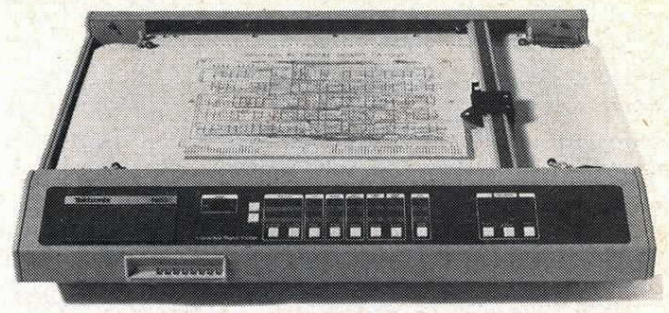
ORDERING INFORMATION

4662 Interactive Digital Plotter $4,195

Option 01, Interactive Digital Plotter (for 4051 Graphic System) . . . . . NC

Option 30, RS232 Interface for 4081 . . . . . Add $525

4663



Built-in Processing Power

C-Size: 420 mm x 594 min

Unique Parameter Entry Device

GPIB Product

The 4663 is the first high speed C-size plotter with the built-in processing power. This built-in processing power together with 5.5k buffer memory frees the host from many routine computational operations.

This gives you maximum system efficiency. The paper advance option is available for roll stock.

The plotter features dual programmable pen control with interchangeable multi-color pens and is capable of producing dotted or dashed lines from local firmwave.

SPECIFICATIONS

Max. Plotting Area — X axis 569 mm x Y axis 432 mm (22.4 in x 17 in).

Repeatability — ±.0025 inches.

Max. Plotting Speed — 16-22 ips Vector Dependent.

Paper Size — U.S. C-size (17 in x 22 in)—European A2-size (420 mm x 594 mm).

Media Type — Paper or acetate.

Baud Rate — −110 −9600 BPS.

Joystick — Manually positions the pens or cross-hairs. US Listed CSA Approved.

ORDERING INFORMATION

4663 Interactive Digital Plotter $9,495

Option 36 Paper Advance . . . . . Add $700

4631

Dry Process Hard Copy Unit

21.6 cm x 28 cm, (8½ in x 11 in), copies
Supports up to Four Terminals with optional multiplexer

SPECIFICATIONS

Paper Size — 21.6 cm x 28 cm, (8½ in x 11 in) Dry Silver.

Copy Size — Position I and III produces 22.5 cm x 17.1 cm, (8.85 in x 6.7 in), copy, oriented horizontally

on an 21.6 cm x 28 cm, (8½ in x 11 in), piece of paper. Position II produces a 18.1 cm x 13.8 cm, (7.1 in x 5.4 in), copy, oriented vertically on an 21.6 cm x 28 cm, (8½ in x 11 in), piece of paper.

Exposure Time — Position I and II approx 7 s., position III approx 14 s.

Dimension — (Height, width, length) 29.5 cm x 40.7 cm x 64.8 cm, (11.6 in x 16 in x 25.5 in).

Weight — Approx 29.5 kg (65 lb).

Standard Accessories — One 10 ft Connecting Cable (012-0547-00).

ORDERING INFORMATION

4631 Hard Copy Unit $4,495

Option 01 — Copy Counter, automatically counts the copies made by the 4631 . . . . . Add $60

Option 02 — Four Channel Multiplexer . . . . . Add $575

One 4631 can copy up to 4 separate terminal displays and/or storage display units.

4632

Simple, Quiet Operation

Completely Self-Contained

Dry Process Developing

Permanent 21.6 cm x 28 cm, (8½ in x 11 in), Gray Scale Copies from Standard Video Signals and Most Refreshed Terminals.

SPECIFICATIONS

Standard Copy size adjustment is 21.6 cm x 28 cm, (8½ in by 11 in), for horizontal raster display (4:3 aspect ratio). Copy time is approx 18 s for the first copy and about 8 s for additional copies of the same display.

Input Requirements — Input signals may be any one of three configurations: composite video, video with horizontal and vertical drive, or video with composite sync. Input video amplitude is from 0.3 V to 5 V. Impedance is 75 ohms, loop-through. Return loss is at least 46 dB. Common-mode rejection is at least 30 dB. Max input is 10 V dc plus peak ac. Input sync amplitude is 0.3 V to 8 V p-p; impedance is 20 kΩ.

ORDERING INFORMATION

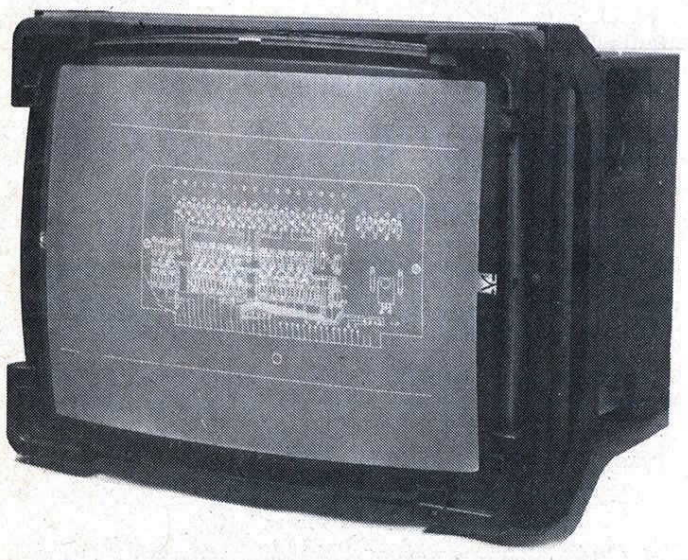
4632 Video Hard Copy Unit $4,595

OEM Products

The GMA Series of displays are designed to allow a system builder significant flexibility in incorporating a computer display with both low-cost and higher-performance options.

The following three GMA's are basic modules, each of which may be coupled to the many performance options to meet the specific need of the system builder. Exceptions on module/performance capability can be noted in the list of options.

GMA 125



The GMA125 was designed exclusively for systems builders and is intended to satisfy display applications of the greatest size and complexity. It incorporates 70% more workspace than even our own previous industry leaders, the 19-inch GMA102A and GMA-101A. Like other members of the GMA series, it provides high resolution storage tube graphics at low cost.

The detail of storage. The dynamics of refresh. The GMA125 features a 25-inch crt that offers unequaled information display capacity. Adjacent points that would be indistinguishable on a smaller screen can be seen as distinct units on the GMA125. It is ideal for group viewing and for greater graphics detail. A new 110 degree crt enables greater brightness with less energy consumption in a more compact package than would be achievable with a 90 degree crt.

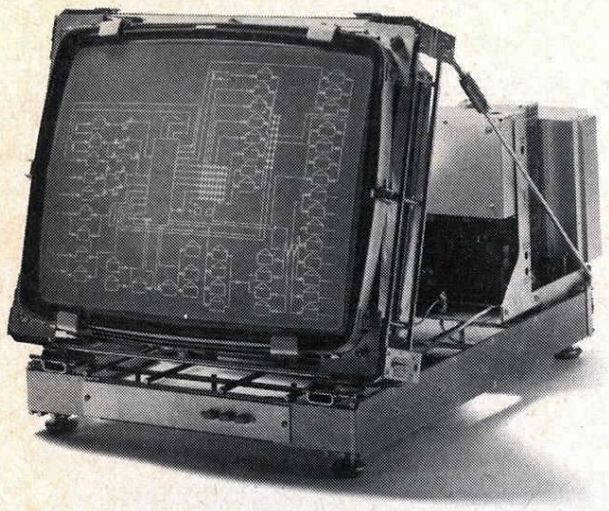
The GMA125 will display up to 1968 vector inches of refreshed data, enabling all the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage. By placing fixed or finalized data in store while retaining dynamic or working data in refresh, you can work interactively with high density graphics and alphanumerics while making maximum use of processing power to address the application rather than support the display.

Modular design assures ideal building economy. Order crt chassis and power supply only, or configure it based on your own manufacturing capabilities and system specifications. The welded-steel, symmetrically structured chassis may be rotated vertically or horizontally, and tilted to any degree. Space is left in the card cage for you to add up to three circuit boards with your own application options.

GMA Series Information Display Group

	GMA 101A		GMA 102A		GMA 125
PERFORMANCE CRITERIA	**Display**	**Opt 32 V/C Gen**	**Display**	**Opt 43 Hi Speed V/C Gen**	**Display**
Screen Size (diagonal)	48.3 cm 19 in		48.3 cm 19 in		63.6 cm 25 in
Stored Writing Speed: Vectors (Kcm/sec) Characters (char/sec) Vectors/msec	10	10 2000 >140	15	>11 >6000 >160	20
Refresh Capacity (30 Hz): Vector inches Characters Vectors/frame			1575 in	>1100 in >300 >13,000	1968 in
Refresh Speed: Vectors (Kcm/sec) Characters (char/sec) Vectors/msec			120	90 >10,000 >390	150
Stored Dot Writing Time (μS)	5		5		2
Settling Time (μS): >1 cm move <1 cm move	5+5/cm 10		1+2/cm 3		1+2/cm 3
Resolution: Line Pairs/inch (Screen center) Line Pairs/axis Addressable Points/long axis Addressable Points/inch Addressable Picture Elements Characters/line Lines/Page Characters/page	40 420x525	 4096 >290 >12M 133 64 >8500	40 420x525	 4096 >290 >12M 133 64 >8500	40 540x675
Contrast Ratio: Refresh (60 Hz) Stored	4:1		4:1 4:1		4:1 4:1
Stored Luminance (foot-Lamberts)	5		5		8

GMA102A/101A



GMA102A is a 19-inch high performance member of the GMA Series with both storage and refresh capability. The GMA 102A can display up to 1575 vector inches of refreshed data while simultaneously providing all of the benefits of storage technology. The refresh feature adds the benefits of selective erase, interactivity and dynamic motion with the same high resolution of storage.

The GMA101A is the 19-inch low cost, high resolution storage display available to the system builder and tailored for an application that emphasizes storage graphics. It has a very fast stored data-drawing capability of 3900 inches per second and at this rate, the entire screen can be redrawn in less than a second, permitting effective zooming or panning.

Modular Construction. Both the GMA102A and GMA101A have crt and printed circuit board modules arranged on a unique high strength wireform chassis. This construction not only supports different performance, interface and packaging options but permits easy removal of modules for field service.

GMA SERIES OPTIONS

Options

Option 30 Non-Hard Copy
Option 31 Vertical format (no charge)*
Option 32 Dot Character/Vector Generator
Option 33 Front Panel Pushbutton Switches*
Option 34 Analog Rear Connector
Option 35 Digital Rear Connector
Option 36 Excess Current +5 Volt Supply
Option 37 Green Glass CRT Filter*
Option 38 Blue Glass CRT Filter
Option 39 Green Plastic CRT Filter*
Option 40 Blue Plastic CRT Filter*
Option 42 High Speed Vector Generator (includes Option 36)**
Option 43 High Speed Vector Character Generator (Includes Option 36)**

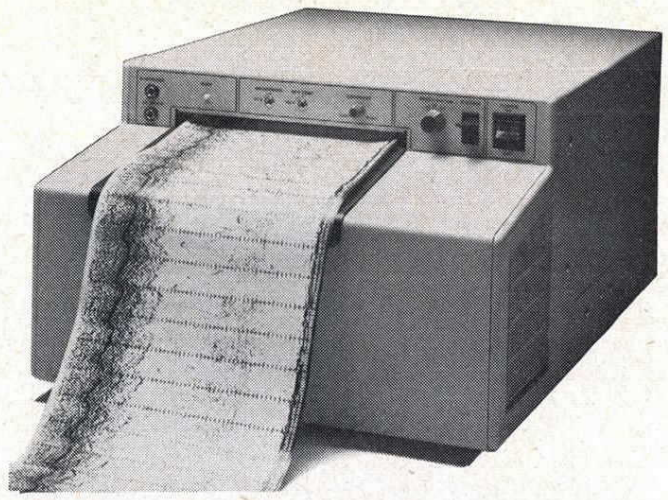
*Available on GMA101A or GMA102A only. Option 37 is included with basic GMA125.

**Available only with GMA102A or GMA125.

Peripheral

TEKTRONIX 4631 Hard Copy Unit

4633A Continuous Recorder. High-resolution black-and-white gray scale output.



The 4633A Continuous Recorder provides high-resolution hard copy from devices such as M-mode ultrasound systems, which produce a Z-axis input signal simultaneously with a horizontal ramp signal. It is particularly easy for the OEM system builder to integrate within any M-mode ultrasound system.

The key to its consistent high quality is the Tektronix fiber optics technology. Images are exposed one line at a time as paper moves across the fiber optic crt. They are then thermally-developed by the internal processor and emerge via a slot in the front panel.

Operation is especially straightforward, for example, in continuous format, output may continue either automatically or only as long as the RECORD switch is depressed. Page formats are adjustable for either 190 mm (7.5 in) or 270 mm (10.6 in) lengths.

Image width is also adjustable to a maximum full seven inches, allowing multiplexing of other signals alongside. Paper speed is selectable from 10 mm/sec, 25 mm/sec, 50 mm/sec and a two times speed control for rates of 20 mm/sec, 50 mm/sec and 100 mm/sec.

These and other options such as, inverted image, or slow scan continuous configurations are front panel selctable and easily implemented via simple jumper strap or pin adjustments on the internal circuit boards.

SPECIFICATIONS

RECORDING SPECIFICATIONS

Recording Paper — 3M Dry Silver, Type 7772.
Roll Paper Length — 152 m (500 ft)
Paper Width — 21.6 cm (8.5 in)
Image Width — 18 cm (7 in).
Resolution — Spot Size: 15 mm (.006 in).
Shades of Gray — 5 distinguishable levels with 8 linear input steps of 0.125 volts each.
Selectable Paper Speeds — 10 mm/s, 25 mm/s, 50 mm/s.
−2X SPEED (jack for foot switch) — 20 mm/s, 50 50 mm/s, 100 mm/s. Depress to double selectable paper speed, release to return to normal speed.
Record Mode Selection — Internal Jumper Selectable for page mode or one of two continuous modes.
Page Format — 190 mm (7.5 in) copy or 270 mm (10.6 in) copy.
Continuous Format — Push to Start, then Push to End the record; Or Push to Start, Release to End the record.
RUN/PAUSE (jack for foot switch) — Depress to initiate record, release to interrupt.

SAFETY

Listed by Underwriters (UL) 114 and Canadian Standards Association (CSA) 154.

4634 Image Forming Module. High contrast, gray scale dry paper records from raster scan video signals.

The 4634 uses Tektronix fiber optics technology to reproduce raster scan video signals on high quality photographic paper. The process is dry, fast, efficient and inexpensive, and is designed to provide the necessary stability required for consistently sharp gray scale images.

Virtually any video refresh display can be exposed and developed within seconds. Line rates are easily selectable—up to 1029 interlaced or 512 non-interlaced. The video image must remain static for about 8.5 seconds for the image to be properly recorded/exposed.

The exposed image is then thermally-processed and advanced through the front panel, dry and ready-to-use. Total image-forming time for an 11-inch record is 26 seconds for the first frame, aproximately 12 seconds for subsequent images.

The 4634 is adaptable, via rear panel switch, to use two types of paper for either best dynamic range and gray scale uniformity, or for instances where gerater operating economy is preferred to enhance gray scale.

SPECIFICATIONS

RECORDING SPECIFICATIONS

Recording Paper — 3M Dry Silver, Type 7772, or switch selectable to 3M Type 7770 paper.
Roll Paper Length — 152 m (500 ft); or about 540 11 inch copies.
Roll Paper Width — 22.6 cm (8.5 in).
Record Length — 17.8 cm (8.5 in).
Image Size — 20.3 cm (8 in) by 15.2 cm (6 in) ma.
Resolution — 125 Line per inch at optical density of 1.0.
Optical Density Range — Max Density 1.5; Min Density 0.12 with 3M Type 7772 paper.

COMPOSITE VIDEO OR VIDEO INPUT

Amplitude — Composite Video: 0.5 to 5 V, P-P.
Impedance — 75 Ω loop-through.
Return Loss — 46 dB or greater from dc to 5 MHz.
Common Mode Rejection — 30 dB or greater at 60 Hz.
System Bandwidth — 16 MHz or greater.
Maximum Input, Operating — ±10 V (Signal and dc offset).

SAFETY —

Listed by Underwriters (UL) 114 and Canadian Standard Association (CSA) 154.

***The GMA and Image Forming Series of IDG OEM Products are ONLY available to those qualified customers who purchase for resale. These products are separately priced and also have specific IDG quantity discounts, warranty arrangements and service contracts.**

MEG 121
MEG 131
MEG 141

Graphic Systems

Four Stage Engineering Tool

GRAPHICS FOR THE MECHANICAL DESIGN AND MANUFACTURING ENGINEER

The DIMENSION Series is a truly modular, uniquely flexible approach to CAD/CAM. We've brought together the state-of-the-art in interactive graphics and processing power, plus the latest generation of proven, powerful, easy to use mechanical design and manufacturing software, packaged according to your special requirements. You select from major software packages and subsets to begin your growth.

Design Software

This package represents the ultimate in two and three dimensional geometric construction, with facilities for splines, conics, surfaces, composites and more by a variety of techniques. A step by step menu guides the designer from rough ideas to refined plot. Various subsets will allow analysis of the geometry defined, including spline analysis, section properties, center of mass, moment of inertia, and other 2-D and 3-D analysis functions.

Finite Element Modeling Software

Our FEM software provides the most powerful graphics yet available to finite element modeling. Interactivity with the menu allows easy selection of commands. Automatic node labeling, nodal copy, Z-plane clipping, shrink element and other convenient commands simplify graphics generation and vastly reduce design time. A Mesh Generator is also available to further enhance your modeling capabilities.

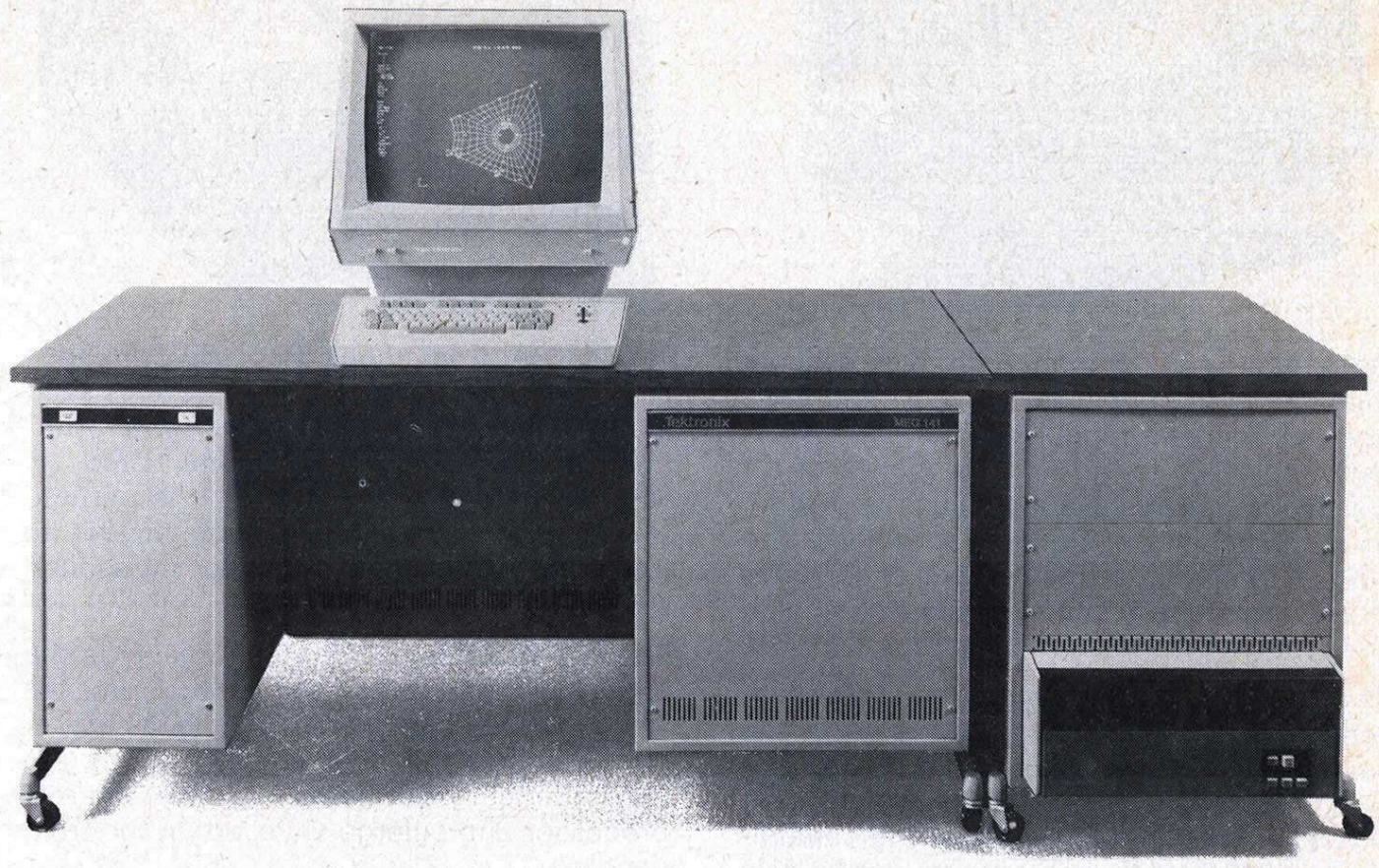
Drafting Software

This package provides a sophisticated, automated environment for mechanical drafting, parts management and attribute management with a variety of view and display controls available. Users can take advantage of dimensioning, line type, cross hatching, balloon and true position tolerance symbols, user definable character sets and basic geometric construction. Options include three dimensional construction and additional, advanced graphing support.

N/C Software

This enables numerical tape preparation via powerful, interactive graphics. Step-by-step menu format permits handling of multi-axis machining problems. It provides for a high level interactivity during both geometry construction and cutter motion creation, enhances clarity through labeling capabilities and alleviates conversion problems by creating a standard APT CL file. Highly modular, N/C software packages permit incremental function enhancements from basic systems to optional multi-axis routines. Contains automatic features or user controlled drive and check surfaces.

Dimension Series hardware is designed to satisfy specific equipment, graphic and growth need in virtually all applications and environments of mechanical design and manufacturing.



MEG121 Graphics Workstation

For users with existing computer systems, MEG121 provides easy access to Tektronix' advanced software capabilities. A complete console assembly incorporating the best of Tektronix' large screen high-resolution graphics, MEG121 can serve as a high performance vehicle for your own software or processing system; as the focal point for Tektronix' application software; or as an additional graphics workstation within a MEG131 multi-user application system.

MEG131 Graphics Application System

In its simplest form, MEG131 is configured with an integral minicomputer and one (or more) graphics workstation. But the real benefit of MEG131 is to provide multi-user capability and integrated data base throughout your design, analysis, drafting, and manufacturing environments.

MEG141 Intelligent Graphics Workstation

The MEG141 provides a powerful, interactive, stand-alone tool, compatible with virtually any host processor including the MEG131 applications system. Its stand-alone capability, disc memory and refresh graphic capabilities make it ideal for mechanical design and manufacturing applications including design, analysis, drafting, and manufacturing.

Peripherals like the following are plug compatible with all workstations and intelligent terminals in the Dimension Series.

4631 Hard Copy Unit

Quiet, quick, and proven reliable, the 4631 provides sharp 8½″ x 11″ paper copies of on-screen displays. Facsimiles are dry, permanent, and processed within seconds.

4662 and 4663 Digital Plotters

Both of these microprocessor-based units have set the standard for B- and C-size plotters. Packed with unexpected capabilities, as well as exceptional speed and precision, both plotters produce camera-ready graphics and alphanumerics on paper or acetate, in one, two or more colors.

4953 and 4954 Graphic Tablets

Console or drawing board size, these tablets let you digitize graphics directly from drawings to on-screen display, thus maximizing your interactivity with the system.

You can rely on us for total support

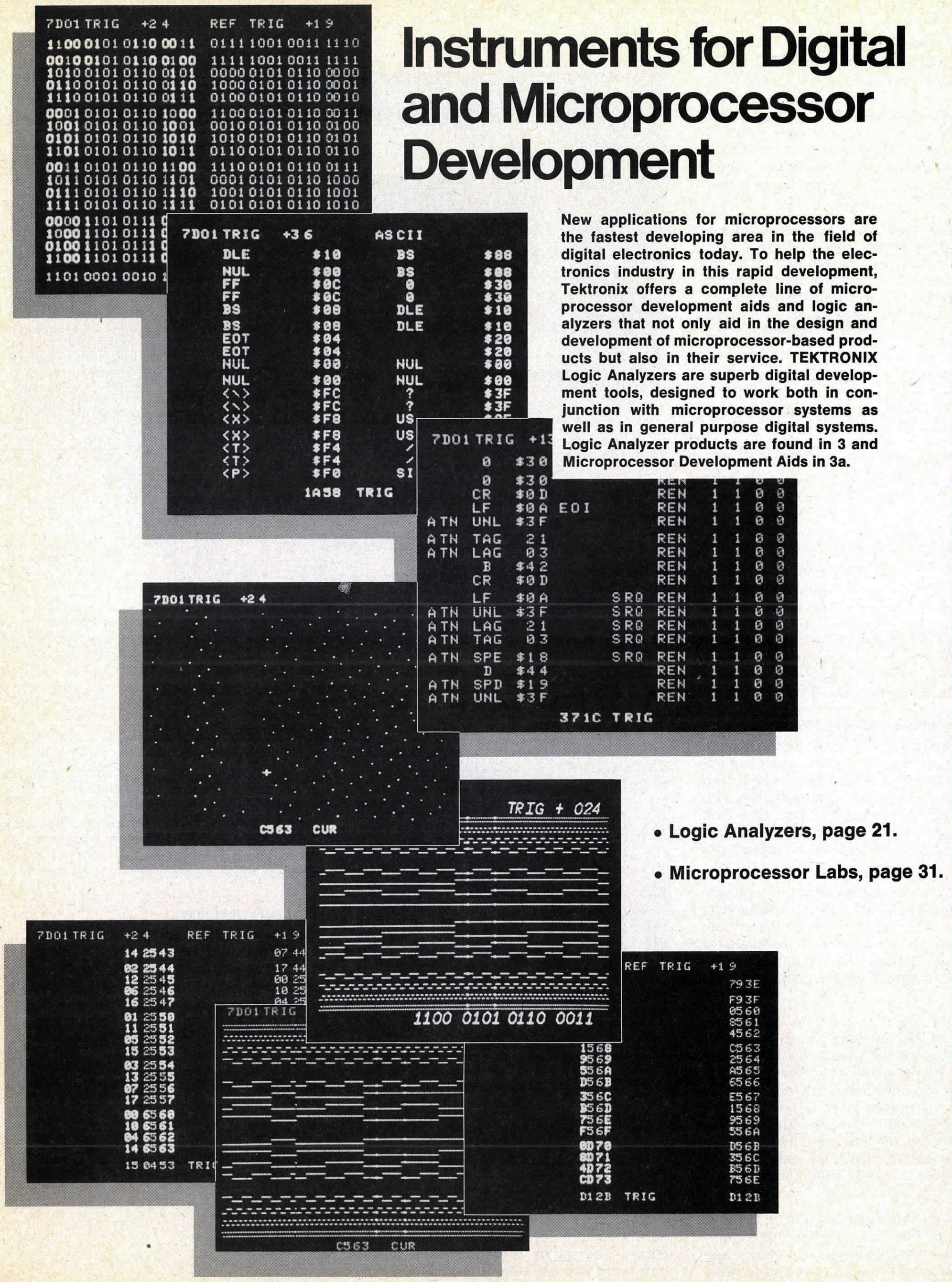
Support that begins at our manufacturing headquarters, with a rigorous inspection and testing program that makes every piece of equipment prove its dependability. You'll have experienced personnel getting your system up and running, and throroughly acquainting your engineers and programmers with its easy operations.

We provide both on-site training and specialized classroom seminars. We provide conscientious response to service requests, and can usually plug in replacement parts to get you back on the job quickly.

Tektronix' excellent warranty and regular maintenance programs make life a lot simpler for you. And there are a variety of financial arrangements available that make the Dimension Series all the more attractive.

Instruments for Digital and Microprocessor Development

New applications for microprocessors are the fastest developing area in the field of digital electronics today. To help the electronics industry in this rapid development, Tektronix offers a complete line of microprocessor development aids and logic analyzers that not only aid in the design and development of microprocessor-based products but also in their service. TEKTRONIX Logic Analyzers are superb digital development tools, designed to work both in conjunction with microprocessor systems as well as in general purpose digital systems. Logic Analyzer products are found in 3 and Microprocessor Development Aids in 3a.



- **Logic Analyzers, page 21.**
- **Microprocessor Labs, page 31.**

INSTRUMENTS FOR DIGITAL DEVELOPMENT

Logic analyzers represent the latest in a growing product family that is dedicated to solving the special problems encountered in the field of digital design. These problems are those generated when digital equipment exchanges information with other digital equipment over many channels simultaneously.

The logic analyzer decodes electronic signals into data words. This enables the designer to check that his random logic circuitry is performing properly and to isolate trouble areas. It also enables the programmer to evaluate the performance of his software while running on its intended hardware.

Whether in design, service, or production, the logic analyzer is the essential tool for everyone who needs to quickly sort through masses of digital information.

Why consider logic analyzers?

Why can't I use a good oscilloscope instead of a logic analyzer? This is the question most of us ask when first shown a logic analyzer. An oscilloscope is still the best general purpose instrument ever developed for analyzing an electrical signal.

Digital systems, however, depend not on a single electrical signal but on a combination of many such signals. The signal does not carry information; rather, the unique combination of signals at a given point in time conveys digital information, or data. This is why a logic analyzer is necessary.

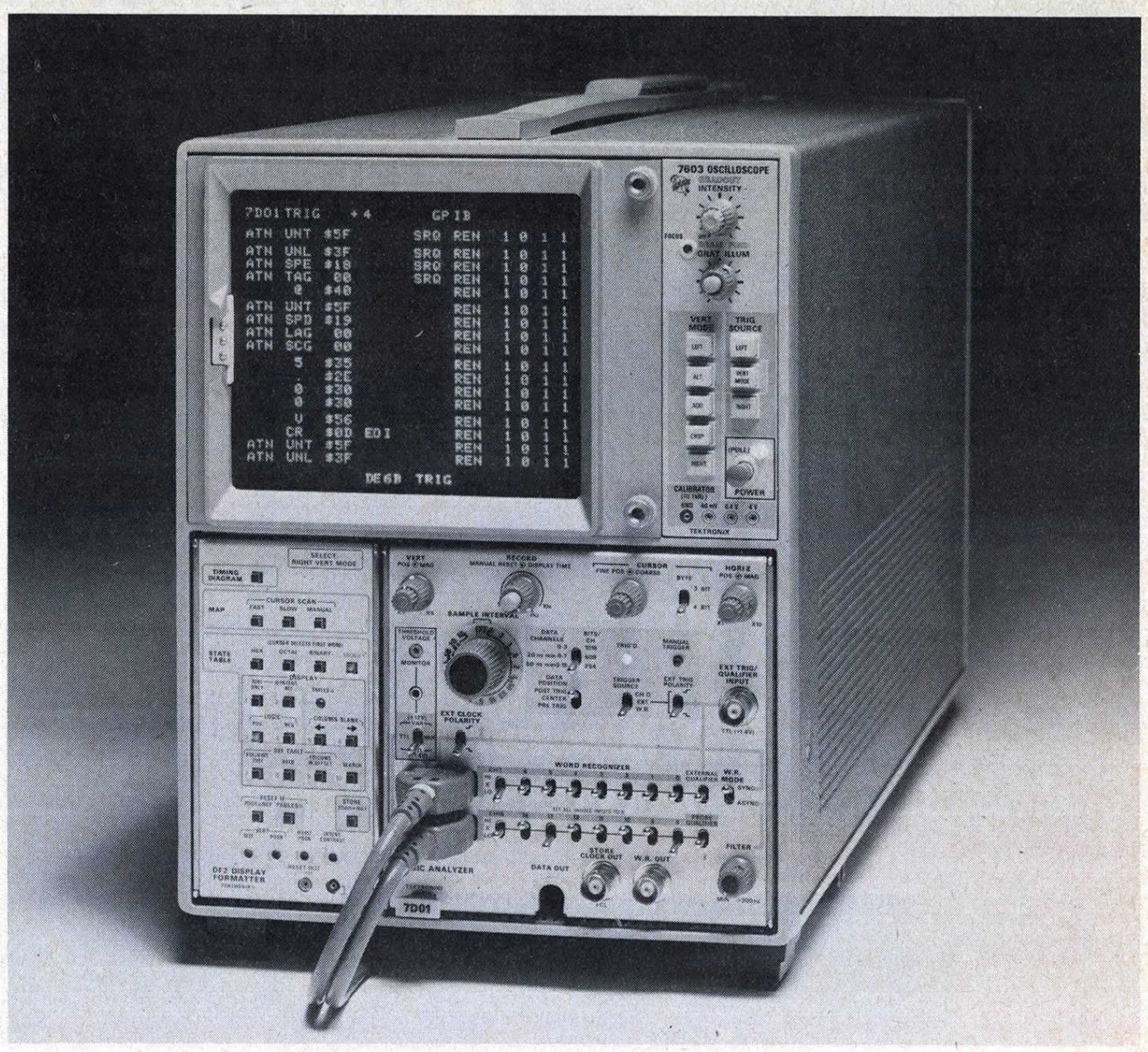
What does a logic analyzer do?

A logic analyzer does one important thing. It saves you time. In design and development, in service and maintenance, in troubleshooting hardware, in evaluating software, logic analyzers save you time and money by displaying logic in terms of data combinations rather than as individual signals.

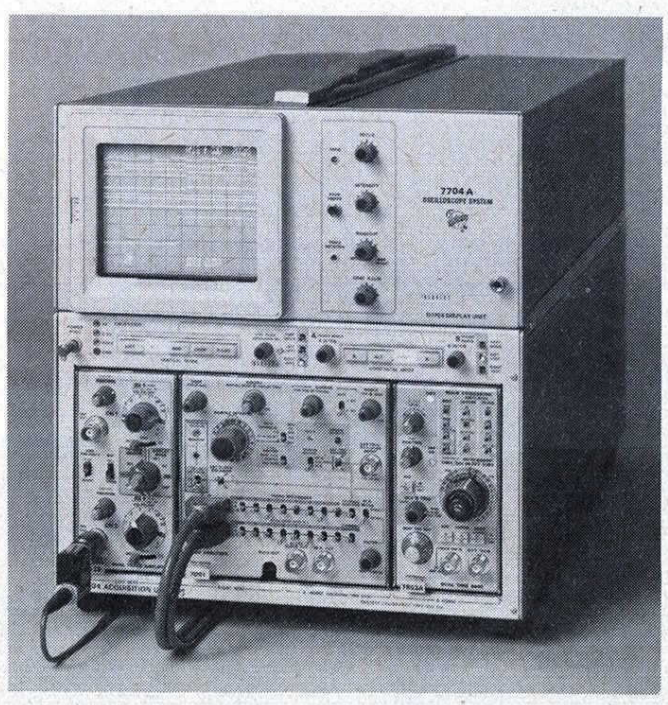
To analyze signal combinations, a logic analyzer acquires signals from many channels simultaneously, and then, at an appropriate trigger, stores the signals as data levels for later display. Storage holds the data so you can have as much time as you wish for analysis.

Sequentially shifting data into storage allows you to display data occurring before the trigger. Since the condition you're examining may be the result of earlier data combinations, you may need to look back in time from the trigger point to see what led up to it. This we call the pre-trigger display of data (or, sometimes, negative time) — the unique ability to display data that occurred before an error trigger was generated.

Likewise you can select a trigger point to display data that occurs after the trigger-post trigger display. Or, you can view a balanced display of pre- and post-trigger data-center trigger display.



The 7D01F2 Logic Analyzer (7D01 Logic Analyzer and DF2 Display Formatter) converts any 7000-Series Mainframe to a logic analyzer with seven ways to look at logic.



The 7D01 Logic Analyzer can be combined with general purpose oscilloscope plug-ins to produce a complete system capable of logic analysis and analog measurements at the same time.

But what about that trigger? Since data is the combination of many signals, the trigger event is most likely a combination of signals. A logic analyzer needs word recognition — the ability to recognize a unique data word and generate a trigger when the word occurs.

Word recognition is often the most versatile source of triggering. Any desired parallel word (up to 16 bits) can be selected with front panel switches for Hi, Lo, or X (don't care) conditions on each channel. The word recognizer will then trigger the logic analyzer whenever an incoming parallel word matches the one selected.

The Logic Company

Logic analyzer systems are available within the 7000-Series of oscilloscope-based instruments from Tektronix. We offer a variety of logic analyzer configurations so you can choose only as much analysis capability as you need. All logic analyzer instruments are compatible with our expanding line of instrumentation components so you can match your logic analyzer needs to your overall instrumentation needs. Match your instrument selection to your needs today or expand your system as your needs grow and as we add new measurement capability to our equipment families.

You can choose high-performance logic analyzers from Tektronix which offer:

- 16-Channel Operation to store and monitor signals on up to 16 data lines.
- Asynchronous Timing Resolution to 15 ns.
- Deep Memory to Store Pre-Trigger Data; Formattable with data rates for resolution of timing problems:

Asynchronous:

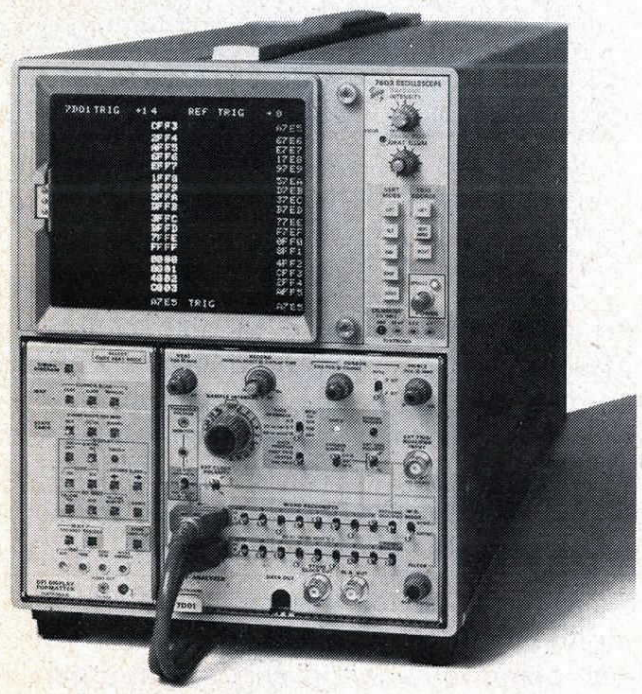
16 channels x 254 bits at 20 MHz
8 channels x 508 bits at 50 MHz
4 channels x 1016 bits at 100 MHz

Synchronous:

Up to 50 MHz

- High Impedance Probes that won't load your circuits.
- Word Recognition using 16 channels and 2 qualifiers.
- Pre-set, variable or split thresholds for working with different logic families.

The 7000-Series uses the modular instrument packaging system. Interchangeability of packages let you minimize your investment. Today's investment will not become obsolete with improvement in technology.



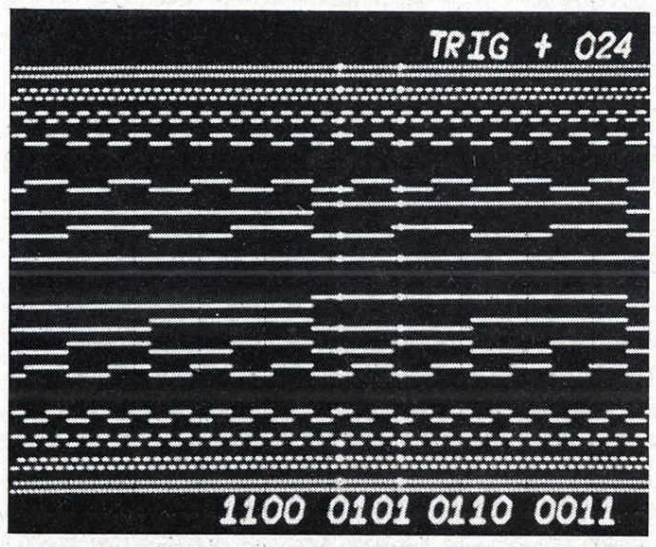
The 7D01F (7D01 Logic Analyzer and DF1 Display Formatter) makes a complete, basic logic analysis system when installed in a 7603 Mainframe.

TEKTRONIX Logic Analyzers are engineered to provide swift solutions to your logic problems. Tektronix will continue to support your application needs in the digital world of logic analyzers as it has for years in the world of oscilloscopes.

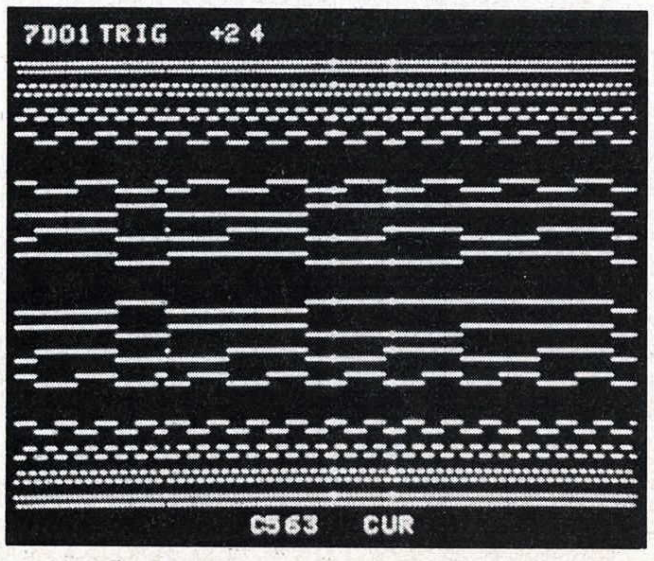
7000-Series Logic Analyzers

Plug-in compatibility within the family enables you to convert any existing 7000-Series Oscilloscope Mainframe into a high-performance logic analyzer. Conversely, the logic analyzer system (mainframe and logic analyzer plug-in) which you buy today can be converted later to a high-performance oscilloscope or spectrum analyzer merely with the addition of a plug-in or two. Consequently, your equipment investment is safe longer, and upgrading is cheaper than it would be with monolithic instruments.

The heart of the 7000-Series Logic Analyzer System is the 7D01 Logic Analyzer. This versatile plug-in acquires 16 channels of data simultaneously, contains its own 16-bit parallel word recognizer with two qualifiers, clock qualifier, has a formattable memory that stores 4096 bits in 4, 8 or 16 channel format, captures single shot data, features a movable cursor and comes equipped with two high-Z probes plus many other features.

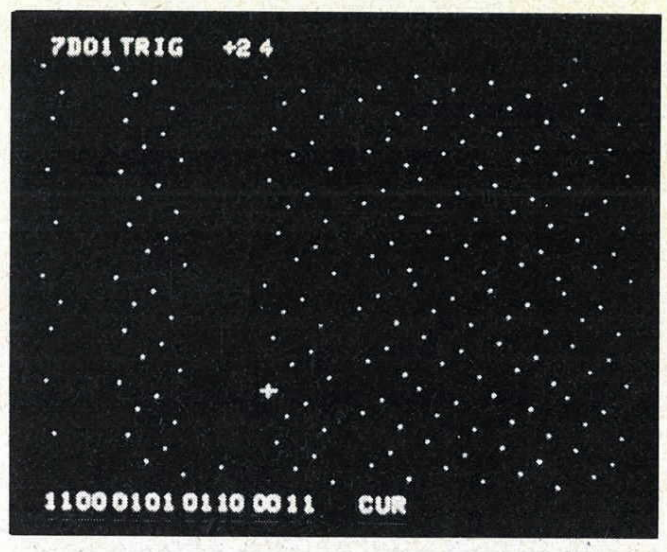


The 7D01 displays 16 channels of timing information, intensifies a movable cursor point on the data stream and displays its location and binary state equivalent on the crt.



The DF1 and DF2 display timing data similar to the 7D01 except that state readout can be binary, hex or octal (plus IEEE 488/GPIB and ASCII in the DF2) as desired, and that the mainframe need not be equipped with crt readout.

Until recently, logic analyzers have been display limited. To choose each different display format, you needed to choose a different instrument. Now, with addition of the DF1 and DF2 Display Formatter to the 7D01 Logic Analyzer, you have numerous display formats.

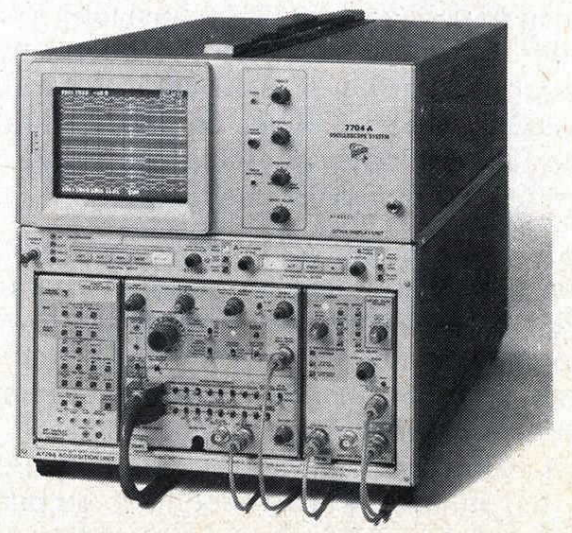


The data map display produced by the 7D01 in association with the DF1 or DF2, is reformatted for full screen display whether you use 4, 8, or 16 data channels.

TEKTRONIX Display Formatters offer you a choice as to the type of display that is best for you. The DF1 gives you five ways to look at logic in one package — Timing, Mapping and state table displays in Binary, Hexadecimal and Octal. The DF2 offers the same five display formats plus two additional modes — IEEE 488/GPIB (General Purpose Interface Bus) and ASCII (American Standard Code for Information Interchange) formats. With both the DF1 and DF2 you can use the map display for an overview of digital system performance. Whether you use 4, 8, or 16 channels, the Tektronix map is reconfigured for a full screen matrix. Or select a state table with binary, hexadecimal or octal words. Or display your data on a timing or ladder diagram for close examination of timing relationships between data lines.

With the DF2, you can display data in ASCII format and even monitor and display activity on a GPIB data bus in GPIB mnemonics.

Another Logic Analyzer Plug-in, the DL2 Digital Latch, extends the 7D01 Logic Analyzer's measurement capability by detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone.

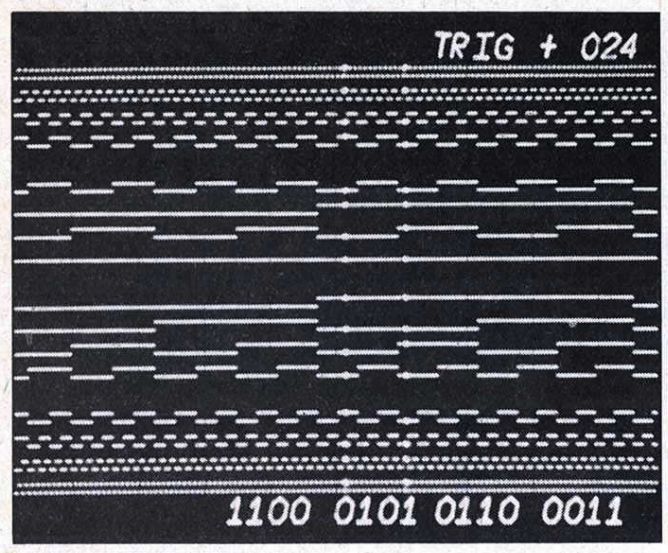


When combined with a 7D10 Digital Events Delay in four-compartment mainframe, the 7D01F System (or 7D01F2) obtains additional triggering flexibility, whereby the trigger of the logic analyzer can be delayed by up to 10^7 events.

7D01 LOGIC ANALYZER

The 7D01 is a dual-wide, plug-in instrument which occupies one vertical amplifier compartment and an adjacent time base compartment in any 7000-Series Oscilloscope Mainframe. With such compatibility, you can convert your existing 7000-Series Oscilloscope to a logic analyzer, or, if you use a four-compartment mainframe, you can combine your logic analyzer with your analog oscilloscope and display the outputs of both at the same time.

In order to get efficient use of the memory at all times, the 7D01 memory is formatted according to the number of input channels used. You can select: 16 data channels of 254 bits each at a 20 MHz sample rate, 8 data channels of 508 bits each at a 50 MHz sample rate, or 4 data channels of 1016 bits each at an asynchronous sample rate of 100 MHz, or a synchronous sample rate of 50 MHz.



The 7D01 displays up to 16 channels of timing data along with the binary state and location of the word at the movable cursor position.

Four methods of obtaining a trigger to store and display data are available. First, you can use the manual trigger button as a trigger source even if no data has been acquired so that you can center the traces and set intensity levels. Second, a trigger can be generated by the first positive-going transition on data channel 0 (CH 0 position). Third, trigger (of either polarity) can be received through a front panel BNC Jack (EXT position). Or fourth, a trigger can be generated by a unique data combination using the word recognizer (W.R. position).

The word recognizer produces an output when the logic states of the input channels match the states of the corresponding word recognizer switches. Probe qualifier and external qualifier functions select the logic state of external signals that can aid in word recognition. A variable filter (10 ns to 300 ns) inhibits word recognizer output to prevent false triggering from glitches or data skew. The store clock out BNC provides the sampling clock, external or internal, at the front panel for interface with digital delay, frequency counters or other external test equipment.

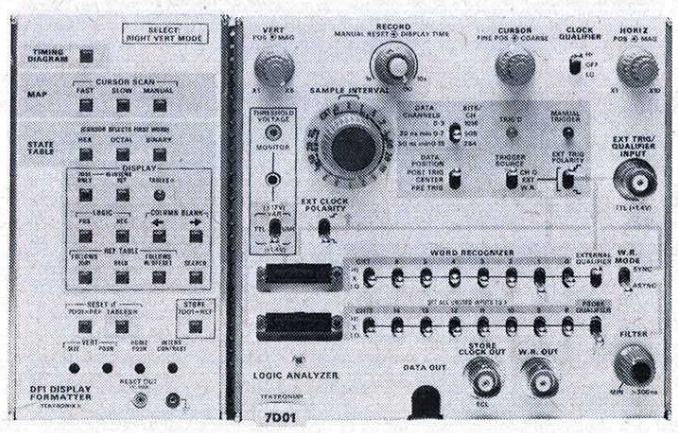
A clock qualifier can be used when the 7D01 is sampling in the synchronous mode, using the clock of the system under test. During normal synchronous operation, new data is sampled into memory once during each clock cycle. When the clock qualifier is activated, sampling will only occur when the clock cycle has been qualified by an external signal.

Data displays can feature data which occurs before the trigger (PRE TRIG selection), data which occurs after the trigger (POST TRIG), or data balanced between pre-trigger and post-trigger (CENTER position selection).

The trigger location is displayed with a column of intensified dots, one on each channel. A second column of intensified dots is positioned anywhere on the display with a movable cursor (COARSE cursor moves the dots in increments of 16 sample intervals or data clocks; FINE POS moves it in single increments). An alphanumeric readout at the top of the display locates the cursor relative to the trigger (in sample or clock intervals). A second readout at the bottom of the display identifies the data word at the cursor location, in binary, hexadecimal or octal.

Data is acquired by the 7D01 through two P6451, 10-channel, high-impedance, active probes. Each probe has eight data input channels, an external clock or qualifier channel and a ground lead. In order to minimize loading on test circuits, probe impedance is 1 MΩ paralleled by 5 pF. Grabber tips conveniently clip onto adjacent DIP leads, or by removing the grabber tip, the probe leads connect directly to 25-mil pins. Logic input thresholds can be selected at a pre-set TTL level or at any variable level between ±12 V. Additionally, one probe may be set to TTL, while the threshold of the other is varied. To assure you've selected the proper level, the threshold voltage can be continuously monitored at a front-panel jack.

Display Formatters



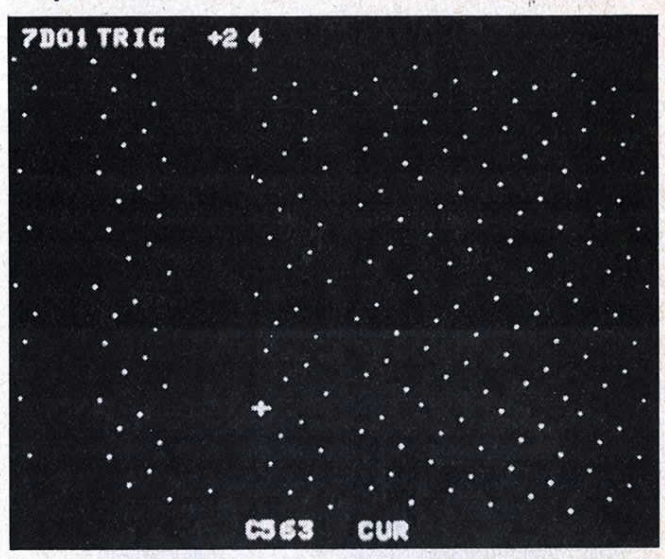
7D01F Logic Analyzer (7D01 and DF1 Display Formatter).

There are two Display Formatters available with the 7D01 Logic Analyzer — the DF1 and DF2. The two are identical in features and function except that the DF2 offers two additional display formats. Both the DF1 and DF2 offer Timing, Mapping and state table displays in Binary, Hexadecimal and Octal formats. The DF2 offers additional formats for IEEE 488/GPIB and ASCII.

Each Display Formatter is a dedicated plug-in for use with the 7D01. It occupies one vertical compartment adjacent to the 7D01 in the 7000-Series Mainframe, but does not function by itself — it connects to the 7D01. In formatting the logic display, the Display Formatter provides complete alphanumeric character generation so that the logic analysis package can be used in mainframes without crt readout (mainframe option 01). For dedicated logic analyzer packages, this saves you $400.

The timing diagram formatted by the Display Formatters is virtually identical to that of the 7D01 except that the state display of the cursor word may be presented in binary, hexadecimal or octal.

Map Mode



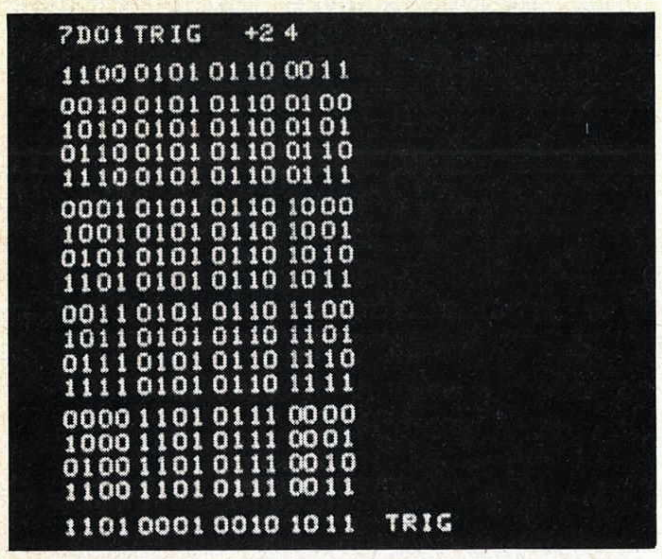
Both the DF1 and DF2 display a formatted map with up to 64K unique data word locations (254 can be displayed at one time) in a dot matrix according to value.

The map mode is used to display unique data words in memory. Up to 254 data words can be displayed at one time in a dot matrix according to value. The least significant half of the word determines the horizontal location of a word while the most significant half determines the vertical location.

In FAST or SLOW modes a "+" symbol automatically scans the map data, moving from point to point in the same order in which data was loaded into memory. A state display beneath the map (binary, hexadecimal or octal) shows the word at the "+" symbol location. In MANUAL mode the "+" symbol is manually moved across the map using the 7D01 cursor control. The cursor location in memory is displayed at the top of the display in all map modes as it is for the timing diagram.

A significant feature of the Display Formatter map is that it is formatted. That is, if 16 channel operation is selected, the map can display up to 64K unique data word locations (254 at one time). However, if only 8 channels are selected, the map is reformatted to use the entire display area for 8-bit words (a 4-bit by 4-bit matrix); similarly, the map is reformatted for full crt use if 4-channel operation is selected.

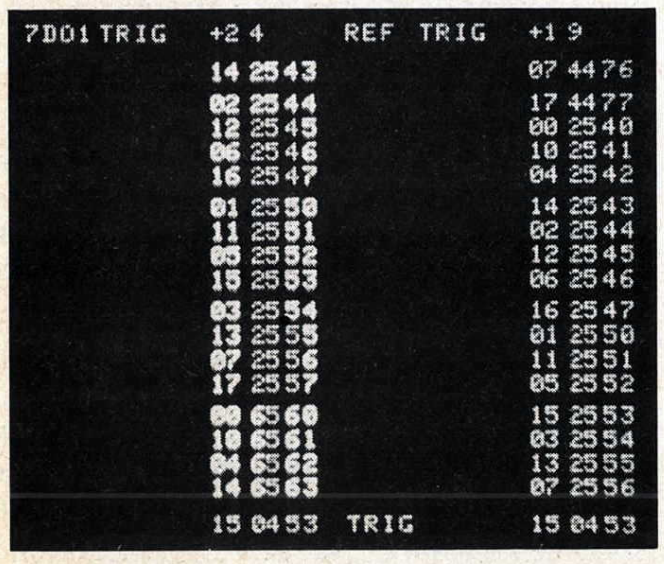
State Display Mode



The DF1 and DF2 display a binary state table consisting of the word selected by the cursor and the 16 following words. The 18th word at the bottom is the trigger word.

With the Display Formatters, you can display state information in the format best suited to your application: binary, hexadecimal or octal. (The DF2 offers additional formats for IEEE 488/GPIB and ASCII.) Each display presents 17 data words. An 18th word, the trigger word, is displayed at the bottom of the crt. When the trigger word occurs on the display, it flashes.

The DF1 and DF2 can display and compare new hexadecimal state data (on left) with stored reference data (on right).

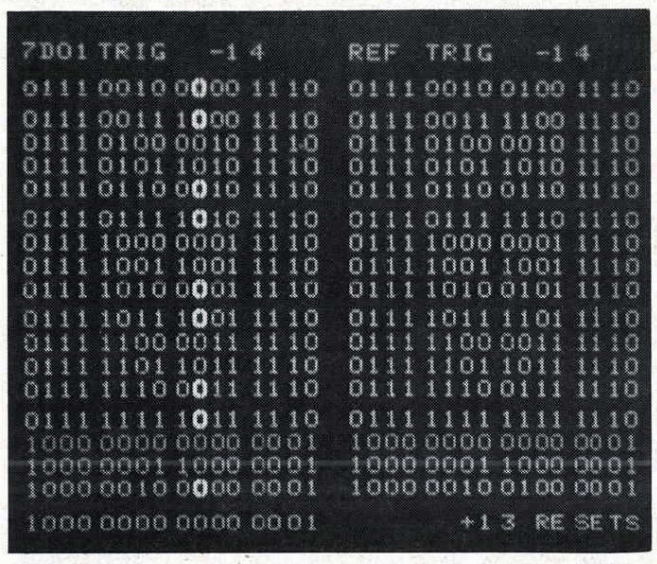


The DF1 and DF2 can display octal state data for convenience to operators who prefer to work in octal-based systems. In this display new octal information (on the left) is being compared with stored reference data (on the right)...

The memory stores 254 bits in 16-channel operation, 508 bits in 8-channel operation and 1016 bits in 4-channel operation. The state table (or page of data) that is displayed is selected by the cursor position. The cursor is used to page through all this data stored in memory in varying increments. Cursor FINE POS steps through data displays one word at a time. Similarly, COARSE cursor control moves the display 16 words at a time. Cursor location, relative to the trigger word, is displayed at the top of the crt.

EXCLUSIVE OR⊕

The 7D01 and DF1 or DF2 logic analysis package offers an EXCLUSIVE OR⊕feature that is used to compare newly acquired 7D01 data with reference data stored in the DF1 or DF2.



The RESET IF feature automatically monitors and detects intermittent faults that may occur in the system under test. The DF1 and DF2, in combination with the 7D01, does this by automatically acquiring up to 4096 bits of data and comparing it to 4096 bits of stored reference data. If a mismatch occurs between memories, the display formatter intensifies the differences so you know exactly where the fault is located.

Both the DF1 and DF2 have 4K memories which permit reference data to be stored and displayed on the crt side by side with 7D01 data for easy comparison. Older or reference data is displayed on the right side of the crt and newer 7D01 data is displayed on the left. With the EXCLUSIVE OR⊕feature you can display one page of memory at a time and any differences between the two state tables will be intensified in the 7D01 table. If there are no differences the TABLE = indicator light.

There are also two modes of automatic data acquisition in both the DF1 and DF2 that automatically compare the entire 7D01 memory to the reference memory. If a difference is detected in the RESET IF 7D01 = REF memory mode, the difference and location will be read out at the top of the 7D01 state table, intensified in the 7D01 table itself, and the number of resets required to find the error also displayed. The RESET IF TABLES=memory mode performs the same function except that it compares only the two tables selected by the cursor control one to another.

An additional feature, column blanking, gives you the ability on state displays to remove unwanted data, column by column, out of all compare functions. This permits you to concentrate your search for data by eliminating columns of data that are not relevant.

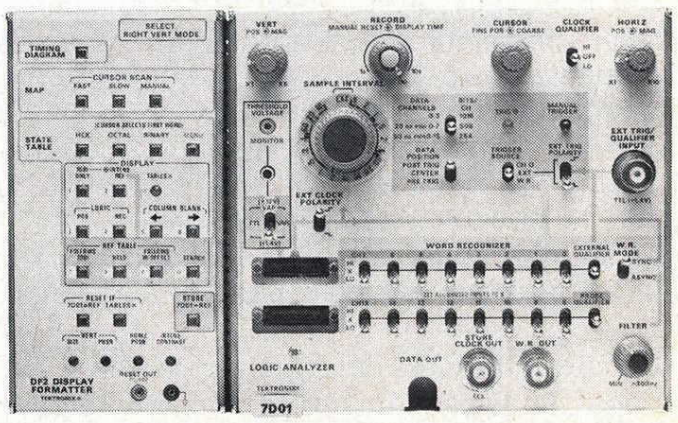
Four other features that augment each of the state displays are: reference table follows 7D01, reference table held, reference table follows with offset, and search.

When the reference table follows the 7D01, both tables begin at the same cursor location so that you can make comparisons between both 4K memories, one page at a time.

When the reference table is held, the cursor moves the 7D01 data display and holds the reference table so that you can compare one page in reference memory to any page of the new data. The amount of offset between the two tables is evident from the cursor locations displayed above both tables. Once an offset is selected in the HELD mode, the selection of FOLLOWS WITH OFFSET maintains a constant offset between the two tables. The cursor moves both displays keeping the offset constant.

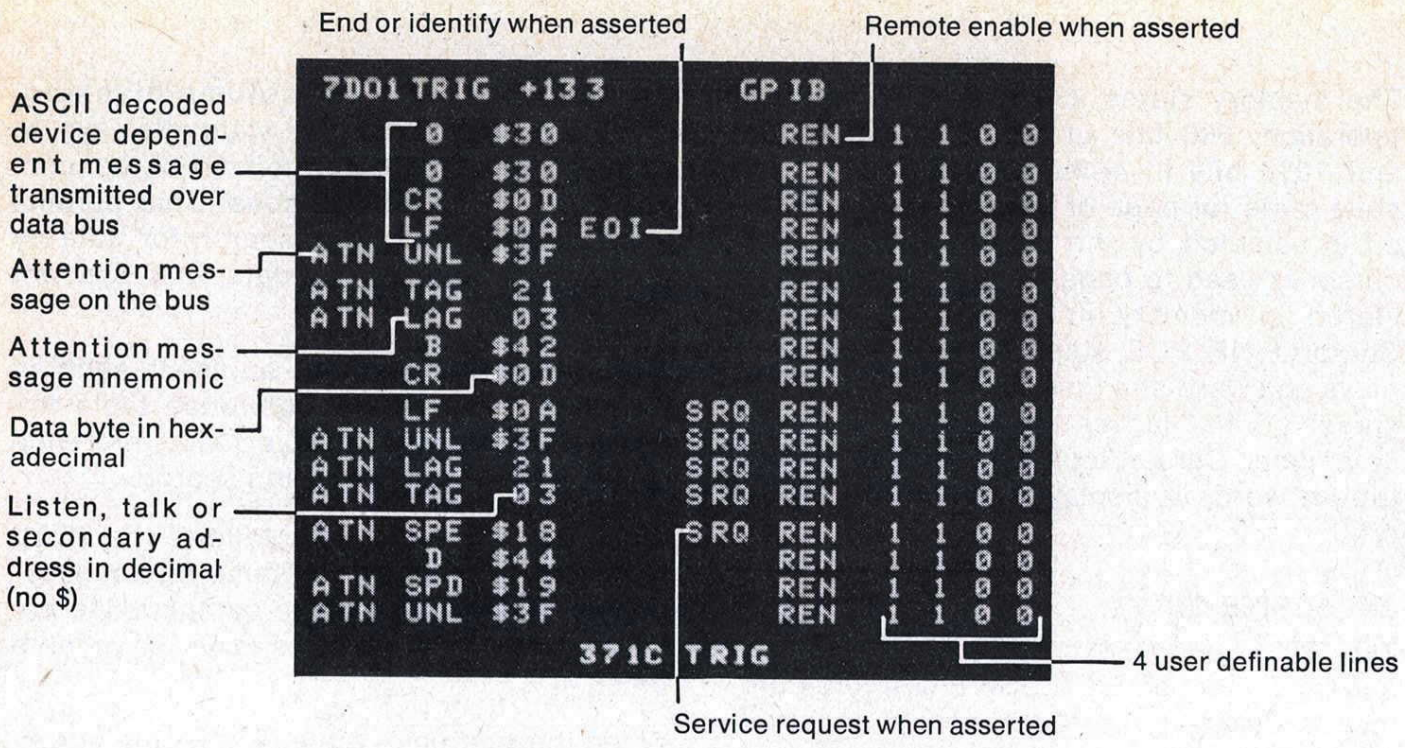
Search mode allows you to automatically scan the 7D01 memory for a word that you have stored in reference memory. This is accomplished by positioning the desired word to the first word in the reference state table. Pressing the SEARCH button will cause the Display Formatter to scan the 7D01 memory for that word. If it locates the word, it positions it to the first word in the 7D01 state display and reads out its location at the top of the crt. This operation is repeated each time the SEARCH button is pressed.

DF2 Display Formatter



7D01F2 Logic Analyzer (7D01 Logic Analyzer with DF2 Display Formatter.)

The DF2 Display Formatter is a second generation companion plug-in to the 7D01 Logic Analyzer and offers the digital designer a choice of seven display formats. Containing all of the features and functions found in the DF1 (including Timing, Mapping and state table displays in Binary, Hexadecimal and Octal), the DF2 provides two additional operational modes. These two modes are a format for ASCII and for IEEE 488/GBIB.



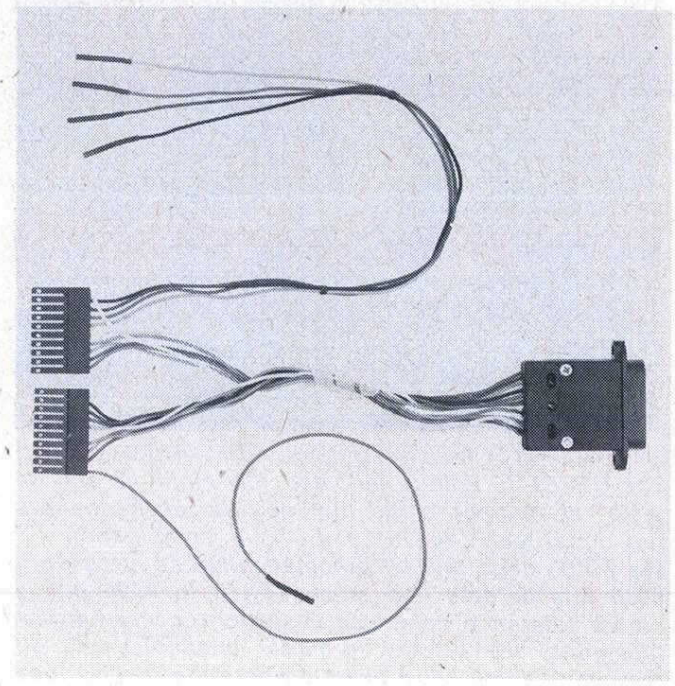
The GPIB mode monitors and displays activity on the GPIB data bus, transfer bus (handshake lines), and management bus (control lines). Disassembled instructions are displayed on the crt in IEEE 488 message mnemonics familiar to the GPIB user.

These two modes are selected from the DF2 front panel by pressing the MENU button. Pressing MENU will initiate a list of numbered items and display them on the crt. These numbered items are marked on the front panel from 1 to 10 (only 1 and 2 are now used).

Pressing button 1 (with the GPIB Probe Adapter connected to the leads of the P6451 Probe) will display on the crt the disassembled instruction in IEEE 488 message mnemonics familiar to the GPIB user.

Information is acquired synchronously using the data valid (DAV) line as a clock. Up to 256 instructions are stored in the 7D01 Logic Analyzer, then disassembled and displayed in format. Up to 18 instructions are displayed at one time, and, as the data is scrolled, all 256 instructions can be viewed. The states of four GPIB management lines (ATN, EOI, SRQ and REN) are displayed in GPIB mnemonics and eight data lines are displayed in hexadecimal or decimal. Four additional lines of data are user definable to provide circuit information and are displayed in binary. This display enables you to monitor and display activity on the GPIB data bus, transfer bus (handshake lines) and management bus (control lines).

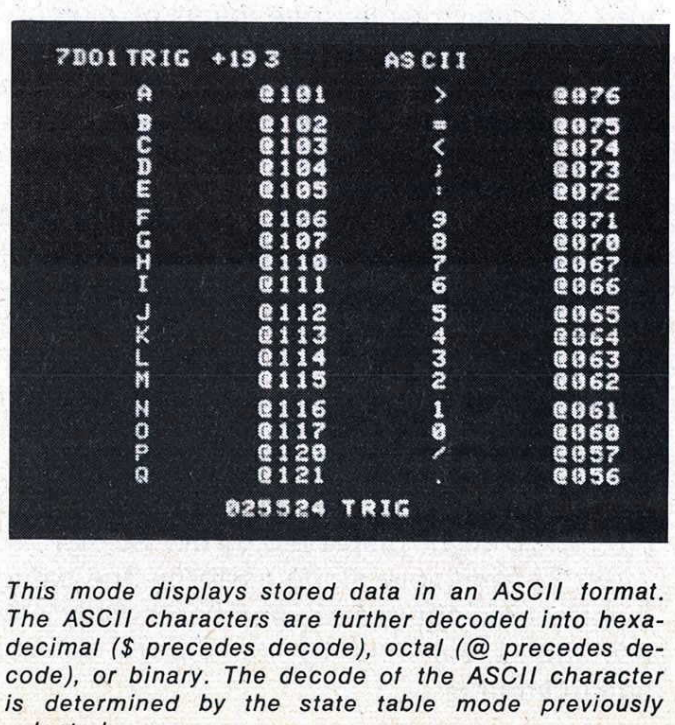
Because the DF2 is attached to the 7D01 Logic Analyzer, timing information relative to the handshake lines can be displayed with 10 ns resolution. This allows you the capability of not only checking the sequence of handshake activity but measuring the time relationships as well.



IEEE 488 standard connector with quick connections to P6451 Probe.

A 24-pin GPIB adapter provides the monitoring of the GPIB bus. Using this adapter, the DF2 is stacked on the system as any other piece of GPIB equipment. With this adapter, the DF2 monitors the bus activity and provides for monitoring of four user-selected lines. The logic analyzer may be triggered via the word analyzer GPIB lines or external event; the user may observe events prior to as well as following the trigger.

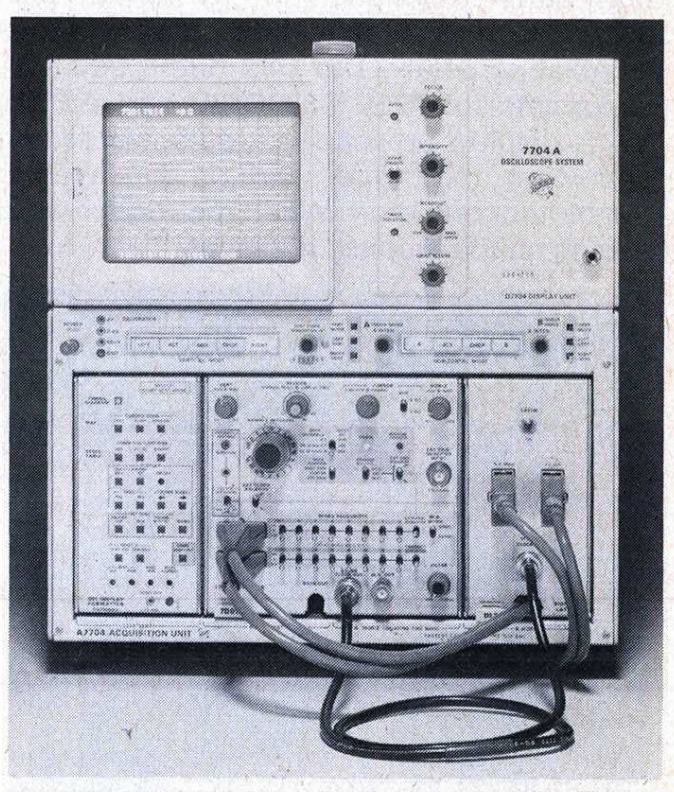
Pressing button 2 will provide a representation of the data recorded in the 7D01 memory in all 128 possible ASCII characters. The appropriate ASCII character will be displayed in 8 or 16 channel along with the binary, octal, or hexadecimal value to the right of the character.



This mode displays stored data in an ASCII format. The ASCII characters are further decoded into hexadecimal ($ precedes decode), octal (@ precedes decode), or binary. The decode of the ASCII character is determined by the state table mode previously selected.

Digital Latch

The DL2 Digital Latch extends the 7D01 Logic Analyzer's measurement capabilities by detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. Operating in an asynchronous mode, the 16-channel Digital Latch can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

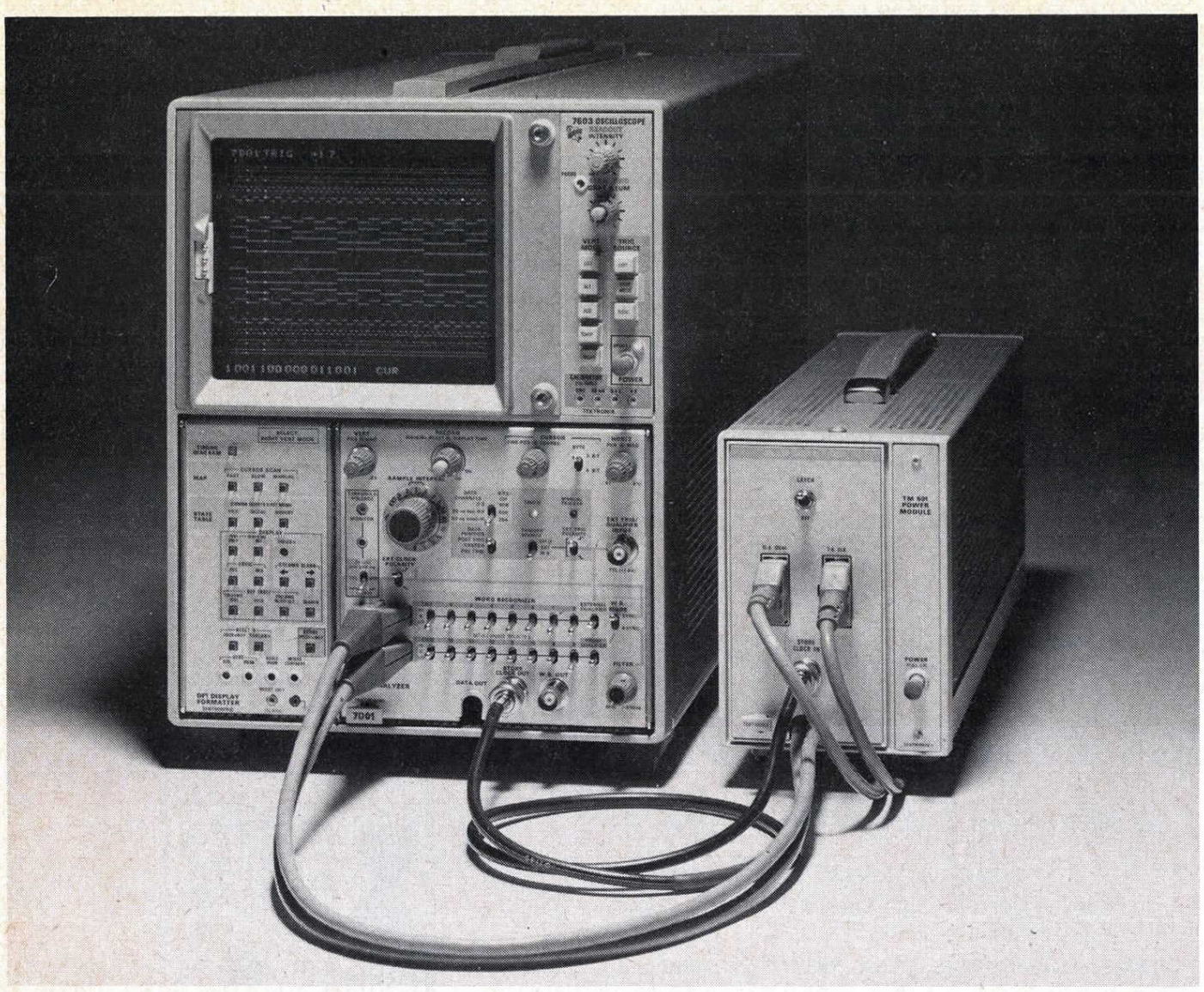


The DL2 Digital Latch extends the measurement capabilities of the 7D01 Logic Analyzer by detecting glitches which are narrower than one sample interval.

In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL2 Digital Latch allows you to expand the time frame in which information can be stored by sampling at a slower rate. The DL2 captures the glitch (or pulses which are narrower than one sample interval), holds it until the next clock edge, then expands it to one sample interval for display.

The DL2 plugs into any compartment of a 7000-Series Mainframe. Two 25-pin connectors connect the DL2 with the TEKTRONIX 7D01 Logic Analyzer. Data is acquired via the P6451 Probes which plug into the front panel of the DL2.

A two position switch allows you to select either the LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the 7D01 Logic Analyzer to the STORE CLOCK IN of the DL2.



The flexibility of the DL 502 allows it to be used in a variety of configurations. It can be used with all TM 500 Mainframes as a companion to the 7D01 Logic Analyzer (as is is depicted above.)

Whether you select the 7D01 Logic Analyzer or any of the combinations (7D01F, consisting of the 7D01 and DF1) or the 7D01 and DF2, you can choose any 7000-Series Mainframe for a powerful logic analysis system that is fully compatible with an extensive oscilloscope measurement system. Performance characteristics of the 7D01, DF1, DF2 and DL2 are listed here. Characteristics of the mainframes may be found on pages 39 through 58.

7D01 CHARACTERISTICS

The 7D01 acquires 4, 8, or 16 channels of data and stores the data in a 4k memory. Data storage format is selectable as 4 channels x 1016 bits, 8 channels x 508 bits, or 16 channels x 254 bits.

Data sampling can be asynchronous (internal clock) or synchronous (external clock). In asynchronous modes, sampling rates can be selected up to 100 MHz in the 4 channel mode, up to 50 MHz in the 8 channel mode, or up to 20 MHz in the 16 channel mode. External sampling clocks up to 50 MHz can be used in the 4 and 8 channel modes, and up to 25 MHz in the 16 channel mode.

An invalid light (blinking light behind knob skirt) warns the operator that he has selected:

1. A sampling rate greater than 20 MHz in the 16 channel mode; or
2. A sampling rate greater than 50 MHz in the 8 channel mode.

SIGNAL INPUTS

Clock, Qualifier, and Data Input Source — Two multi-lead P6451 Probes provide connections for 10 channels (9 input and ground) each. Channels 0-7 and clock are through probe 1, and channels 8-15 and qualifier are through probe 2. Each probe attaches through a 25-pin connector at the 7D01 front panel.

Clock Qualifier —	Setup	Hold
P6451	20 ns	0 ns
*External	11 ns	7 ns

*Measured at external BNC jack. For 0 ns hold time, 42 inch BNC coaxial cable is recommended.

Input Impedance — 1 MΩ paralleled by 5 pF (at probe head).

Threshold at Probe Tips — Front panel switch selects fixed TTL (+1.4 V ±0.2 V), variable (±12 V) or split (variable for top probe, TTL for bottom probe). Front panel jack monitors variable threshold only.

Minimum Logic Swing — 500 mV plus 2% of threshold voltage p-p or less, centered on the threshold voltage.

Maximum Logic Swing — −60V or less, to at least threshold voltage plus 10 V. (Max non-destructive input ±60 V.)

MEMORY

Storage — 4096 bits

Format — Front panel selectable.

Data Channels Displayed	Bits per Channel
0-3	1016
0-7	508
0-15	254

SAMPLING RATE

Asynchronous (internal clock) — Sampling intervals are selectable from 10 ns to 5 ms in 18 steps using a 1-2-5 sequence.

Data Channels Displayed	Maximum Sampling Rate	Minimum Sampling Interval*	Min. Data Pulse Width*
0-3	100 MHz	10 ns	15 ns
0-7	50 MHz	20 ns	25 ns
0-15	20 MHz	50 ns	55 ns

*Minimum data pulse width to insure recording is one sample interval +5 ns.

Synchronous (external clock) — + or − edge of clock pulse can be selected to initiate sample.

Data Channels Displayed	Max. Clock Freq.	Minimum Clock Width*	Data Set-up Time Required	Data Hold Time Required
0-3	50 MHz	10 ns	20 ns	0
0-7	50 MHz	10 ns	20 ns	0
0-15	25 MHz	20 ns	23 ns	0

*High and low clock width.

INTERNAL CLOCK

Crystal Oscillator Frequency — 100 MHz ±0.005 MHz.

Sample Intervals — 10 ns to 5 ms/sample in a 1-2-5 sequence.

Store Clock Out Connector — Sampling clock is output during store cycle. This clock may be either the internal or external clock. ECL Level. Reverse terminated in 50 Ω. Do not terminate at receiving end.

WORD RECOGNIZER

Word Recognizer — 16 data inputs, Probe Qualifier and External Qualifier. Output is true when input conditions match settings (HI, X, LO).

Format	Minimum Input Pulse Width (Asynchronous Mode)
Any Single Channel	10 ns or less
Channels 0-3	15 ns or less
Any Other Combination	20 ns or less

Inputs — 16 data input channels plus 2 qualifiers.

Qualifiers — Can be used to recognize 18 bit words.

Word Selection — Made using eighteen 3-position toggle switches. Positions are HI, X (don't care), and LO.

Modes — Synchronous (looks for a match with the selected logic states only at an external clock edge) and asynchronous (looks for a match with the selected logic states at any time).

Synchronous Mode Characteristic	Time Requirement
Minimum Setup Time	12.5 ns or less
Minimum Hold Time	8.5 ns or less

Async Filter — Rejects recognized words that remain true for less than an operator selected time period. Period is variable from 10 ns to 300 ns.

W.R. Out Connector — A recognized word produces a displayed trigger marker and a front panel output for triggering external circuitry.

Characteristic	Requirement
HI Level	≥1.9 V
LO Level	≤0.1 V
Impedance (Rising Edge)	50 Ω ±10%

TRIGGER

Source — Three-position switch provides selection of trigger source from among channel 0, external (External Trigger/Qualifier Input), or internal word recognizer. A display can also be obtained with front panel MANUAL TRIGGER pushbutton.

Channel 0 — Triggers on rising edge of CH 0 data.

External Trigger/Qualifier Input Connector (EXT TRIG/QUALIFIER INPUT) —

Characteristics	Requirement
Threshold	+1.4 V, ±0.2 V (TTL Level)
Minimum Pulse Width	15 ns
Maximum Safe Input Voltage	−5 V or less, to at least +10 V

Triggered Light — Indicates display trigger has occurred.

Trigger Marker — Trigger position on crt display is marked by an intensified spot. Spot appears on all displayed channels.

DATA POSITIONING

Three-position switch selects between pre-trigger, center-trigger, and post-trigger modes. In the pre-trigger mode ≈90% of the displayed data occurs before the trigger and ≈10% after. In the center-trigger mode ≈50% of the data occurs before the trigger and ≈50% occurs after. In the post-trigger mode ≈10% of the data occurs before the trigger and ≈90% after.

CURSOR

Word Selection — Cursor appears as a movable second intensified spot on the crt display. It is used to select and mark a word.

Coarse and Fine Position Controls — Coarse control moves cursor in increments of 16 sample intervals. Fine control moves cursor in increments of 1 sample interval.

Cursor to Trigger Position Crt Readout — The difference in sample interval bits between cursor position and trigger position is displayed by the crt readout at the top, right-hand portion of the crt graticule (e.g., TRIG ± XXX).

Cursor Position Binary Data — The logic state of each displayed channel coincident with the cursor position is displayed in binary by the readout at the bottom of the crt (HI=1; LO=0).

Cursor Byte Display — The two-position CURSOR BYTE switch selects the display format of the cursor readout to either a 3-bit or 4-bit byte. In 16 channel/3-bit byte format, the most significant byte group remains 4 bits.

DISPLAY

Type — Data is displayed as a timing diagram. The number of sample intervals between the trigger and the word selected by the cursor appears as an alphanumeric readout. The word selected by the cursor is displayed as ones and zeros in 3-bit or 4-bit groups.

Display Time — A rotary control is used to select the time for which stored data will be held for display before a new record cycle starts. Variable from less than 1 s to at least 10 s. A detent position provides indefinite storage of data. A new record cycle can be started at any time by pushing the MANUAL RESET button.

Vertical Display Controls (VERT POS/MAG) — A variable vertical magnifier control magnifies the on-screen display from X1 to X5. A concentric vertical position control positions the display within the graticule area.

Horizontal Display Controls (HORIZ POS/MAG) — A variable horizontal magnifier control magnifies the on-screen display from X1 to approximately X9. A concentric horizontal position control positions the display within the graticule area.

Display Format — Selectable by a switch (DATA CHANNELS).

Format	Bits/Chan	Display
Chan 0-3	1016 bits	1 group of 4 traces
Chan 0-7	508 bits	2 groups of 4 traces each
Chan 0-15	254 bits	4 groups of 4 traces each

Crt Retrace Blanking Time —

Format	Bits Blanked
Chan 0-3	8 bits
Chan 0-7	4 bits
Chan 0-15	2 bits

Trigger Intensified Marker — Intensified zone indicating the trigger point, selectable by a switch (DATA POSITION).

Data Position Switch Setting	Intensified Zone Location
Pre-trigger	Near extreme right of display
Center-trigger	Near center of display
Post-trigger	Near extreme left of display

Trigger Intensified Marker Accuracy — Position of intensified zone with respect to word recognizer output.

Sample Interval Control Setting	Maximum Bit Error
10 ns	±4 bits
20 ns	±3 bits
50 ns to 5 ms	±1 bit

DATA OUTPUT

Connector — A 25-pin connector (inside 7D01) provides output of stored data from the 7D01. It also provides control signals necessary for transfer of that data to other equipment. All outputs are ECL levels.

Parallel Data — 16 pins provide parallel access to stored data.

Serial Data — One pin provides serial access to stored data.

Flag — A positive-going edge on this pin indicates the end of each channel.

Format — 2 pins are used to identify the stored format as 4 channels x 1016 bits, 8 channels x 508 bits, or 16 channels x 254 bits.

Frame — Occurs every 16th sweep. A positive-going edge indicates end of channel 3. Negative during channel 3.

Display/Store Mode — Store HI
Display LO

Trigger Marker Output — LO = marker point in data stream.

External Display Clock Input — Allows data output at externally selected rates 1 Hz-2 MHz.

POWER

Line Voltage Ranges — Determined by the 7000-Series Oscilloscope Mainframe.

Power Consumption — 32 W at nominal line voltage.

ENVIRONMENTAL

Temperature — Operating: 0°C to +40°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: to 15,000 feet. Nonoperating: to 50,000 feet.

Vibration — With the 7D01 and DF1 or DF2 combined, frequency swept from 10 to 50 cps at one minute per sweep. Vibrate for 15 minutes along each of the 3 major axes at 0.015 inch total displacement. Hold 3 minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 s duration, 2 shocks in each direction along 3 major axes, for a total of 12 shocks.

INCLUDED ACCESSORIES

Two, P6451 Data Input Probes (010-6451-03).

DF1 CHARACTERISTICS

The DF1 reformats the output of the 7D01 in a choice of five display formats including Timing, Mapping and state table displays in Binary, Hexadecimal and Octal. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

DF2 CHARACTERISTICS

The DF2 reformats the output of the 7D01 in a choice of seven display formats including Timing, Mapping and state table displays in Binary, Hexadecimal, Octal, ASCII and IEEE 488/GPIB. It imposes no significant electrical characteristics on the 7D01 which affect measurement parameters.

INCLUDED ACCESSORIES

GPIB Probe Adapter for the P6451 (103-0209-00). (A 24-pin IEEE Standard Connector with quick connection to the P6451 Probe Head.)

DL2 CHARACTERISTICS

The 16-channel DL2 aids the 7D01 measurement capabilities by detecting narrow asynchronous pulses of less than one sample interval or as narrow as 5 ns in a data stream. The DL2 plugs into any compartment of a 7000-Series Mainframe. Two 25-pin connectors connect the DL2 with the 7D01. Data is acquired via two P6451 Probes which plug into the front panel of the DL2.

Minimum pulse width to initiate latch — 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock—20 ns.

ORDERING INFORMATION

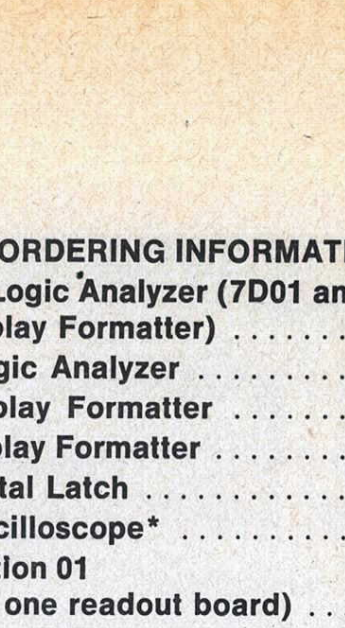
7D01F2 Logic Analyzer (7D01 and DF2 Display Formatter) $5450
7D01 Logic Analyzer $3520
DF1 Display Formatter $1530
DF2 Display Formatter $2140
DL2 Digital Latch $1650
7603 Oscilloscope* $2260
7603 Option 01 (Deletes one readout board) . . . . . Sub $400
7704A Oscilloscope* $3635
7704A Option 01 (Deletes one readout board) . . . . Sub $400

To modify your present 7D01 to include the new clock qualifier feature order Clock Qualifier* modification kit.

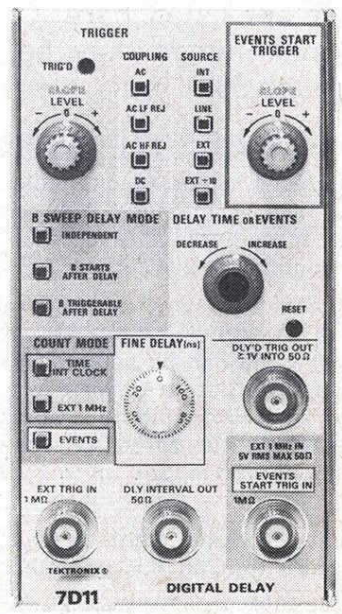
040-0891-00 . . . . . $65**

*See pages 39 through 66 in this catalog for details on these and additional 7000-Series Mainframes. See pages 67 through 86 for details on complementary 7000-Series Plug-ins.

**Price does not include installation.



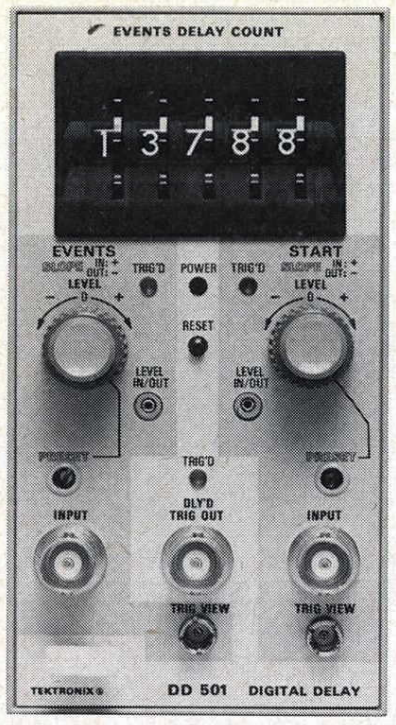
7D10 Digital Events Delay



7D11 Digital Delay

The 7D10 or 7D11 let you add delay to your 7D01 Logic Analyzer trigger. The 7D11 has all of the features of the 7D10, plus it delays by time as well as digital events. Both units provide a trigger pulse output upon counting a preselected number of digital pulses.

For example, you can start the delay counter with the W.R. out pulse, count some number of clock pulses, and then supply an external trigger to the 7D01. See page 77 for complete details.



DD 501 Digital Delay

Delay by Events Counting Rate to 65 MHz

Divide by N Mode with Counting Rate to 20 MHz

Delays by up to 99,999 Events

Companion Unit for Any Logic Analyzer

The DD 501 provides delay by events in a plug-in for TM 500 Mainframes. Using five thumbwheels on the control panel, the operator can set any desired delay from 1 through 99,999 events. When the number of input events reaches the preset count, the DD 501 will put out a trigger pulse which can be used for triggering a logic analyzer, oscilloscope, or counter.

The logic analyzer memory window is easily delayed from the trigger by a selected count using the DD 501.

Because the DD 501 creates its delay by counting a number of pulses rather than by analog timing of an interval, jitter is not a problem, even when viewing pulses toward the end of a long train. Events can be counted at frequencies up to 65 MHz. With the selected number of events clearly displayed on the thumbwheel dials, the operator knows at all times what part of a pulse train he is viewing on the accompanying logic analyzer or oscilloscope.

SPECIFICATIONS

EVENTS DELAY

Count — 1 to 99,999 events.

Max Count Rate — 65 MHz.

Insertion Delay — 30 ns or less from final event to trigger output pulse.

Recycle Time — 50 ns or less.

Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs.)

Input Impedance — 1 MΩ, 20 pF.

Slope — Either + or −, selectable.

Sensitivity — 85 mV p-p @ 30 MHz.

Frequency Response — Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width — 5 ns.

Threshold Level Range — From −1.5 V to +1.5 V (−15 V to +15 V with 10X probe). Can be externally programmed or monitored at front panel jacks.

Trigger View Out — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).

Events Triggered Light — Visual indication that events are being detected.

Start Triggered Light — Visual indication that delay is in progress.

TRIGGER OUTPUT

Pulse Width — Width of events pulse plus 6 ns or less.

Voltage Swing — + 0.8 V or less to at least + 2.0 V with 3 TTL loads (≃ 5 mA).

Light — Indicates output trigger.

GENERAL

Temperature — Operating 0°C to +50°C. Non-operating: −40°C to +75°C.

Altitude — Operating: to 15,000 ft; Nonoperating to 50,000 ft.

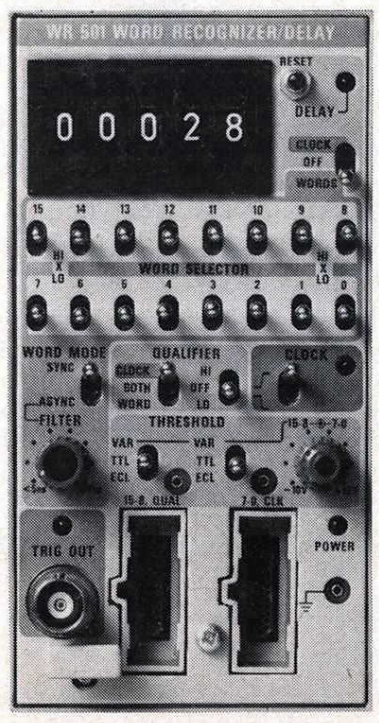
Shipping Weight — 3 lb.

Dimensions — 2.6 in wide, 5 in high, 12.2 in deep (6.6 x 12.7 x 31 cm).

ORDERING INFORMATION

DD 501 Digital Delay $800

*The DD 501 must be plugged into a TM 500 Mainframe to achieve a working unit.



WR 501 Word Recognizer with Digital Delay

The WR 501 is a 16-bit parallel Word Recognizer with digital delay that produces trigger pulses when a preselected word occurs. It occupies one plug-in position in any TM 500 Series Power Module Mainframe.

The WR 501 may be used separately as a word recognizer to generate triggers for oscilloscopes or other measurement instruments. It gives you fast access to any unique word in the data stream.

SPECIFICATIONS

Inputs — 16 data inputs plus a clock and qualifier.

Word Selection — Made using sixteen three-position toggle switches. Positions are HI, X (don't care), and LO.

Qualifier — Can expand the word recognizer to 17 bits, act as a gate for the external clock or do both.

Clock — Selects positive- or negative-going edge of clock input signal. Used for synchronous operation.

Modes — Front panel selection of synchronous word recognition (a trigger is produced only when the operator selected word occurs at a clock edge; either position, positive or negative edge, may be selected), or asynchronous word recognition (a trigger is produced anytime the recognized word occurs).

Synchronous Mode —

Minimum Set-up time	18 ns
Minimum Hold time	0 ns

(Filter is automatically disabled)

Asynchronous Mode and Filter —
Minimum coincidence time is variable from 15 ns or less to 200 ns or more.

ORDERING INFORMATION

WR 501 Word Recognizer $1,650

DL 502 Digital Latch

The TEKTRONIX DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. Operating in an asynchronous mode, the 16-channel Digital Latch can detect spikes or glitches between system clock edges that are narrower than the sample clock interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high-speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch allows you to expand the time frame in which information can be stored by sampling at a slower rate. The DL 502 captures the glitch (or pulses which are narrower than one sample interval) holds it until the next clock edge, then expands it to one sample interval for display.

The DL 502 plugs into any compartment of a TM 500 Mainframe. Two 25-pin connectors connect the DL 502 with the 7D01 Logic Analyzer. Data is acquired via P6451 Probes which plug into the front panel of the DL 502.

A two-position switch allows the user to select either the LATCH input mode or OFF. An asynchronous clock input is required from the STORE CLOCK OUT of the 7D01 Logic Analyzer to the STORE CLOCK IN of the DL 502.

SPECIFICATIONS

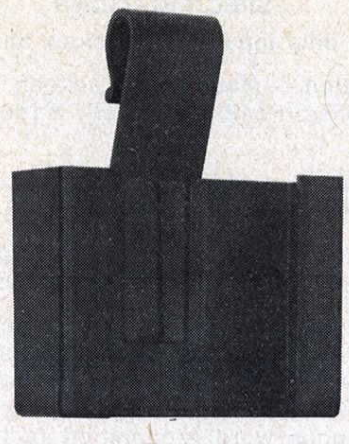
Minimum pulse width to initiate latch — 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock—20 ns.

ORDERING INFORMATION

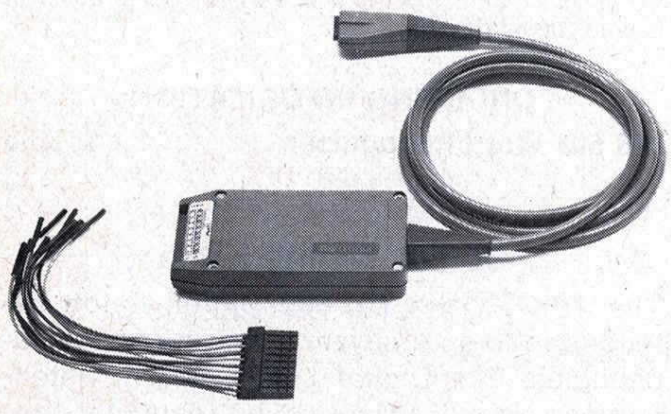
DL 502 Digital Latch $1,480



Probe Holder — Clip-on holder accommodates probe pod from P6451.
(352-0473-01) **$2.50**

BNC Cable — Used with the Digital Latch
(012-0118-00) **$16.00**

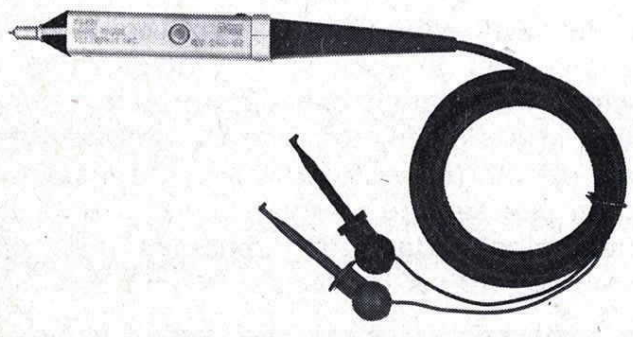
P6451 Probe



P6451 Replacement Active Probe — For WR 501, 7D01, 7D01F or 7D01F2. Two probes are needed for 16 channel operation.
(010-6451-03) **$400.00**

BNC Cable — 50 Ω 8 in
(012-0076-00) **$15.00**

P6401 Logic Probe



The small, lightweight, hand-held P6401 indicates the state of logic levels in TTL, DTL, or any other system with threshold between 0.7 and 2.15 volts. A strobe input can be used to detect the coincidence of logic signals at two points. An indication of whether a logic pulse has or has not occurred can be obtained in a "store" mode.

Power may be obtained from the unit under test or any 5 V supply.

Two bright lights in the probe tip indicate condition of the logic signal.

SPECIFICATIONS

Low State Input Voltage Range — 0 V to +0.7 V ±0.125 V.

High State Input Voltage Range — 2.175 V ±0.125 V to Vcc.

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≈ 7.5 kΩ paralleled by ≈ 6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 kΩ.

Max Safe Input — ±150 V (dc or rms).

Minimum Recognizable Strobe Pulse Width — 20 ns.

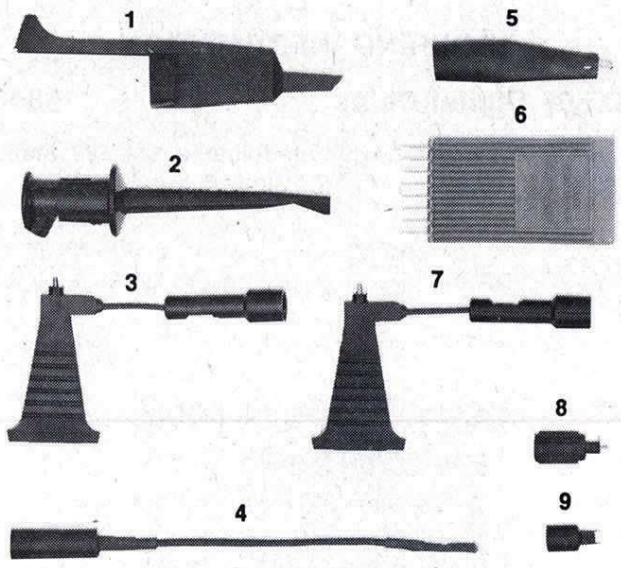
Max Safe Strobe Input — ±30 V (dc or rms).

Strobe Input Impedance — 5.6 kΩ within 20%.

ORDERING INFORMATION

P6401 5 ft. Probe (010-6401-01) **$105**

Includes: Hook Tip (206-0114-00)
Strobe Lead (175-0958-01)
Strobe Lead (175-0958-00)
Probe Tip to 0.025 in square pin adapter (206-0137-01)
White Plug (348-0023-00)
2 Alligator Clips (344-0046-00)
Accessory Pouch (016-0537-00) not shown



1. Retractable Hook Tip — Suitable for use with P6401 Logic Probe.
(013-0106-00) **$7.00**

2. Pomona Hook Tip to 6-32 —
(344-0267-00) **$3.00**

3. Probe Pin Tip — Accepts 0.025 in IBM SLT pin. Slip on.
(206-0209-00) **$2.65**

4. Probe Tip — Flexible probe tip to fit 0.025 in square pin.
(206-0193-00) **$6.00**

5. Miniature Alligator Clip —
(344-0046-00) **$1.00**

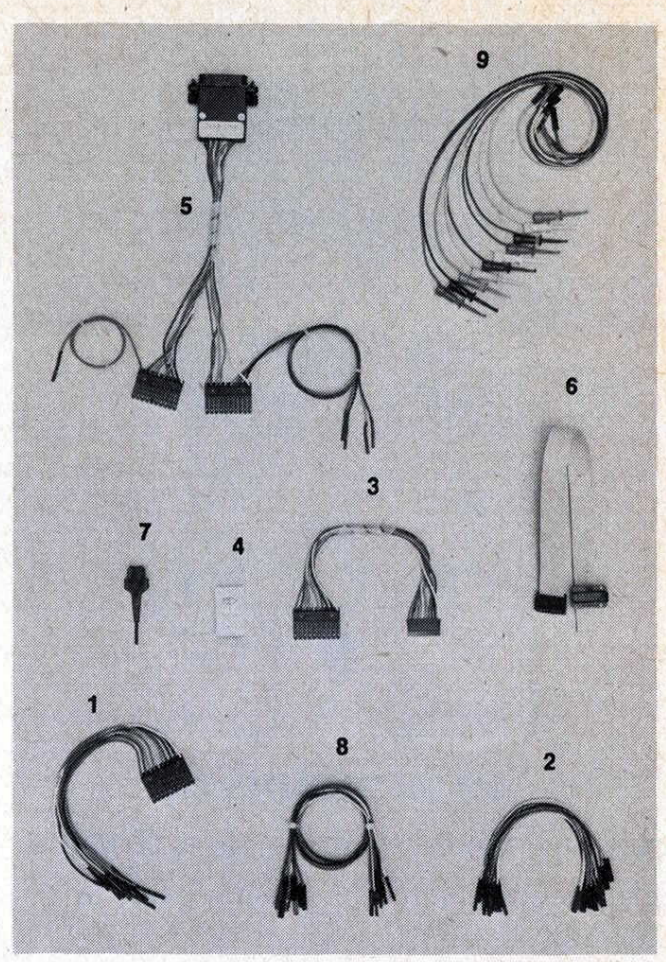
6. Clothes Pin IC Clip —
(003-0709-00) **$24.00**

7. Probe Pin Tip — Accepts 0.025 in IBM SLT pin. Screw on.
(206-0134-03) **$3.15**

8. Probe Ground Lead Adapter — #6-32 to 0.025 in IBM SLT square pin.
(206-0137-01) **$1.40**

9. Miniature Probe Tip Adapter — For testing integrated circuits. Package of 10.
(015-0201-01) **$2.50**

Additional accessories are described on pages 227 through 228.



1. 10 Wide Comb — With 10 grabber tips.
(012-0747-00) **$25.00**

2. 20 cm Individual Connectors — Grabbers not included.
(012-0655-02) **$25.00**

3. 10 Wide Comb — With Harmonica Connector.
(012-0800-00) **$20.00**

4. Clother Pin IC Clip —
(003-0709-00) **$24.00**

5. GPIB Connector —
(103-0209-00) **$45.00**

6. 16 Pin Low Profile Dip Clip — Can be used with 14 or 16 pin IC's.
(015-0330-00) **$25.00**

7. Grabber Tip —
(206-0222-00) **$2.50**

8. 40 cm, Color Coded Replacement Lead Set* — For the P6450 Probe or the P6451 Probe. 10 leads/set connects probe lead to 0.025 in, square pins.
(012-0655-01) **$30.00**

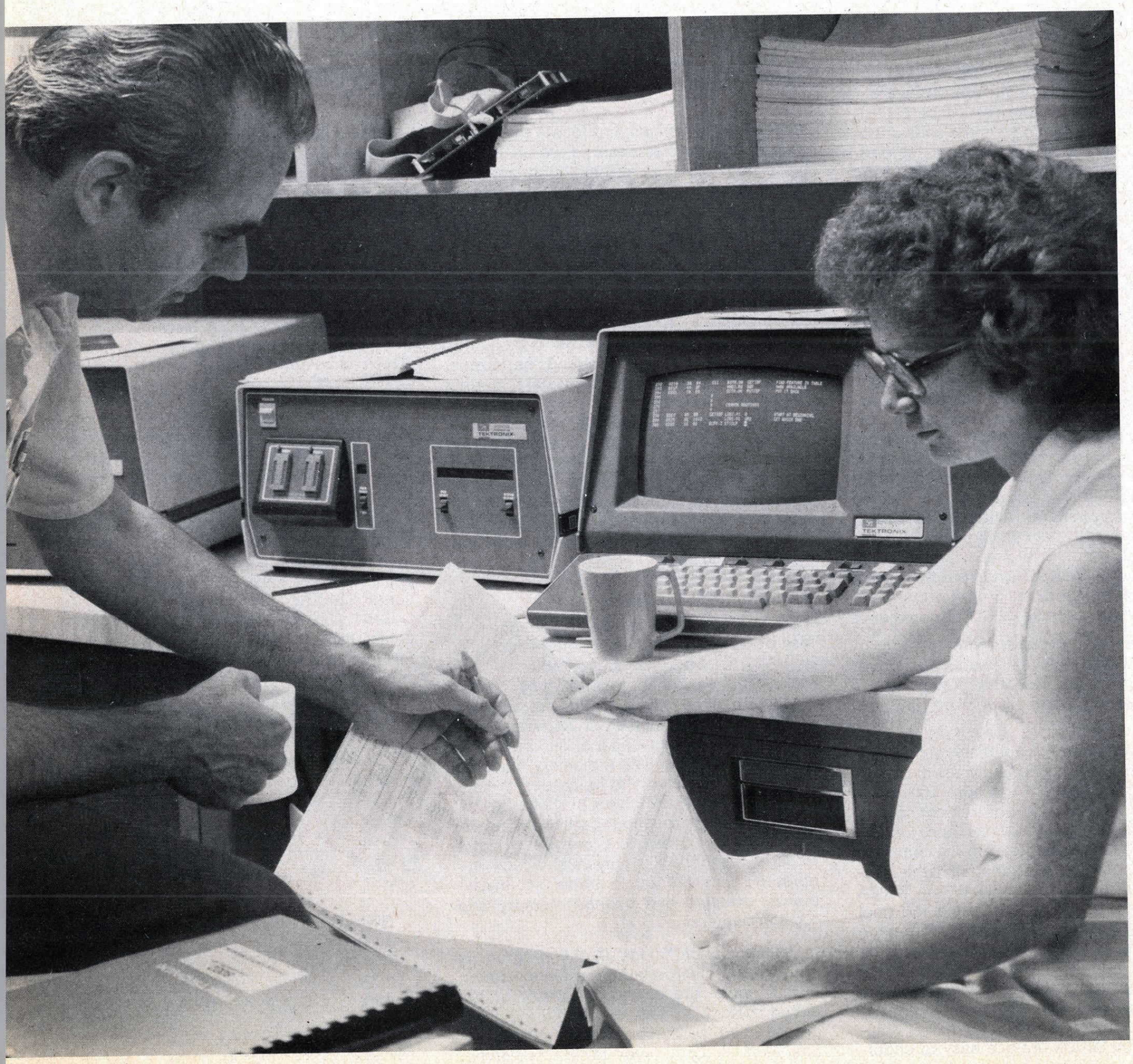
9. 40 cm Individual Connector* — 10 wire with Pomona Grabbers.
012-0670-00 ..... **$36.00**

*Note: EMI can exist with the 40 cm length. This can be a problem if using a digital latch.

Instruments for Digital Development

Microprocessor Labs

3a

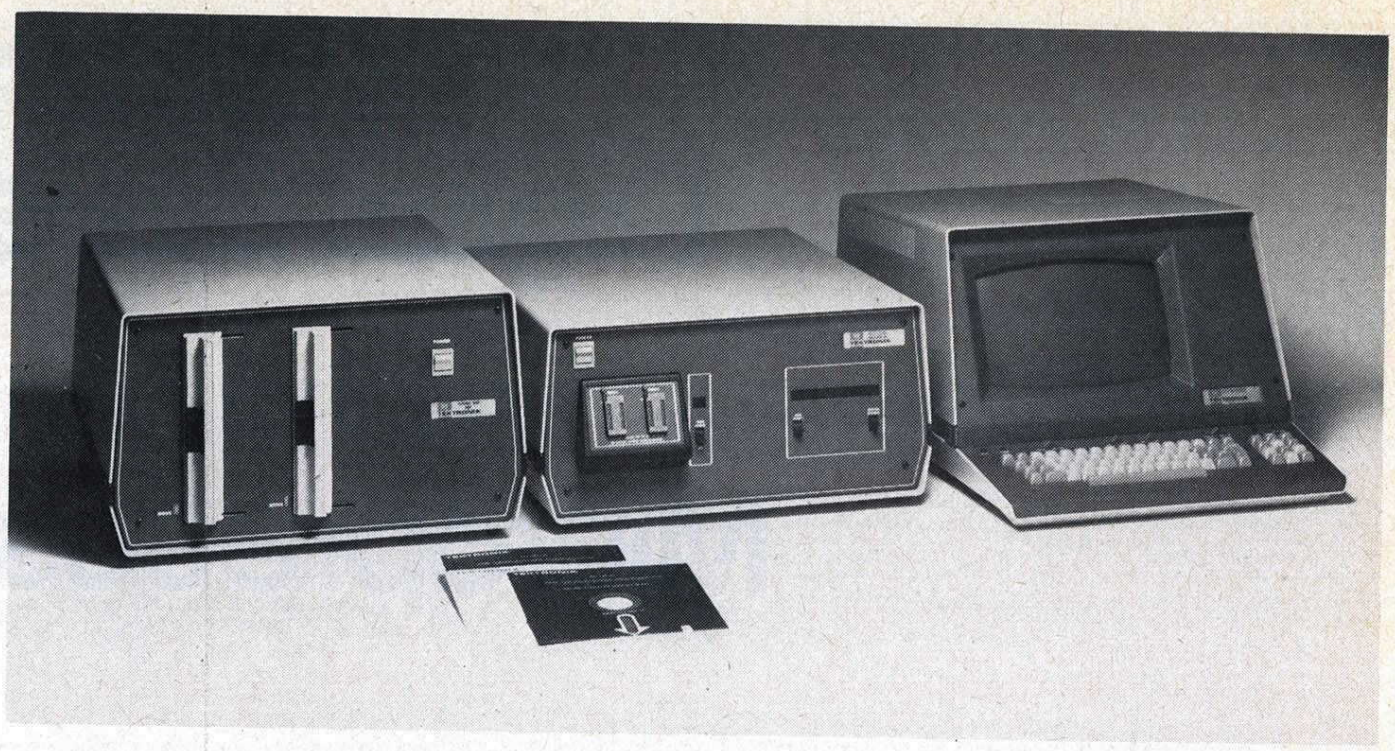


8002A | Microprocessor Lab

A Complete Software Development System

Multiple Microprocessor Support

Real-Time Trace Option



The 8002A Microprocessor Lab consists of the 8002A Mainframe with 32K of Program Memory, and the dual flexible disc unit. Recommended optional peripherals are the CT 8100 Crt Terminal, the CT 8101 TTY Terminal, the 4024/4025 Computer Display Terminals, or the LP 8200 Line Printer.

The 8002A Microprocessor Lab is a complete software development system for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900, Zilog Z80A, Fairchild F8, and the Mostek 3870 and 3872. In addition to multiple microprocessor support, the 8002A offers a superior operating system and powerful text editor, assembler, and debugging programs; three optional levels of emulation for software debugging, partial and full emulation; and a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

Software Development and Debugging

In a typical design sequence, software is developed using all the resources of TEKDOS, the disc-operating system software for the 8002A Microprocessor Lab. TEKDOS performs flexible disc and file utility functions, data transfer functions, and system/peripheral device control functions. In addition to relieving the user of these housekeeping chores, TEKDOS also supervises the text editor, assembler, and linker programs and the optional emulation support, debugging system, and PROM programming routines.

Program entry and editing may be accomplished module by module. The line-oriented text editor provides 150 60-character lines of buffer workspace, and offers several convenience features for preparing, correcting, and modifying the program quickly and easily. The macro command allows a multiple-step routine to be defined by one new command. At the end of each work session, file space is allocated by TEKDOS; duplicate files of important material may be readily created. When program entry has been completed, all program files may be merged with a single TEKDOS command.

The assembler processor, with the appropriate disc inserted in the flexible disc drive, performs program assembly functions for each microprocessor supported by the 8002A.

The powerful macro capability allows the designer to access frequently used sets of code by referencing the macro by name. The linker, working with the relocating features of the Assembler, links and locates multiple code segments into a complete executable program. Additionally, the conditional assembler capability of the 8002A allows the designer to customize the final program by testing conditions to determine which of certain code segments are to be assembled into the final program. Code management is further enhanced by the Assembler's versatile string handling capability. Extension English language diagnostics of the 8002A provide easy to understand error messages and locate the line in which the error has occured. When assembly is completed, the assembled object code is stored on disc in a newly created binary format file.

After an error-free assembly listing has been obtained, the resulting object code may be executed in system emulation (mode 0) on the optional emulator processor. The emulator processor is identical to the microprocessor that will finally be installed in the user's prototype. Execution is performed under control of the debug system; during execution, program steps can be traced, software breakpoints can be set, and memory can be examined and changed as required. Should an error be discovered, that portion of the program can be corrected at the source level using the text editor. It can then be reassembled and executed again. This procedure continues until the program is correct.

Partial and Full Emulation

After the software has been debugged, it may be exercised on the prototype circuitry in the partial emulation mode (mode 1). During partial emulation, control may be released from the 8002A to the prototype in stages. The developmental software runs using 8002A memory space and prototype I/O and clock. The 8002A memory mapping feature allows memory to be gradually mapped over to the prototype in 128-byte address blocks. Throughout partial emulation, the user has access to prototype circuitry through the debugging system, which enables him, as before, to trace, set breakpoints, examine and change memory and register contents.

In full emulation (mode 2) the program is run on the prototype, but program execution is still under the complete control of the debug system. All I/O and timing functions are directed by the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, then, the user may still direct program activity from the 8002A.

8002A CHARACTERISTICS

The 8002A Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules (Standard Program Memory consists of 32 k bytes of RAM), and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

A system communications module provides three RS-232-C-compatible ports for interface with system peripherals. Two ports are designated for such peripherals as the optional TEKTRONIX CT8100 Crt Terminal, CT8101 Console Terminal, 4024/4025 Computer Display Terminals, and LP8200 Line Printer. The remaining port is designated as a communications port for use with a modem. Baud rate is selectable for each port as 110, 300, 600, 1200, or 2400.

8002A PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	24.7	9.6
Width	48.3	18.8
Length	57.3	22.3
Weight	**kg**	**lb**
Net	30	66

8002A ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +35°C (+32°F to 95°F).
Storage	Not available.
Humidity	To 90° relative noncondensing.
Altitude	
Operating	To 15,000 ft max.
Storage	To 50,000 ft max.

8002A ELECTRICAL CHARACTERISTICS

Ac Input Voltages	115 V ac ±10% or 230 V ac ±10%.
Frequency Range	60 Hz (50 Hz special order).

8002A DUAL FLEXIBLE DISC CHARACTERISTICS

Flexible Disc Unit — The Flexible Disc Unit consists of two disc drives, a controller, and power supplies. The two disc drives are designated as drive 0 and drive 1. Drive 0 is the default system drive. System programs are placed in this drive, including disc-operating system programs, the text editor, and the debugging routines peculiar to a specific emulator processor. Drive 1 may be used for storing user files, for modifying user files, or as a scratch data area. Drive 0 or drive 1 may be designated as the system drive.

Disc Organization — Each disc contains 77 concentric tracks. Each quarter track, or block, is split into eight sectors, and each sector can contain 128 bytes. Due to directory limitations, a maximum of 72 files can be contained on one disc. The disc-operating system reserves track 0 for the disc directory; tracks one through four are normally automatically reserved for system programs.

Write Protection — Each disc has a write-protect slot. If the slot is covered, the disc is write-enabled; if the slot is not covered, the disc is write-protected. If an attempt is made to write to a write-protected disc, an error message will be displayed on the appropriate peripheral.

ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	+10°C to 35°C (+50°F to 95°F).
Humidity	
Operating	To 90% relative noncondensing.
Altitude	
Operating	To 15,000 feet max.
Storage	To 50,000 feet max.

PHYSICAL CHARACTERISTICS

Size	**cm**	**in**
Height	27	10.5
Width	44	17.5
Length	60	23.6
Weight	**kg**	**lb**
Net	38.6	85

ELECTRICAL CHARACTERISTICS

Line Voltages	Voltage	Current
	115 V ac ±10% at 60 Hz	3.5 A
	230 V ac ±10% at 50 Hz	2.0 A
Line Frequency	60 Hz (50 Hz special order).	

DISC UNIT CHARACTERISTICS

Capacity		**Bits**	**Bytes**
Per Disc	77 x 32 x 128 x 8 bits =	2,523,136	315,392
Per Track	32 x 128 x 8 bits =	32,768	4,096
Per Sector	128 x 8 bits =	1,204	128
Access Time	10 ms/track		

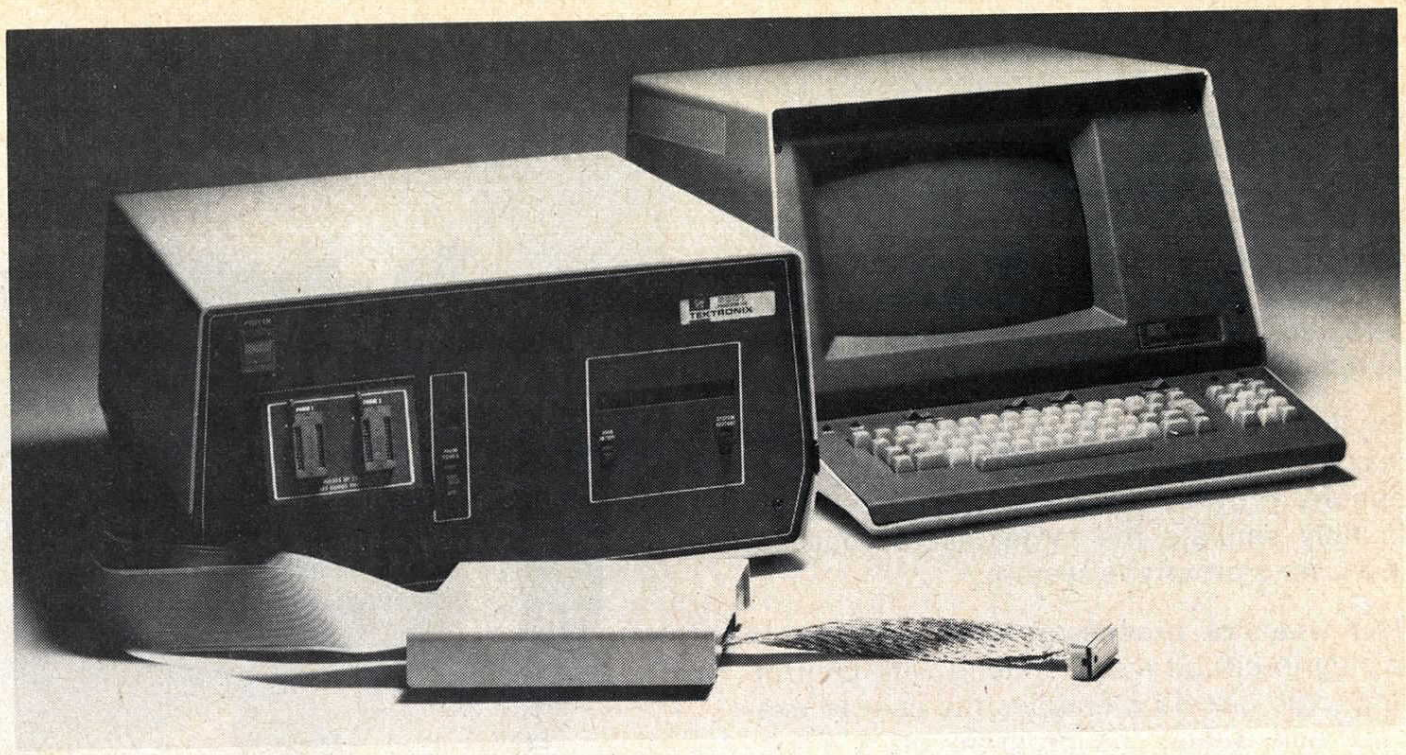
ORDERING INFORMATION

8002A Microprocessor Lab $10,790

***Option 45 32K Program Memory Module $3100**

***Option 49 16K Program Memory Module $1550**

*8002A Standard Program Memory consists of 32 k bytes of RAM.



The 8001 Microprocessor Lab consists of the 8001 Mainframe with 16 K of Program Memory. Microprocessor Support Packages for microprocessors are optional. A Microprocessor Support Package includes an emulator ROM, an emulator processor, and a prototype control probe. The CT 8100 Crt Terminal, CT 8101 TTY Terminal, 4024/4025 Computer Display Terminals, or the LP8200 Line Printer are recommended optional peripherals.

Multiple Microprocessor Support
Real-Time Trace Option

The 8001 Microprocessor Lab is a total hardware debugging system for the design of microprocessor-based products. A key feature is its ability to support many microprocessor chips, including the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900, Zilog Z80A, Fairchild F8 and Mostek 3870 and 3872. In addition to multiple microprocessor support, the 8001 offers three emulation modes for software debugging, partial and full emulation, as well as a real-time prototype analyzer option offering all the capabilities of a microprocessor analyzer with eight channels of external input.

Three Emulation Modes

In a typical design sequence, software is first developed independently using time-sharing, a minicomputer, another development system, or some other means. It is then downloaded to the 8001. At this point the in-prototype emulation and software/hardware integration capabilities of the 8001 come into play.

In emulation mode 0, the software runs only on the emulator processor. This enables the program to be debugged on a microprocessor identical to the one that will ultimately be used in the completed product. In emulation modes 1 and 2, the prototype control probe is connected to the emulator processor at one end and plugged into the prototype's empty microprocessor socket at the other.

Partial emulation (mode 1) lets the user release control in methodical steps from the 8001 to the prototype. The developmental software runs using 8001 memory space and prototype I/O and clock. The 8001 memory mapping feature allows memory to be gradually mapped over to the prototype in address blocks. Throughout partial emulation, the user has access to prototype circuitry via the powerful 8001 debugging system, which enables him to trace, set breakpoints, examine and change memory and register contents.

Full emulation (mode 2) lets the user exercise the program on the prototype while still maintaining complete control through the Microprocessor Lab. All I/O and timing functions are directed by the prototype; all memory has been mapped over to the prototype; and only the prototype control probe is still in place, emulating the target microprocessor. Although the prototype is effectively free-standing, then, the user may still direct program activtity through the prototype control probe.

8001 CHARACTERISTICS

The 8001 Microprocessor Lab is a modular system whose mainframe houses up to 20 plug-in circuit boards. Emulator processor modules for the microprocessor of choice, its associated prototype control probe, and an ROM-based software module are optional. A terminal is necessary for system operation, and may be ordered as an optional peripheral.

The Real-Time Prototype Analyzer module, additional 16K byte Program Memory modules, and PROM Programmer modules for the 1702 or 2704/2708 are available as system options.

A system communications module provides three RS-232-C-compatible ports for interface with system peripherals. Two ports are designated for such peripherals as the optional TEKTRONIX CT8100 Crt Terminal, CT8101 Console Terminal, 4024/4025 Computer Display Terminals, and LP8200 Line Printer. The remaining port is designated as a communications port for use with a modem. Baud rate is selectable for each port as 110, 300, 600, 1200, or 2400.

8001 PHYSICAL CHARACTERISTICS

Dimensions	**cm**	**in**
Height	24.7	9.6
Width	48.3	18.8
Length	57.3	22.3
Weight	**kg**	**lb**
Net	30	66

8001 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +35°C (+32°F to 95°F).
Humidity	To 90° relative noncondensing.
Altitude	
Operating	To 15,000 feet max.

8001 ELECTRICAL CHARACTERISTICS

Ac Input Voltages	115 V ac ±10% or 230 V ac ±10%.
Frequency Range	60 Hz (50 Hz special order)

ORDERING INFORMATION

8001 Microprocessor Lab $4610

****Option 45 32K Program Memory Module $3100**

****Option 49 16K Program Memory Module $1550**

(**8001 Standard Program Memory consists of 16 k bytes of RAM.)

Emulator Processor and Prototype Control Probe Support Packages

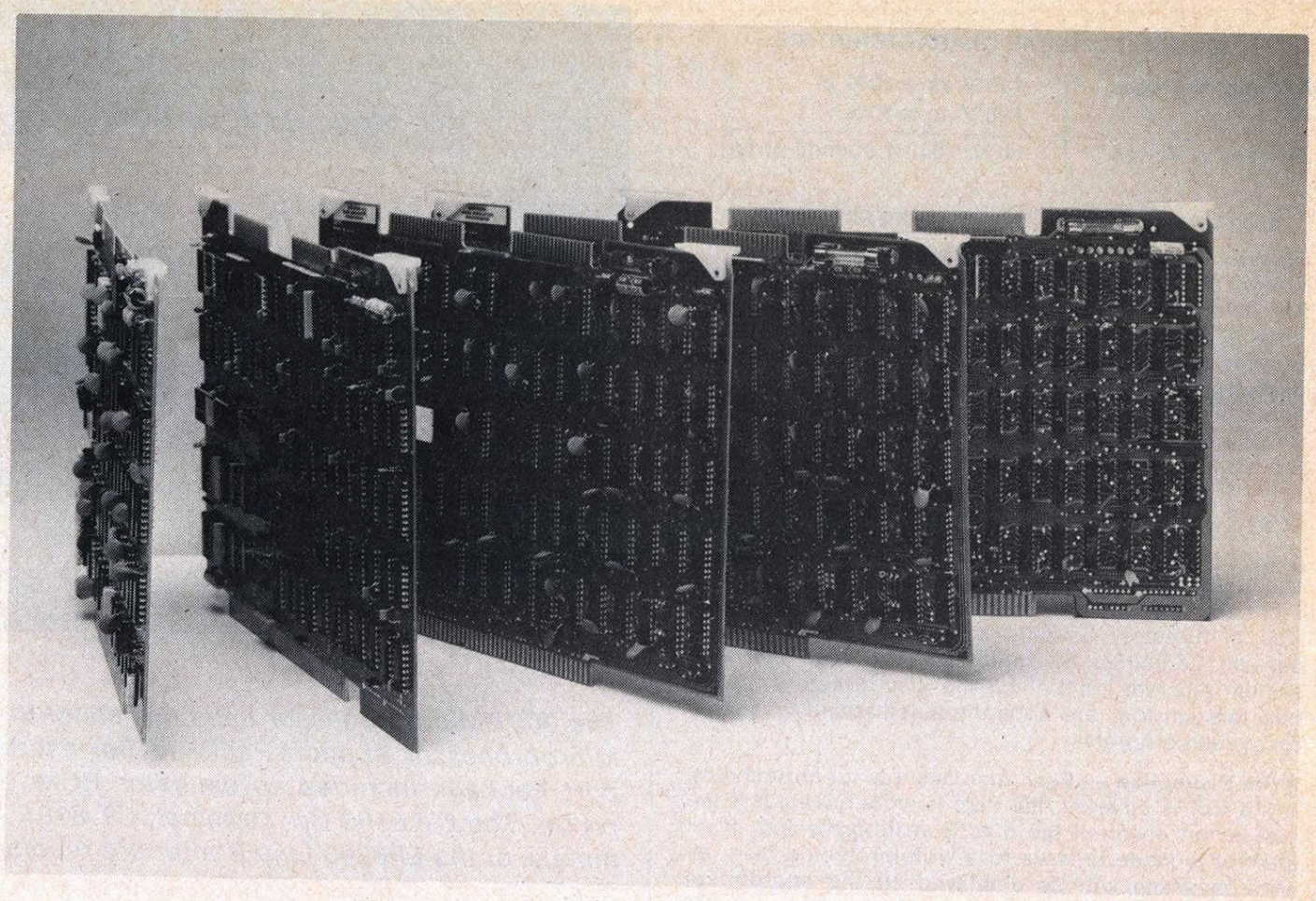
The 8002A and 8001 Microprocessor Labs currently support six different microprocessors: the Intel 8085A and 8080A, Motorola 6800, Texas Instruments TMS9900, Zilog Z80A and Fairchild F8; plus two microcomputers: the Mostek 3870 and 3872. Tektronix will continue to introduce support for selected microprocessors and microcomputers on a regular schedule.

Emulator packages for the 8002A and 8001 may be ordered as system options. These options provide the capabilities necessary to fully emulate the target microprocessor in a user's prototype system.

The emulator processor, which resides on a plug-in circuit module along with controlling logic circuitry, enables the user to execute and debug the program on a microprocessor identical to the one which will be used in the prototype, while giving him access to the full 64K bytes of Microprocessor Lab program memory.

The prototype control probe, which links the emulator processor to the prototype system, allows partial and full in-circuit emulation.

All emulation operations are controlled by the powerful Microprocessor Lab system software. The user is able to monitor program execution, set software breakpoints, examine and change memory and register contents. Debug trace information is displayed in a format unique to the microprocessor, with instruction fetches disassembled into mnemonics for easy interpretation.



F8, 3870, 3872 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

F8 refers to microprocessors manufactured by Fairchild's Corporation; the 3870 and 3872 refer to microprocessors manufactured by Mostek Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the F8, 3870, or 3872 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from emulator processor to the interface assembly. 1 ft (30 cm) of cable from the interface to 40-pin plug.

Cable Configuration

6 ft (1.8 m) — Two 40 conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm)—Two 40 conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the F8/3870/3872 Emulator Processor module.

1 ft (30 cm)—Not terminated.

TIMING CHARACTERISTICS

3870/3872 — The 3870/3872 Prototype Control Probe was designed to meet all the ac characteristics of the 3870 and 3872 Microcomputers.

F8 (3850) — The F8 Prototype Control Probe meets all of the F8 ac characteristics with the following exceptions: (1) the worst-case delay from the falling edges of WRITE to the ROMC lines being valid is 650 nsec (compared to 550 nsec for the F8 CPU); (2) the worst-case skew between an external clock input is 0 to 90 nsec longer than that specified for the F8.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	**$4610**		
Option 06 3870/3872 Microcomputer Support Package	**+$4190**	**8001F06**	**$4240**
Option 07 F8 Microprocessor Support Package	**+$4190**	**8001F07**	**$4240**
8002A Microprocessor Lab	**$10,790**		
Option 06 F8/3870/3872 Assembler Software Support	**+$ 550**	**8002F06**	**$ 600**
Option 21 F8/3870/3872 Emulator Support	**+$2510**	**8002F21**	**$2610**
Option 36 3870/3872 Prototype Control Probe	**+$ 920**	**8002F36**	**$1020**
Option 37 F8 Prototype Control Probe	**+$ 920**	**8002F37**	**$1020**

8080A EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8080 and 8080A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 8080 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1.5 ft. (45.8 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40 conductor ribbon cables with alternating ground and signal paths.

1.5 ft (45.8 cm) — 2 twisted pair 40 conductor cables.

Termination

6 ft (1.8 m) — The interface assembly contains resistive termination and receivers for data, address, and control from the emulator processor module.

1.5 ft (45.8 cm) — Not terminated.

40 pin plug—40 pin spring plate protected plug. When used with a zero insertion force socket, an included 40 pin low profile DIP socket must be used between the zero insertion force socket and the 40 pin probe plug.

TIMING CHARACTERISTICS

Emulation Interface Delays*

To 8080A from Interface Assembly	Typ	Max (in ns)
ø1	44	60
ø2	44	60
HOLD	44	67
RESET	44	67
RDY**	35	40
INT	63	104
DATA	44	53

From 8080A to Interface Assembly	Typ	Max (in ns)
HOLDA***	39	55
SYNC	37	45
WAIT	37	45
WR	37	45
DBIN	37	45
INTE	39	55
ADDRESS	27	35
DATA	50	63

**Assumes 6 ft of cable at 1.5 ns/ft.*

***RDY is ignored unless user memory or I/O is accessed in control mode 2 or special mode.*

****The equation for HOLDA to tristate timing is as follows: HOLDA • DBIN = FLOAT. Tristate of data and address follows the trailing edges of DBIN or WR by approximately 20 ns.*

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	**$4610**		
Option 01 8080A Microprocessor Support Package	**$3690**	**8001F01**	**$3740**
8002A Microprocessor Lab	**$10,790**		
Option 01 8080A Assembler Software Support	**+$550**	**8002F01**	**$ 600**
Option 16 8080A Emulator Support	**+$2010**	**8002F16**	**$2110**
Option 31 8080A Prototype Control Probe	**+$920**	**8002F31**	**$1020**

Emulator Processor and Prototype Control Probe Support Packages

6800 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

6800 refers to microprocessors manufactured by Motorola Corporation. Tektronix, Inc., does not guarantee that other vendors' versions of the 6800 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40-pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40 conductor ribbon cables with alternating ground and signal paths.

1 ft (30 cm) — 2 twisted pair 40 conductor cables made up of signal/ground pairs.

TIMING CHARACTERISTICS

Emulation Interface Delays*

To 6800 from Interface Assembly	Maximum	TPCS[1] (in ns)
ø1	26	—
ø2	26	—
NMI	30	200
IRQ	67	200
RESET	94	200
HALT**	72	—
DATA	28	114 (input setup)
DBE****	—	—
TSC***	not used	—

From 6800 to Interface Assembly	Maximum	TAD[2] (in ns)
ADDRESS	20	300
DATA****	28	460
VMA	45	300
R/W	63	300
BA	35	—

**Assumes 6 ft of cable at 1.5 ns/ft.*

***HALT must occur within 80 ns after the falling edge of ø1 to be recognized at the rising edge of the following ø2.*

****Delay to tristate, TSD=36 ns. Tristate is performed by the interface buffers, not by the 6800.*

*****Data from the 6800 will be available to the prototype 460 ns after the rising edge of ø1 or DBE + 36 ns, whichever is greater.*

[1]TPCS—Control signal setup time prior to ø2 falling edge.

[2]TAD—Output propagation delay from clock after ø1 rising edge.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$4610		
Option 02 6800 Microprocessor Support Package	$3690	8001F02	$3740
8002A Microprocessor Lab	$10,790		
Option 02 6800 Assembler Software Support	$ 550	8002F02	$ 600
Option 17 6800 Emulator Support	+$2010	8002F17	$2110
Option 32 6800 Prototype Control Probe	+$ 920	8002F32	$1020

Z80 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

Z80 and Z80A refer to microprocessors manufactured by Zilog Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the Z80 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processort to the interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40 conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm) — 2 40 conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the Z80 Emulator Processor module.

1 ft (30 cm) — Not terminated.

TIMING CHARACTERISTICS

The Z80 Emulator Processor was designed to match the ac characteristics of the Z80 Microprocessor with two exceptions. Those exceptions are:

Prototype Clock

The prototype clock may not be stretched over a total of 10 μs during any one memory or I/O request when a Microprocessor Lab memory access may occur in the next cycle. This exception is valid only if the prototype clock runs in excess of 1 MHz.

NMI

NMI (Non Maskable Interrupt) must occur one-half cycle earlier than in a standard Z80 configuration. This means the NMI must occur before the next to last trailing edge of the M cycle just prior to M1.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$4610		
Option 03 Z80 Microprocessor Support Package	$3690	8001F03	$3740
8002A Microprocessor Lab	$10,790		
Option 03 Z80 Assembler Software Support	$ 550	8002F03	$ 600
Option 18 Z80 Emulator Support	+$2010	8002F18	$2110
Option 33 Z80 Emulator Prototype Control Probe	+$ 920	8002F33	$1020

TMS9900 EMULATOR SUPPORT PACKAGE CHARACTERISTICS

TMS9900 refers to microprocessors manufactured by Texas Instruments Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the TMS9900 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

9.5 in (24.2 cm) of cable from the interface assembly to the 64 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40 conductor ribbon cables with chassis ground plane and signal paths.

9.5 in (24.2 cm) — 2 32 conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the TMS 9900 emulator processor module.

9.5 in (24.2 m) — Not terminated.

TIMING CHARACTERISTICS

To TMS9900 from Interface Assembly	Emulation Typical	Interface Delays* Maximum (in ns)
ø1	41	59
ø2	41	59
ø3	41	59
ø4	41	59
CRUIN	12	23
INTREQ	12	18
IC0	12	23
IC1	12	23
IC2	12	23
IC3	12	23
HOLD	12	18
READY	12	18
LOAD	12	18
RESET	68	98
DATA	14	21

From TMS9900 to Interface Assembly	Typical	Maximum (in ns)
DBIN	24	41
MEMEN	12	18
WE	12	18
CRUCK	12	23
CRUOUT	12	23
HOLDA	12	23
WAIT	12	23
IAQ	12	23
ADDRESS	14	21
DATA	14	21

**Assumes 1.5 ft of cable at 1.5 ns/ft.*

Note: All inputs and outputs of the 64 pin plug at the end of the prototype control probe are buffered by 74LSXXX type devices. In all cases, data and control should not change during clock ø1.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$4610		
Option 04 TMS9900 Microprocessor Support Package	$4120	8001F04	$4180
8002A Microprocessor Lab	$10,790		
Option 04 TMS9900 Assembler Software Support	$ 550	8002F04	$ 600
Option 19 TMS9900 Emulator Support	$2280	8002F19	$2380
Option 34 TMS9900 Prototype Control Probe	+$1090	8002F34	$1190

8085A EMULATOR SUPPORT PACKAGE CHARACTERISTICS

8085 and 8085A refer to microprocessors manufactured by Intel Corporation. Tektronix, Inc., does not guarantee that other vendor's versions of the 8085 will be compatible with the TEKTRONIX Microprocessor Labs.

PHYSICAL CHARACTERISTICS

Length 6 ft (1.8 m) of cable from the emulator processor to the interface assembly.

1 ft (30 cm) of cable from the interface assembly to the 40 pin plug.

Cable Configuration

6 ft (1.8 m) — 2 40 conductor ribbon cables with chassis ground plane and signal paths.

1 ft (30 cm) — 2 40 conductor twisted pair cables.

Termination

6 ft (1.8 m) — The interface assembly contains receivers for data, address, and control from the 8085 emulator processor module.

1 ft (30 cm) — Not terminated.

AC CHARACTERISTICS

Emulation Clock

Mode 1 or Mode 2 (user's clock), with 8085A Prototype Control Probe.	6.25 MHz max*; crystal, RC timing network or TTL input to X1.
Mode 0 (system clock)	6.25 MHz ±0.01%

Operational Speed

Full speed or 1 wait state per machine cycle during 8001/8002A program memory access selectable with jumper.

One wait state per machine cycle is inserted when using DEBUG breakpoints (BKPT) regardless of jumper position. When the Real-Time Prototype Analyzer option is installed, real-time operation with breakpoints automatically ensured during DEBUG by using the event triggers (EVT).

**A clock error detection circuit ensures that the user's clock is operational and basically within Intel max (1 μs) and min (160 ns) specifications.*

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$4610		
Option 05 8085A Microprocessor Support Package	$3690	8001F05	$3740
8002A Microprocessor Lab	$10,790		
Option 05 8085A Assembler Software Support	$ 550	8002F05	$ 600
Option 20 8085A Emulator Support	+$2010	8002F20	$2110
Option 35 8085A Prototype Control Probe	+$ 920	8002F35	$1020

Real-Time Prototype Analyzer

The Real-Time Prototype Analyzer, Option 46 for the 8002 and 8001 Microprocessor Labs, is comprised of a real-time trace module, a data acquisition interface, and an 8-channel general logic probe. This option provides a real-time trace of the user program executing on the emulator processor, with 43 channels of data acquired simultaneously. The prototype address bus, data bus, control bus, and any eight external locations on the prototype circuit may be monitored without slowing up the operational speed of the processor. The Real-Time Prototype Analyzer is indispensable when isolating critical timing errors and hardware/software sequence discrepancies during the final integration phases of prototype development.

The analyzer module is a separate plug-in circuit card that may be inserted into either the 8002A or 8001 system mainframe. The P6451 Probe connects to the prototype circuitry and permits data transference from the prototype to the analyzer. Data from the prototype is buffered and driven by the probe to the data acquisition interface, and then loaded into the analyzer module's real-time trace buffer.

As the user program executes on the emulator processor, 48-bit data words are sequentially acquired from the prototype and loaded into the real-time trace buffer. Each data word contains 16-bit data from the address bus; 8-bit or 16-bit data from the data bus; 8-bit data from the test probe; 3-bit data identifying cycle type (read, write, I/O, memory, or instruction fetch); and 5-bit data used internally to identify last start/stop of the emulator processor. The analyzer will continue to acquire these sequential cycles of logic input until the processor is stopped or the real-time trace buffer is frozen by a specified trigger occurrence. The real-time trace buffer can retain up to 128 data words in pre-, variable center, or post-trigger modes; thus enabling the storage of pertinent program bus transactions.

The Real-Time Prototype Analyzer offers expanded breakpoints to aid in efficient location of prototype problems. Two event comparators located within the analyzer module can be utilized to halt program execution and stop real-time trace. A trigger may be generated on any specific data occurrence in the address bus, data bus, test probe input, and instruction cycle type. Triggering may be immediate; delayed by counting the number of passes; or delayed by counting the number of clock select outputs (clock select may be by microseconds, milliseconds, emulator clocks, etc.). In addition, an output pulse may be generated, via the data acquisition interface, to trigger a logic analyzer or an oscilloscope.

The two event comparators (triggers) may be set to designate a break or halt in the program execution. These comparators may be used as independent breakpoints; or they may be used together to enable a breakpoint on a specific event combination. The program execution can be halted when two trigger events occur simultaneously; when one trigger event precedes another; or when either trigger event occurs. When a break in the program execution takes place, program transactions stored in the real-time trace buffer may be displayed or printed.

Data stored in the real-time trace buffer is displayed sequentially in the order it was acquired from the prototype. Buffer content may be displayed in whole or in part. Optional command parameters are available to limit the storing of data to any specific transaction type, such as memory reads only. If the total buffer contents are displayed, a blank line will separate the data sequence associated with each program starting point.

The Real-Time Prototype Analyzer features a convenient and easy-to-understand display format. With this format, the address location, data, probe input, and control bus data of each acquired transaction are displayed. If the transaction was an instruction fetch, the instruction is also disassembled into the appropriate mnemonic readout unique to the emulator type being used.

The Real-Time Prototype Analyzer functions in all emulation modes and operates with all commercial microprocessors supported by the 8002A and 8001 Microprocessor Labs.

REAL-TIME PROTOTYPE ANALYZER CHARACTERISTICS

OPERATIONAL SPEED CHARACTERISTICS

Processor	Maximum Processor Clock Rate*
8085A	3.125 MHz (internal clock)
8080A	2.08 MHz
6800	1.00 MHz
Z80	4.00 MHz
TMS9900	3.33 MHz
3870/3872	4.00 MHz
f8	2.00 MHz

**Maximum processor clock rate for Real-Time Prototype Analyzer operation.*

INPUT/OUTPUT CHARACTERISTICS

Variable Threshold

Range	>+10 V dc to <−10 V dc
Preset TTL Voltage	+1.4 V dc ±200 mV
Event Trigger Out	High level voltage out (when Vcc=Min, Vi=0.5, Ro=50 Ω to GND) is >2 V dc.

Adjustments—Variable Threshold may be adjusted from >+10 V dc to <−10 V dc with a screwdriver adjustment accessible at the rear panel of the Microprocessor Lab. This voltage must be monitored with a voltmeter having an input impedance of at least 10 MΩ.

Jumpers—With the internal jumper in position '0-3' the clock threshold is designated to be the same as channels 0-3. In position '4-7' the jumper designates the clock threshold to be the same as channels 4-7.

Cable Length — 50 cm (19.5 in).

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$4610		
Option 46 Real-Time Prototype Analyzer	+$2500	8001F46	$2700
8002A Microprocessor Lab	$10,790		
Option 46 Real-Time Prototype Analyzer	+$2500	8002F46	$2700

8002A Microprocessor Lab Basic

High level languages provide the easiest, most natural programming method available for microprocessor development. No other high-level language approaches the simplicity of BASIC. BASIC keywords are extremely easy to learn and use. Typically, the novice can program an application within hours of being introduced to BASIC. Because BASIC is widely used, computer books and magazines contain hundreds of programs, and various application programs are available for microprocessor development.

8002A Microprocessor Lab BASIC is a modification of ANSI standard BASIC. It supports modular programming and the use of specific microprocessor features and 8002A I/O resources. A BASIC program may be developed in modular components that are separately compiled. Sub routines and data defined in one module may be used (referenced) by another. The target processor's I/O and interrupt structures as well as 8002A peripherals and file I/O can be accessed with BASIC constructs. The language provides data handling capabilities for integers, strings, and arrays of these types.

The 8002A BASIC Compiler supports software development for the 8080A and 8085A Microprocessors (and the 8080A subset of the Z-80). A BASIC program consists of one or more modules and may include assembly modules. The programmer uses the 8002A text editor to enter and modify BASIC source code. The 8002A BASIC compiler translates BASIC source modules into symbolic assembly modules. The assembly code contains as comments the corresponding BASIC statements. It can be listed and edited. The 8002A Assembler translates these assembly modules into relocatable object modules for the 8080A/8085A. The 8002A Linker combines BASIC modules and any user-coded assembly modules with selected BASIC run-time routines. The executable load module thus produced is loaded into ROM and RAM as specified. The program executes in any 8002A emulation mode. The full debugging capabilities of the 8002A can be used to complete program development.

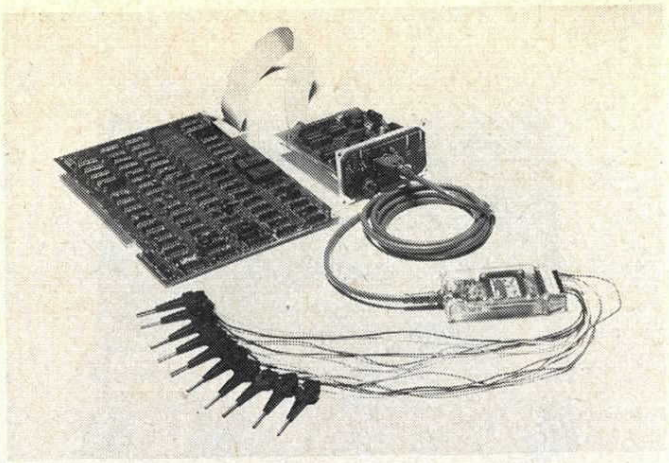
8002A Microprocessor Lab BASIC Software Support

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8002A Microprocessor Lab	$10,790		
Option 1A 8080A/8085A BASIC Software Support* (Requires 64K Program Memory and Option 1)	$900	8002F1A	$950
Option 3A 8080A/Z80 BASIC Software Support** (Requires 64K Program Memory and Option 3)	$900	8002F3A	$950
Option 5A 8080A/8085A BASIC Software Support* (Requires 64K Program Memory and Option 5)	$900	8002F5A	$950

*Option 1A and 5A are identical.

**The compiler generates 8080A assembly language. This output must be assembled with 8080A assembler which is included in Option 3A. The 8080A output can then be run on the Z-80.



1702 and 2704/2708 PROM Programmer

The 1702 and 2704/2708 PROM Programmer, Options 47 and 48 for the 8002A and 8001 Microprocessor Labs, provide the ability to program either 1702 or 2704/2708 erasable PROM chips. When the module is installed in an 8002A or 8001 Mainframe, the PROM Programmer software enables communication between 8002A or 8001 program memory and the PROM installed in the front-panel PROM programming porch.

1702 or 2704/2708 PROM Programmer software transfers one data byte at a time, and actual addresses are assigned. Data may be written from 8002A or 8001 program memory (WPROM); read from PROM into program memory (RPROM); or compared on the system terminal (CPROM).

The RPROM command allows the programmed PROM to be read into program memory and dumped to the system console. The CPROM compare function performs an address-by-address comparison between the PROM and the program under development. When an inequality between PROM bytes and memory bytes occurs, the memory address, memory byte content, and PROM byte content are displayed on the system console. A successful comparison between designated PROM and memory bytes is indicated by an End of Job message on the console.

ORDERING INFORMATION

Option Description	Factory Price	Field Number	Field Price
8001 Microprocessor Lab	$8300		
Option 47 1702 PROM Programmer	+$650	8001F47	$700
Option 48 2704/2708 PROM Programmer	+$650	8001F48	$700
8002A Microprocessor Lab	$10,790		
Option 47 1702 PROM Programmer	+$650	8002F47	$700
Option 48 2704/2708 PROM Programmer	+$650	8002F48	$700

CT 8100 Crt Terminal

The CT 8100 Crt Terminal is an optional peripheral recommended for use with the 8002A and 8001 Microprocessor Labs.

The CT 8100 is interfaced to the 8002A or the 8001 through an EIA standard RS-232-C port on the system communications module. Data formats and baud rate are switch-selectable for TTY or EIA operation.

The keyboard provides selection of the full ASCII set of 96 characters.

The console screen provides space for 24 lines of 80 characters each, allowing the 12-inch diagonal, refreshed crt to display up to 1920 characters.

ELECTRICAL CHARACTERISTICS

115/230 (Hi, Medium, Lo) V ac,
50 to 400 Hz; nominal 220 W.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	33.02	13
Width	45.72	18
Length	68.58	27
Weight	**lb**	
Net	46	
Shipping	67	

ORDERING INFORMATION

CT 8100 Crt Terminal $3495

8002A and 8001 Microprocessor Lab System Peripherals

CT 8101 Console Terminal

The CT 8101 Console Terminal is an optional peripheral recommended for use with the 8002A and 8001 Microprocessor Labs.

The CT 8101 in interfaced to the 8002A or 8001 through an EIA standard RS-232-C port on the system communications module. Data formats and baud rate are switch-selectable for TTY or EIA operation.

The keyboard provides selection of the full ASCII set of 96 characters. It also features character repeat when any key is pressed at the same time as the REPEAT key.

ELECTRICAL CHARACTERISTICS

Voltage	115 V RMS; +10%, −15%.
Frequency	47 through 63 Hz.
Power	75 W max.

PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	10.79	4.25
Width	37.08	14.60
Length	38.73	15.25
Weight	**lb**	
Net	11.20 (including paper)	

ORDERING INFORMATION

CT8101 Console Terminal $1395

4024 Computer Display Terminal

The 4024 Computer Display Terminal is an optional peripheral recommended for use with the 8001 or 8002A Microprocessor Labs.

The 4024 Computer Display Terminal is serially interfaced to either Microprocessor Development Labs through an EIA standard RS-232-C port on the systems communications module. The 12 inch (30 cm) diagonal crt displays up to 34 line of 80 characters each, and the keyboard contains a full ASCII set of characters in upper and lower case. Option 20 (8K bytes Program Memory) is required for proper 8001 and 8002A operation.

4024 Computer Display Terminal with Option 20* $3245

4025 Computer Display Terminal

The 4025 Computer Display Terminal is an optional peripheral for use with the 8001 or 8002A Microprocessor Development Labs.

The 4025 Computer Display Terminal is serially interfaced to either Microprocessor Development Labs through and EIA standard RS-232-C port on the systems communications module. The 4025 Terminal provides all the capabilities of the 4024 plus the ability to expand from basic alphanumerics, to forms ruling and then into graphics. Option 20 (8K bytes Program Memory) is required for proper 8001 and 8002A operation.

4025 Computer Display Terminal with Option 20* $3845

*Option 20 (8K bytes Display Memory) is required for proper 8001 and 8002A operation.

LP 8200 Line Printer

The LP 8200 Line Printer is an optional system peripheral for the 8002A and 8001 Microprocessor Labs.

The LP 8200 is serially interfaced to either Microprocessor Lab through an EIA standard RS-232-C port on the system communications module. Baud rates of 300 to 9600 are selectable.

The printout provides space for 132 characters/line, 6 lines/vertical inch. The full ASCII set of 96 upper/lower case characters is provided.

ELECTRICAL CHARACTERISTICS

Voltage	90 to 132 V ac standard*
Frequency	60 Hz ±1 Hz.
Power	400 W max (printing); 200 W max (idle).

PHYSICAL CHARACTERISTICS

Dimensions	cm	in
Height	85.09	33.5
Width	69.85	27.5
Length	55.12	21.7
Weight	**lb**	
Net	102	

ORDERING INFORMATION

LP8200 Line Printer $3765

*Alternate line voltages are available for the LP 8200. Please contact a Tektronix Field Office in your area for more information.

7000-Series Instruments

Pick a Plug-in Oscilloscope for:

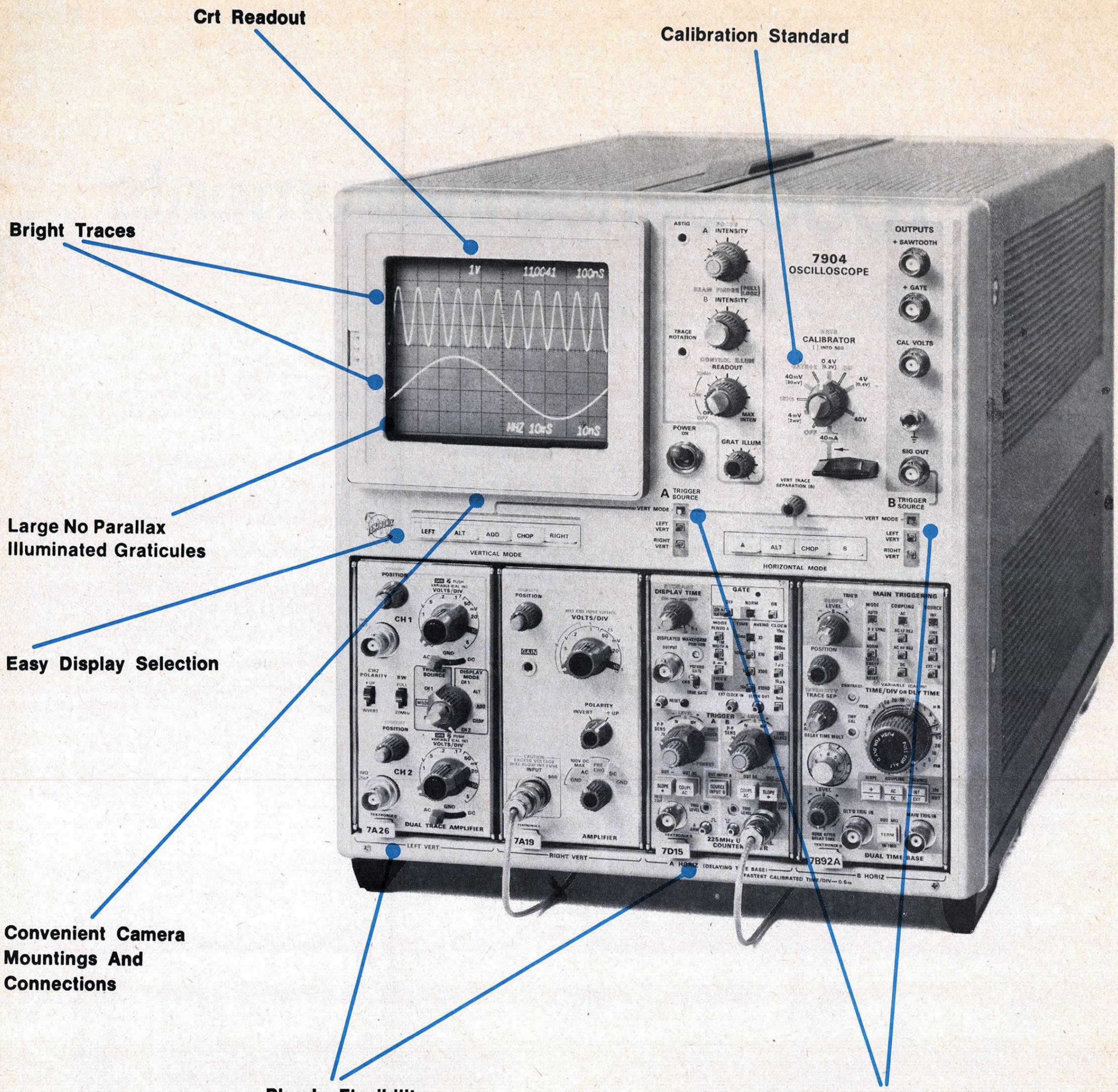
Superior Performance. The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system. The new 7104 Oscilloscope features a 1-GHz bandwidth combined with the fastest rise time and writing speed available today.

Flexibility. Mainframes in the family offer a choice of popular bandwidth ranges and a variety of additional features. With over 35 compatible plug-ins to choose from, you can configure a flexible scope package based on your individual needs.

Expandability. This assures you that the instrument you buy today will adapt to changing measurement needs, and that it won't become obsolete soon after you buy it. Three of Tektronix' most recent developments in plug-in scope capability are: The Fast Storage Oscilloscope, the Logic Analyzer Plug-in, and the Spectrum Analyzer Plug-in.

The 7000 Series...more than an oscilloscope.

7000 Series...more than an oscilloscope

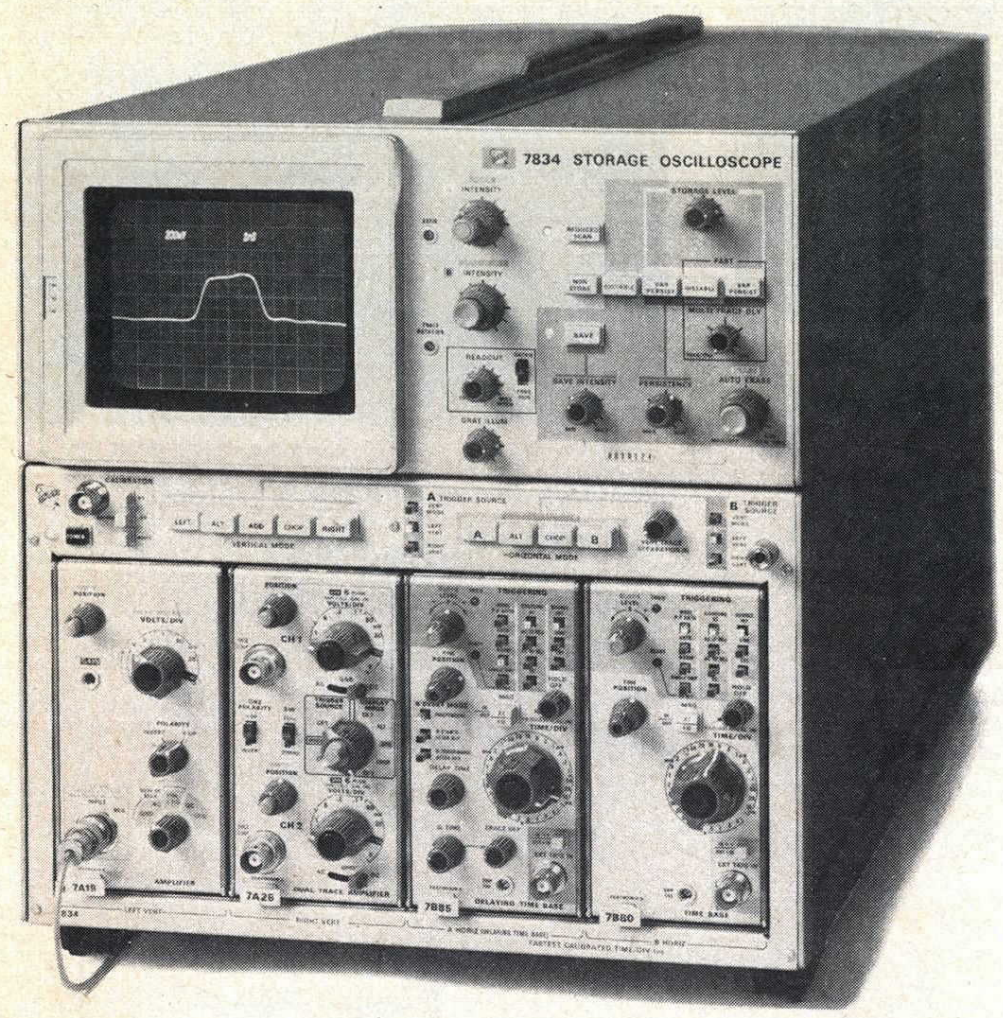


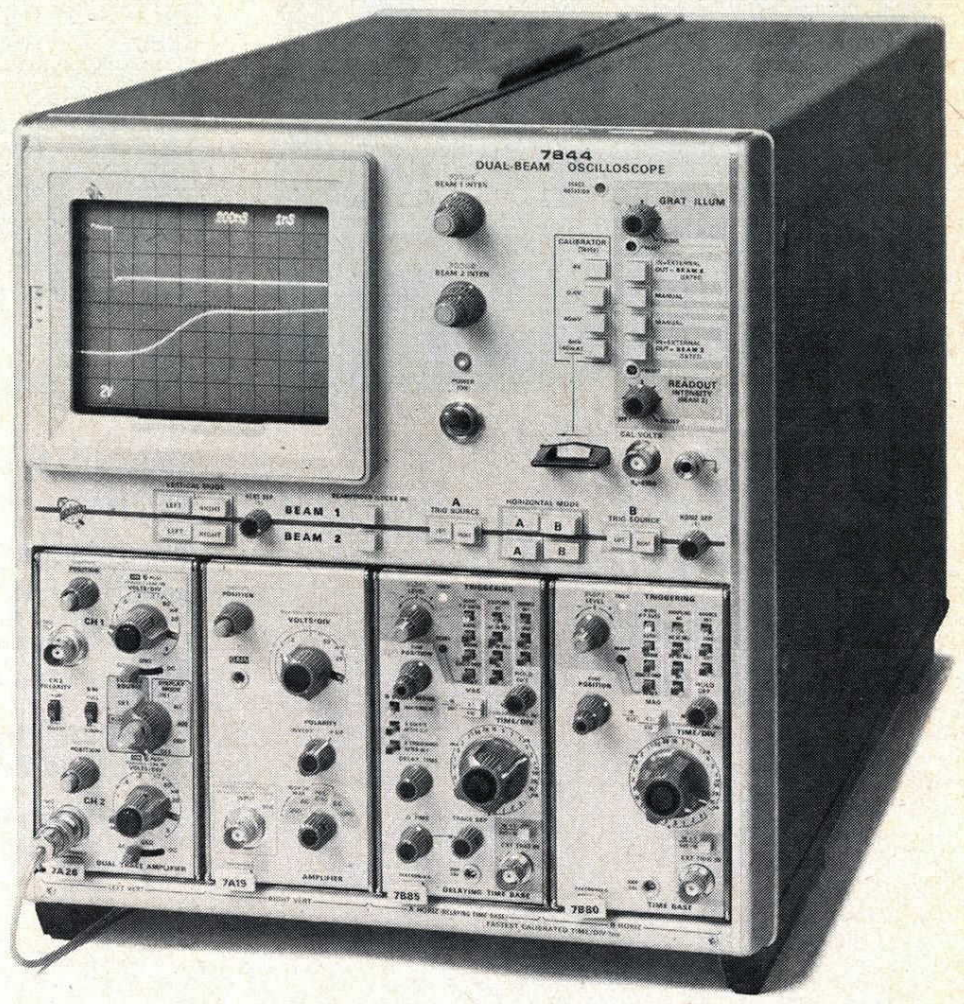
The 7000 Series is a unique family of instrumentation components, a continuation of the Tektronix heritage of bringing to the laboratory the ultimate in measurement technology.

Numerous measurement concepts—oscilloscopy, synergistic analog-digital measurements, spectrum analysis, sampling, time domain reflectometry, curve tracing—are fused into a family of interdependent cathode-ray-tube mainframes and instrumentation plug-ins.

A system can be tailored for your exact measurement needs. Mainframes in the family offer a choice of popular bandwidth ranges and a wide selection of additional features. Plug-ins—including oscilloscope vertical amplifiers and time bases as well as instruments for a variety of applications—can be selected to round out your tailored system.

In opposition to an industrial world that is frequently faulted for planning obsolescence, this instrument family strategically defers obsolescence. Each mainframe and each plug-in reflect the latest technology at their inceptions, yet each fits a well-planned niche in this interdependent family. The result is an array of instrumentation components that can adapt to our new developments while protecting your initial investment. Today's system may be expanded to meet future needs at a relatively low cost by the addition of a plug-in or two. When the time comes to add a more powerful mainframe, your older model continues to be useful for a host of applications.





Crt Readout*

All significant parameters are displayed in alphanumeric characters right on the crt. They are readily visible when you need them for quick oscilloscope measurements, and they are permanently recorded on your waveform photographs for future analysis. When your 7000-Series Measurement System includes a digital instrument plug-in, the measurement is presented in clear, accurate digital terms, along with a corresponding analog waveform.

Bright Traces

All 7000-Series Crts have bright displays and excellent photographic writing speeds. For applications requiring maximum photographic writing speeds, several mainframes feature a condensed scan on a reduced area in the center of the crt.

Large Illuminated Graticules Eliminate Parallax

The display area is 8 by 10 divisions (0.9, 0.98, 1.0, or 1.22 cm/div depending upon mainframe) with a parallax-free graticule. All graticules are illuminated except the 7313.

Convenient Camera Mountings and Connections

A standard bezel connector matches all TEKTRONIX Oscilloscope Cameras to 7000-Series Mainframes.

*Not available in mainframes or plug-ins with "N" suffix.

Independent Intensity Controls

Separate intensity controls allow for independent adjustment of A sweep, B sweep, and character readout brightness. The intensity of each sweep may be adjusted to a level that suits your application.

Autofocus

The trace stays in focus with changes in intensity. After the focus is initially set, an autofocus circuit reduces the need for additional adjustments.

Adjustable Graticule Illumination

This gives you easier viewing and sharper photos. Not available on the 7313.

Plug-ins

Flexible Measurement Systems

More than thirty plug-ins provide you with flexibility to choose just the measurement capability you require.

Analog/Digital Synergism

Digital instrumentation plug-ins create unsurpassed measurement capabilities. Highly accurate digital measurements may be made at selectable points on complex waveforms by visually superimposing gate waveforms over signal waveforms.

Mainframes

Calibration Standard

All the 7000-Series Calibrators serve as a voltage standard for calibrating vertical plug-ins, a 1 kHz square wave for adjusting probe compensation, or a 1 kHz frequency standard in the 7800- and 7900-Series Mainframes. The output is available in several dc or 1 kHz square-wave voltages.

Trigger Source Flexibility

The left and right trigger selector mainframe pushbuttons route the desired trigger source to the appropriate time base. A VERT mode position automatically routes whichever source has been chosen for vertical inputs.

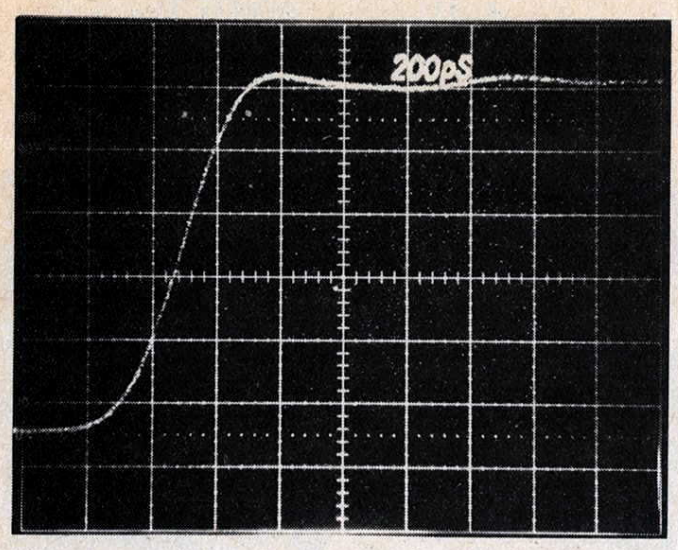
Easy Display Selection

Vertical mode switches allow you to easily select the desired vertical amplifier or interaction of amplifiers (e.g., alternate, chopped, or added modes). Four-compartment mainframes provide equivalent flexibility for time bases as well.

Mainframe Flexibility

Numerous options add even more flexibility in creating the oscilloscope system that most closely meets your measurement requirements.

7104 NON-STORAGE



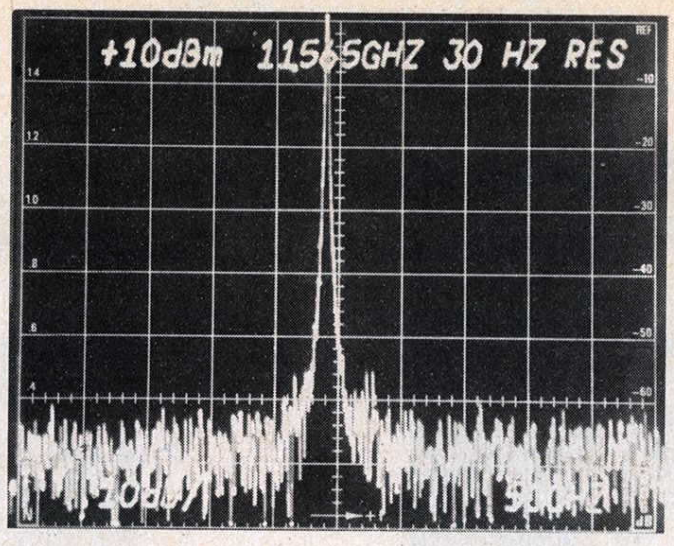
1 GHz Bandwidth

10 mV/Div Sensitivity

200 ps/Div Sweep Speed

20 cm/ns Writing Speed

SPECTRUM ANALYZER



Accurate Amplitude Measurements at 11 GHz

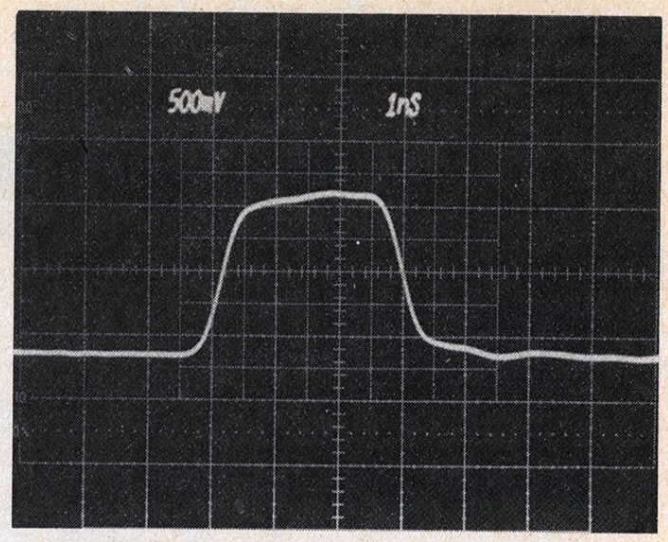
Crisp, Clean Displays via Low Residual FM'ing

60 dB Dynamic Range at Offset Frequencies as Low as 500 Hz

Spurious Free Displays with Internal Calibrated Preselector

Flicker Free Digital Storage

STORAGE



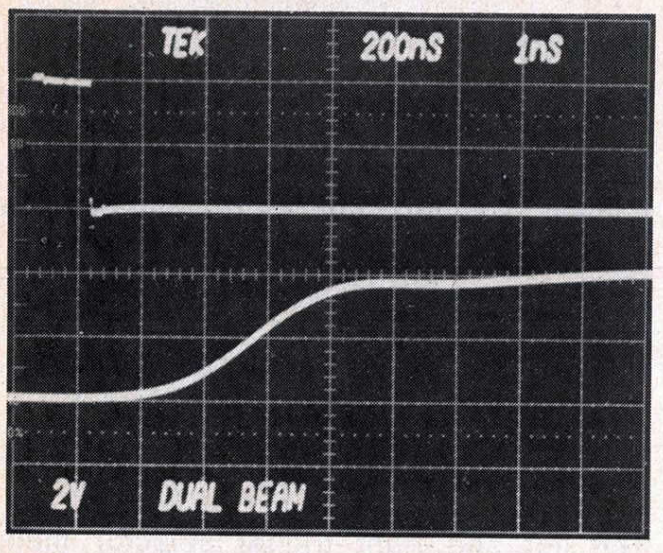
Readout Stored with the Waveform

Fast Stored Writing Speeds

Multimode 7834/7633/7623A

Variable Persistence 7613
or
Split Screen Bistable 7313

DUAL BEAM

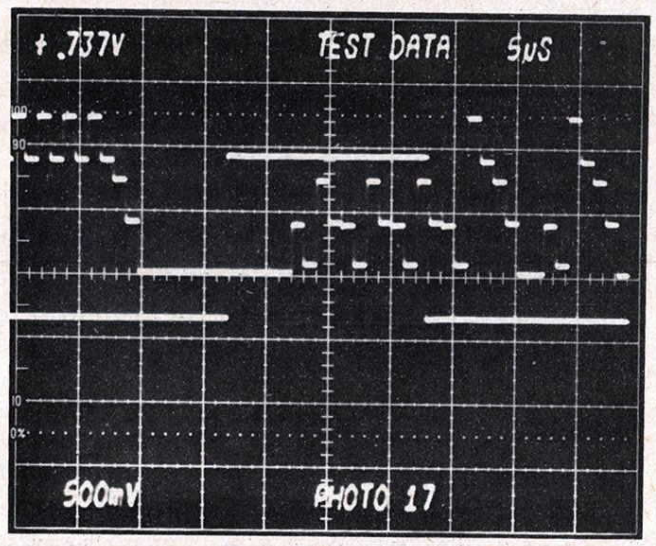


400 MHz Bandwidth

Full Vertical and Horizontal Cross-over Switching
(one input shown at two sweep speeds)

Full Overlap on 8 x 10 cm Display

DIGITAL



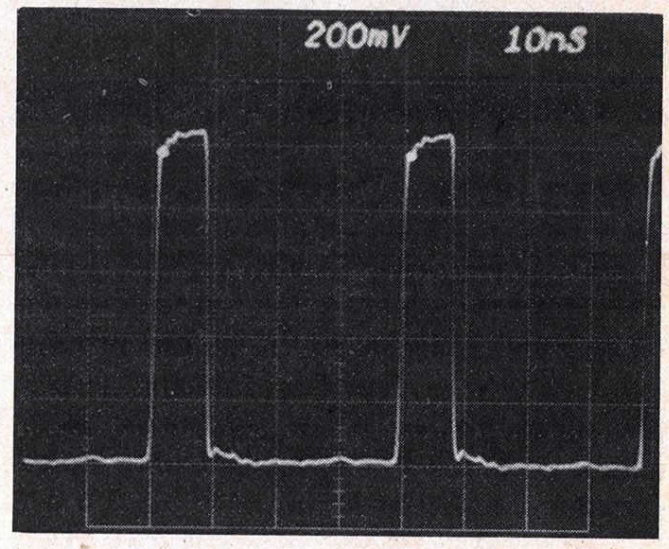
Sample and Hold Dvm Measures Difference Voltage between Two Points on Complex Waveform (gate waveform indicates two points—leading and trailing edges—where voltage difference is made—+0.737 V)

Readout Unit Identifies this Waveform as TEST DATA-PHOTO 17

Counter/Timer Measurement with Analog Display

Compare Digital Measurement with Analog Display

SAMPLING



Two-Dot Time Measurement

Calibrated Delayed Sweep

Simultaneous Sampling & Conventional Displays

Operational Ease of a Conventional Oscilloscope

7000-Series Storage Oscilloscopes

Storage, as it applies to most instruments in the TEKTRONIX 7000 Series, involves techniques for capturing and retaining signals within the cathode-ray tube itself. (Systems for digitally reconstructing signals, sometimes included under the broad umbrella of storage, are discussed on pages 169 and 170).

Why Store?

Capturing an event for detailed analysis is perhaps the most obvious application for a storage crt, but many other situations also call for its unique advantages. Some examples include capturing the entire display of a slowly occurring signal . . . observing signal changes during circuit adjustment . . . comparing incoming signals with a standard . . . increasing the brightness of a repetitive signal for viewing in normal ambient light . . . reducing flicker or noise . . . baby-sitting, or unattended monitoring for a transient event . . . and enhancing other recording techniques such as photography.

Storage Features

Since 1962, when Tektronix introduced phosphor target bistable storage in the 564, techniques for capturing and retaining waveforms have grown at an explosive rate in order to keep pace with measurement demands.

However, the language of storage—such terms as bistable, variable persistence, and mesh transfer—frequently presents as much confusion as the measurement that must be made.

Characteristics of individual 7000-Series Mainframes employing storage techniques are listed on pages 59 through 66. A review, though, of storage concepts should prepare the reader to evaluate the various alternatives more knowledgeably.

Bistable

Phosphor target bistable, available on the 7313 Mainframe, offers a low-cost alternative with relatively long view times. Waveform storage takes place directly on the crt phosphor. This easy-to-use technique offers the flexibility of split-screen storage. Upper and lower halves of the screen may be stored independently. Thus, a reference signal may be stored on one half for comparison against signals on the other half.

Phosphor target bistable has a relatively slow writing speed and a dim contrast between the trace and the background brightness.

Bright Bistable

Bright bistable storage, available as one storage mode on the 7834, 7633 and 7623A Mainframes, employs a mesh between the electron gun and the crt phosphor. It features bright, long-lasting displays with reduced contrast.

Variable Persistence

Variable persistence storage is available in the 7613, 7623A, 7633, and 7834 Mainframes. It features bright, high-contrast displays and controlled persistence.

A front-panel persistence knob provides control of the decay (fade-away) rate of the stored image. The rate can be varied from almost instantaneous disappearance to a view time of greater than 15 s in the 7613 (30 s in the 7623A, 7633, and 7834).

Fast Multimode

Fast multimode storage, available in the 7623A, 7633, and 7834, provides four storage modes. The four modes combine the previously discussed bright bistable and variable persistence storage modes with fast bistable and fast variable persistence.

The display characteristics of fast bistable and fast variable persistence are the same as bistable and variable persistence respectively. In either fast storage mode the trace image is first written on a fast mesh, then transferred to a long retention mesh for viewing.

As the name implies, fast provides increased storage writing speed. For example, in the reduced scan display mode, the variable persistence writing speed of 5.4 cm/μs is increased to 2500 cm/μs by selecting fast variable persistence. The 2500 cm/μs writing speed is fast enough to capture a single event equivalent to the 7834's 400-MHz bandwidth or a 900 ps rise time.

400 MHz Dual-Beam

Dual-beam oscilloscopes are essentially two oscilloscopes in one. Each beam operates separately and independently of the other. They are required for many applications where two transient events must be compared simultaneously. These application areas include stimulation and reaction events in such fields as medicine, biology, chemistry, engineering mechanics, to name just a few.

Depending on the plug-ins selected, up to eight traces can be displayed at a time.

Digitals

The 7000-Series Digital Plug-ins include: a universal counter/timer, 525 MHz direct frequency counter, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, and a special readout unit to label each test for future reference. Together with a 7000-Series Mainframe, these give you the advantage of seeing what you're measuring, plus accuracy of digital techniques.

This combination offers many advantages over separate test units. You get: scope-controlled digital measurements, measuring convenience and confidence, increased accuracy, easier and faster solution to complex problems, a lower dollar investment, more bench space and signal conditioning.

Sampling

The 7000-Series Sampling Plug-ins provide some unique measurement capabilities not available in other sampling oscilloscopes. You get: a low-cost storage crt for slow scans, a random mode that lets you see leading edges with pretrigger or bandwidth-limiting delay line, a wide choice of sampling heads at minimal cost, and the convenience of sampling and conventional displays at the same time on the crt.

The sampling waveform on the preceding page was displayed using the 7S14. You can position the two bright dots to any two points in a waveform which is displayed at 10 ns/div or faster. The separation between dots is controlled by a calibrated 10-turn DTM dial. Repeated time measurements on similar waveforms may be made more rapidly and accurately and with less fatigue using this unique two-dot method.

Spectrum Analysis

Unexcelled plug-in performance from 20 Hz to 60 GHz is provided by the 7L5, 7L13 and 7L18 Spectrum Analyzer. Stable, sensitive and spurious-free, these analyzers work in any 7000-Series Mainframe. The same mainframe may be used with other plug-ins for oscilloscope measurements.

Some plug-in analyzers have microprocessor-aided controls for easy operation, and digital storage and display capability for recalling and comparing signals. Others offer 30 Hz resolution for viewing close-together signals. Some optional tracking generators are available for swept frequency measurements.

Refer to the Spectrum Analyzer section beginning on p. 188 for more information.

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A15A	7A16A	7A17	7A18	7A19	7A21N	7A22	7A24	7A26	7A29
PAGE			68	70	68	68	69	71	69	69	70	71	71	71
PERFORMANCE FEATURE			Low-capacitance FET probe amplifier	Differential dc offset, high-freq cmrr amplifier	Low-cost conventional input amplifier	Wide-bandwidth conventional input amplifier	Low-cost, easy to customize amplifier	Dual-channel amplifier	Wide-bandwidth 50-Ω input amplifier	Direct crt access	Dc-coupled, high-gain differential amplifier	Dual-channel 50-Ω amplifier	Dual-channel amplifier	
MIN DEFL FACTOR			5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)[2]	5 mV/div	50 mV/div	5 mV/div	10 mV/div	<4 V/div	10 μV/div	5 mV/div	5 mV/div	10 mV/div
ACCURACY[1] WITHOUT PROBE			2% (integral)	1.5%	2%	2%	—	2%	3%	—	2%	2%	2%	2%
7900 FAMILY (0°C to 30°C)	7104	BW	250 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	600 MHz	—	1 MHz ± 10%	400 MHz	200 MHz	1000 MHz
		TR	1.4 ns	3.5 ns P6053* 3.5 ns P6106** 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.6 ns		300 ns ± 9%	0.9 ns	1.8 ns	0.35 ns
	7904 R7903 R7912[6]	BW	250 MHz	105 MHz P6053B* 105 MHz P6106** 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz	1 GHz	1 MHz ± 10%	350 MHz	200 MHz	500 MHz
		Tr	1.4 ns	3.4 ns P6053B* 3.4 ns P6106** 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ps	350 ns ± 9%	1.8 ns	1.0 ns	0.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	—	1 MHz ± 10%	140 MHz	140 MHz	300 MHz
7800 FAMILY (0°C to 35°C)	7844/R	BW	200 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz[3]	1 GHz	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	350 ps	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
	7834	BW	200 MHz	95 MHz P6053B* 95 MHz P6106** 65 MHz P6055	80 MHz	200 MHz	150 MHz	75 MHz	400 MHz	—	1 MHz ± 10%	300 MHz	180 MHz	400 MHz
		Tr	1.8 ns	3.7 ns P6053B* 3.7 ns P6106** 5.4 ns P6055	4.4 ns	1.8 ns	2.4 ns	4.7 ns	0.9 ns	—	350 ns ± 9%	1.2 ns	1.9 ns	0.9 ns
	7704A Opt 9 (0°C to 30°C)	BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	170 MHz	150 MHz	75 MHz	250 MHz[4]	—	1 MHz ± 10%	200 MHz	170 MHz	250 MHz
		Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.1 ns	2.4 ns	4.7 ns	1.5 ns	—	350 ns ± 9%	1.8 ns	2.1 ns	1.5 ns
		SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	—	1 MHz ± 10%	70 MHz	70 MHz	80 MHz
7700 FAMILY	7704A	BW	170 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	160 MHz	150 MHz	75 MHz	200 MHz	—	1 MHz ± 10%	200 MHz	150 MHz	200 MHz
		Tr	2.1 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.2 ns	2.4 ns	4.7 ns	1.8 ns	—	350 ns ± 9%	1.8 ns	2.4 ns	1.8 ns
		SIG OUT BW	70 MHz	60 MHz P6053B* 60 MHz P6106** 50 MHz P6055	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	—	1 MHz ± 10%	70 MHz	70 MHz	80 MHz
	R7704	BW	150 MHz	100 MHz P6053B* 100 MHz P6106** 65 MHz P6055	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	—	1 MHz ± 10%	160 MHz	140 MHz	175 MHz
		Tr	2.4 ns	3.5 ns P6053B* 3.5 ns P6106** 5.4 ns P6055	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	—	350 ns ± 9%	2.2 ns	2.5 ns	2.0 ns
		SIG OUT BW	60 MHz	55 MHz P6053B* 55 MHz P6106** 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	—	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
7600 FAMILY and STORAGE FAMILY	7603/R 7633/R	BW	100 MHz	75 MHz P6016 55 MHz P6055	65 MHz	100 MHz	100 MHz	75 MHz	100 MHz	—	1 MHz ± 10%	100 MHz	100 MHz	100 MHz
	7623A/R 7613/R	Tr	3.5 ns	5.0 ns P6016 6.4 ns P6055	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.5 ns	—	350 ns ± 9%	3.5 ns	3.5 ns	3.5 ns
	7603N Opt 11[5]	SIG OUT BW	60 MHz	55 MHz P6016 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	—	1 MHz ± 10%	60 MHz	60 MHz	65 MHz
	7313 R7313	BW	25 MHz	25 MHz P6062B 24 MHz P6055	25 MHz	25 MHz	25 MHz	25 MHz	25 MHz	—	1 MHz ± 10%	25 MHz	25 MHz	25 MHz
		Tr	14 ns	14 ns P6062B 15 ns P6055	14 ns	14 ns	14 ns	14 ns	14 ns	—	350 ns ± 9%	14 ns	14 ns	14 ns
		SIG OUT BW	60 MHz	55 MHz P6062B 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	—	1 MHz ± 10%	60 MHz	60 MHz	65 MHz

System Environmental Specifications (apply to all instruments except where noted)—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

[1]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%.

[2]Obtained with X10 gain at reduced bandwidth of 10 MHz.

[3]Bandwidth is 325 MHz to 10 mV/div.

[4]Bandwidth is 200 MHz at 10 mV/div.

[5]All 7000-Series Plug-ins are compatible with the 7603N Opt 11. However, they do not meet the rigid environmental specifications required by the military.

[6]Refer to Transient Digitizer, R7912 not available with signal outputs.

*P6053B has Trace Identify

**P6106 has Ground Reference

RECOMMENDED COMBINATIONS 7000-SERIES MAINFRAMES AND TIME BASES

MAINFRAME		7104	7904 R7903	7834	7844/R	7704A R7704	7603/R	7603N Opt 11	7633/R 7623A/R	7613/R	7313/R
Time Base	PERFORMANCE FEATURE	● INDICATES RECOMMENDED COMBINATION									
7B50A	Single time base					●	●		●	●	●
7B53A	Dual time base with mixed sweep						●	● *	●	●	●
7B53A Opt 05	7B53A with tv sync triggering						●		●	●	●
7B80	Single time base (used also as delayed time base)		●	●	●	●					
7B85	Single time base with delaying and Δ delay sweep function		●	●	●	●(1)					
7B92A	Dual time base with display switching		●	●	●	●(1)					
7B10	Single time base (used also as delayed time base)	●	●	●	●						
7B15	Single time base with delaying and Δ delay sweep function	●	●	●	●						

*7B53AN Opt 11 is recommended; one is supplied with 7603N Opt 11S system.

(1)No trace separation on R7704 only.

7000-SERIES
OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART*

		PASSIVE VOLTAGE 1-MΩ INPUT COMPATIBLE							PASSIVE VOLTAGE 50-Ω INPUT COMP		FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE		**P6101 1 Meter**	**P6106 1 Meter P6053B 3.5'**	**P6055 3.5'**	**P6009 9'**	**P6015 10'**	**P6062B 6'**	**P6105 P6108 2 Meter**	**P6056 6'**	**P6057 6'**	**P6202 2 Meter**	**P6046 6'**	**P6201 6'**	**w/passive term P6021 5' 10 mV/mA**	**w/passive term P6022 5' 10 mV/mA**	**P6302/ AM 503 6'**
FEATURES		**Miniature Probe**	**Fastest Probes Compatible with 1-MΩ Input**	**Adj Attenuation for Differential Use**	**1.5 kV Compatibility**	**40 kV Pk Pulse Compatibility**	**Selectable Attenuation**	**Miniature Probe**	**Fastest 10X Passive Probe Low C**	**Fastest 100X Passive Probe Low C**	**10-MΩ Input Impedance Dc, Offset**	**Differential Probe High Cmrr**	**Low Capacitive Loading Ac Coupling Dc Offset**	**Ac High Current**	**Ac High Frequency**	**Dc High Current**
ATTENUATION		**1X**	**10X**	**10X**	**100X**	**1000X**	**Selectable**	**10X**	**10X**	**100X**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**
7104	**7A19**	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	100 MHz	430 MHz	Nc	Nc	50 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	350 MHz	350 MHz	300 MHz	100 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz		100 MHz			185 MHz	90 MHz	195 MHz	60 MHz	140 MHz	50 MHz
	7A29	Nc	Nc	Nc	Nc	Nc	Nc	Nc	950 MHz	800 MHz	450 MHz	100 MHz	660 MHz	Nc	Nc	50 MHz
7900 FAMILY	**7A11***	Nc	Nc	Nc	Nc	Nc		Nc						55 MHz	150 MHz	45 MHz
	7A13	34 MHz	105 MHz	65 MHz	85 MHz	65 MHz		75 MHz		105 MHz	105 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		80 MHz	80 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	200 MHz		130 MHz	80 MHz				205 MHz	205 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		75 MHz	75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	500 MHz	480 MHz	300 MHz	95 MHz	430 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc		Nc	Nc	Nc	Nc	350 MHz	350 MHz	290 MHz	90 MHz	310 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz					185 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
7800 FAMILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	130 MHz	45 MHz
	7A13	34 MHz	95 MHz	65 MHz	85 MHz	60 MHz		100 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	55 MHz	75 MHz	75 MHz			80 MHz	60 MHz	80 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	160 MHz		110 MHz	75 MHz		100 MHz			170 MHz	85 MHz	165 MHz	55 MHz	130 MHz	45 MHz
	7A18	34 MHz	85 MHz		80 MHz	60 MHz	85 MHz	85 MHz			75 MHz	65 MHz	90 MHz	45 MHz	70 MHz	40 MHz
	7A19	Nc	Nc	Nc	Nc	Nc	Nc	Nc	400 MHz	400 MHz	320 MHz	95 MHz	360 MHz	Nc	Nc	50 MHz
	7A22	1 MHz	Nc	1 MHz	1 MHz	1 MHz	1 MHz	Nc						1 MHz	1 MHz	1 MHz
	7A24	Nc	Nc	Nc	Nc	Nc	Nc	Nc	300 MHz	300 MHz	270 MHz	90 MHz	280 MHz	Nc	Nc	45 MHz
	7A26	34 MHz	145 MHz		105 MHz	75 MHz		100 MHz			150 MHz	85 MHz	155 MHz	55 MHz	125 MHz	45 MHz
7704A	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						55 MHz	125 MHz	45 MHz
	7A13	34 MHz	100 MHz	65 MHz	85 MHz	65 MHz		70 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A15A	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	145 MHz		115 MHz	75 MHz		100 MHz			160 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19**	Nc	Nc	Nc	Nc	Nc	Nc	Nc	250 MHz	250 MHz	220 MHz	85 MHz	215 MHz	Nc	Nc	45 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	34 MHz	Nc		Nc	Nc	Nc	Nc	200 MHz	200 MHz	185 MHz	80 MHz	180 MHz	Nc	Nc	45 MHz
	7A26	Nc	140 MHz		105 MHz	75 MHz		100 MHz			160 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
7600 FAMILY	**7A11**	Nc	Nc	Nc	Nc	Nc	Nc	Nc						50 MHz	85 MHz	40 MHz
	7A13	34 MHz	75 MHz	55 MHz	60 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A15A	34 MHz	60 MHz		55 MHz	50 MHz	60 MHz	60 MHz			65 MHz	50 MHz		40 MHz	60 MHz	35 MHz
	7A16A	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	1 MHz	Nc	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A26	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
7313	**7A11**	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	Nc	Nc	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A13	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	Nc	Nc	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A15A	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	Nc	Nc	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A18	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	Nc	Nc	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A22	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	Nc	Nc	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz

***Note: The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.**

**** = Option 09 Mainframe**

Nc = Not compatible

If there is no bandpass specified the probe/plug-in combination is compatible but not recommended.

DIMENSIONS AND WEIGHTS 7000-SERIES MAINFRAMES AND PLUG-INS

Dimensions		**7104**	**7904**	**R7903**	**7844**	**R7844**	**7834**	**7704A**	**R7704**	**7603**	**R7603**	**7603N OPT 11S**	**7603N OPT 11**	**7633, 7623A, 7613, 7313**	**R7633, R7623A, R7613, R7313**	**PLUG-INS**	
																SINGLE	**DOUBLE**
Height	in	13.6	13.5	5.3	12.9	7.0	13.6	13.6	7.0	11.4	5.25	11.5	11.5	12.0	5.25	5.0	5.0
	cm	34.5	34.3	13.5	32.8	17.8	34.5	34.5	17.8	29.0	13.3	29.2	29.2	30.5	13.3	12.7	12.7
Width	in	12.0	12.0	19.0	12.0	19.0	12.0	12.0	19.0	8.7	19.0	9.7	9.7	8.7	19.0	2.8	5.5
	cm	30.5	30.5	48.3	30.5	48.3	30.5	30.5	48.3	22.1	48.3	24.6	24.6	21.2	48.3	7.1	14.0
Length	in	23.5	23.3	22.8	23.8	24.8	23.2	22.7	22.4	24.0	24.7	25.2	23.5	23.5	22.3	14.5	14.5
	cm	59.2	59.2	57.9	60.5	63.0	58.9	57.7	56.9	61.0	62.7	64.0	59.7	59.7	56.6	36.8	36.8
Weights (approx)																	
Net	lb	43.6	32	27	36	33	35.5	30	44	30	30	45	36	30	32	2	9
	kg	19.8	14.5	12.2	16.3	15.0	16.1	13.6	20.0	13.6	13.6	20.4	16.3	13.6	14.5	0.9	4.1
Shipping	lb		44	52	47	63	47	43	77	46	62	72	42	42	62	5	12
	kg		20	23.6	21.3	28.5	21.3	19.5	35.0	20.8	28.2	32.7	19.0	19.0	28.2	2.3	5.4

SUMMARIZED CAMERA CHARACTERISTICS

CAMERA	RECOMMENDED FOR	PERFORMANCE FEATURES AND BENEFITS	LENS				FILM BACKS		PRICE with back ordinarily used
			MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3.25 x 4.25 in Polaroid Film except where noted)	ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	
C-51	7904, R7903, 7844, 7704A	Fastest writing speed with 0.5 mag lens.	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Roll	Polaroid Pack and 4 x 5 in Graflok	$1500
C-53	All except 7603 7603N11S	General-purpose with 0.85 mag lens.	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 in	Polaroid Pack	Polaroid Roll and 4 x 5 in Graflok	$1225
C-59	7603 7603N11S	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in	Polaroid Pack	Polaroid Roll and 4 x 5 in Graflok	$750
C-5B	All	Low cost.	f/16	0.67 or 0.85 selectable	0.02	9.76 x 12.2 cm	Polaroid Pack	None	$395

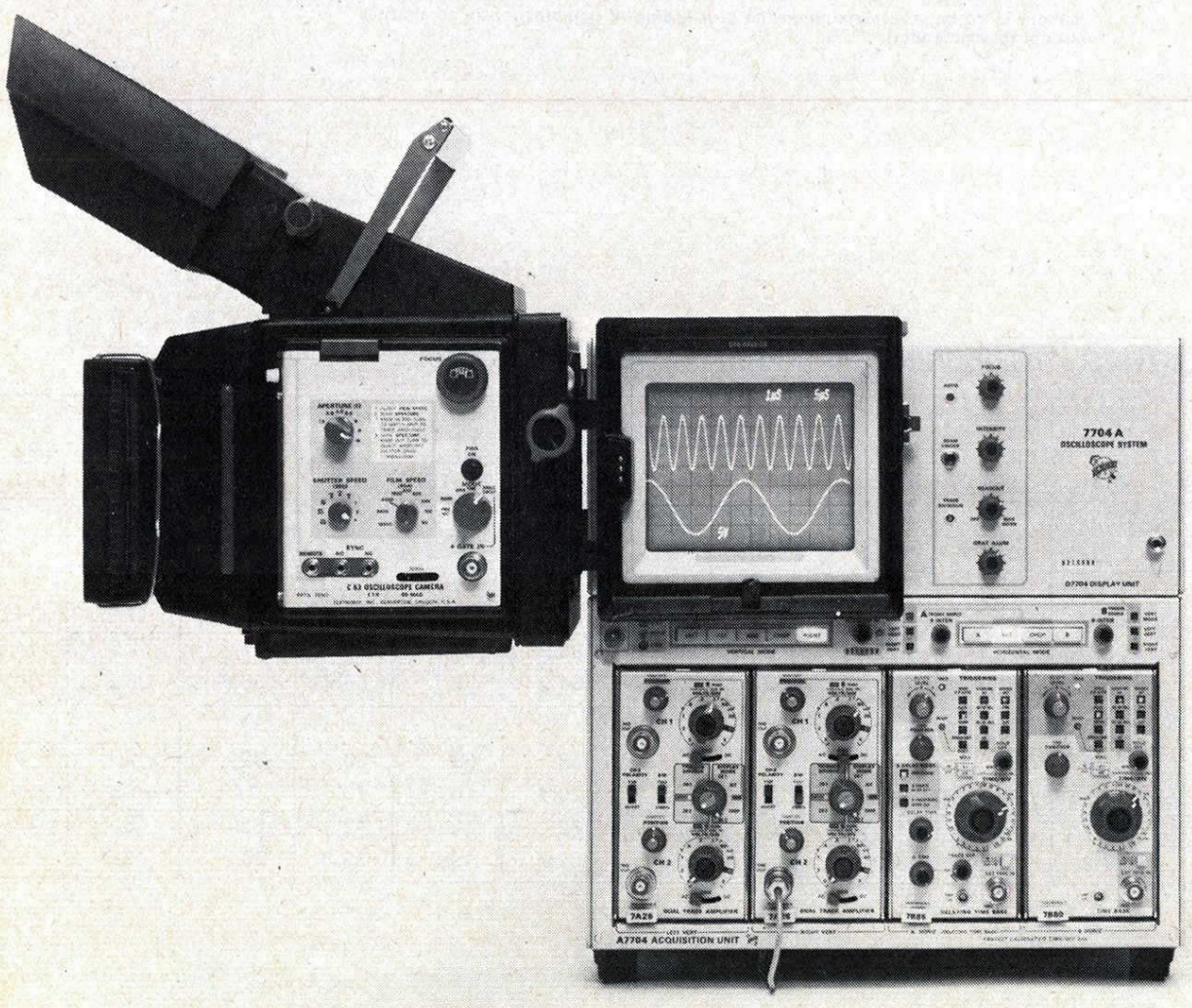
*Relative light-gathering power.

Recommended Cameras and Adapters

OSCILLOSCOPE	RECOMMENDED CAMERA
7904, R7903, 7844, 7704A	C-53 or C-51
7104, 7633, 7623A, 7613, 7834	C-53
7603, 7603N Opt 11S	C-59

C-50 Series Camera Adapter, part number 016-0249-03, included with camera.

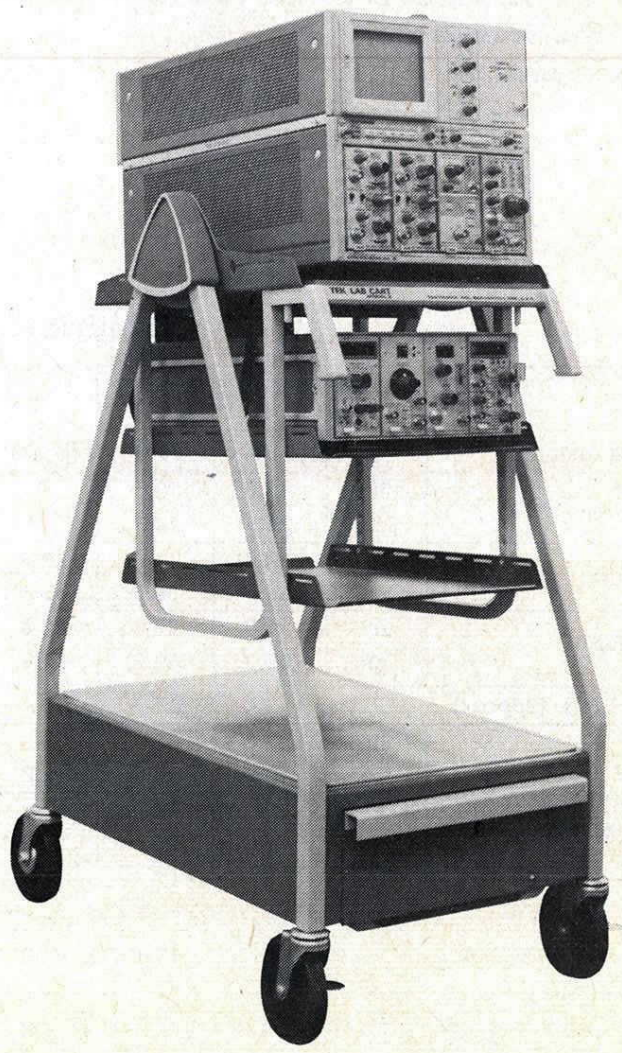
For full details see camera section, page 209.



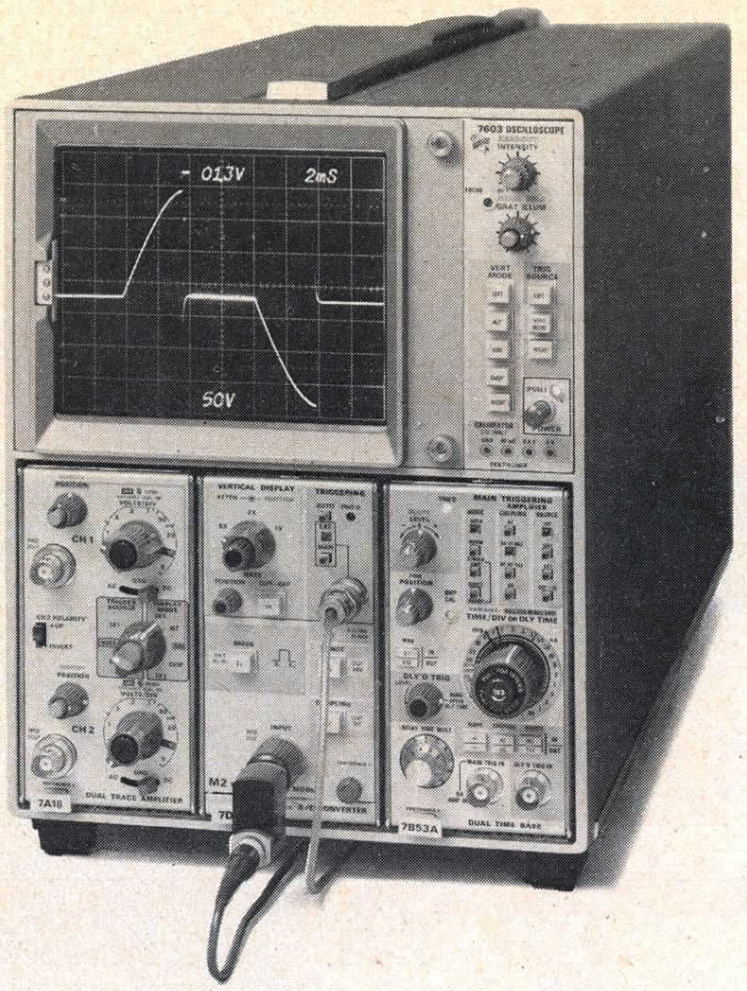
TEK Lab Cart Model 3

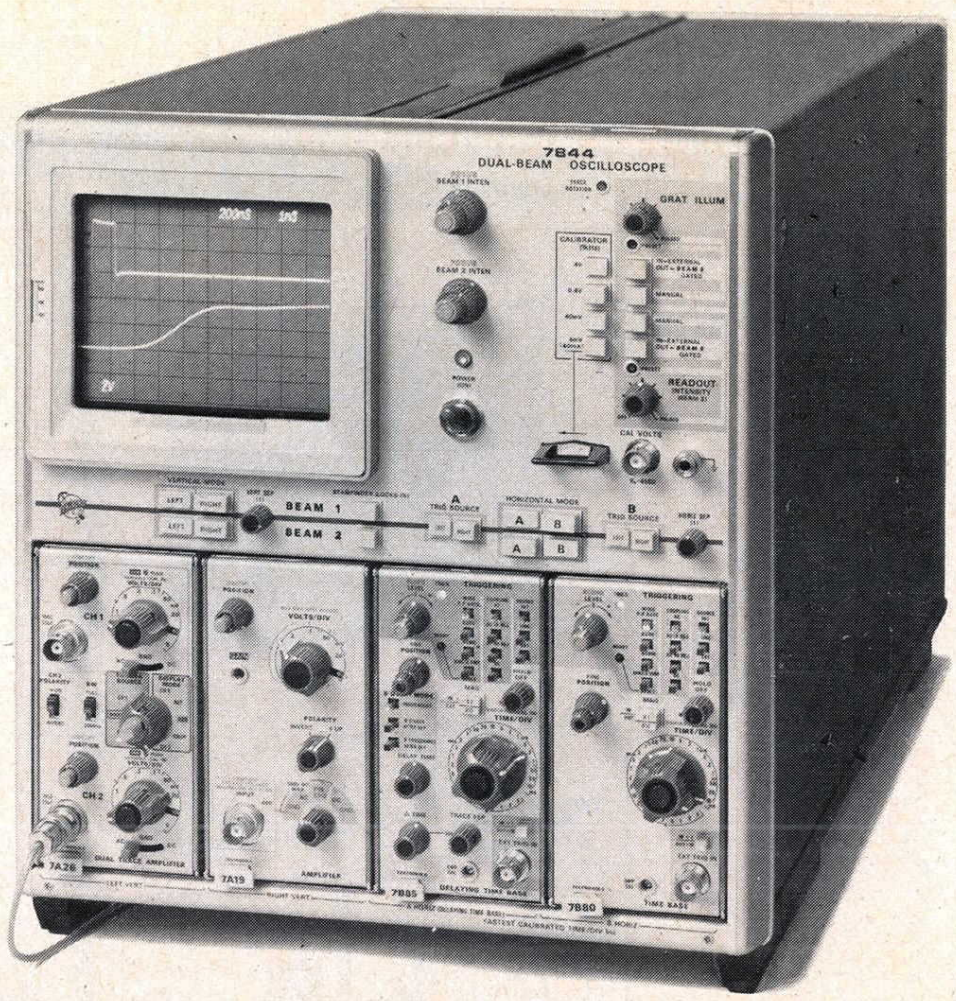
Model 3 Lab Cart accepts all 7000-Series Oscilloscopes. A lockable drawer for storage and a movable shelf for additional instrumentation are included. The shelf accepts TM 500 Test and Measurement instruments, 5000-Series Oscilloscopes, or 400-Series Oscilloscopes.

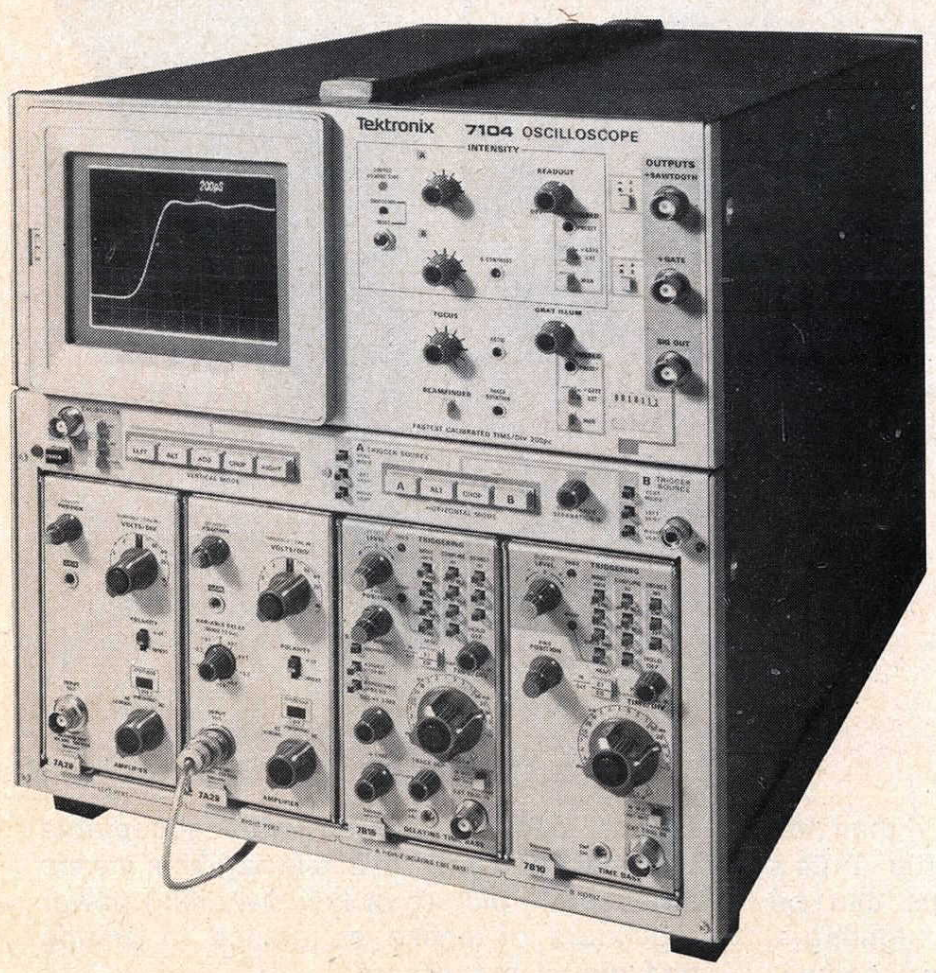
For full details see SCOPE-MOBILE® Cart section, page 234.



7000-Series Nonstorage Mainframes







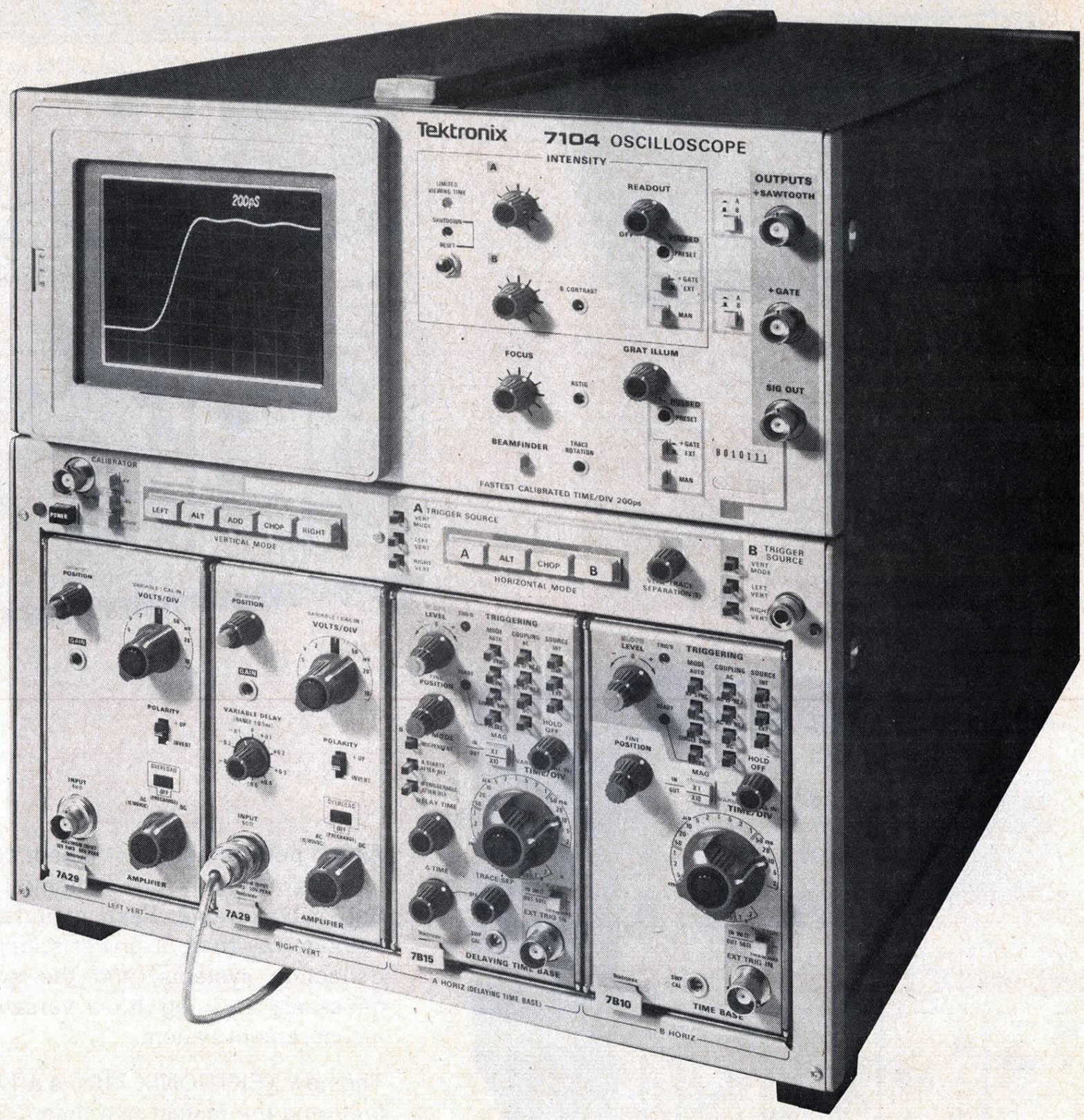
A high performance instrument system begins with the basic oscilloscope building block — the 7000-Series Mainframe. Each mainframe consists of a cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete measurement system.

The new TEKTRONIX 7104 is a 1 GHz oscilloscope featuring the fastest rise time (350 ps) and writing speed (20 cm/ns) available today.

Choose from a variety of features, including bandwidth, dual-beam, alphanumeric displays, rack-mounting, and three- or four-plug-in flexibility:

7100 Series	**1 GHz**	**page 48**
7900 Series	**500 MHz**	**page 50**
7800 Series	**400 MHz**	**page 52**
7700 Series	**200 MHz**	**page 56**
7600 Series	**100 MHz**	**page 54**

the 7000 Series . . . more than an oscilloscope



1 GHz at 10 mV/div

200 ps/div Fastest Calibrated Sweep Rate

20 cm/ns Writing Speed

X-Y 350 MHz Option Available

Crt Readout

Over 30 Compatible Plug-ins

The 7104 is a new measurement instrument combining versatility and dependability with exceptionally high performance.

The 7104 gives you a 1 GHz bandwidth with rise times of up to 350 picoseconds. This, combined with our fastest sweep speed of 200 picoseconds per division means that troublesome high frequency overshoot and digital pulse ringing can be detected and measured in detail.

A writing speed of 20 cm/ns makes the 7104 almost a thousand times brighter than the next best oscilloscope. Thus the 7104's single shot rise time of 350 ps can be viewed under normal ambient lighting—without image loss. Tedious and complicated photographic techniques are no longer needed to photograph fast single-shot waveforms. Single-shot jitter and glitches can be made visible—even when superimposed over a multi-MHz repetitive signal, by the 7104's distinct image viewing. With an X-Y bandwidth of 350 MHz, fast switching signals can be plotted with acceptable phase accuracy (2° to 350 MHz). This means an accurate picture of fast switching power regulators or phase coherence in analog and digital processors.

The 7104 is compatible with standard 7000 Series plug-in units, including several new ones from Tektronix that take the instrument to the limit of its specifications.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

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

Chopped Mode—Repetition rate is approx 1 MHz.

Trace Separation Range (Dual-sweep Modes)—The B trace can be positioned 4 divisions above or below the A trace when 7104 operates in ALT or CHOP horizontal modes.

Delay Line—Permits viewing leading edge of displayed waveform when using 7B10, 7B80 and 7B90 Series Time Bases. 7B50 Series not recommended.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B10, 7B80 and 7B90 Series. 7000-Series Vertical Amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate—200 ps/div with the 7B10 or 7B15.

Chopped Mode—Repetition rate is approx 200 kHz.

Bandwidth—DC to 350 MHz.
With delay compensation (7104 Option 02 using 7A19s or 7A29s, at least one of which has the Variable Delay Option, B Horizontal compartment only), within 2° from dc to 50 MHz after adjusting variable delay for balance at 35 MHz. Phase balance can be obtained at any frequency up to 350 MHz. Phase shift is within 2° from dc to 50 kHz without delay compensation.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (0.85 cm/div) graticule with variable illumination. Accelerating potential is 12.5 kV with P 31 phosphor standard.

Pulse Readout and Graticule Illumination—Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton.

Min Photographic Writing Speed (Using Polaroid Film Type 107, 3000 ASA w/out film fogging) — 20 cm/ns (w/o blue filter). Phosphor: Standard P31. Camera: TEKTRONIX C-53, f/1.9, 1:0.85 lens.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled. Bandwidth is dc to 1 MHz.

CALIBRATOR

Voltage Output—Square wave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within .25%.

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

OUTPUTS/INPUTS

+Sawtooth—User selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+Gate—Positive-going rectangular waveform user selectable from A or B horizontal. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Output R is approx 950 Ω.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±25%) into 50 Ω, 0.5 V (±25%) into 1 MΩ. Bandwdith depends upon vertical plug-in. Output R is approx 950 Ω.

Camera Power — Three-prong connector to the left of the crt provides power, ground, and remote single-sweep reset access for C50-Series Camera.

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

Single-sweep Ready Indicators A and B—+5 V, rear panel BNC outputs for single sweep ready indications.

Graticule/Readout, Single-shot — Ground closure, rear panel BNC input initiates one frame of crt readout and the GRAT ILLUM is illuminated for approx 0.5 sec.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

POWER REQUIREMENTS

Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 250 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 215 W, 3.3 A at 90 V line, 60 Hz.

Dimensions and Weights — See page 45.

For Recommended Cameras — See page 46.

7104 ORDERING INFORMATION
(Plug-ins not included)

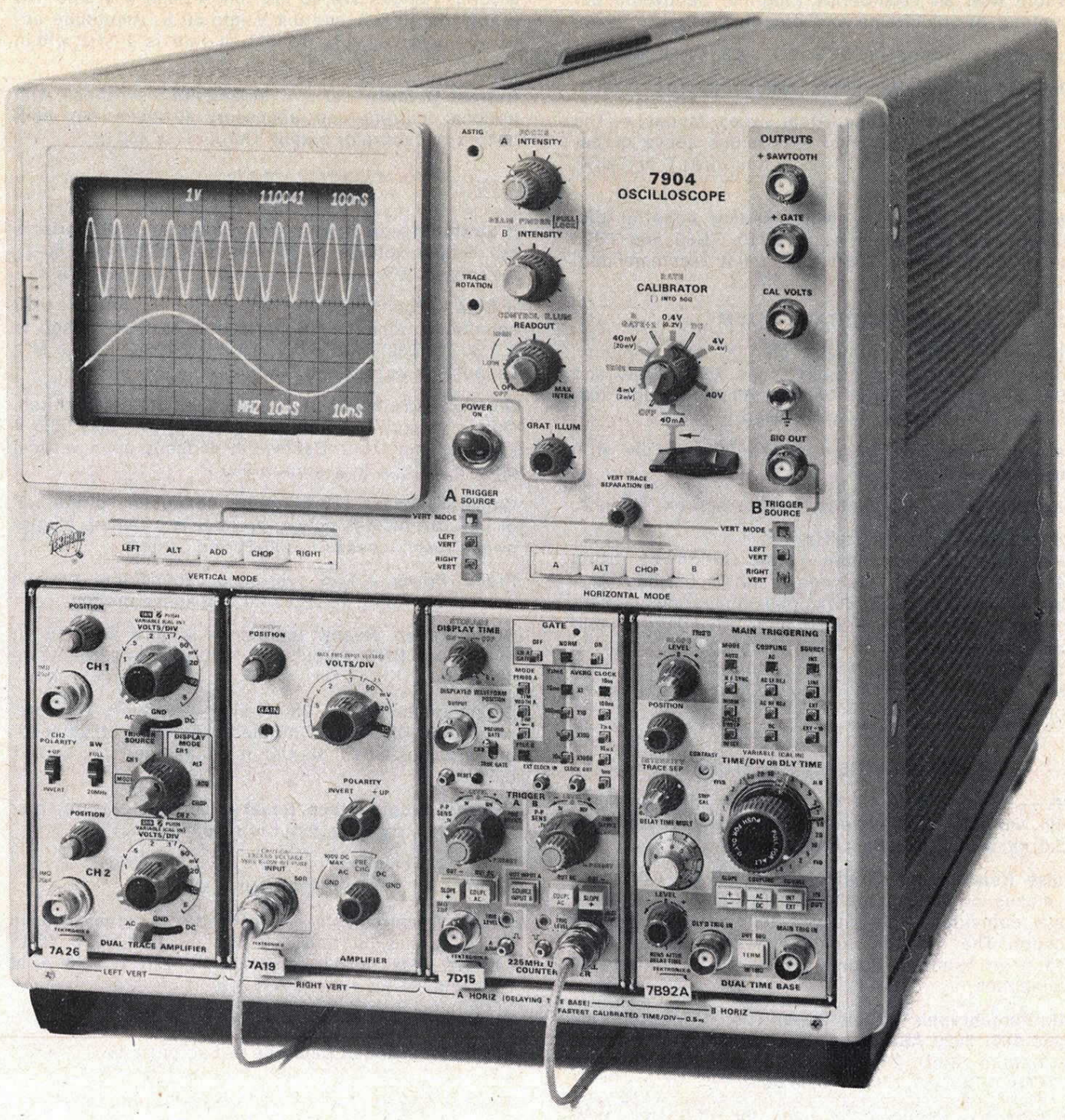
7104 Oscillocsope $14,400

OPTIONS

Option 02 X-Y Horiz Comp. . . . . Add $300
Option 03 Emi Modification . . . . . Add $250

7904
R7903

7000-Series 500-MHz General-Purpose Oscilloscopes



500 MHz at 10 mV/div

1-GHz Direct-access Unit (less than 4 V/div)

500 ps/div Fastest Calibrated Sweep Rate

Greater than 15 cm/ns Enhanced Writing Speed

Crt Readout

Over 30 Compatible Plug-ins

900-MHz FET Probe Available

The 7904 and 5¼ in rackmount R7903 are the second-widest, real-time bandwidth, general-purpose oscilloscopes available today. The 7A19 Amplifier/7904 Mainframe attains 500 MHz at 10 mV. A 7A19 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900-MHz bandwidth by itself, and in combination with the 7A19/7904, it provides a system bandwidth of 450 MHz at 10 mV.

The crt, the major contributor to the performance of the 7904 and R7903, has excellent visual brightness and an 8 x 10 cm display area. The C-51R Camera, Writing Speed Enhancer, 10,000 ASA film and P11 phosphor can produce writing speeds of at least 9 cm/ns. Speeds up to 15 cm/ns are possible when an optional max-brightness crt with a 4 x 5 cm display area is used.

7904 and R7903 — VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned 4 divisions above or below the A trace (7904 only).

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases. 7B50 Series not recommended.

7904 — HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000-Series Vertical Amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

Chopped Mode — Repetition rate is approx 200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, Option 02) between vertical and horizontal channels. Bandwidth is dc to at least 1 MHz.

R7903 — HORIZONTAL SYSTEM

Single Channel — Right-hand plug-in compartment compatible with time bases of 7B80 and 7B90 Series. 7000-Series Vertical Amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

7904 and R7903 CRT AND DISPLAY FEATURES

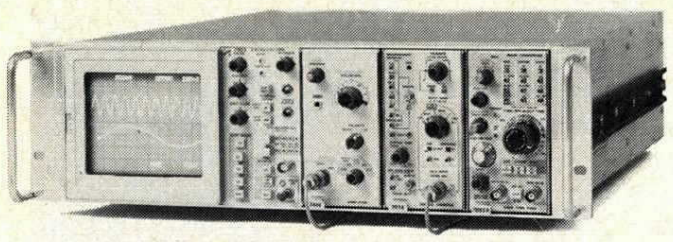
Standard — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard.

Option 01, without Crt Readout — No crt readout.

Option 04, Max Brightness Crt With Reduced Area — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. P11 phosphor provides max writing rate. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor

Option 10, Pulsed Graticule (R7903 Only) — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with crt readout, Option 10 provides additional controls and inputs for crt readout pulsed operation.



The R7903 requires only 5¼ in of rack height in a standard 19 in rack. It is fan-cooled and comes complete with slide-out chassis tracks.

Min Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical applications P31 phosphor has approx one-half the writing speed of P11 phosphor.

Crt	Writing Speed cm/ns P11		Camera	Lens
	Type 410	Type 47		
Standard 8 x 10 cm	6.1	3.1	C-51R	f/1.2 1:0.5
Option 04 4 x 5 cm	10.0	5.0	C-51R	f/1.2 1:0.5

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer. See chart on page 52 for further information.

Polaroid Film		Approx Relative Writing Speed		
Type	ASA Equivalent Speed	Unfogged		Fogged
		Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination*
107	3000	1 (Reference)	Print base is opaque	3
47	3000	1	1.2	3
410	10,000	2	2.2—2.4	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

7904 — CALIBRATOR

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%), dc or B Gate ÷ 2.

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 (±1%).

Current Output — 40 mA dc or 1 kHz.

R7903 — CALIBRATOR
(Not Available with Option 10)

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω (±1%).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

7904 — OUTPUTS/INPUTS

+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 (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+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. Rise time is 5 ns or less into 50 Ω; output R is approx 950 Ω.

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. Bandwidth depends upon vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω.

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

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

R7903 — OUTPUTS/INPUTS
(Standard)

+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 approx 950 Ω.

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 7 ns or less into 50 Ω. Output R is approx 950 Ω.

Sig Out — Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends on the vertical plug-in. See the Vertical System Specifications Chart. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweep.

Crt Readout, Inhibit — Ground closure, rear panel BNC input locks out crt readout. Not available with Option 10.

Crt Readout, Single-shot — Ground closure, rear panel BNC input initiates one frame of crt readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

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

Probe Power — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

R7903 — OUTPUTS/INPUTS OPTIONS

Option 10, Pulsed Graticule — No crt readout single-shot input, crt readout inhibit input, calibrator, and probe power. Single-shot graticule and crt readout (ground closure) rear-panel BNC input is added. Initiates one frame of crt readout and pulses graticule. Crt readout inputs are not functional with Option 01.

POWER REQUIREMENTS

7904 Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 190 W, 2.5 A at 115 V line, 60 Hz.

R7903 Power Requirements — Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 160 W, 2 A at 115 V line, 60 Hz.

7904 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); 9-pin cable-mount plug (134-0049-00).

R7903 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware.

Dimensions and Weights — See page 45.

For Recommended Cameras — See page 46.

7904 ORDERING INFORMATION
(Plug-ins not Included)

7904 Oscilloscope $5695

7904 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 02	X-Y Horiz Comp	Add $150
Option 03	Emi Modification	Add $250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)	Add $500
Option 78	P11 Phosphor	Add $35

7904 CONVERSION KITS

040-0605-03	Crt Readout	$480
040-0606-00	X-Y Horiz Comp	$200
040-0570-00	Emi Modification	$300

R7903 ORDERING INFORMATION
(Plug-ins not Included)

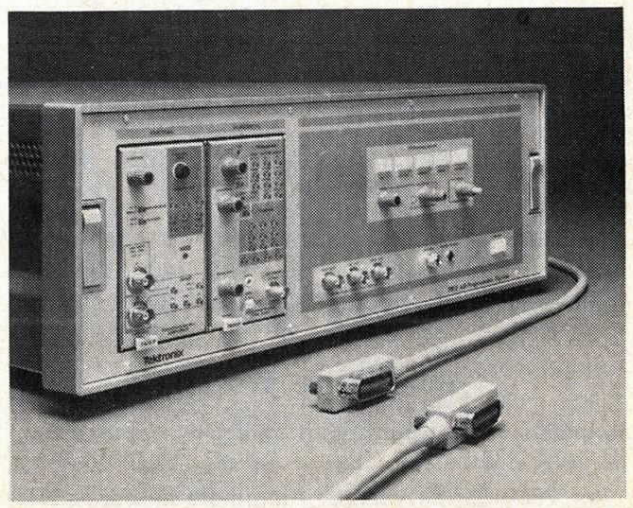
R7903 Oscilloscope $5150

R7903 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)	Add $500
Option 10	Pulsed Graticule	Add $100
Option 78	P11 Phosphor	Add $35

R7903 CONVERSION KITS

040-0605-03	Crt Readout	$480
040-0647-00	Emi Modification	$280



SIGNAL PROCESSING SYSTEMS
7912AD Programmable Digitizer

The 7912AD Programmable Transient Digitizer features unparalleled performance in analog-to-digital conversion for total waveform analysis.

The 7912AD is the core of two completely programmable signal processing systems designed and built for state-of-the-art waveform analysis. For more information on the 7912AD and the complete line of Waveform Digitizing Instruments and Systems, please turn to page 169 of this catalog.

7844
R7844

7000-Series 400-MHz Dual-Beam Oscilloscopes

400-MHz Bandwidth

Dual Beam

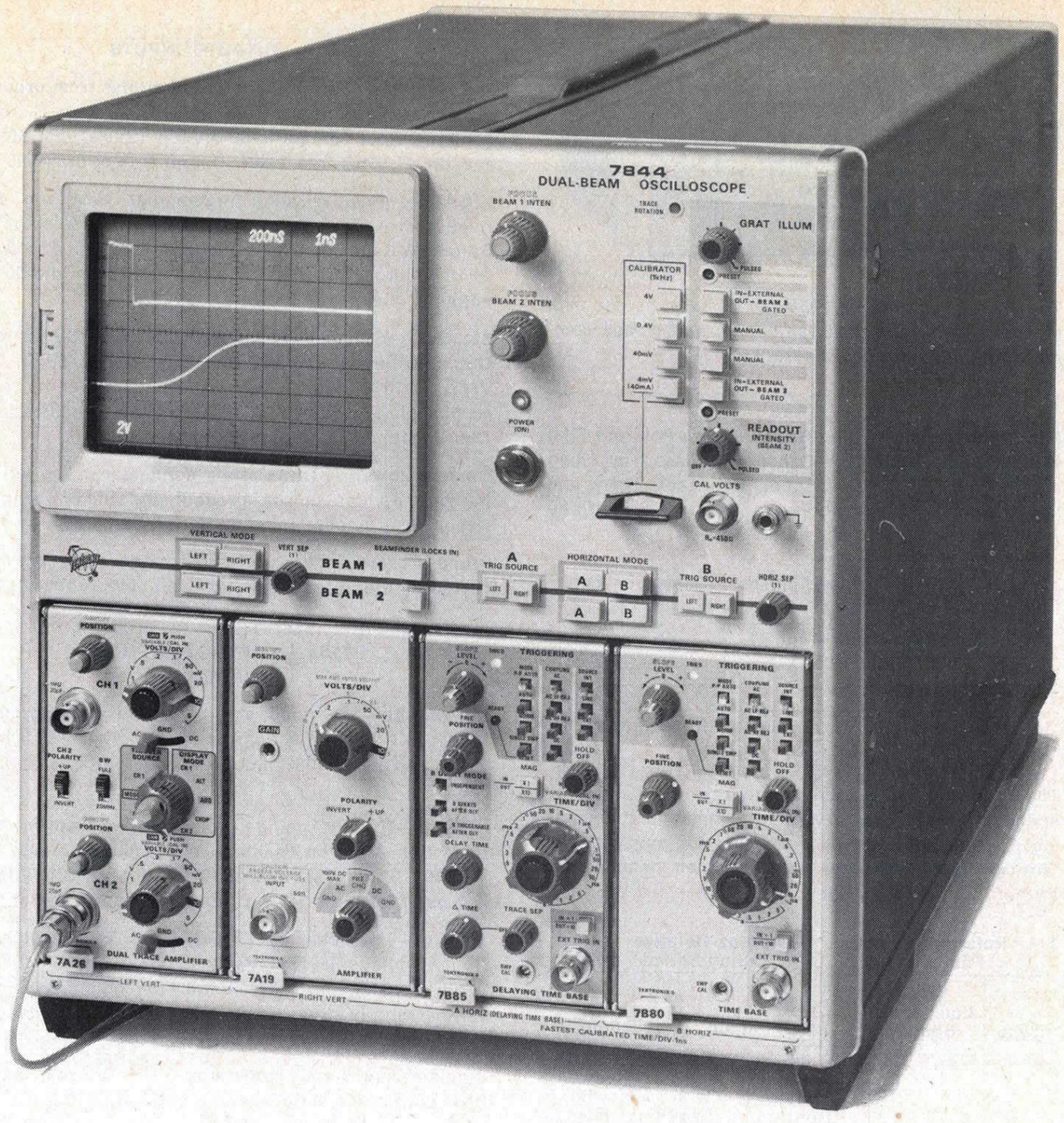
Full Vertical Crossover Switching

8 x 10 cm Full Scan Overlap Crt

Crt Readout

1 ns/div Max Calibrated Sweep

1-GHz Direct-access Unit (less than 4 V/div)



The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed crt readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

Display Logic —

	Beam 1	Beam 2
Vertical Compartment Controlling Beam	Left	Left
	Left	Right
	Right	Left
	Right	Right

Vertical Crossover — Permits viewing the same signal on two time bases.

Vertical Trace Separation — Beam 1 can be positioned ±4 cm with respect to Beam 2.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B80 and 7B90 Series Time Bases; not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B80 and 7B90 Series. 7000-Series Vertical Amplifiers and specialized plug-ins may also be used. 7B53AN11 requires modification for use in the 7844.

Fastest Calibrated Sweep Rate — 1 ns/div.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz.

Bandwidth — Dc to at least 1 MHz.

Horizontal Separation — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic —

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

Crt — Dual beam, full overlap. 8 x 10 cm graticule with variable illumination. Crt readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with P31 phosphor standard.

Option 78, P11 Phosphor

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls) — Limits display within graticule area and intensifies beam.

External Z-Axis Input (Beam 1 and Beam 2) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

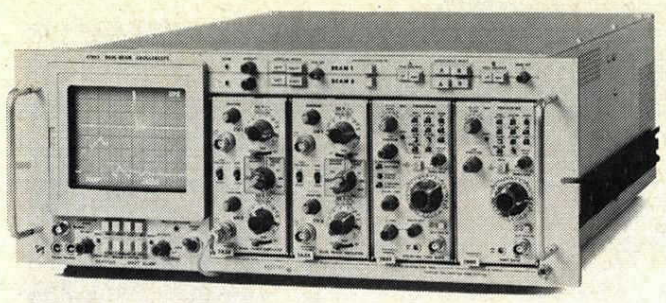
Minimum Photographic Writing Speed — 1.7 cm/ns using Polaroid type 47 film, C-51R and optional P11 phosphor. In typical camera applications, P31 phosphor has about one-half the writing speed of P11 phosphor. Writing speed can be increased by using the TEKTRONIX Writing Speed Enhancer or Polaroid type 410 film or both.

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer.

Polaroid Film		Actual Relative Film Writing Speed		
		Unfogged		Fogged
Type	ASA Equivalent Speed	Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination*
107	3000	1 (Reference)	Print base is opaque	3
47	3000	1	1.2	3
410	10,000	2	2.2—2.4	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

The Photographic Writing Speed Enhancer (Opt 22) provides a preset automatic method of photographic writing speed enhancement. Opt 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available. With Opt 22, photographic writing speed can be increased approx 2 times.



PULSED READOUT AND GRATICULE ILLUMINATION

Provides a means of pulsing the graticule lights or crt readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights or crt readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

CALIBRATOR

Calibrator — Rectangular positive-going waveform from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output — 40 mA (±1%) rectangular waveshape, front panel current loop 7844, optional current loop adapter (012-0341-00) required for R7844.

OUTPUTS/INPUTS

A and B + 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 approx 950 Ω.

A and B + Gate — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweeps.

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

Probe Power — Two connectors provide correct operating voltages for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90-132 V), 230 V nominal (180-264 V).

Line Frequency — 48 to 440 Hz.

Max Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

INCLUDED ACCESSORIES

R7844 — 1 rackmount hardware kit, 1 rackmount slide guide (351-0314-00).

Dimensions and Weights — See page 45.

For Recommended Cameras — See page 46.

ORDERING INFORMATION

(Plug-ins not Included)

7844 Oscilloscope **$8295**

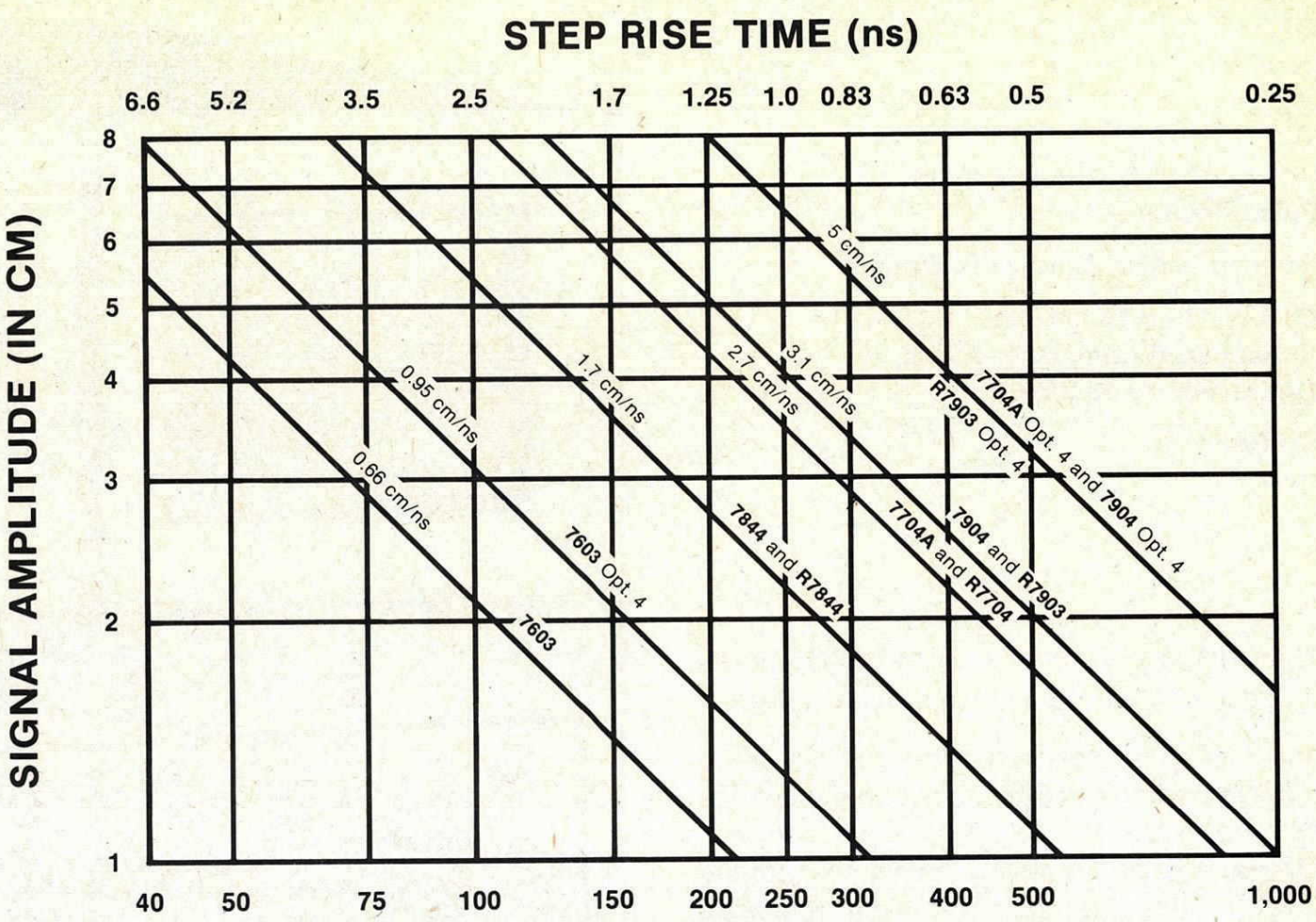
R7844 Oscilloscope **$8605**

OPTIONS

Option 03 Emi Modification ..... **Add $250**

Option 22 Writing Speed Enhancer Modification ..... **Add $275**

Option 78 P11 Phosphor ..... **Add $35**



The above graph shows the relationship of writing speed to practical measurement parameters of signal amplitude and frequency or rise time.

The vertical scale is the maximum peak-to-peak signal amplitude. The horizontal scale below the graph is maximum sine-wave frequency. Above the graph, the horizontal scale is the equivalent signal rise time for nonsinusoidal signals. These speeds assume a horizontal spot velocity that is small compared to the maximum vertical velocity. The step rise time is assumed to be a linear ramp measured between 10% and 90% points. The diagonal lines represent the minimum photographic writing speeds for 7000-Series Mainframes and are all measured under the following conditions: Camera, TEKTRONIX type C-51R, f 1.2, with the shutter opened before the sweep and closed 5 seconds after the sweep. Phosphor, P11 (optional). Film, Polaroid type 47 (ASA 3,000), no fogging for film speed enhancement, developed for 20 seconds at 25°C and viewed with back illumination.

7704A
R7704

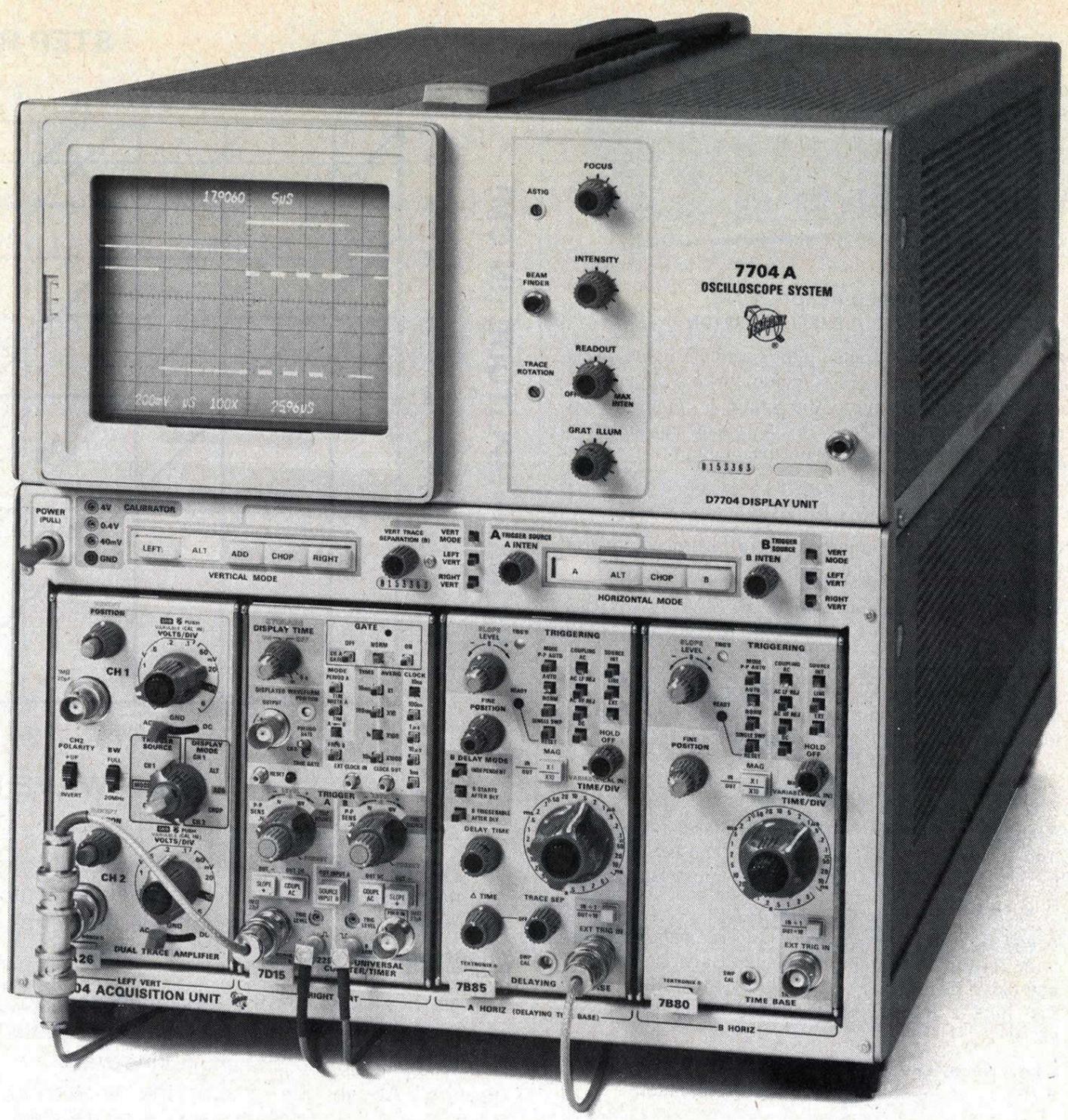
7000-Series 250-MHz General-Purpose Oscilloscope System

Dc to 200 MHz with Optimum Pulse Response

Dc to 250 MHz Bandwidth Option

Greater than 15 cm/ns Enhanced Writing Speed with Optional Crt and WSEN

Crt Readout



The 7704 family is a wide bandwidth general-purpose oscilloscope measurement system.

The 7704A Oscilloscope offers you the capability to optimize the oscilloscope's response for your type of work. For pulse analysis, aberrations are reduced below the normal level in the optimized transient response version while still giving you a bandwidth of 200 MHz. The 250 MHz option is optimized for bandwidth performance for high-frequency applications. The R7704 offers a 175 MHz bandwidth.

The 7704A modularity permits the addition of a processing module. With this addition and a Controller, the 7704A is converted into a Digitizer Oscilloscope. This modularity also provides for easy maintenance.

Quite often the need arises to photograph the waveforms that are produced. The 7704A gives you a choice of two designs available for this purpose: the standard 8 x 10 cm crt and an optional 4 x 5 cm reduced-scan crt for high writing-speed applications. The standard crt affords 5.3 cm/ns writing speed (C-51R Camera, P11 phosphor, and 10,000 ASA film), without enhancement, and 8 cm/ns with the TEKTRONIX Writing Speed Enhancer. With the optional crt and film fogging technique, writing speed can be increased to at least 15 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition. See chart on page 53 for additional information.

Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

Option 09 Bandwidth Change (250 MHz) — 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper —3 dB) when 7A19 is used. Provides additional performance for those working in this frequency domain.

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

Chopped Mode — 7704A, repetition rate is internally selectable, approx 100 kHz or 1 MHz; R7704, fixed at approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned above or below the A trace.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 2 ns/div with 7B80 or 7B90 Series.

Chopped Mode (between Horizontal Plug-ins) — 7704A, repetition rate is internally selectable, approx 20 kHz or 200 kHz; R7704, fixed at approx 200 kHz.

X-Y Mode — Phase shift is within 2° from dc to 50 kHz (7704A), from dc to 35 kHz (R7704) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

Option 02, X-Y Horizontal Compensation (R7704 only) — Provides phase shift compensation to less than 2° from dc-to-2 MHz.

CRT

Standard — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard.

Option 01, without Crt Readout — No crt readout.

Option 04, Max Brightness Crt With Reduced Area (7704A Only) — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard, P11 optional. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor

Minimum Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical application, P31 phosphor has approx one-half the writing speed of P11 phosphor. See chart on page 51 for further information.

Mainframe	P11 Writing Speed cm/ns		Camera	Lens
	Type 410	Type 47		
7704A R7704 8 x 10 cm	5.3	2.7	C-51R	f/1.2 1:0.5
7704A Option 04 4 x 5 cm	10.0	5.0		

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input (7704A only) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

External Z-Axis Inputs (R7704 only) — High sensitivity input: minimum pulse width to blank trace is 30 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%. Max input voltage is 15 V (dc + peak ac) and p-p ac.

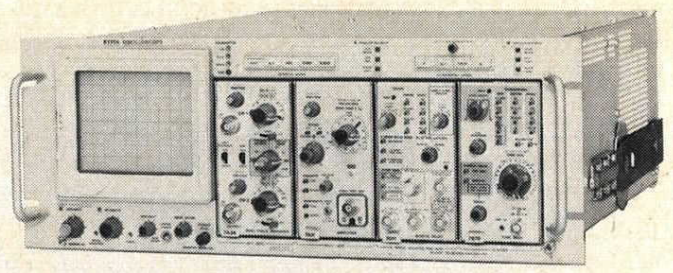
High Speed Input — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for full intensity range from dc to 100 MHz. A positive signal blanks the trace; input R is 18 kΩ within 20%. Max input voltage is 60 V (dc + peak ac) and p-p ac.

OUTPUTS/INPUTS

+ 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 nominal.

+ 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. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω nominal.

Sig Out — Selected by B TRIGGER SOURCE switch.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

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 Vertical System Specifications Chart. Output R is 950 Ω nominal.

External Single-sweep Reset — Ground closure, rear-panel input to reset sweep.

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

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes. R7704 connectors are located on both the front and rear panels. Probe power is deleted on Option 01 of 7704A.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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

POWER REQUIREMENTS

Line Voltage Ranges — 90 to 132 V ac and 180 to 264 V ac.

Line Frequency — 48 to 440 Hz (7704A), 48 to 66 Hz (R7704).

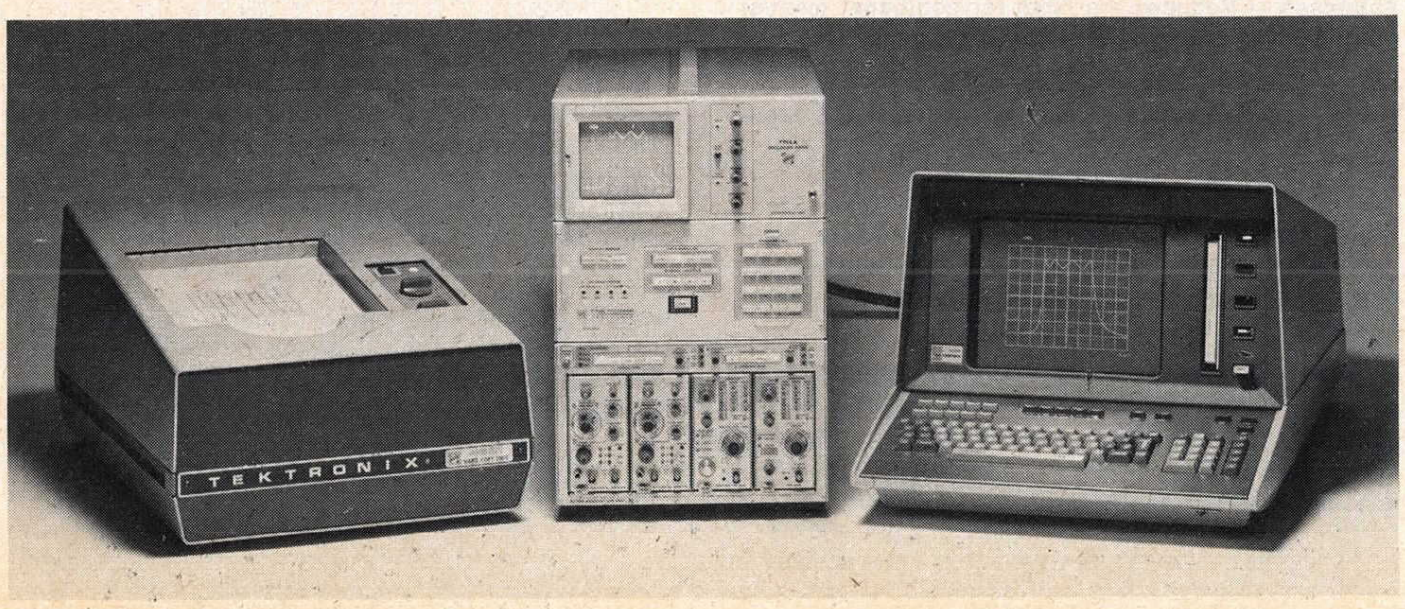
Option 05, Line Frequency Change (50-400 Hz) — Converts the R7704 to 50-400 Hz operation (not required for 7704A).

Max Power Consumption — 180 W, 2.5 A at 115 V line 60 Hz (7704A); 225 W, 2.8 A at 115 V line, 60 Hz (R7704).

Included Accessories — For 7704A: 20 in cable, two-pin-to-BNC, (175-1178-00). For R7704: 42 in BNC 50-Ω cable (012-0057-01); 20 in cable, two-pin-to-BNC (175-1178-00); rackmounting hardware.

Weights and Dimensions — See page 45.

For Recommended Cameras — See page 46.



ORDERING INFORMATION
(Plug-ins not Included)

7704A	Oscilloscope	$3635
R7704	Oscilloscope	$4630

7704A OPTIONS

Option 01	without Crt Readout and Probe Power	Sub $400
Option 03	Emi Modification	Add $250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)	Add $500
Option 09	Bandwidth Change (250 MHz)	Add $200
Option 78	P11 Phosphor	Add $35

R7704 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 02	X-Y Horiz Comp	Add $150
Option 03	Emi Modification	Add $250
Option 05	Line Freq Change (50-400 Hz) (not required for 7704A)	Add $125
Option 78	P11 Phosphor	Add $35

7704A CONVERSION KITS

040-0613-00	Crt Readout and Probe Power	$480
040-0612-00	Emi Modification	$285
040-0619-00	Sig Out/In	$125

R7704 CONVERSION KITS

040-0533-01	Crt Readout	$480
040-0529-00	X-Y Horiz Comp	$110
040-0562-00	Emi Modification	$275

SIGNAL PROCESSING SYSTEMS
Digitizing Oscilloscope

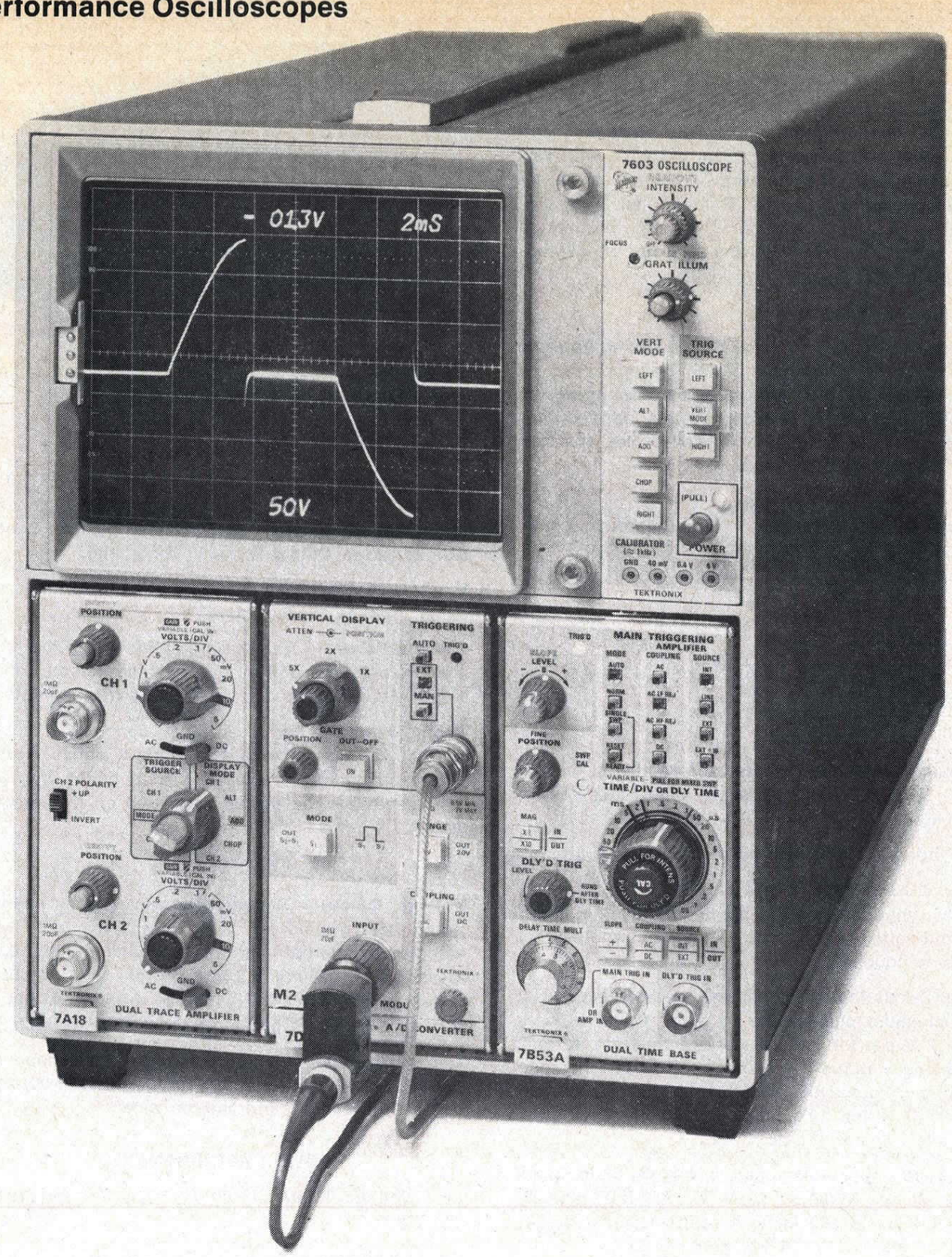
Tektronix combines the 7704A and P7001 Digitizer (with local 4-channel memory) into one powerful and versatile digitizing oscilloscope. This scope is compatible with 7000-Series Plug-ins including amplifiers up to 175 MHz, sampling to 14 GHz and a wide range of time base and spectrum analyzer plug-ins.

We build completely programmable waveform digitizing systems around this versatile scope, utilizing the GPIB/IEEE 488 interface bus. Through this interface the Digitizing Oscilloscope can "talk" to a wide range of controllers and peripherals for automated signal processing.

For more information about our high performance Digitizing Oscilloscope and the complete line of waveform digitizing instruments, please turn to page 169 of this catalog.

7603
R7603

7000-Series 100-MHz Wide Performance Oscilloscopes



Dc to 100 MHz Bandwidth

6½ in Crt

Crt Readout

5¼ in Rackmount

The TEKTRONIX 7603 and R7603 Oscilloscopes represent the best price/performance ratio available in the 100-MHz plug-in oscilloscope market today.

The crt is large, 8 x 10 div (1.22 cm/div), and features an internal graticule with variable illumination and 15 kV accelerating potential. An optional maximum brightness crt with a smaller 8 x 10 cm display and 18 kV potential gives you greater visual brightness and higher photographic writing speed.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

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

Chopped Mode — Repetition rate is approx 1 MHz.

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.

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

CRT AND DISPLAY FEATURES

Standard — Internal 8 x 10-div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with P31 phosphor.

Option 01, without Crt Readout — No crt readout.

Option 04, Max Brightness Crt With Reduced Area — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 18 kV with P31 phosphor standard.

Option 06, Spectrum Analyzer Graticule.

Optional Phosphors (Specify) — P7, P11, or P7/SA. (Phosphor/Spectrum Analyzer graticule combination.)

Minimum Photographic Writing Speed — Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer.

Crt	Writing Speed div/μs				Camera	Lens
	Type 107/47		Type 410			
	P31	P11	P31	P11		
Standard 8 x 10 div (1.22 cm/div)	100	150	200	300	C-50	f/1.9 1:0.7
Option 04 8 x 10 div (1 cm/div)	200	300	400	600		

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. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been adjusted.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

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

+Gate — Positive pulse of the same duration and coincident with sweep. Output R is 950 Ω. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Rise time is 20 ns or less into 50 Ω. Source is selectable from Main, Delay, or Auxiliary Gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 0.5 V/div (±10%) into 1 MΩ, 25 mV/div (±10%) into 50 Ω. Output R is 950 Ω. Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart.

External Single-sweep Reset — Ground closure, rear panel BNC provides input to reset sweep.

Single-sweep Ready Indicator — Rear panel BNC provides 5 V for single-sweep ready condition.

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-Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

Current Output — 40 mA rectangular waveshape (dc current available when selected by internal jumper) with optional current-loop accessory (012-0259-00) connected between 4 V and gnd pin jacks.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50 Hz to 400 Hz (7603); 50 Hz to 60 Hz (R7603).

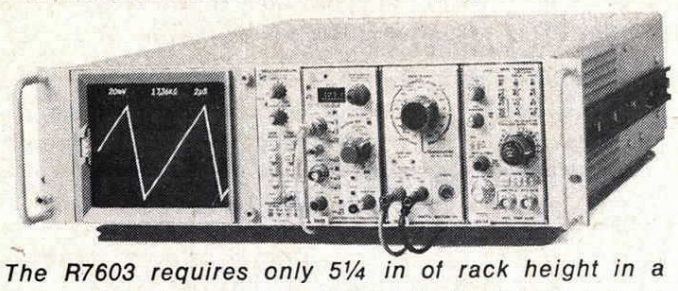
Option 05, Line Frequency Change (50-400 Hz) — Converts the R7603 to 50-400 Hz operation (not required for 7603).

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

Included Accessories — (For 7603 and R7603) 20 in cable (two-pin-to-BNC) (175-1178-00); crt filter (Blue 337-1700-01, Clear 337-1700-04). The R7603 includes rackmounting hardware.

Dimensions and Weights — See page 45.

For Recommended Cameras — See page 46.



The R7603 requires only 5¼ in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

ORDERING INFORMATION

(Plug-ins not Included)

7603	**Oscilloscope**	**$2260**
R7603	**Oscilloscope**	**$2560**

7603 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)	Add $200
Option 06	with Internal Spectrum Analyzer Graticule	$50
Option 08	Protective Panel Cover	Add $100

R7603 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 04	Max Brightness Crt With Reduced Area (Specify Phosphor)	Add $200
Option 05	Line Freq Change (50-400 Hz) (not required for 7603)	Add $300
Option 06	with Internal Spectrum Analyzer Graticule	Add $50

7603 CONVERSION KITS

040-0654-02	Crt Readout	$480
040-0662-00	Emi Modification	$300
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30
040-0718-00	X-Y Horiz Comp	$150

R7603 CONVERSION KITS

040-0674-02	Crt Readout	$480
040-0679-00	Emi Modification	$275
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30
040-0718-00	X-Y Horiz Comp	$150

PHOSPHOR OPTIONS (7603/R7603)

Option 76	P7 Phosphor	Add $35
Option 77	P7 Phosphor with Internal Spectrum Analyzer Graticule	Add $35
Option 78	P11 Phosphor	Add $35

7000-Series Ruggedized Oscilloscope System | 7603N11S

Ruggedized for Extreme Environments

Meets or Exceeds MIL-O-24311 (EC) (AN/USM-281C Specifications)

Large Bright Display—6½ in Crt (15 kV)

5 ns/div Delaying Sweep

0.5 mV Vertical Sensitivity

Three-plug-in Flexibility

Versatile Trigger-source Selection

Pushbutton Switching

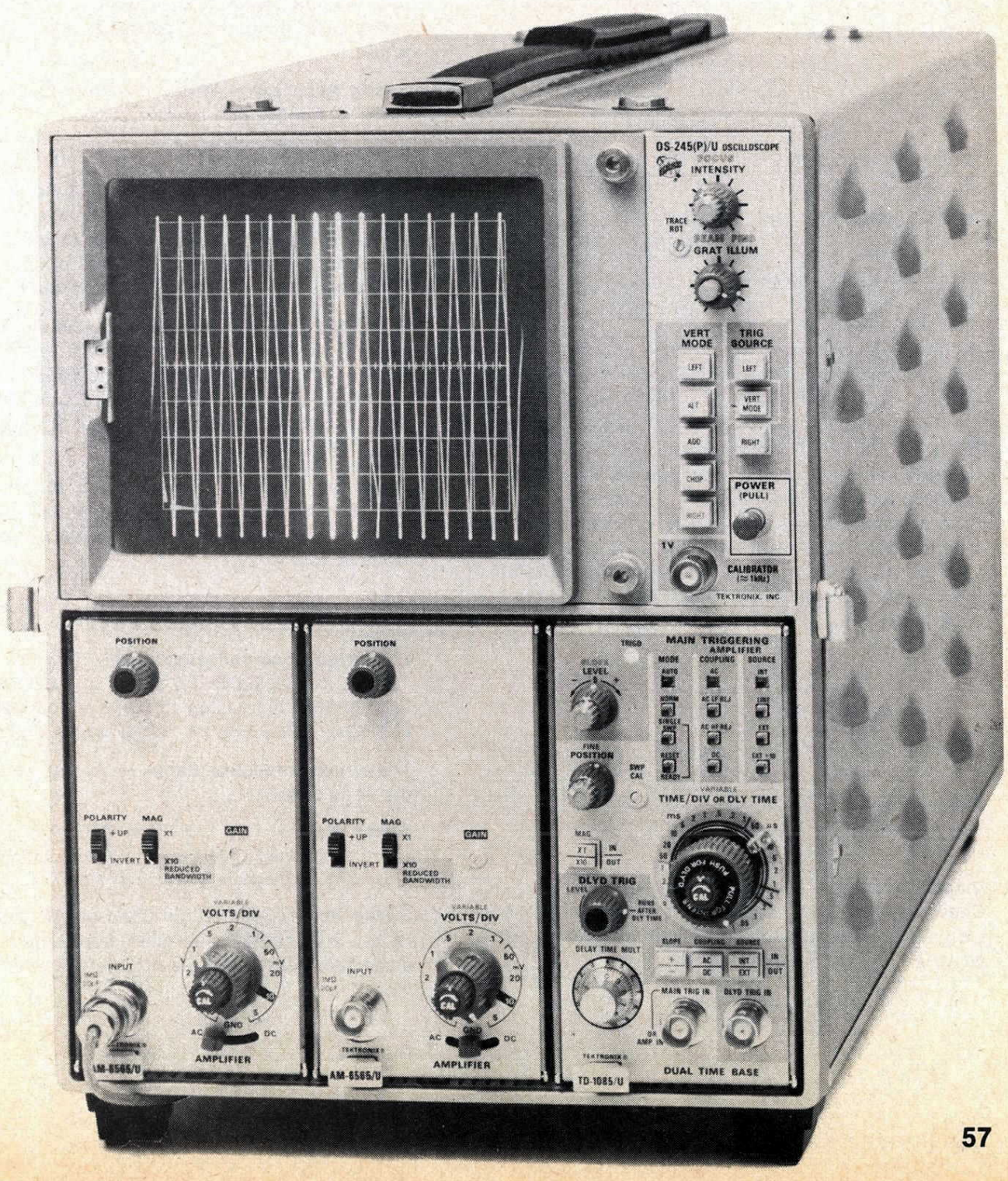
Illuminated No-Parallax Graticule

Color-keyed Panels

Protective Cover with Accessories

The 7603N11S Ruggedized Oscilloscope System meets the rigid environmental and electrical specifications required by MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311. The system consists of a three-plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

Although the military spec requires only 50-MHz performance, this system actually performs to 65 MHz. Other better-than-required specs include operating altitude, sensitivity at reduced bandwidth with X10 gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and crt size.



7603N11S Ruggedized Oscilloscope System

The mainframe and plug-ins are compatible with the TEKTRONIX 7000-Series product line. The system does not have crt readout, and it can't be used with the digital plug-ins.

ENVIRONMENTAL

Temperature — Nonoperating −62°C to +75°C, operating −28°C to +65°C.

Humidity — 0 to 95% rh over entire temperature range, operating or nonoperating.

Altitude — Nonoperating sea level to 50,000 ft, operating sea level to 15,000 ft.

Vibration (Operating) — 5 to 15 Hz at 0.060 in ±0.012 in p-p amplitude, 16 to 25 Hz at 0.040 in ±0.008 in p-p amplitude, 26 to 33 Hz at 0.020 in ±0.004 in p-p amplitude.

Shock (Operating) — 9 consecutive 400-pound hammer blows without failure from 1, 3, and 5 ft in vertical, horizontal, and longitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

Inclination (Operating) — As per MIL-E-16400.

Drip Proof (Nonoperating) — As per MIL-STD-198.

Salt Spray (Nonoperating) — As per MIL-E-16400.

Electromagnetic Interference — As per MIL-STD-462 performed by MIL-STD-461 for the following tests:

CE-01	30 Hz to 20 kHz	Power lead emission
CE-03	20 kHz to 50 MHz	Power lead emission
CS-01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS-02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS-06	Spike Test	Power lead, spike susceptibility
RE-01	30 Hz to 30 kHz	Instrument radiation, magnetic
RE-02	14 kHz to 10 GHz	Instrument radiation, electric
RS-01	30 Hz to 30 kHz	Instrument susceptibility, magnetic
RS-03	14 kHz to 10 GHz	Instrument susceptibility, electric

Reliability — Optimum performance and reliable service are provided during continuous or interrupted operation. The MIL-O-24311(EC) MTBF requirement of greater than 600 hours is met as tested under the following conditions: temperature +40°C ±2°C; relative humidity 70% ±5%; vibration 25 Hz at 0.040 in ±0.0008 in p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8 hour manned schedule; power cycled at 4 hour intervals with 10 minutes power off for each 4 hour period of the manned test schedule. An MTBF of greater than 2000 hours was achieved during testing.

VERTICAL SYSTEM
(Includes Two 7A15AN11 Plug-ins)

Channels — Two left-hand plug-in compartments, with a delay line which allows the leading edge of the displayed waveform to be viewed. All 7000-Series Plug-ins are compatible (except those which require crt readout).

Display Modes — LEFT, ALT, ADD, CHOP, RIGHT. Chopped frequency is approx 1 MHz. Added mode displays signals algebraically with a cmrr of 20:1 to 25 MHz.

Bandwidth/Sensitivity — Dc to 65 MHz from 5 mV/div to 10 V/div, accuracy within 2%, variable extends to 25 V/div. Max sensitivity is 0.5 mV at 10 MHz with X10 gain. A-c coupled Tower—3 dB point is less than 2 Hz. Rise time is 5.4 ns with less than 2% aberrations.

Input R and C — 1 MΩ within 2%, less than 27 pF.

Max Input Voltage — 400 V (dc + peak ac).

Dc Stability — Less than 1 div/hr drift at 25°C.

HORIZONTAL SYSTEM
(Includes One 7B53AN11 Plug-in)

Channels — One right-hand plug-in compartment. All 7000-Series Plug-ins are compatible (except those which require crt readout).

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

X-Y Mode — The phase shift between vertical and horizontal channels is less than 2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Rise time is less than 175 ns. Using the 7B53AN11 time-base external amplifier, 10 mV, 100 mV, and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN11, may be used in the horizontal compartment, providing a greater number of sensitivities for calibrated X-Y displays.

Sweep Display Modes — Main Sweep, Main Sweep Intensified by Delayed Sweep, Delayed Sweep.

MAIN (DELAYING) SWEEP

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

Sweep Accuracy — Within 3% from 0.05 μs/div to 5 s/div, within 5% at 5 ns/div.

Sweep Modes — Normal, Auto, Single Sweep.

Delay Time — Multiplier range is 0 to 10 times the Time/Div setting. Accuracy is within 1% from 0.5 s/div to 0.5 μs/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is less than 1 part in 20,000 of X10 Time/Div setting.

Triggering (Source/Sensitivity) — Internal 0.5 cm to 50 MHz. External, 0.25 V to 20 MHz, 0.5 V to 50 MHz. Ext ÷ 10, 2.5 V to 20 MHz, 5 V to 50 MHz. Triggering extends to 100 MHz with reduced sensitivity in both Internal and External Modes. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; ac lf Rej, 30 kHz to 50 MHz; ac hf Rej, 30 Hz to 50 kHz; dc, dc to 50 MHz. With external level range, slope is ±30 V.

DELAYED SWEEP

Triggering (Source/Sensitivity) — Internal 0.3 div to 10 MHz increasing to 1.5 div at 50 MHz. External, 0.1 V to 10 MHz increasing to 0.5 V at 100 MHz. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; dc, dc to 50 MHz.

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or is triggerable after delay time.

Sweep Accuracy — Within 3% from 50 ms/div to 0.5 μs/div, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div, which is within 6%.

CRT

Accelerating Potential — 15 kV.

Phosphor — P31.

Graticule — Internal 8 x 10 cm with variable illumination. The 6½ in crt permits 2 cm of linear overscan in both axes, making a total viewing area of approx 10 x 12 cm.

Crt Controls — Located on front panel are Focus, Intensity, Graticule Illumination, Beam Finder, and Trace Rotation. Astigmatism is an internal control.

External Z-Axis Input (BNC Connector on Rear Panel) — 2 V p-p for full intensity range from dc to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. Max input voltage is 10 V (dc + peak ac).

OUTPUTS

Calibrator (BNC Connector on Front Panel) — 1 V within 1%, 1 kHz square wave within 20%.

Horizontal — Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

POWER REQUIREMENTS

Input Voltages — 100, 110, 120, 220, and 240 V ac ± 10% internally selectable with quick-change jumpers with 47.5—440 Hz single phase line frequency. Max power consumption is 125 W.

C281 COVER WITH ACCESSORIES

The cover provides protection during transport and packages the included accessories.

INCLUDED ACCESSORIES
(All Packaged in Cover)

Two P6006 Probe packages (010-0127-00); two 8 ft long 50-Ω BNC cables (012-0366-00); two BNC female to uhf male adapters (103-0015-00); two BNC male to uhf female adapters (103-0032-00); two BNC male to binding post adapters (103-0033-00); two BNC T connectors (103-0030-00). One set of technical manuals (not packaged in cover).

Dimensions and Weights — See page 45.

For Recommended Cameras — See page 46.

ORDERING INFORMATION

7603N11S Oscilloscope System (AN/USM-281C)
Order 7603NMS $4895

System Includes — One each 7603N11 Oscilloscope, two each 7A15AN11 Amplifier Plug-ins, one each 7B53AN11 Time Base*, and one each C281 Cover with Accessories.

To Order Separately:

7603N11 Oscilloscope (OS-245(P)/U) $2595

7A15AN11 Amplifier Plug-in (AM-6565/U)
Order 7A15ANM $510

7B53AN11 Time Base* Plug-in (TD-1085/U)
Order 7B53ANM $1325

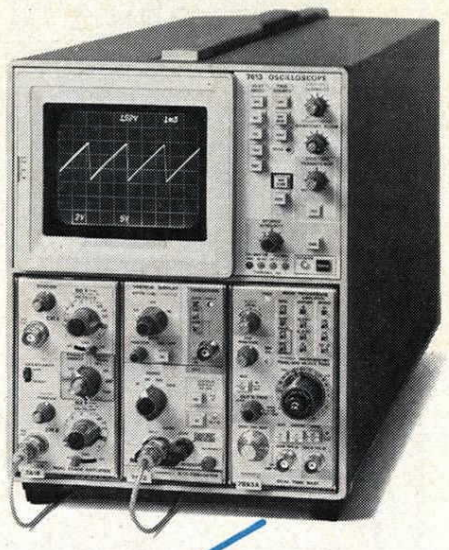
016-0553-00, C281 Cover W/Accessories $120

*Requires modification for use in the 7844.

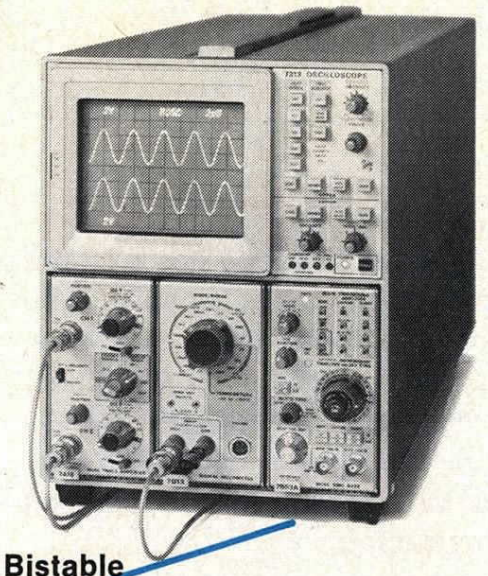
7000-Series Storage Mainframes

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≈0.03 cm/μs for mechanical, spectrum analysis, or TDR applications, to 2500 cm/μs for capturing fast single events such as high speed digital logic. A selection of storage modes offer the following features:

Bistable	**Long View Time**
Variable Persistence	**High Contrast Displays**
FAST Bistable	**Captures Fast Single or Multiple Events**
FAST Variable Persistence	**Provides Maximum Stored Writing Rate**

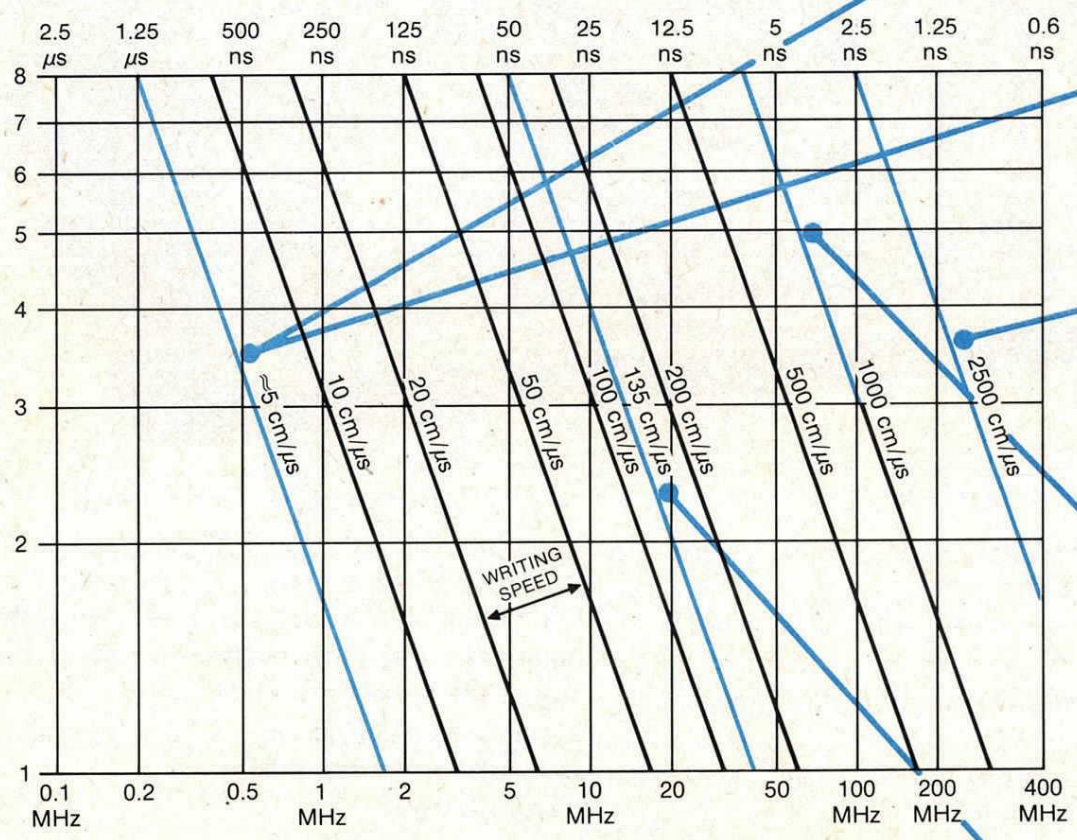


7613
Variable Persistence

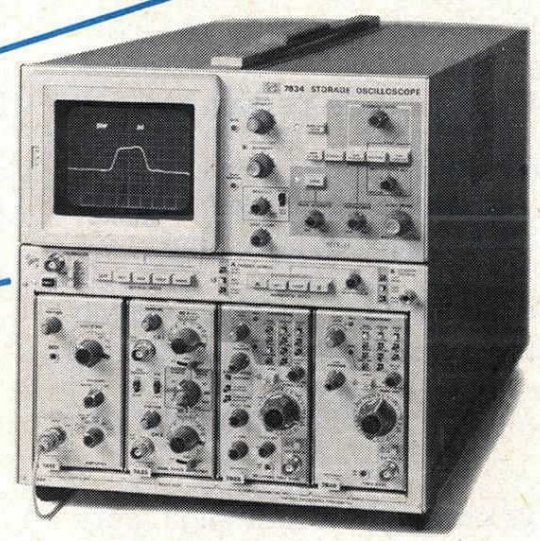


7313
Split Screen Bistable

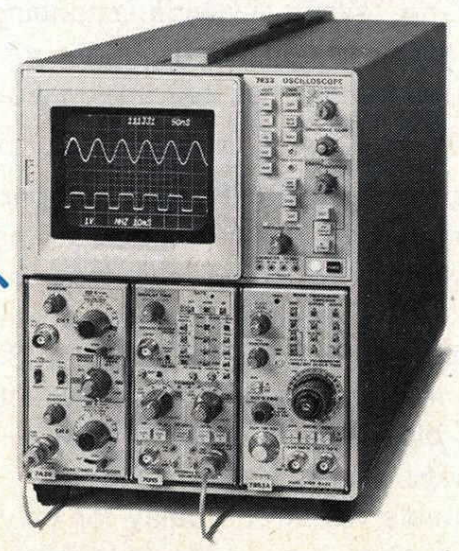
STEP RISE TIME



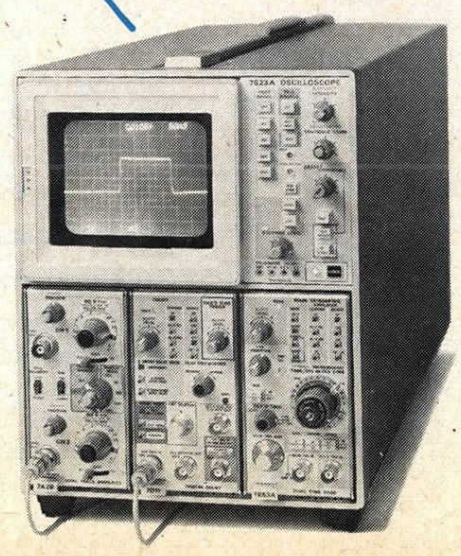
SINE WAVE FREQUENCY



7834
FAST Multimode



7633
FAST Multimode

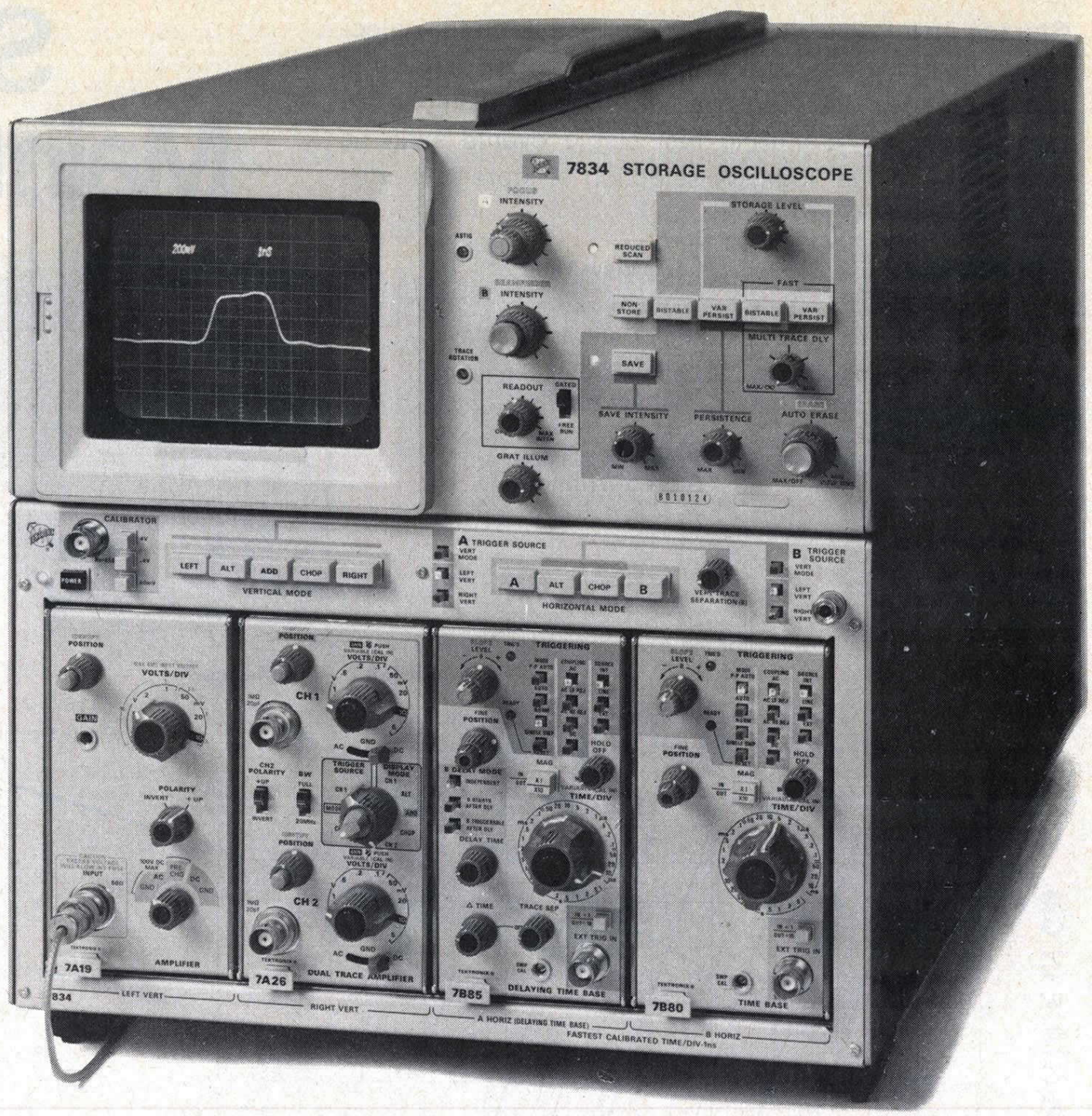


7623A
FAST Multimode

7800-Series Storage	**400 MHz**	**page 60**
7600-Series Storage	**100 MHz**	**page 62**
7300-Series Storage	**25 MHz**	**page 66**

7834 | 7000-Series Fast Storage Oscilloscope

2500 cm/μs Stored Writing Speed
4 Plug-in Compartments
Dc to 400 MHz Bandwidth
Multimode Storage
Long View Time



The 7834 Storage Oscilloscope has a stored writing speed of 2500 cm/μs, enabling you to capture single-shot rise times to 1.4 ns, 3.5 cm high, at full reduced scan amplitude. The 7834's mainframe bandwidth is 400 MHz (nonstore). The system bandwidth may vary from 160 MHz to 400 MHz depending on the plug-in selected.

This instrument has four storage modes—bistable and variable persistence, FAST bistable and FAST variable persistence.

FAST Variable Persistence provides the maximum stored writing rate of 2500 cm/μs (reduced scan). View time at least 30 s.

FAST Bistable increases bistable writing rates to 350 cm/μs (reduced scan).

Bistable lets you store displays for long periods of time.

Variable Persistence gives you high contrast displays of both single-shot and repetitive phenomena. When viewing changing waveshapes, you get continuous bright displays of new information as old information fades from the crt.

The 4-compartment flexibility lets you perform more than one measurement at the same time without switching plug-ins. The 7834 also offers auto-erase for automatic display updating . . . a save control for 30 times longer viewing . . . gated readout which prevents the blooming that tends to occur between sweeps with nongated readout . . . and an adjustable multitrace delay for varying the viewing time prior to the next sweep in the FAST transfer mode.

The multimode storage unit is designed for single shot, low-rep-rate or fast pulse analysis in laser fusion, digital design and nondestructive component testing applications.

VERTICAL SYSTEM

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

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

Mainframe Bandwidth—400 MHz with 7A19 Amplifier plug-in (325 MHz at 10 mV).

Mainframe Step Response—0.9 ns or less with 7A19 Amplifier plug-in (1.1 ns at 10 mV).

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform (not recommended for use with 7B50 Series time bases).

Trace Separation Range—In dual-sweep modes, B trace can be positioned 4 divisions above or below the A trace.

HORIZONTAL SYSTEM

Input—Two right-hand plug-in compartments; compatible with all 7000-Series Plug-ins. 7000-Series Vertical Amplifiers and specialized plug-ins may also be used.

Modes of Operation—A, ALT, CHOP, B.

Fastest Calibrated Sweep Rate—1 ns/div.

Chopped Mode—Repetition rate is approx 200 kHz.

X-Y Mode—Phase shift between vertical and horizontal channels is within 2° from dc to 35 kHz without phase correction (dc to 1 MHz with phase correction, B horizontal only, Option 02). Bandwidth is dc to at least 1 MHz.

CRT AND DISPLAY FEATURES

Graticule—Internal variable illuminated graticule. 8 x 10-division (0.9 cm/div) graticule in full scan and 8 x 10-division (0.45 cm/div) in reduced scan.

Option 01, without Crt Readout and Probe Power—Deletes crt readout and probe power.

Accelerating Potential—Approx 10 kV full scan mode, and 12 kV in reduced scan mode.

Phosphor—P31.

Crt Display Modes—Nonstore, Bistable, Variable Persistence, FAST Bistable and FAST Variable Persistence (full and reduced scan).**

Persistence—(Variable Persistence mode only) controls rate of continuous erasure of the variable persistence and fast variable persistence stored displays.

Auto Erase—Continuously variable from less than 1 s to greater than 10 s.

Multitrace Delay—Adjusts the transfer cycle time in the FAST transfer modes. Continuously variable from less than 1 s to greater than 4 s.

Save—Prevents display from being accidentally erased, and provides up to 30 times longer viewing times in all modes.

External Z-Axis Input—2 V peak-to-peak for full intensity range from dc to 1 MHz. Positive signal blanks the trace. Maximum input voltage is 15 V (dc plus peak ac).

Auto-Focus—Maintains crt focus following changes in display intensity after focus control has been initially set.

Beam Finder—Limits display within graticule.

STORAGE WRITING SPEED

FULL SCAN (Center 6 x 8 div at 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	270 cm/μs (300 div/μs)	45 cm/μs (50 div/μs)	1.8 cm/μs (2 div/μs)	0.027 cm/μs (.03 div/μs)
View Time	30 s*	30 min	30 s*	30 min
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

**REDUCED SCAN Center 8 x 10 div at 0.45 cm/div

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	2500 cm/μs (5,500 div/μs)	350 cm/μs (776 div/μs)	5.4 cm/μs (12 div/μs)	0.09 cm/μs (.2 div/μs)
View Time*	30 s	30 min	30 s	30 min
Erase Time* (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

*View times are at full stored display intensity; they may be increased more than 30 times by using reduced intensity in the SAVE display mode.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-peak Sine wave	Step Response
Reduced Scan 5,500 div/μs (0.45 cm/div)	≥1 ns/div	7.1div 250 MHz	7.7 div 1.4 ns
		8 div 221 MHz	8 div 1.45 ns
Full Scan 300 div/μs (0.9 cm/div)	≥10 ns/div	3.2 div 30 MHZ	3 div 10 ns
		6.4 div 15 MHz	5 div 16.6 ns

OUTPUTS/INPUTS

+Sawtooth—Positive going with baseline at 0 V ±1 V into 1 MΩ. Voltage is 1 V/div (±10%) into 1 MΩ, 50 mV/div (±15%) into 50 Ω. Output R is approx 950 Ω.

+Gate—Positive pulse of the same duration and coincident with sweep. Output voltage is 10 V (±10%) into 1 MΩ, 0.5 V (±10%) into 50 Ω. Output R is approx 950 Ω. Source is selectable from A Gate, B Gate, or A Delayed Gate.

Vertical Signal Out—Selected by A TRIGGER SOURCE switch. Output voltage is 0.5 V (±10%) into 1 MΩ, 25 mV (±10%) into 50 Ω. Output R is approx 950 Ω. Bandwidth depends upon vertical plug-in.

Remote Single Sweep Reset, Remote Save and Remote Erase—Rear panel BNC connector inputs, ground closure activated.

Remote FAST Transfer Gate—TTL compatible. Low to high transition enables high speed target to receive information to be stored; high to low transition initiates transfer from high speed target to storage target.

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-Series Cameras.

CALIBRATOR

Voltage Output—Square wave, positive-going from ground. Ranges are 40 mV, 0.4 V, and 4 V into 100 kΩ; 4 mV, 40 mV, and 0.4 V into 50 Ω. Amplitude accuracy is within 1%; repetition rate is 1 kHz within .25%.

Current Output—40 mA available through CALIBRATOR output with optional BNC to current loop adapter.

Dimensions and Weight. See page 45.
For Recommended Cameras—See page 46.

POWER REQUIREMENTS

Line Voltage Ranges—90 V-132 V.
180 V-250 V.

Line Frequency—48-440 Hz.

Max Power Consumption—215 watts.

Included Accessories—Gray crt filter (installed) (378-0625-02) green crt filter (378-0625-08); power cord (161-0066-00).

ORDERING INFORMATION

(Plug-ins not Included)

7834 Storage Oscilloscope $7695

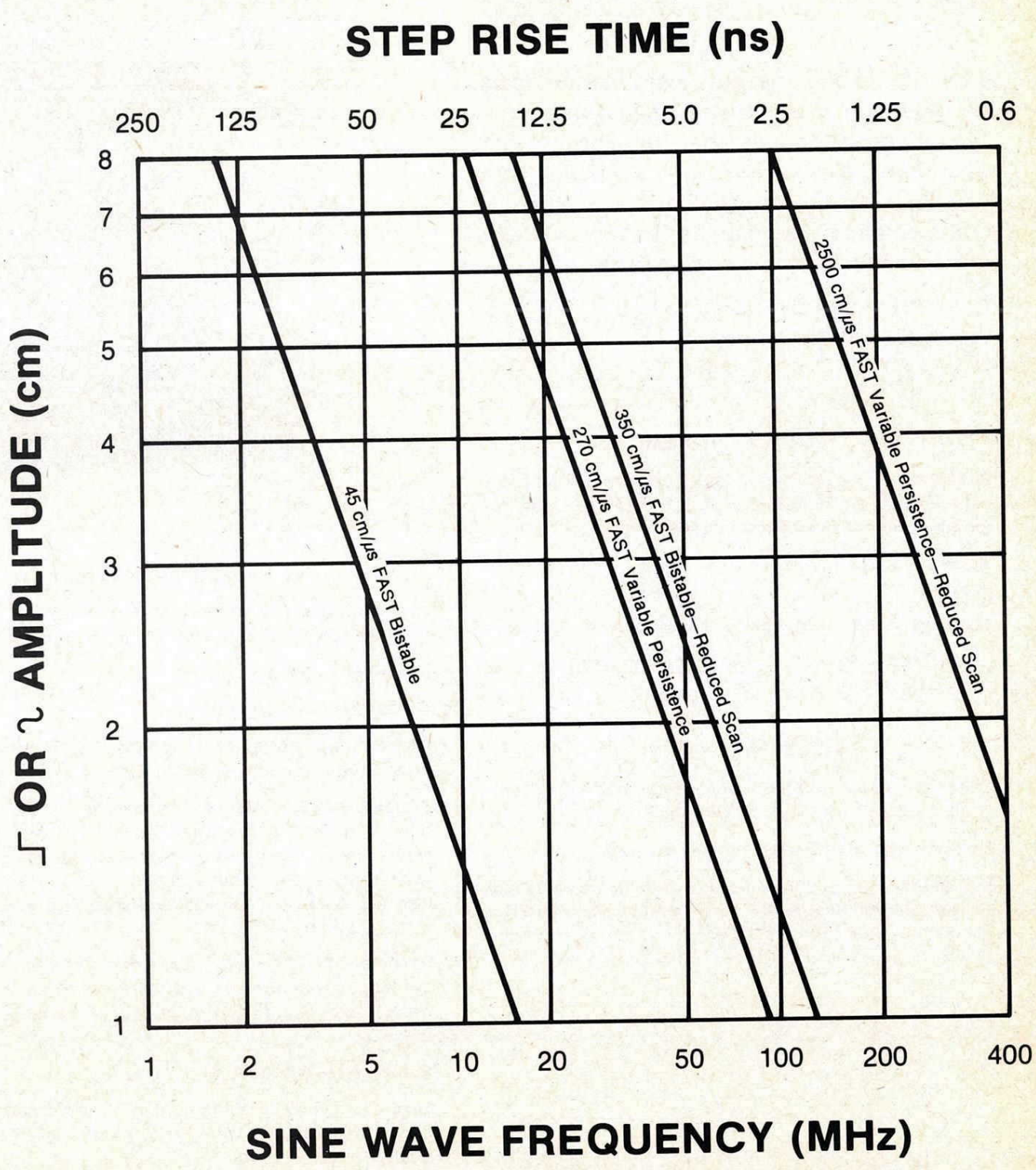
OPTIONS

Option 01 Without Crt Readout and Probe Power ..... Sub $400

Option 02 X-Y Mode Phase Correction..... Add $150

Option 03 Emi Modification..... Add $250

For Rackmounting, order Cradle Mount Adapter 040-0560-00 ..... $155



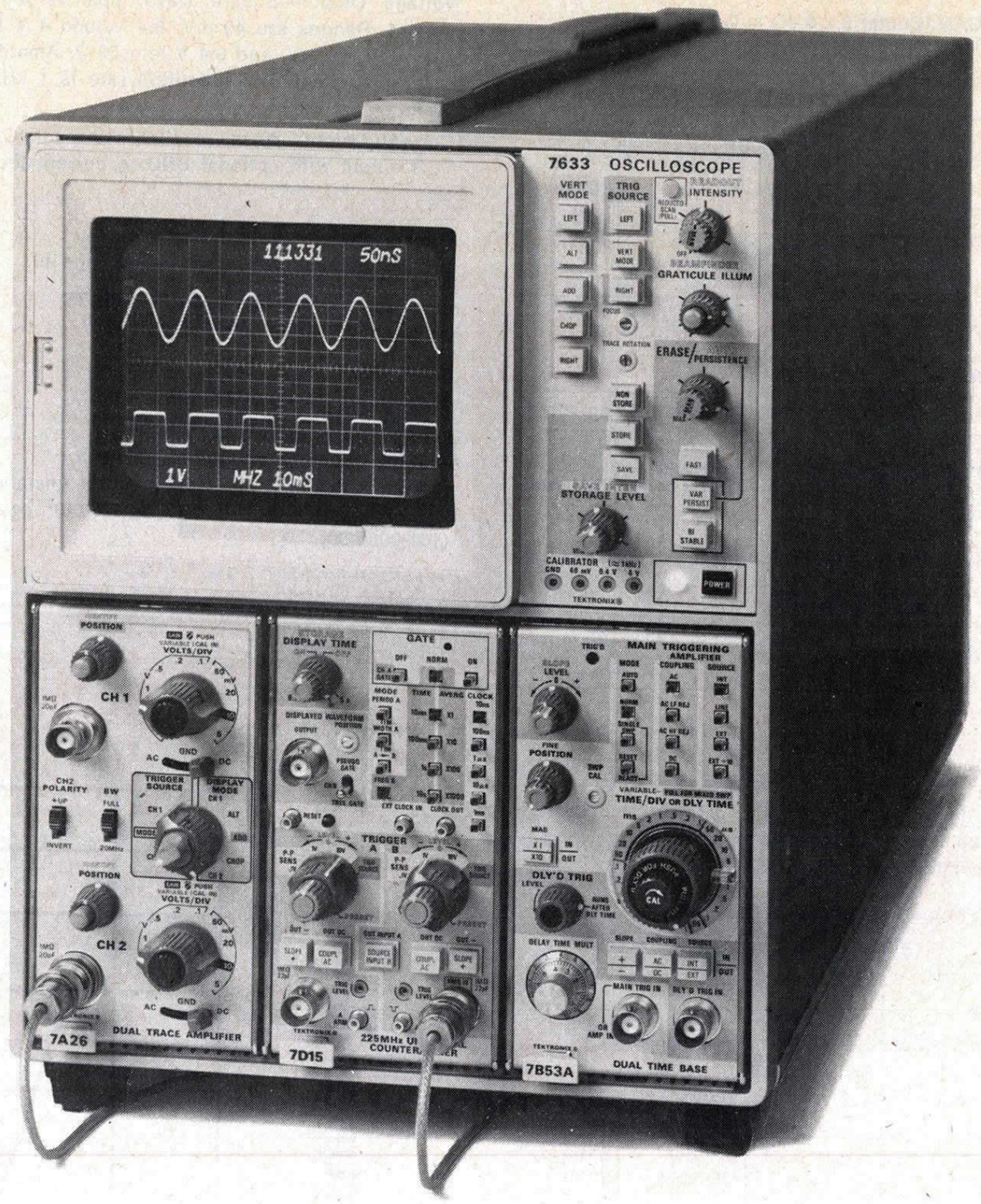
Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

7633
7623A

7000-Series Multimode Storage Oscilloscopes

7633

1000 cm/μs Stored Writing Speed
Long View Time
Multimode Storage
Dc to 100 MHz Bandwidth



The TEKTRONIX 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100-MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The top writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div) is achieved in reduced scan mode.

This multimode storage instrument allows for retention and viewing of fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms. The instrument's capability and versatility make it a problem solver in computer sciences, aerospace, ballistics, communications, and many other fields.

Characteristics are common to the 7633 and the 7623A unless noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 5 ns/div.

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

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 01 — No crt readout.

Accelerating Potential — Approx 8.5 kV in normal mode, 10 kV in reduced scan mode.

Storage Display Modes — Nonstore, FAST variable persistence, FAST bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire crt; select reduced scan for the fastest writing rate.

Persistence — Variable. When set to max, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

Autoerase — Variable up to 10 s.

Save — Prevents erasing and storing additional displays; also extends view time in variable persistence mode.

External Z-Axis Input — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for calibrated manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

STORAGE WRITING SPEED

Full Scan (7633 and 7623A)

Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/μs	45 cm/μs	0.45 cm/μs	0.027 cm/μs
View Time	30 s*	30 min. minimum	30 s*	30 min. minimum
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

Reduced Scan (7633 Only)

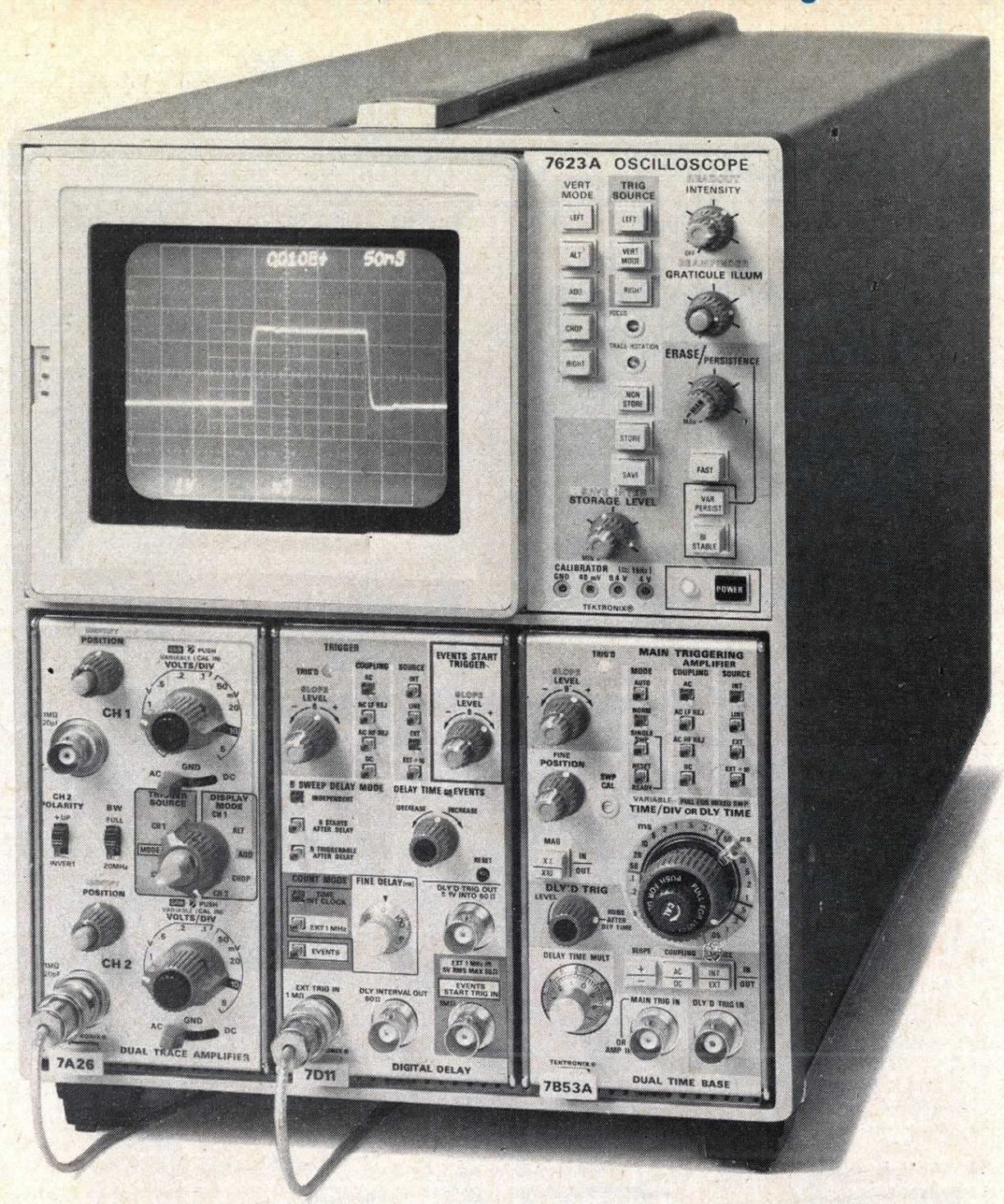
Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	1000 cm/μs	180 cm/μs	1.35 cm/μs	0.9 cm/μs
View Time	30 s*	30 min. minimum	30 s*	30 min. minimum
Erase Time (Approx)	1.4 s	1.4 s	0.9 s	0.9 s

*These times are at full stored display intensity; they may be increased more than 30 times by using reduced intensity in the save display mode.

7623A

135 cm/μs Stored Writing Speed
Long View Time
Multimode Storage
Dc to 100 MHz Bandwidth

The TEKTRONIX 7623A Storage Oscilloscope has all the features and performance of the 7633 except the reduced scan mode.

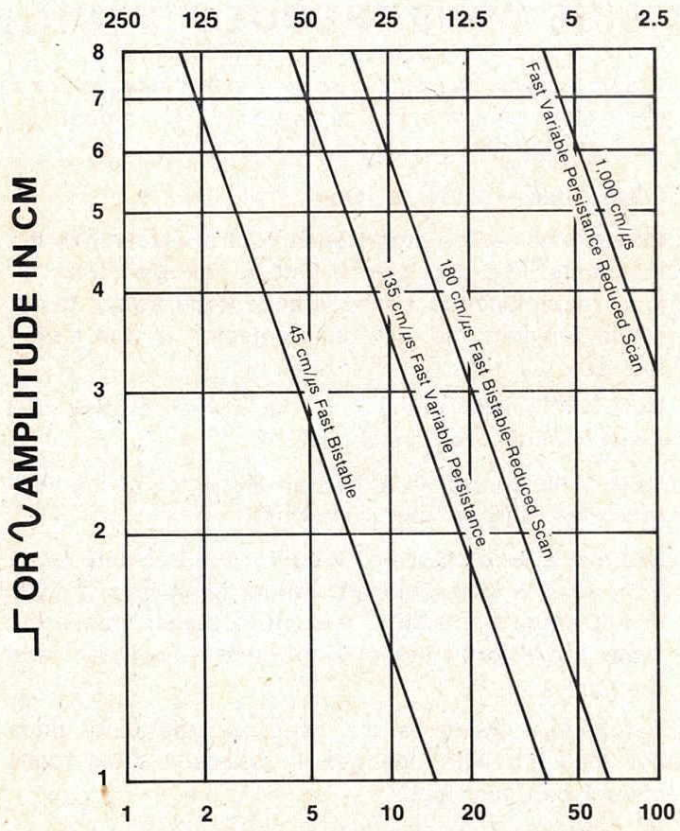


Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-peak Sine	Step Response
Reduced Scan** 2200 div/μs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz 8 div 89 MHz	7.7 div 3.5 ns 8 div 3.7 ns
Full Scan 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz 6.4 div 7.5 MHz	3 div 20 ns 5 div 33 ns

**Applies to 7633 only.

STEP RISE TIME (ns)



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

OUTPUTS/INPUTS

+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. Rise time is 20 ns or less into 50 Ω, output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Vertical Signal Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

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-Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50-60 Hz.

Option 05, Line Frequency Change (50-400 Hz) — Converts the 7633 and R7633 to 50-400 Hz operation.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

Included Accessories — 20 in cable (two-pin-to-BNC) (175-1178-00); crt filter Green (378-0625-08). The R7633 and R7623A include rackmounting hardware.

Weights and Dimensions — See page 45.

For Recommended Cameras — See page 46.

ORDERING INFORMATION
(Plug-ins not Included)

7633 Storage Oscilloscope	**$5615**
R7633 Storage Oscilloscope	**$5915**
7623A Storage Oscilloscope	**$4295**
R7623A Storage Oscilloscope	**$4595**

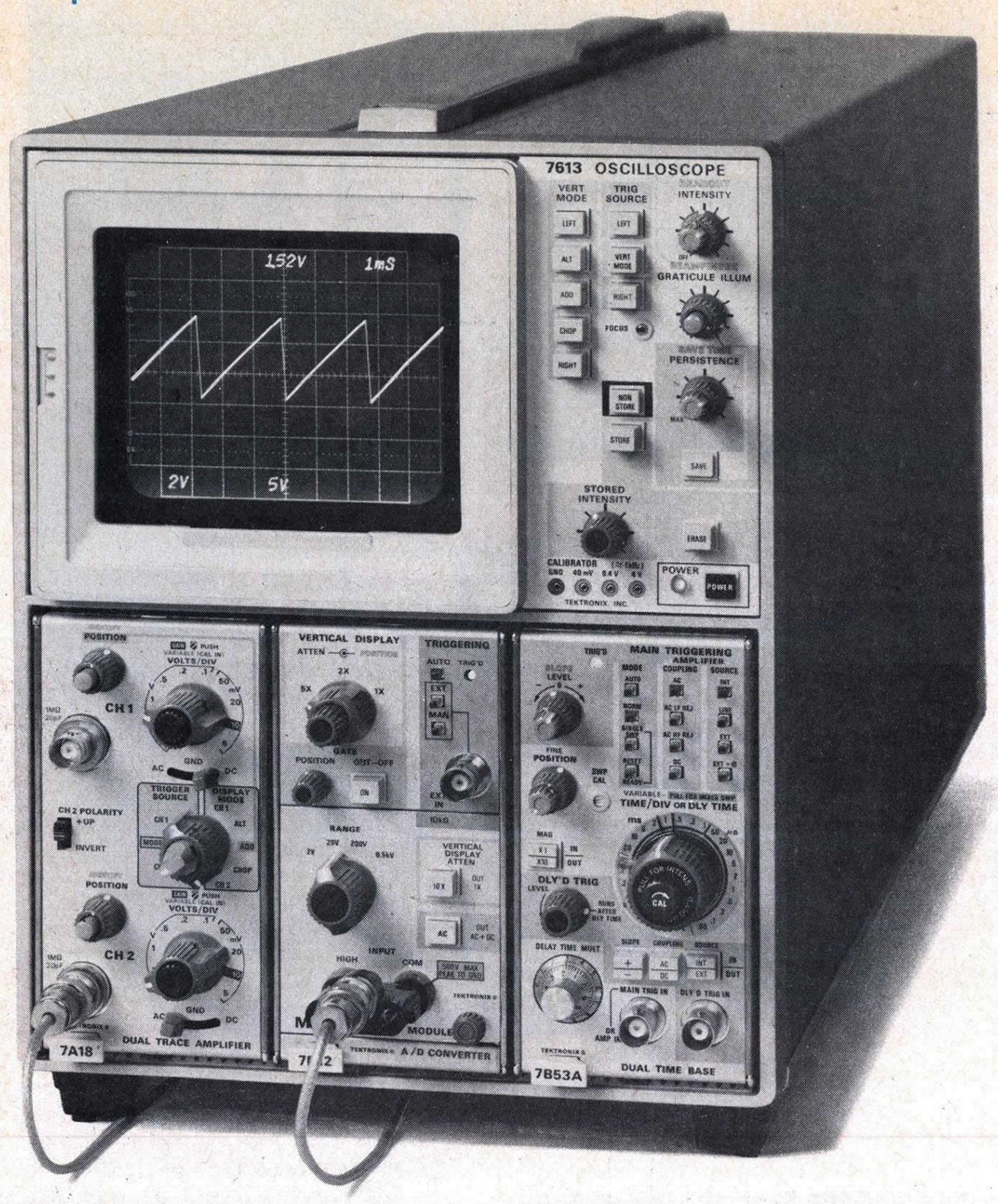
OPTIONS

Option 01	**without Crt Readout**	**Sub $400**
Option 03	**Emi Modification**	**Add $250**
Option 05	**Line Freq Change (50—400 Hz)**	**Add $300**

CONVERSION KITS

Crt Readout (040-0748-01 Cabinet)	**$480**
(040-0759-01 Rackmount)	**$480**
Emi Modification	
(040-0663-00 Cabinet)	**$300**
(040-0678-00 Rackmount)	**$285**
Sig Out/In (040-0629-01 Cabinet)	**$120**
(040-0633-00 Rackmount)	**$85**
Power Supply to Light Plug-in Pushbuttons (040-0686-00)	**$30**

7613 | 7000-Series Variable Persistence Storage Oscilloscope



Variable Persistence Storage
4.5 cm/μs Stored Writing Speed
Dc-to-100 MHz Bandwidth
Burn Resistant Crt
5¼" Rackmount Height

The TEKTRONIX 7613 Storage Oscilloscope offers variable persistence operation with a stored writing speed of 5 div/μs or nonstorage operation. Stored traces may be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div). The 7613 crt is burn resistant and doesn't require any special operating precautions.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical System Specifications Chart.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 5 ns/div.

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

CRT AND DISPLAY FEATURES

Variable Persistence Storage Crt — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 01 — No crt readout.

Accelerating Potential — 8.5 kV.

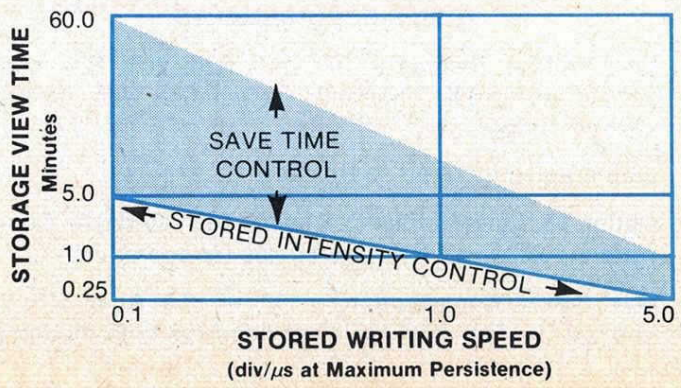
Nonstore Mode — For displaying waveforms in the conventional (nonstorage) mode.

Store Mode — For displaying waveforms using the variable persistence storage feature.

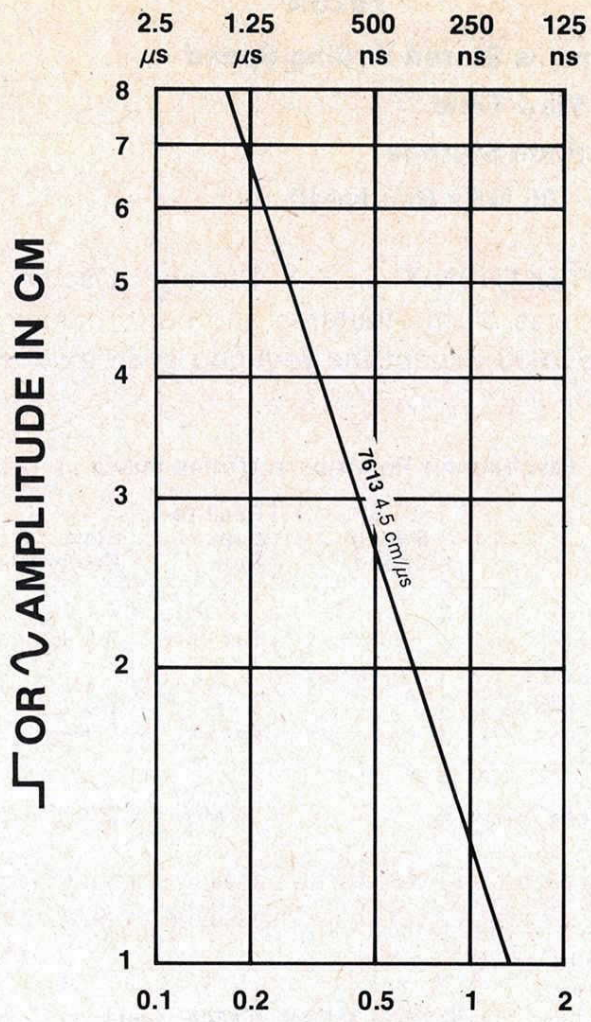
Max Stored Writing Speed — Greater than 4.5 cm/μs.

View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds or 0.25 minutes with the stored intensity control fully cw. Adjusting the stored intensity ccw will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).



STEP RISE TIME



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed for a given sine wave or step rise time at a given amplitude.

Erase Time — 0.5 s or less.

Persistence — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

Save — Prevents erasure of the stored display and activates the save time control.

Save Time Control — Allows an extension of the view time (see Storage View Time Chart).

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. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Autofocus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+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. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

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. Bandwidth depends upon vertical plug-in; see Vertical System Specifications Chart. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

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-Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground. (Dc voltage available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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.

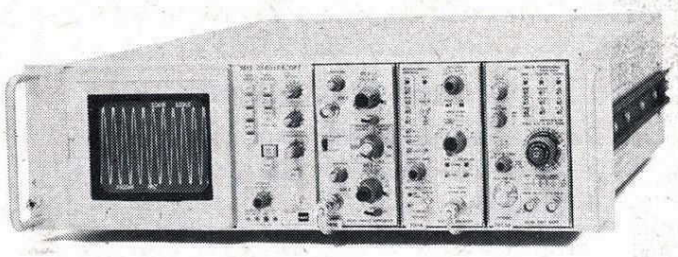
POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50-60 Hz.

Option 05, Line Frequency Change (50-400 Hz) — Converts the 7613 and R7613 to 50-400 Hz operation.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.



The R7613 requires only 5¼ in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

Included Accessories (for 7613 and R7613) — 20 in cable (two-pin-to-BNC) (175-1178-00); crt filter (gray, 378-0625-02). The R7613 includes rackmounting hardware.

Weights and Dimensions — See page 45.

For Recommended Cameras — See page 46.

ORDERING INFORMATION
(Plug-ins not Included)

7613 Storage Oscilloscope **$3430**
R7613 Storage Oscilloscope **$3730**

7613 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 05	Line Freq Change (50-400 Hz)	Add $300
Option 06	Special Int Graticule (Spectrum Analyzer)	Add $50
Option 08	Protective Panel Cover	Add $100

R7613 OPTIONS

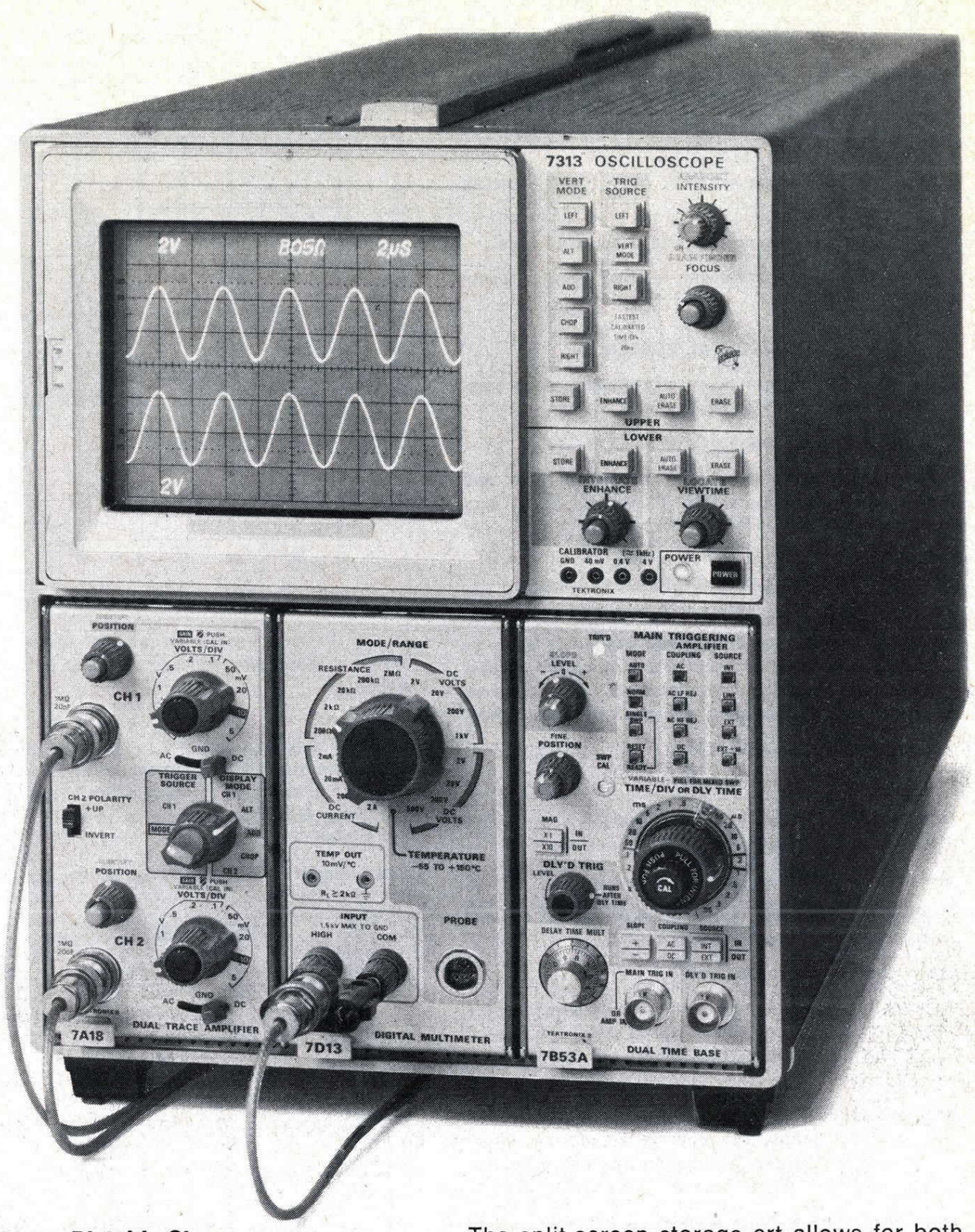
Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 05	Line Freq Change (50-400 Hz)	Add $300
Option 06	Special Int Graticule (Spectrum Analyzer)	Add $50

7613 CONVERSION KITS

040-0656-02	Crt Readout	$480
040-0663-00	Emi Modification	$300
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30

R7613 CONVERSION KITS

040-0676-02	Crt Readout	$480
040-0678-00	Emi Modification	$285
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30



Split-Screen Bistable Storage
4.9 cm/μs Stored Writing Speed
Dc to 25 MHz Bandwidth
Burn-Resistant Crt
5¼ in Rackmount

The TEKTRONIX 7313 Storage Oscilloscope offers split-screen bistable operation or non-storage operation. It has a stored writing speed of 5 div/μs. Stored traces may be viewed for at least 30 minutes on a display area of 8 x 10 div (0.98 cm/div). The 7313 crt is burn resistant.

The split-screen storage crt allows for both a stored display and a real-time display on the same crt at the same time. This capability is useful in many applications. The operator may wish to store a reference trace and then view the change in waveform characteristics as he varies circuit components. He can do this easily by operating half the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in the conventional mode may be precisely adjusted to the stored reference trace.

7313 and R7313 Bistable Storage Oscilloscopes

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series Plug-ins. Bandwidth determined by mainframe and plug-in unit, limited to 25 MHz.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 20 ns/div.

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

STORAGE CRT AND DISPLAY FEATURES

Split-Screen Bistable Storage Crt — Internal 8 x 10 div (0.98 cm/div) **non-illuminated** graticule. Store on upper or lower half of screen with nonstore display on other half. Store on entire screen or nonstore on entire screen. Independent operation on both halves.

Accelerating Potential — 4 kV.

Phosphor — P1.

Stored Writing Speed — Normal, 500 div/ms; adjustable to at least 5000 div/ms in Enhance Mode.

Storage View Time — At least 30 minutes.

Autoerase View Time Range — 0.5 or less to at least 10 s after end of sweep.

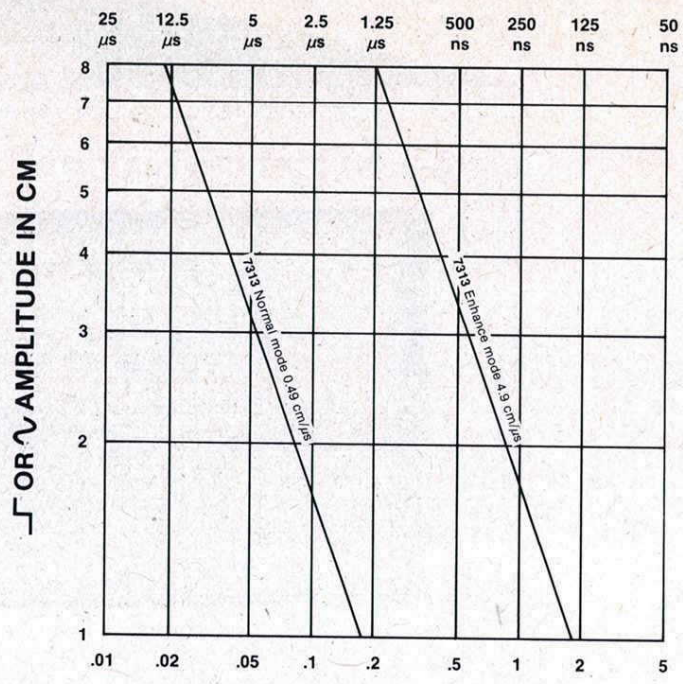
Erase Time — 400 ms or less.

Enhance Mode — Controls single-sweep writing capabilities of the storage crt. Up to 5000 cm/ms or better can be stored with minimal loss of resolution and contrast.

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

Autoerase Mode — Viewing time continuously variable up to 10 s. The sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep, the stored display is retained and further sweeps are locked out for the viewing interval selected by the VIEW TIME Control. Then the display is erased and the time-base enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MANUAL control.

STEP RISE TIME



Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

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. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

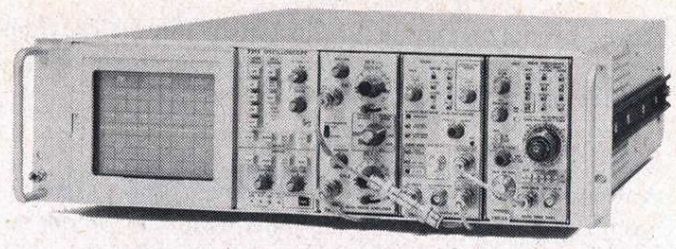
+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω within 2%.

+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. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

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. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace. Internally selectable for either or both halves of crt.



The R7313 requires only 5¼ in of rack height in a standard 19 in rack. It is fan cooled and comes complete with slide-out chassis tracks.

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-Series Cameras.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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.

POWER REQUIREMENTS

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

Line Frequency — 50-400 Hz (7313), 50-60 Hz (R7313).

Option 05, Line Frequency Change (50-400 Hz) — Converts the R7313 to 50-400 Hz operation (not required for 7313).

Max Power Consumption — 180 W, 2 A at 115 V line, 60 Hz. Fan cooling is provided for the R7313.

Included Accessories (for 7313 and R7313) — 20 in cable (two-pin-to-BNC) (175-1178-00); green crt light filter (378-0625-08). The R7313 includes rackmounting hardware.

Weights and Dimensions — See page 45.

For Recommended Cameras — See page 46.

ORDERING INFORMATION
(Plug-ins not Included)

7313 Storage Oscilloscope $3535

R7313 Storage Oscilloscope $3835

7313 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250

R7313 OPTIONS

Option 01	without Crt Readout	Sub $400
Option 03	Emi Modification	Add $250
Option 05	Line Freq Change (50-400 Hz) Not Required for 7313	Add $300

7313 CONVERSION KITS

040-0655-02	Crt Readout	$480
040-0664-00	Emi Modification	$285
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30

R7313 CONVERSION KITS

040-0675-02	Crt Readout	$480
040-0678-00	Emi Modification	$285
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$30

7000-Series Plug-ins

For the 7000-Series you can select from over thirty different plug-ins. For example, digital multimeters, counters and A-D converters. With this plug-in selection you can solve problems in many applications including spectrum analysis, curve tracing, spectroscopy, logic analysis, and sampling. This variety lets you tailor your instrument to meet your immediate need. And to expand its capabilities later as your needs change.

Amplifiers **Pages 67-71**

Twelve vertical amplifiers offer choices in system bandwidth, number of input channels, vertical sensitivity, input impedance, and differential inputs.

Time Bases **Pages 73-75**

Seven horizontal time bases offer choices in sweep speeds, single or dual sweeps, and now, digital delta delay measurements.

Sampling and TDR **Pages 82-86**

Five plug-in units offer a choice of single- and dual-channel sampling, general-purpose sampling combined with time domain reflectometry, sampling sweep, and dual delay line.

Digital Measurements **Pages 77-81**

Six digital instruments, one with three interchangeable modules, offer unique solutions to complex measurement problems. Timing and amplitude measurement instruments interact with the oscilloscope to easily obtain accurate measurements of complex signals.

Sampling Heads **Pages 83-86**

Ten sampling heads offer choices in input impedance, equivalent bandwidth, and triggering for a matched sampling system.

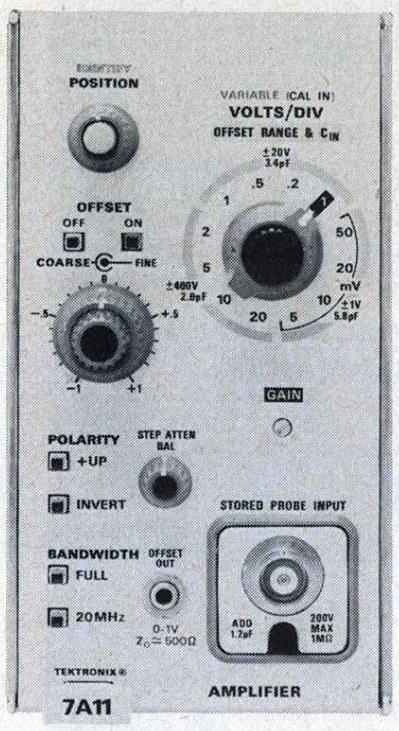
Special Purpose Plug-ins

7CT1N Curve Tracer see page 182
7L5/L1/L2/L3 Spectrum Analyzer see page 192 and 193
7L12 Spectrum Analyzer see page 191
7L13 Spectrum Analyzer see page 190
7L18 Spectrum Analyzer see page 189
7K11 CATV Preamplifier see page 195
7M13 Readout Unit see page 76

7D01 Logic Analyzer, see page 77
DF1 Display Formatter, see page 23
DF2 Display Formatter, see page 23
DL2 Digital Latch, see page 23

7A11
7A15A
7A16A

7000-Series Single-Trace Amplifiers



7A11

Built-in FET Probe

DC-to-250 MHz Bandwidth (7900 Family)

5 mV/div to 20 V/div
Calibrated Deflection Factors

Dc Offset

Lit Pushbuttons

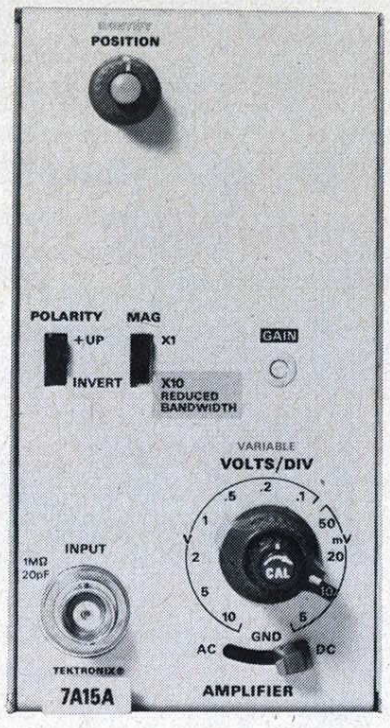
The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF at 5 mV/div), without loss of signal amplitude by probe attenuation. Two 20X attenuators, physically mounted in the probe tip, are relay-switched into the input signal path at the appropriate deflection factor. Therefore you need not concern yourself with manual plug-on attenuators and signal dynamic range.

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 to at least 50 V/div.

Input R and C — 1 MΩ within 1%; ≈ 5.8 pF (5 mV/div to 50 mV/div), ≈ 3.4 pF (0.1 V/div to 1 V/div), ≈ 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 40 MHz)	200 V (dc + peak ac, ac component to 70 MHz)
Max Ac-coupled Input (Dc Component)		±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, may be used to offset the trace. (See chart for offset range.) An OFFSET OUT jack allows for monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within 3%.

Included Accessories — Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adapter (013-0085-00); 3 in ground lead (nose) (175-0849-00); 3 in ground lead (screw-in) (175-0848-00); 12 in ground lead (screw-in) (175-0848-02); three miniature alligator clips (344-0046-00); two insulated sleeves (166-0404-01); probe hook tip (206-0114-00); probe tip to GR 50 Ω termination (017-0088-00); 18 in cable (offset out) (175-1092-00).

Order 7A11 Amplifier **$1560**

7A15A

Dc-to-80 MHz Bandwidth (7900 Family)

5 mV/div to 10 V/div
Calibrated Deflection Factors

500 μV/div at 10 MHz (X10 Gain)

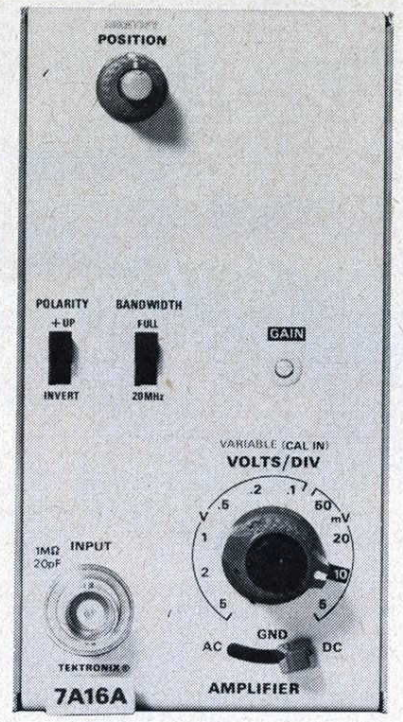
The 7A15A is an easy-to-use, 80-MHz amplifier that features a X10 magnifier to increase the sensitivity to 500 μV/div with 10 MHz bandwidth. It has a constant bandwidth at all deflection factors in the X1 setting. Polarity of the display is selectable.

Deflection Factor — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500 μV) accuracy is within 10% at 10-MHz bandwidth throughout deflection factor settings. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

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

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

Order 7A15A Amplifier **$435**



7A16A

Dc-to-225 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div
Calibrated Deflection Factors

The 7A16A is an easy-to-use, 225-MHz amplifier. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable; bandwidth is selectable to FULL or limited to 20 MHz for low-frequency applications.

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 to at least 12.5 V/div.

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

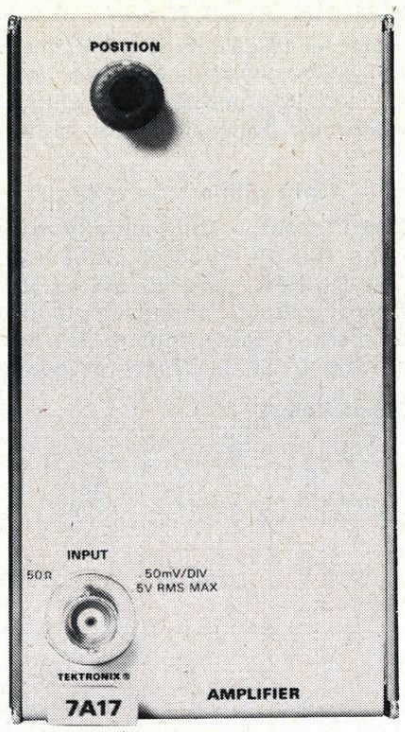
Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

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

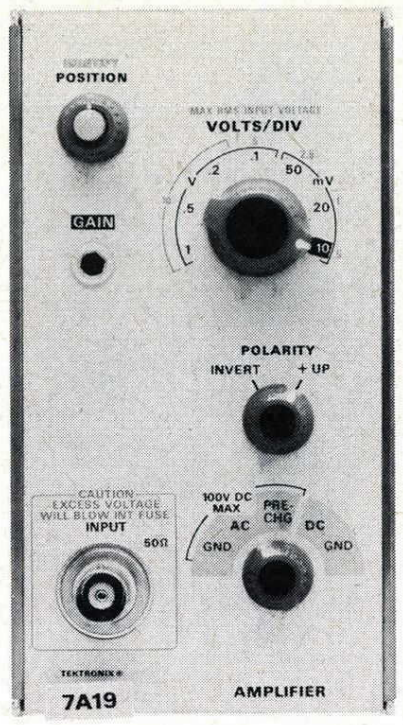
Order 7A16A Amplifier **$755**

For recommended probes—refer to page 45.

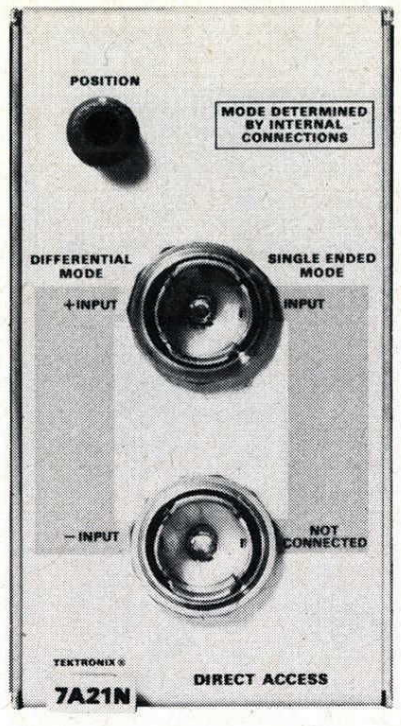
7A17



7A19



7A21N



7A17

Low Cost

Dc-to-150 MHz Bandwidth (7900 Family)

50 mV/div Calibrated Deflection Factor

Easy to Customize

The 7A17 is a unique wideband, plug-in amplifier electrically and mechanically suitable for do-it-yourself design and modification.

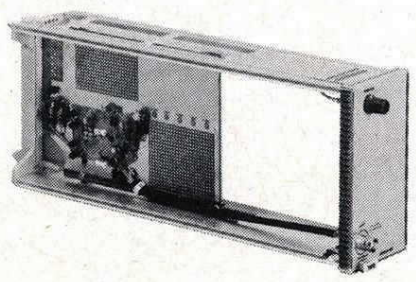
The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front subpanel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

Deflection Factor — Adjustable to 50 mV/div. There is no step attenuation.

Input Z — 50 Ω.

Max Input Voltage — 5 V rms.

Order 7A17 Amplifier **$200**



7A19

Dc-to-500 MHz Bandwidth (7900 Family)

10 mV/div to 1 V/div Calibrated Deflection Factors

Optional ±500 ps Variable Delay Line

The 7A19 is a high-performance, wide-bandwidth, single-trace plug-in amplifier designed primarily for use with the 7900-, 7800-, and 7700-Family Mainframes. The polarity of the display is selectable, either normal or inverted.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 3%.

Input R — 50 Ω.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

Max Input — 50 div peak or 10 V rms (2 W), whichever is less, in the dc-coupled mode. 100 V dc additional in the ac-coupled mode.

Order 7A19 Amplifier **$1325**

7A19 OPTION

Order Option 04 Variable Sig Delay . . . . . **Add $150**

7A21N

Bandwidth to 1 GHz (Useable with 7844, R7844, 7904, R7903)

Less than 4 V/div Deflection Factor

Single and Differential Inputs

Positioning Control

The 7A21N unit is designed so that high-frequency or fast rise time signals may be ac-coupled directly into the wide-bandwidth crt of the 7844 and 7900-Family Oscilloscopes. Two front-panel input connectors allow single-ended or differential operation (internally selected). Vertical-trace positioning is controlled on the front panel.

Direct access means that the vertical amplifier is bypassed. Interconnection boards and coupling cables are supplied with each 7A21N. The 7A21N is not a plug-in since it is hardwired to the crt vertical deflection system even though it is installed in a vertical compartment. The 7A21N does not incorporate crt readout or an internal trigger.

When used in 7900-Family Oscilloscopes, vertical mode switching is inoperative, and plug-ins can't be used in the adjacent vertical channel.

With the 7844 or R7844 Oscilloscopes, the 7A21N may be used in one or both vertical compartments. When one 7A21N is used with Beam 1 left vertical compartment, preamps or specialized plug-ins may be used with Beam 2 right vertical compartment, leaving the crt readout operative for Beam 2 and the horizontal compartments. Vertical mode switching is inoperative when a 7A21N is used with Beam 1. When two 7A21Ns are used, crt readout and vertical mode switching are inoperative. Horizontal mode switching is always operative.

An 80-ns pretrigger should be provided for fast single-shot events. If this is impractical, use a 7M11 Dual Delay Line in the signal path. The 7A21N is compatible only with the 7900- and 7800-Family Oscilloscopes, excluding the 7834.

Bandwidth — 20 kHz to 1 GHz.

Deflection Factor — Less than 4 V/div.

Input Z — 50 Ω.

Max Input Voltage — 25 V dc, 100 V pulsed ac.

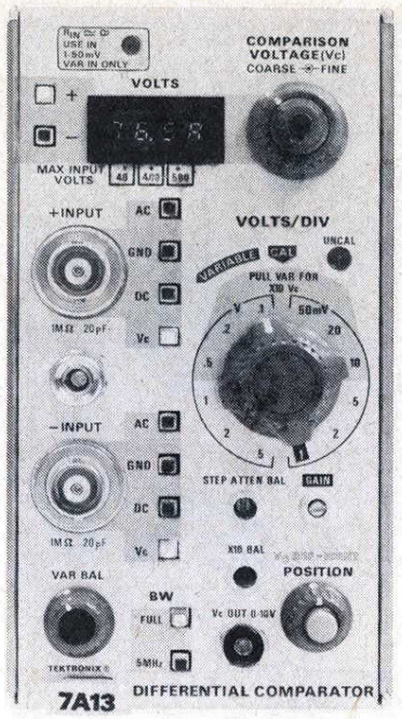
Included Accessories — Interconnecting board assembly.

Order 7A21 Direct Access **$1065**

For recommended probes—refer to page 45.

7000-Series Differential Amplifiers

7A13



7A13

Dc-to-105 MHz Bandwidth (7900 Family)

1 mV/div to 5 V/div Calibrated Deflection Factors

20,000:1 Cmrr

10,000 Cm Effective Screen Height

Lit Pushbuttons

The 7A13 is a differential comparator amplifier. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000 Series vertical plug-ins.

The 7A13 has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable to FULL or 5 MHz for best displayed noise conditions for low-frequency applications.

As a differential amplifier the 7A13 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 200:1 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 loses its differential capability, 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.

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

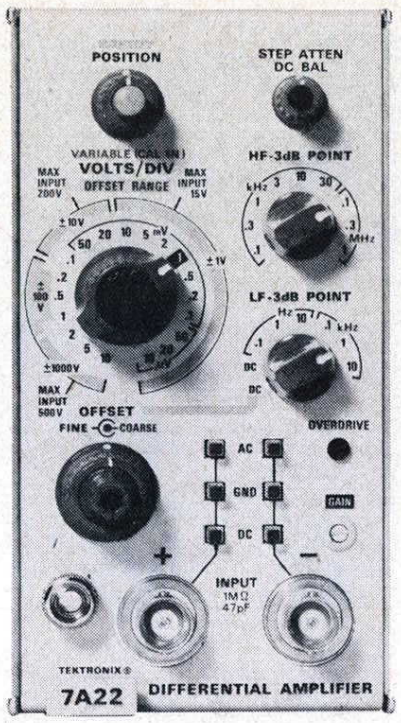
Deflection Factor — 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 1.5% with gain adjusted at 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

Signal Range

Deflection Factor Settings	1mV to 50mV/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
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	

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.

7A22



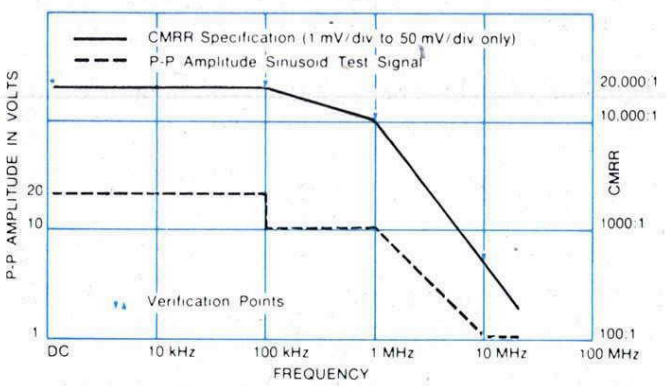
Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minute warm-up. Long term, 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hour interval after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 2 mV/10°C to 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 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less, regardless of pulse duration.

Internal Comparison Voltage — Range, 0 V to ±10 V; accuracy, ±(0.1% of setting + 3 mV); 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.

Order 7A13 Amplifier $2050

7A22

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 well suited for difficult low-amplitude, low-frequency measurements.

*With constant temperature. See dc stability specifications.

Bandwidth — Hf −3 dB point; selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; rise time 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 to 1 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

Input R and C — 1 MΩ within 1%; ≈ 47 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).

Signal and Offset Range

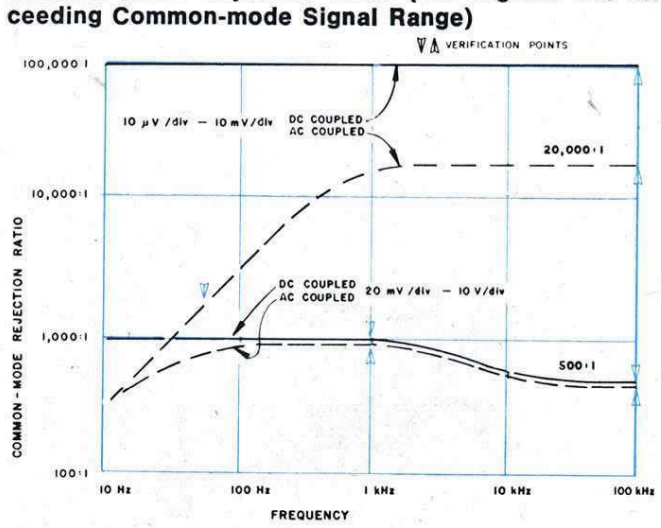
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-mode Signal Range	±10 V	±100 V	±500 V	
Max Dc-coupled Input (Dc + Peak Ac at 1 kHz or Less)	±15 V	±200 V	±500 V	
Max Ac-coupled Input (Dc Voltage)	±500 V dc rejection, at least 4 x 10⁵:1			
Dc Offset 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 max 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). Front-panel OVERDRIVE light indicates that an overdrive condition is being approached.

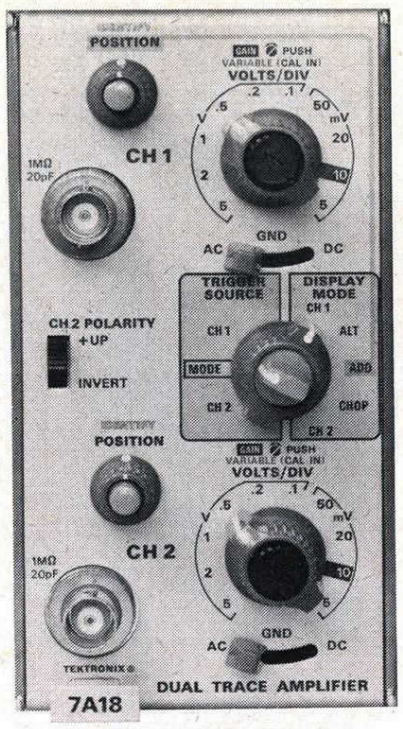
Common-mode Rejection Ratio (For Signals not Exceeding Common-mode Signal Range)



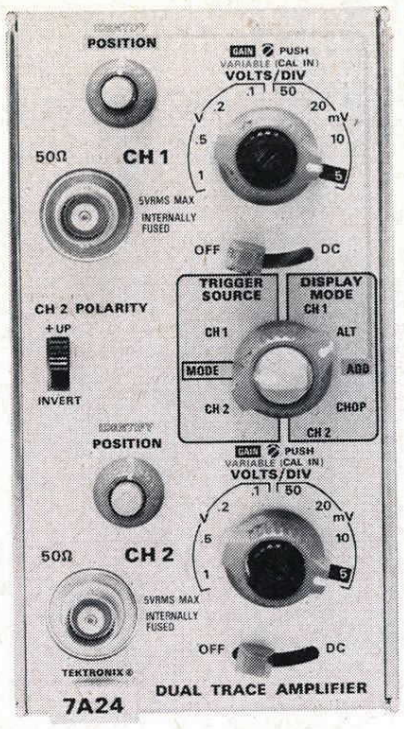
Order 7A22 Amplifier $1060

For recommended probes—refer to page 45.

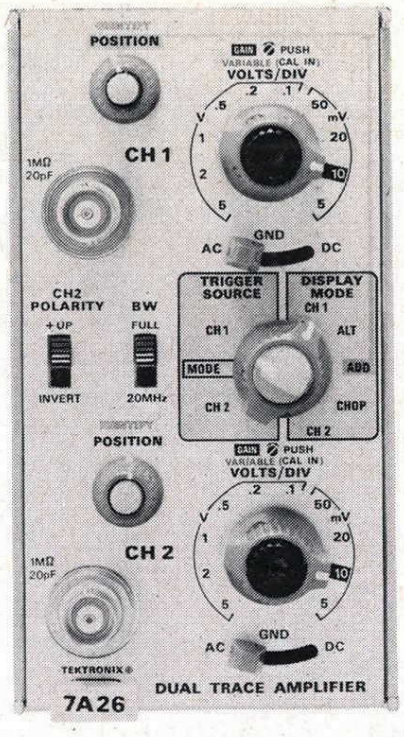
7A18



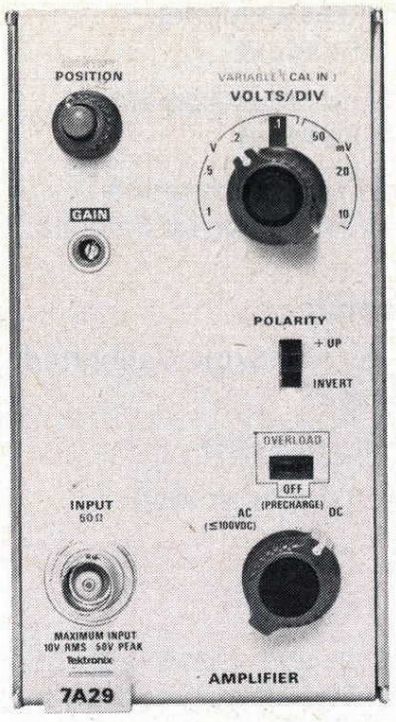
7A24



7A26



7A29



7A18

Dc-to-75 MHz Bandwidth

5 mV/div to 5 V/div
Calibrated Deflection Factors

The 7A18, the basic building block of 3- and 4-trace operation, is a dual-trace plug-in amplifier. The 7A18 features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The 7A18 has a trace identify function. Polarity of channel 2 is selectable.

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

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

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 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) is 0.02 div in any one minute after 1 hour warm-up.

Common-Mode Rejection Ratio (ADD, CH 2 Invert) — At least 10:1, dc to 50 MHz.

Order 7A18 Amplifier $915

DC Offset Option

Dc Offset is for the user who needs to analyze small signals that are riding on larger signals, such as power supply ripple.

Option 06, Dc Offset — Two separate Channel-1 and Channel-2 variable offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ±200 div max, equivalent to ±1 V at 5 mV/div.

Accuracy — When in DC OFFSET the deflection accuracy is derated by 1%.

Order Option 06 Dc Offset . . . . . Add $115

7A24

Dc-to-350 MHz Bandwidth (7900 Family)

5 mV/div to 1 V/div
Calibrated Deflection Factors

50-Ω Input

The 7A24, a high-performance, wide-bandwidth, dual-trace amplifier, is designed primarily for use with the 7700-, 7800-, and 7900-Series Mainframes. The 7A24 offers 350 MHz bandwidth and 5 mV/div sensitivity; this provides the basic building block for 3 or 4 trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable.

Deflection Factor — 5 mV/div to 1 V/div in 8 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 2.5 V/div.

Input R — 50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

Max Input — 5 V rms; 0.5 W max input power, internally protected.

Common-Mode Rejection Ratio — At least 10:1, dc to 50 MHz.

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

Order 7A24 Amplifier $1560

7A26

Dc-to-200 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div
Calibrated Deflection Factors

1-MΩ Input

The 7A26, a dual-trace plug-in amplifier, is a basic building block for 3- or 4-trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable. Bandwidth may be set at FULL or limited to 20 MHz for low-frequency applications.

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 to at least 12.5 V/div.

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

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

Common-Mode Rejection Ratio (ADD, CH 2 Invert) — At least 10:1, dc to 50 MHz.

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

Order 7A26 Amplifier $1435

7A29

Dc-to-1 GHz Bandwidth (7104)

10 mV/div to 1 V/div
Calibrated Deflection Factors

50-Ω Input

The 7A29 is a high performance, wide-bandwidth, single-trace plug-in amplifier designed primarily for use with the 7104 and the 7900, 7800, and 7700-Family mainframes. A vertical amplifier to bw of mainframe, the 7A29 has a 10 mV/div to 1 V/div vertical sensitivity.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 0.1 V/div. Uncalibrated variable is continuous between steps to at least 2.5 V/div.

Input R — 50 Ω.

Option 04, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 10 ps. Range is 1 ns.

Max Input — 10 V RMS or 1 W-second pulses not exceeding 50 V peak in dc coupled mode. 100 V dc additional in ac coupled mode.

Input Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Order 7A29 Amplifier $1 895

7A29 OPTION

Order Option 04 Variable Sig Delay . . . . . Add $350

For recommended probes—refer to page 45.

7B10
7B15

7000-Series Delayed and Δ Delaying Time Bases

7B15 Features:

Δ Time Measurements with Crt Readout

Delay Time Measurements with Crt Readout

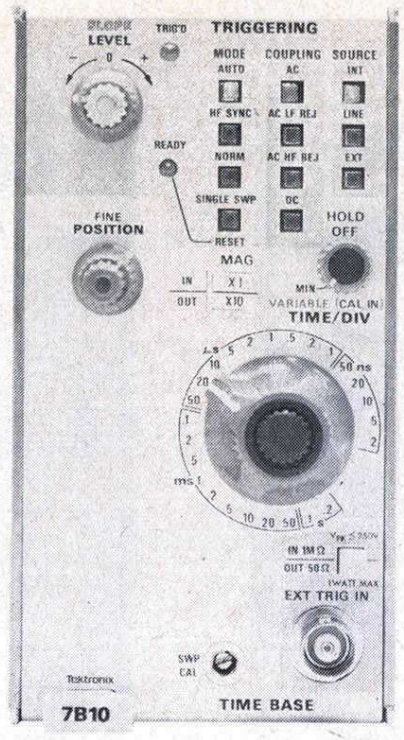
Vertical Trace Separation between Two Delayed Sweeps

Both Feature:

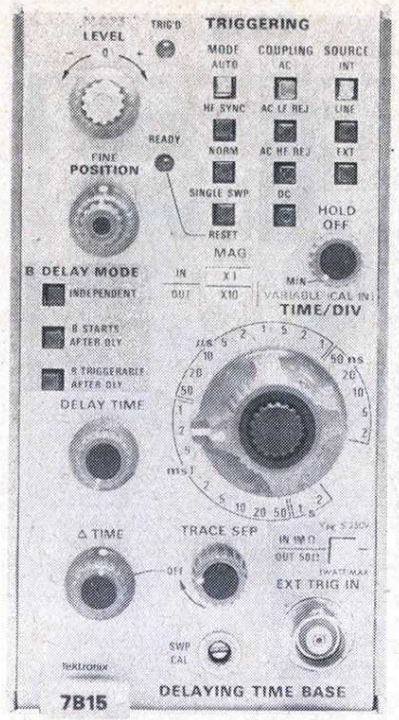
0.2 ns/div to 0.5/div Calibrated Time Bases

Triggering to 1 GHz

Variable Trigger Holdoff



7B10



7B15

The 7B10 and 7B15 are horizontal time bases designed for use with the 7104 Mainframe to provide optimum bandwidth/sweep-speed compatibility, but may also be used with the 7700-, 7800-, and 7900-Series Mainframes. (Each may be used in any slower 7000-Series Mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Together they provide the Δ time measurement capability in addition to the standard delay time capability. Either time interval is digitally displayed on the crt. A single intensified zone which you can position anywhere on the trace identifies the delay time interval (the time from the "A" or main sweep to the start of the intensified zone). Two intensified zones which you can position anywhere on a trace identify the Δ time interval (time between intensified zones). Alternate sweep switching makes it possible to display the information between the intensified zones full screen at the "B" sweep speed. By overlapping the two expanded waveforms, you are confident of the exact positioning of the intensified zones on the "A" sweep. This results in easy-to-make, precise and repeatable timing measurements.

By rotating the TRACE SEPARATION control out of the OFF position, the Δ time mode is activated. Two intensified zones can be independently positioned. As in the conventional delay mode, the DELAY TIME knob adjusts the time to the first intensified zone; the Δ TIME knob adjusts the time between the two intensified zones. Now, the crt digital readout shows the Δ time between the two delays.

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

CHARACTERISTICS

Sweep Rates — 0.2 s/div to 2 ns/div in 25 steps. X10 MAGNIFIER extends fastest calibrated sweep rate to 0.2 ns/div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep.

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7104, 7900, or 7800-Series Mainframes. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
0.2 s/div to 10 ns/div	2%	3%
5 ns/div and 2 ns/div	3%	4%

[1]Fastest calibrated sweep rate is limited by 7900, 7800, 7700, 7600, and 7300-Series Mainframes.

Trigger Holdoff Time —

	Minimum	Maximum with VARIABLE
0.2 s/div to 50 ms/div	40 ms	400 ms
20 ms/div to 2 μs/div	2X the TIME/Div Setting	20X the TIME/Div Setting
1 μs/div to 0.5 μs/div	2 μs	20 μs
0.2 μs/div to 2 ns/div	2 μs	6 μs

Δ Time Range — 0 to at least 9 times TIME/DIV setting.

Δ Time Accuracy — Within (0.5% measurement plus 3 least significant digits) 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in Δ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — 0.02% of TIME/DIV setting up through 50 μs/div. 0.03% of TIME/DIV setting plus 0.1 ns for sweep speeds of 20 μs/div through 100 ns/div.

TRIGGERING

Triggering Sensitivity

Coupling	Triggering Frequency Range[2]	Minimum Triggering Signal Required: Internal	Minimum Triggering Signal Required: External
AC	30 Hz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
AC LF REJ[2]	50 kHz to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV
AC HF REJ	30 Hz to 40 kHz	0.5 div	50 mV
DC[3]	Dc to 250 MHz 250 MHz to 1 GHz	0.5 div 1.5 div	50 mV 150 mV

[1]The triggering frequency ranges given here are limited to the −3 dB frequency of the oscilloscope vertical system when operating in the Internal mode.

[2]Will not trigger on sine waves at or below 60 Hz when amplitudes are less than 8 division Internal or 3 volts External.

[3]The Triggering Frequency Range for DC COUPLING applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

Single Sweep — Requirements are same as for repetitive inputs.

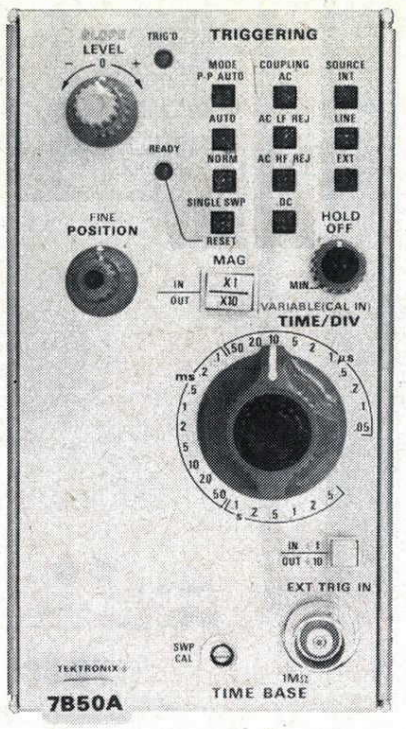
Internal Trigger Jitter — 30 ps or less at 1 GHz into 0.3 div, (50 mV EXTERNAL).

H F Sync Mode — 250 MHz to 1 GHz.

External Trigger Input — Max input voltage is 250 V (dc + peak ac) for 1 MΩ input. I W average for 50 Ω input. Input R and C for 1 MΩ Input is 1 MΩ within 5%, 20 pf within 10%; for 50 Ω input, 50 Ω within 2%. Level range is at least ±3.5 V in EXT ÷1.

Order 7B10 Time Base **$1,495**

Order 7B15 Delaying Time Base **$1,695**



7B50A

5 ns/div to 5 s/div Calibrated Time Base

Triggering to 150 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

Single-Sweep Operation

The easy-to-use 7B50A Time Base is recommended for use with 7313 and 7600-Series Mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000-Series Mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

This time base features expanded capability in maximum triggering frequency — now 150 MHz — and variable trigger holdoff — for stability on lengthy asynchronous data trains.

Pushbutton positions select triggering mode, coupling method, and source. For routine applications, hands-off triggering is accomplished by actuating three switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE. The P-P AUTO MODE provides a base line 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 automatic. The other triggering positions are useful for specific applications.

AC LF REJ attenuates undesirable trigger components below 30 kHz. AC HF REJ attenuates components above 50 kHz, which can cause triggering problems during low-frequency applications. Single-sweep functions with lighted READY indicator and manual reset are associated with the trigger mode controls.

X-Y displays are available with Option 02 installed. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B50A. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

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

Sweep Accuracy — Measured over center 8 div, +15°C to +35°C, with any 7000-Series Mainframe. Derate accuracies by an additional 1% each for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
5 s/div to 1 s/div	4%	*
0.5 s/div to 0.5 μs/div	2%	3%
0.2 μs/div to 0.05 μs/div	3%	4%

[1]Fastest calibrated sweep rate is limited to 20 ns/div by 7313 mainframe.

*Unspecified

Trigger Holdoff Time —

MIN Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 50 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for sweep rates of 20 ms/div or faster	

Triggering —

Sensitivity (AUTO and NORM modes)

Coupling	Triggering Frequency Range[1]	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
AC LF REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC[3]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV

[1] *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

[2] *Will not trigger on sine waves of less than 8 div INT, or 3 V EXT, at or below 60 Hz.*

[3] *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto Triggering mode.*

Sensitivity (P-P AUTO MODE) (Ac or Dc Coupling)

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 150 MHz	1.5 div	375 mV

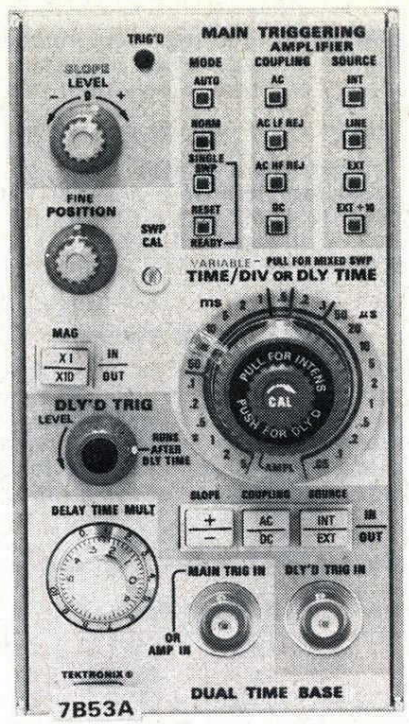
Option 02

X-Y Phase Shift (Determined by the circuitry in mainframe) — For mainframes without X-Y horizontal compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

Order 7B50A Time Base $675

7B50A OPTION

Order Option 02, X-Y ..... Add $50



7B53A

5 ns/div to 5 s/div Calibrated Time Base

Calibrated Mixed Sweep

Triggering to 100 MHz

Single-Sweep Operation

Optional Tv Sync-Separator Triggering

The easy-to-use 7B53A Dual Time Base is recommended for use with 7313 and 7600-Mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000-Series Mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

The 7B53A Time Base features four kinds of sweep: normal, intensified delaying, delayed, and mixed. The pushbutton switches cannot be lit.

DELAYING SWEEP

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

Sweep Accuracy — Measured over the center 8 div.

Time/Div	Unmagnified +15°C to +35°C	Unmagnified 0°C to +50°C	Magnified +15°C to +35°C	Magnified 0°C to +50°C
5 s/div to 1 s/div	3%	4%	*	*
0.5 s/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

*Unspecified

Delay Time Multiplier Range — 0 to 10 times the DELAY TIME/DIV setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy — 5 s/div to 1 s/div ±1.4% of measurement + 0.3% of full scale; 0.5 s/div to 1 μs/div: ±0.7% of measurement +0.3% of full scale. Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 DTM divisions from +15°C to +35°C.

Jitter — 0.05% or less of TIME/DIV setting.

Triggering —

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz-10 MHz	0.3 div	100 mV
	10 MHz-100 MHz	1.5 div	500 mV
Ac Lf Rej*	30 kHz-10 MHz	0.3 div	——
	150 kHz-10 MHz	——	100 mV
	10 MHz-100 MHz	1.5 div	500 mV
Ac Hf Rej	30 Hz-50 kHz	0.3 div	100 mV
Dc	Dc-10 MHz	0.3 div	100 mV
	10 MHz-100 MHz	1.5 div	500 mV

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

7B80
7B85

7000-Series Delayed and Δ Delaying Time Bases

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until 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, the fastest calibrated sweep rate, is 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, delayed sweep, and variable main sweep holdoff.

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 approx +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise time is 50 ns or less; output R is 350 Ω 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	100 mV 500 mV
Dc	Dc-10 MHz 10 MHz-100 MHz	0.3 div 1.5 div	100 mV 500 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 +1.5 V to −1.5 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.

Bandwidth

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

TV SYNC

Option 05, Tv Sync Separator Triggering — Permits stable internal line or field rate triggering from displayed composite video or composite sync waveforms. 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. Individual lines may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system.

Order 7B53A Dual Time Base $1135

7B53A OPTION

Option 05 — Deletes ac line trigger and External ÷ 10 from trigger source.

Order Option 05, Tv Triggering . . . . . Add $75

7B85 Features:

Δ Time Measurements with Crt Readout

Delay Time Measurements with Crt Readout

Vertical Trace Separation between Two Delayed Sweeps

Both Feature:

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

The 7B80 and 7B85 are horizontal time bases recommended for use with 7700-, 7800-, and 7900-Series Mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may be used in any slower 7000-Series Mainframe with some reduction in sweep accuracy at the fastest sweep speed.)

Together they provide the Δ time measurement capability in addition to the standard delay time capability. Either time interval is digitally displayed on the crt. A single intensified zone which you can position anywhere on the trace identifies the delay time interval (the time from the "A" or main sweep to the start of the intensified zone). Two intensified zones which you can position anywhere on a trace identify the Δ time interval (time between intensified zones). Alternate sweep switching makes it possible to display the information between the intensified zones full screen at the "B" sweep speed. By overlapping the two expanded waveforms, you are confident of the exact positioning of the intensified zones on the "A" sweep. This results in easy-to-make, precise and repeatable timing measurements.

By rotating the TRACE SEPARATION control out of the OFF position, the Δ time mode is activated. Two intensified zones can be independently positioned. As in the conventional delay mode, the DELAY TIME knob adjusts the time to the first intensified zone; the Δ TIME knob adjusts the time between the two intensified zones. Now, the crt digital readout shows the Δ time between the two delays.

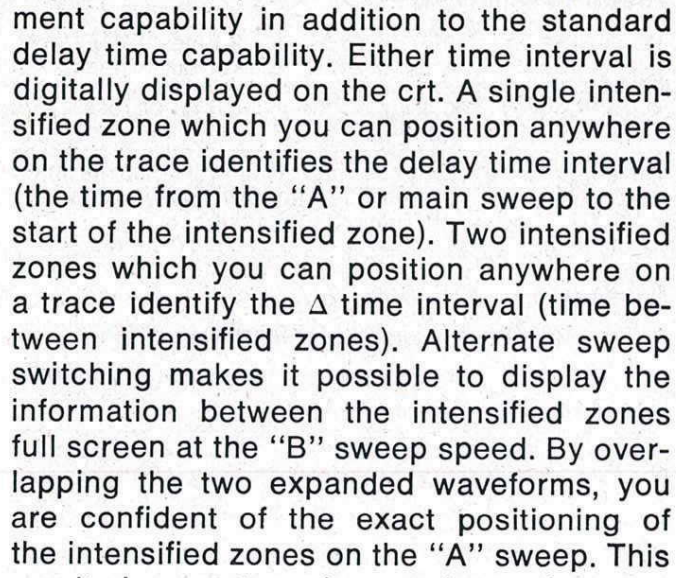
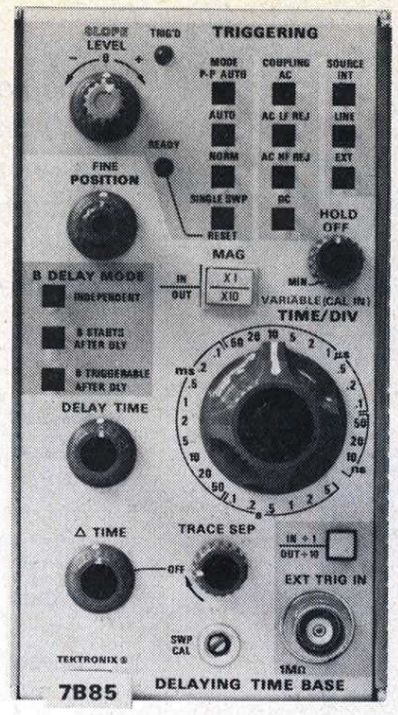
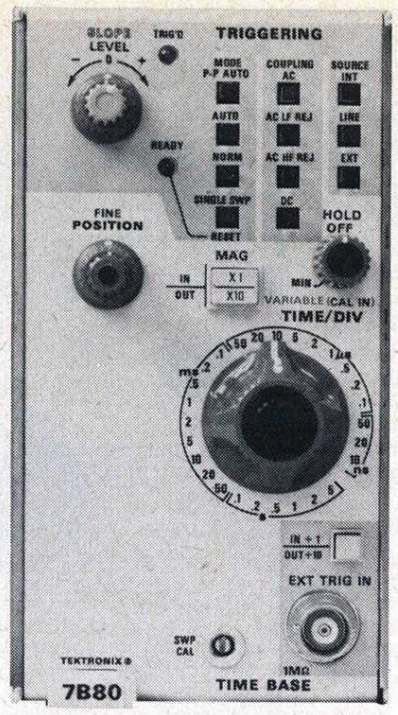


Fig 1. Delaying and delayed sweeps are shown with the mainframe selecting ALT sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the crt.



7B85



7B80

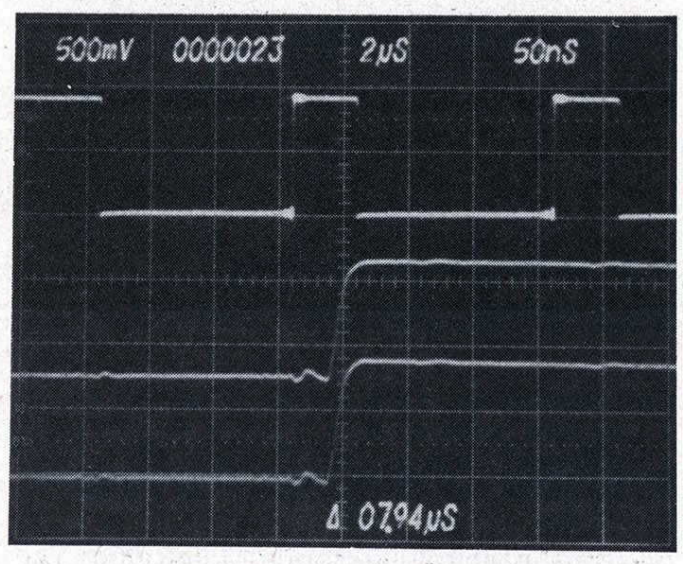


Fig 2. With the mainframe still selecting ALT sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower crt edge shows the time between the two sweep delays. The TRACE SEPARATION knob is used to position the second delayed sweep below the first delayed sweep with up to 3 div of separation.

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 02. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

Sweep Rates — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 MAGNIFIER extends fastest calibrated sweep rate to 1 ns div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy — Measured over the center 8 div, +15°C to +35°C, in the 7700, 7800, or 7900-Series Mainframe. Derate accuracies by an additional 1% for 0°C to +50°C.

Time/Div[1]	Unmagnified	Magnified
5 s/div to 1 s/div	4%	Unspecified
0.5 s/div to 50 ns/div	1.5%	2.5%
20 ns/div to 10 ns/div	2.5%	4.0%

[1] *Fastest calibrated sweep rate is limited by 7700, 7600, and 7300-Series Mainframes.*

Trigger Holdoff Time —

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

△ **Time Range** — 0 to at least 9 times TIME/DIV setting.

△ **Time Accuracy** — (+15°C to +35°C)

Within (0.5% measurement + 0.3% of TIME/DIV setting + 1 least significant digit) from 20 ms/div to 100 ns/div.

Trace Separation Range — Functional only in △ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — 0.02% of TIME/DIV setting + 0.1 ns, or less.

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) — (from repetitive signals)

Coupling	Triggering Frequency Range[1]	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac Lf Rej[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
Ac Hf Rej	30 Hz to 50 kHz	0.3 div	50 mV
Dc[3]	Dc to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV

1 Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.

2 Will not trigger on sine waves of less than 8 div Int, or 3 V Ext, at or below 60 Hz.

3 Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the Auto triggering mode.

Single Sweep — Requirements are same as for repetitive inputs.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Sensitivity (P-P AUTO Mode) — (ac or dc coupling)

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV
Low Frequency Response: At least 50 Hz	2.0 div	500 mV

External Trigger Input — Max input voltage is 250 V (dc + peak ac). Input R and C is 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ±1.5 V in EXT ÷ 1, and at least ±15 V in EXT ÷ 10.

7B80 Option 02

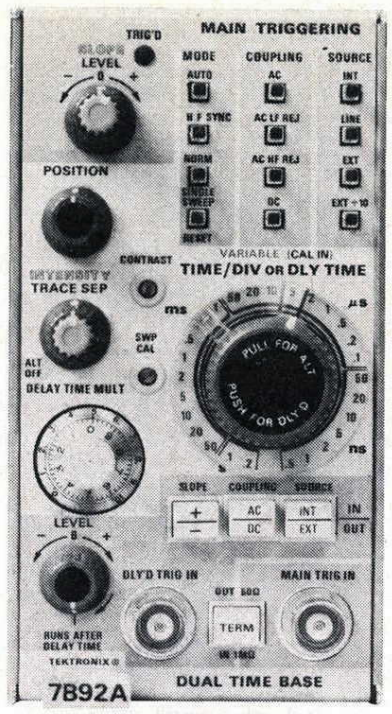
X-Y Phase Shift (Determined by the circuitry in mainframe) — For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

Order 7B80 Time Base $945

Order 7B85 Delaying Time Base $1120

7B80 OPTION

Order Option 02, X-Y ..... Add $50



7B92A

0.5 ns/div to 0.2 s/div Calibrated Time Base
Triggering to 500 MHz
Alternate Display of Intensified Delaying and Delayed Sweeps
Contrast Regulation between Delaying and Delayed Sweeps

The 7B92A Dual Time Base is recommended for use only in the 7800- and 7900-Series Mainframes (the 7B92A may be used in all other mainframes at slower sweep speeds).

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (excepting alternate in R7704). When operating in the AUTO mode of main triggering, a bright base line is displayed in the absence of a trigger signal.

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900-Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%

Delay Time Multiplier Range — 0 to 9.8 times the DLY TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.96 seconds).

Differential Delay Time Measurement Accuracy — (+15°C to +35°C)

Sweep Speed

0.2 s/div to 0.1 μs/div	Both delay time mult dial settings at 0.5 or greater	±(0.75% of measurement + 0.25% of full scale)
	One or both delay time mult dial settings at less than 0.5	±(0.75% of measurement + 0.5% of full scale + 5 ns)
50 ns/div to 10 ns/div	Both delay times equal to or greater than 25 ns	±(1% of measurement + 0.5% of full scale)
	One or both delay times less than 25 ns	±(1% of measurement + 1% of full scale + 5 ns)

Full scale is 10 times the TIME/DIV or DLY TIME setting. Accuracy applies over the center 8 Delay Time Multiplier div from +15°C to +35°C.

Delay Time Jitter — Not applicable for the first 2% of max available delay time (DELAY TIME MULT dial setting greater than 0.2).

0.2 s/div to 50 μs/div	1 part in 50,000 of the max available delay time
20 μs/div to 10 ns/div	1 part in 50,000 of the max available delay time + 0.5 ns

Max available delay time is 10 times the TIME/DIV or DLY TIME switch setting.

MAIN TRIGGERING

Auto, Norm

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV
Ac Lf Rej	30 kHz-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV
Ac Hf Rej	30 Hz-50 kHz	0.5 div	100 mV
Dc	Dc-20 MHz	0.5 div	100 mV
	20 MHz-500 MHz	1.0 div	500 mV

EXT ÷ 10 switch attenuates external signal 10 times.

HF SYNC — Triggering sensitivity is 0.5 div INT or 100 mV EXT, from 100 MHz to 500 MHz for any coupling except Ac Hf Rej.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in EXT, and at least ±35 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900-Family Oscilloscope:

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

Delayed Triggering

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Dc	Dc to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

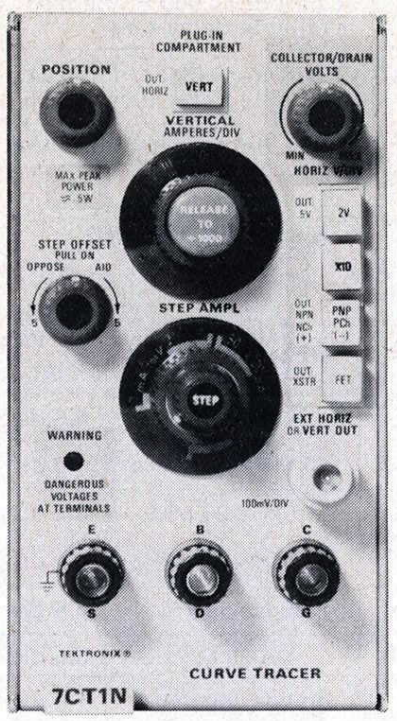
Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1-MΩ input, and 1 W average for 50-Ω input. Range of trigger level is at least ± 3.5 V in EXT.

Order 7B92A Dual Time Base $2260

7CT1N
7M13

7000-Series Curve Tracer and Readout Unit



7CT1N

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

The 7CT1N Curve Tracer Plug-in displays characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000-Series Oscilloscopes.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Max Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short-circuit current, within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light, indicating that dangerous voltages may exist at the test terminals, appears on the front panel.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least X5 amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental: within 3% between steps. Absolute: within ± (3% + X0.3 amplitude setting).

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in 1 step increments between 0 and 10.

Offset — Selectable to 5 steps. Polarity aids or opposes the step polarity.

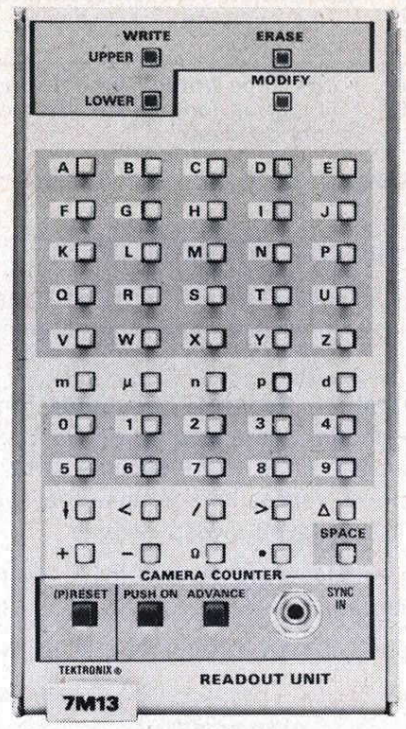
Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal volt in the ÷1000 mode.

Horizontal Deflection Factors — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy on the plug-in being driven. The plug-in is a vertical or horizontal amplifier with a 100 mV/div deflection factor and an input R of at least 50 kΩ when it is used in the horizontal compartment.

Order 7CT1N Curve Tracer $895



7M13

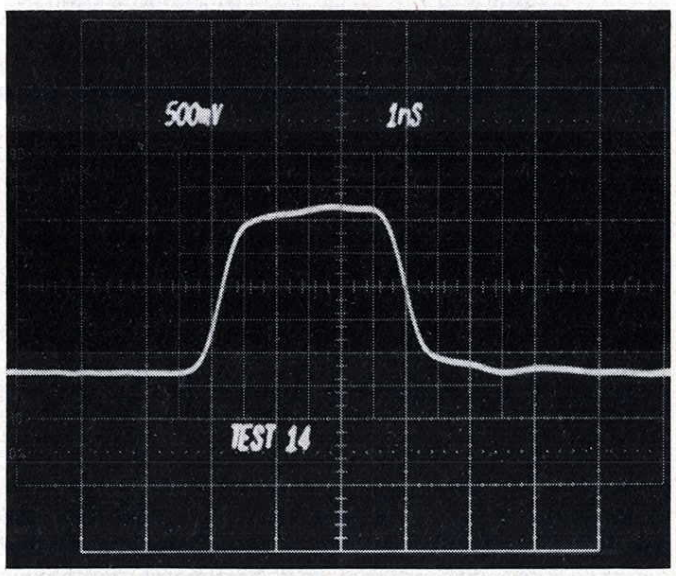
Easy and Convenient Identification of Photographed Displays

Automatic Sequence Advance with Each Camera Exposure

The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the crt readout characters. Up to ten alphanumeric characters can be displayed at the top and/or at the bottom of the crt. The 7M13 is designed for use in all 7000-Series Mainframes with crt readout. A remote-advance cable is supplied with the 7M13 to connect it to the shutter x-sync connector of the C-50-Series Cameras. An optional cable is available for cameras using an ASA connector for x-sync.

Included Accessory — Remote-advance cable (012-0339-01).

Order 7M13 Readout Unit $545

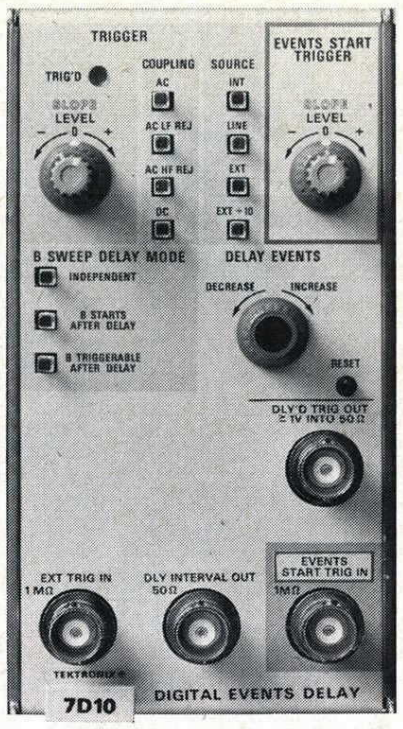


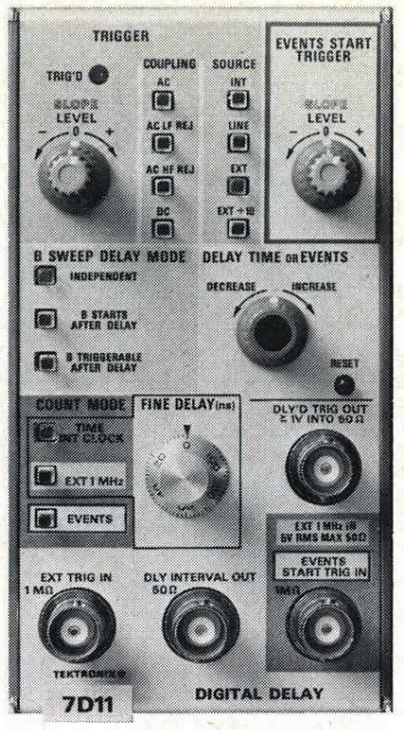
The photograph above was identified as TEST 14 by using the 7M13 in 7834 Oscilloscope.

Optional Accessory — Remote-advance cable with ASA connector for camera x-sync

Order 012-0364-01 . . . . . $16

Delay by Time or Events
Digital Delay Readout to 7½ Digits
100-ns to 1-s Delay Time
1-ns Resolution
2.2-ns Delay Time Jitter
0.5-ppm (±2 ns) Accuracy
Delay Interval Crt Display





The 7D10/7D11 Digital Delay Plug-ins give stable delayed triggers for measurements requiring low jitter. The 7D11 also provides precision time delays. The 7D10/7D11 may be used in any compartment of a 7000-Series Mainframe equipped with crt readout. It provides a variety of outputs.

The delay-by-events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

In the delay-by-events, the 7D10/7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see Fig 2).

An accurate and jitter-free delay-by-time is very useful when working with digital logic, pcm telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

When the 7D10/7D11 is installed in a vertical compartment, the crt can display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D10/7D11 triggers on. From a vertical compartment, the 7D10/7D11 can trigger a time base such as 7B80, 7B53A, or another 7D10/7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates a display similar to the "A Intensified by B" mode of conventional delayed sweep (see Fig 2). When used in the A horizontal compartment, the 7D10/7D11 B sweep delay mode controls will permit the B sweep to run after the delay generated by the 7D10/7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D10/7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1-MHz timing standard through the EXT 1-MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as tdr, radar timing, etc, the crt readout would display the "one-way-trip" time.

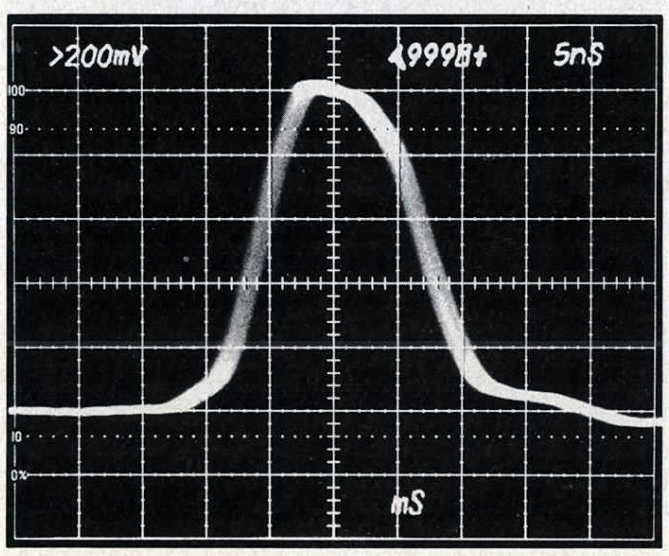


Fig 1. Delay-by-time. A 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

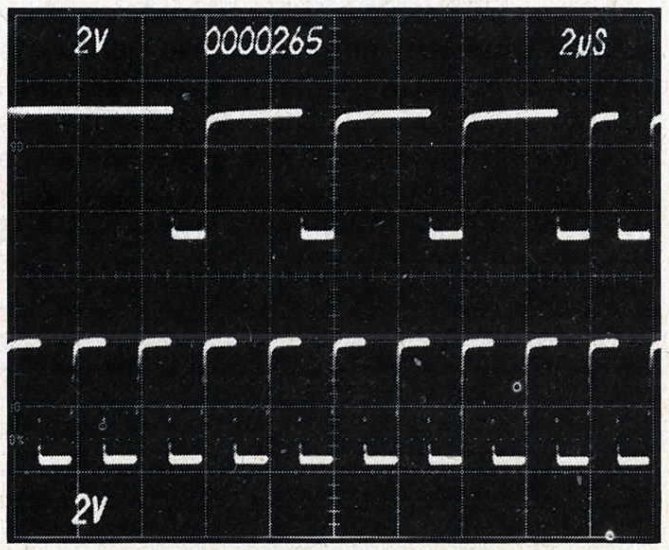


Fig 2. Delay-by-events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

EVENTS DELAY

Events Delay Range — One to 10^7 events.
Delay Increment — One event.
Insertion Delay — 35 ns ±5 ns.
Recycle Time — Less than 500 ns.
Max Event Frequency — At least 50 MHz.

TRIGGERING

	External Trigger
Source	Int, Line, Ext, Ext ÷ 10
Coupling	Dc, Ac, Ac Lf Rej, Ac Hf Rej
Max Input Voltage	250 V dc + peak ac
Level Range	±1.75 V in Ext ±17.5 V in Ext ÷ 10
Input R and C	1 MΩ ±5%, 20 pF ±2 pF

	Coupling	Frequency Range	Min Signal Required Int	Min Signal Required Ext
Sensitivity	Ac	30 kHz-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV
	Ac Lf Rej*	30 kHz-10 MHz 150 kHz-10 MHz 10 MHz-50 MHz	0.3 div — 1.0 div	— 150 mV 750 mV
	Ac Hf Rej	30 Hz-50 kHz	0.3 div	150 mV
	Dc	Dc-10 MHz 10 MHz-50 MHz	0.3 div 1.0 div	150 mV 750 mV

*Will not trigger on sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

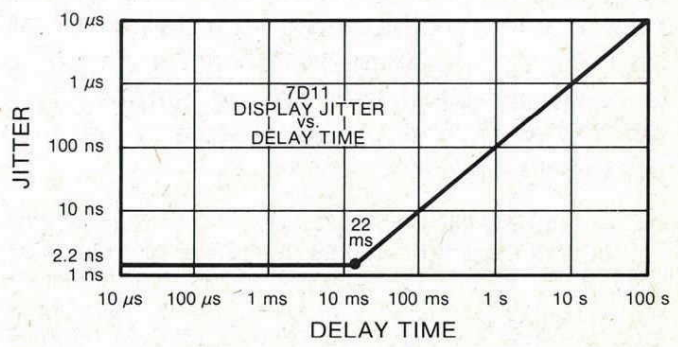
	Events Start Trigger
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc + peak ac
Level Range	±3 V
Input R and C	1 MΩ within 5%, 20 pF ± 2 pF
Sensitivity	100 mV minimum, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.

TIME DELAY

Digital Delay Range — Normal mode: 100 ns to 1 s in 100 ns increments. Echo mode: 200 ns to 2 s in 200 ns increments.

Analog Delay — Continuously variable from 0 to at least 100 ns, accuracy within 2 ns of indicated delay.

Jitter with Internal Clock — 2.2 ns or delay time X10^{-7} whichever is greater.



Insertion Delay — Zero within 2 ns.
Recycle Time — Less than 575 ns.
Time Base — 500 MHz oscillator phase-locked to internal or external clock.
Internal Clock — 5 MHz crystal oscillator. Accuracy is 0.5 ppm.
External Clock — 1 MHz within 1%, ac coupled, 50 Ω.

OUTPUTS

Delayed Trigger Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time into 50 Ω load: 2 ns or less. Fall time into 50 Ω load: 5 ns or less. Pulse width: 200 to 250 ns.

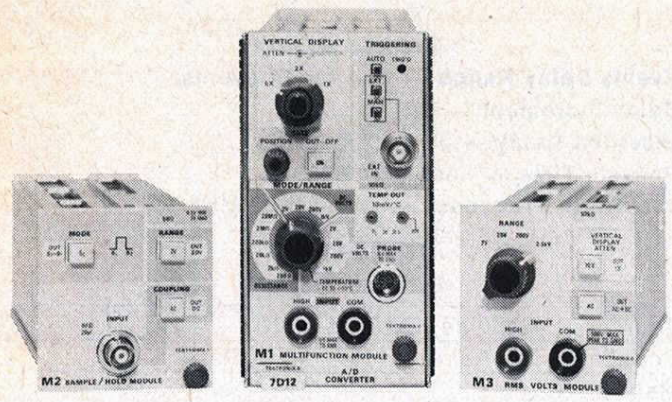
Delay Interval Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time and fall time: 5 ns or less. Accuracy: equal to delay interval less 20 to 30 ns.

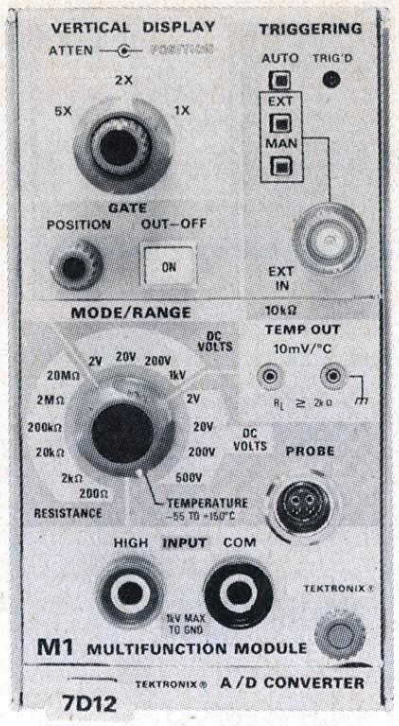
READOUT

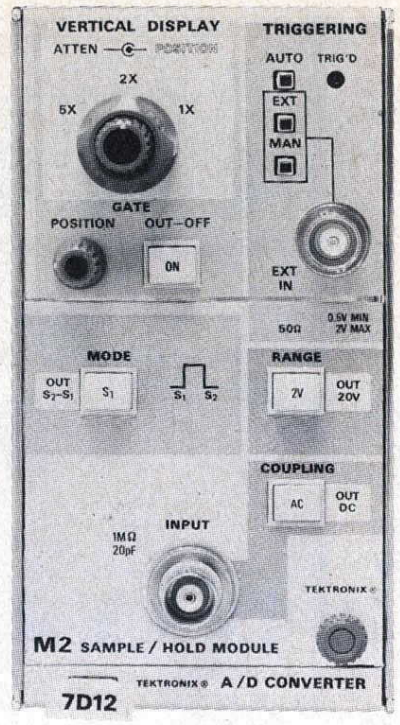
Display — 7½ digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

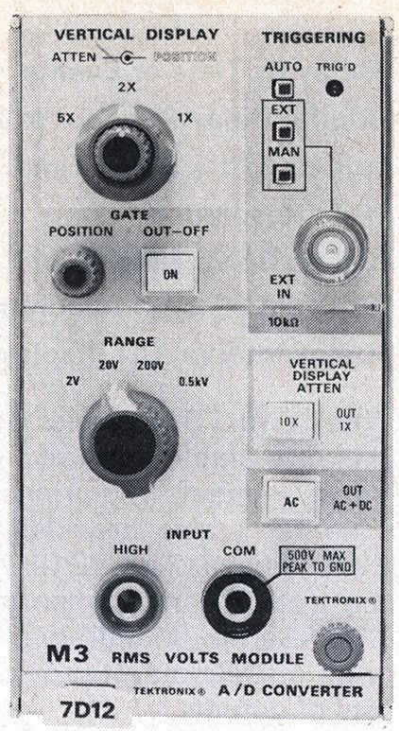
Order 7D10 Digital Events Delay Unit $1115
Order 7D11 Digital Delay Unit $1870

7D12 | 7000-Series A/D Converter with Interchangeable Modules









7D12/M1 **7D12/M2** **7D12/M3**

Versatile 0.01% A/D Converter with Vertical Amplifier

3 Plug-in Modules Available

Automatic, Manual, or External Triggering

Automatic Polarity and Overrange Indicators

Lit Pushbuttons

The 7D12 A to D Converter, constructed in modules, is a versatile and expandable DVM measurement system. The 7D12 and three interchangeable modules will make most DVM measurements, including dc volts, resistance, temperature, one- or two-point sample and hold, and true rms volts.

The 7D12 is designed for use with all 7000-Series Oscilloscope Mainframes with crt readout.

7D12/M1 MULTIFUNCTION MODULE

Temperature Mode

4½ Digit Crt Readout

100 μV Resolution

Probe Measures Temperature or Voltage

The M1 Multifunction Module measures dc volts, resistance, and temperature. The input can be elevated 1 kV above ground without probe, with a 10-MΩ input impedance on the dc volts scale. When the temperature probe is used, a front-panel analog output of 10 mV/°C (0°C = 0 V) is available regardless of model selected.

Dc Voltage Range — 0 to 1000 V in four ranges. 4½-digit presentation of 1.9999 V, 19.999 V, 199.99 V, 1000 V. Accuracy is ±0.03% of reading ±0.005% of full scale from +20°C to +30°C; ±0.04% of reading ±0.005% of full scale from +15°C to +40°C. Input impedance is 10 MΩ on all ranges. Max safe input is 1 kV peak between either connector and ground. Polarity is automatic. Cmrr is at least 80 dB at 60 Hz (100 Ω imbalance). Normal-mode rejection ratio is at least 50 dB at 60 Hz.

Resistance Range — 0 to 20 MΩ in six ranges. 4½-digit presentation of 199.99 Ω, 1.9999 kΩ, 19.999 kΩ, 199.99 kΩ, 1.9999 MΩ, 19.999 MΩ full scale. Accuracy is ±0.09% of reading ±0.01% of full scale from +15°C to +40°C. Input is fuse protected.

Temperature Range — −55°C to +150°C in one range. Accuracy (+15°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Temperature out is 10 mV/°C into a load of at least 2 kΩ.

Settling Time — 2 s or less to within 1 count of final reading (voltage and resistance modes).

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Included Accessories — P6058 voltage/temperature probe package (010-0260-00); pair of test leads (012-0427-00). (See 7D13 for P6058 probe specs.)

7D12/M2 SAMPLE/HOLD MODULE

Oscilloscope-controlled Sampling DVM

10-ns Aperture Uncertainty

Input Signal and Sample Points Displayed on Crt

3½ Digit Crt Readout

Approaching 0.25% Accuracy

1-mV Resolution

25-MHz Bandwidth

0-to-2 V and 0-to-20 V Input Range, 200 V with P6055 Probe

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) is taken. In the S1 mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken, and the voltage amplitude, from the 0 V level, is digitally displayed on the crt readout. In the S2-S1 mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the crt readout.

Sample-gate Display Amplitude — 2 div, rise time and fall time 5 ns or less.

Analog-signal Display — Bandwidth is dc to 25 MHz (dc-coupling), 3.4 Hz to 25 MHz (ac-coupling). Vertical sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

Input R and C — 1 MΩ and 20 pF.

Max Input Voltage — 100 V peak.

Measurement Readout — 0 to 20 V in two ranges. 3½-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 probe.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Aperture Uncertainty — 10 ns or less.

Pulse-width Sample Time (S2-S1 mode) — 30 ns to 5 ms with repetitive signal. 150 μs to 5 ms with single-shot signal.

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

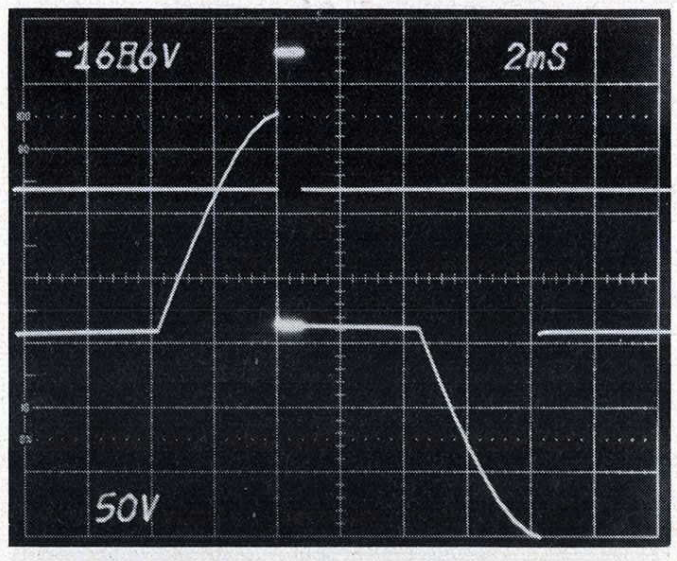
Settling Time — 40 ns.

Accuracy without Probe (40 ns after Input Signal Step Function)

Temperature Range	S1 Mode	S2-S1 Mode
+20°C to +30°C	±0.15% of p-p input voltage, ±0.1% of reading, ± 2 counts, ± % of ac decay*	±0.25% of p-p input voltage, ±0.15% of reading, ± 2 counts, ± % of ac decay*
+15°C to +40°C	±0.25% of p-p input voltage, ±0.2% of reading, ± 3 counts, ± % of ac decay*	±0.35% of p-p input voltage, ±0.25% of reading, ± 3 counts, ± % of ac decay*

*Applicable when M2 is ac-coupled.

Included Accessory — 3.5 ft P6055 probe package (010-6055-01).



Sample and Hold DVM measures difference voltage (−168.6 V) between two points on complex waveform. Gate waveform indicates two points: leading and trailing edges where voltage difference is made.

7D12/M3

True Rms Measurements with Isolated-analog Display (Floating Common-mode Capability)

Measures Ac + Dc or Ac Only

40 Hz-to-100 kHz Ac Voltage Range

0.25% Accuracy from 40 Hz to 40 kHz

3½ Digit Crt Readout

1 mV Resolution

500 V Max Peak Common-mode Voltage

The M3 RMS Volts Module measures the true rms voltage of signals from 40 Hz to 100 kHz. Voltages up to 1 kV peak may be measured while floating the input connectors.

Input R and C — 1 MΩ; ≃ 50 pF.
Max Crest Factor — 5 (crest factor = $\frac{E_{pk}}{E_{RMS}}$).
Max Input Voltage

Range		2 V, 20 V, 200 V	0.5 kV
Ac or Dc coupled†	Max Input between connectors	2.5 X range peak	500 rms 1 kV peak
	Max Input between either connector and chassis ground	500 V peak	500 V peak

†Ac-coupling adds an additional 200 V dc isolation.

Digital System Cmrr — 66 dB at dc to 60 Hz, decreasing 20 dB per decade for higher frequencies (100-Ω imbalance load).

Measurement Readout — 0 to 500 V rms in four ranges. 3½ digit presentation of 1.999 V, 19.99 V, 199.9 V, 0.500 kV full scale.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

Accuracy — Stated with form factor of 1.2 or less (form factor = $\frac{E_{RMS}}{E_{average}}$); +15°C to +40°C*.

Range	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz	40 kHz to 100 kHz
2 V, 20 V	±0.5%	±0.25%	±0.25%	±0.5%
200 V	±0.5%	±0.25%	±0.5% plus 1% of reading	±0.5% plus 1% of reading
500 V	±1%	±1%	±2% plus 1% of reading	±2% plus 1% of reading

*Accuracies represent a percentage of full scale. For signals with form factors greater than 1.2, add ± [0.1% x (form factor −1)] to the above percent of full scale accuracy specifications.

Analog-Signal Display — Bandwidth is dc to 700 kHz, max slew rate limited to full scale voltage ÷ 1 μs (100 V/μs max). Vertical sensitivity is 100 mV/div to 500 V/div in 12 steps (1-2-5 sequence, combining M3 and 7D12 vertical display attenuation). Accuracy is within 5%, and aberrations are 5% or less.

Included Accessories — Pair of test leads (012-0427-00).

7D12/M1/M2/M3 ORDERING INFORMATION

7D12 A/D Converter (Modules not included **$895**

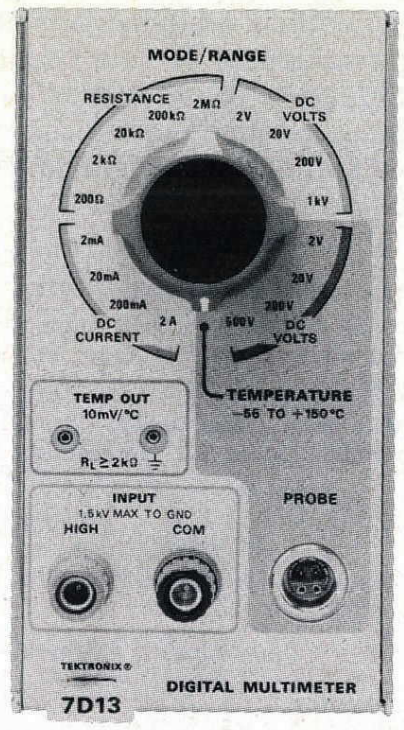
M1 Multifunction Module **$490**

Option 02 without P6058 ..... **Sub $100**

M2 Sample/Hold Module **$840**

Option 02 without P6055 ..... **Sub $120**

M3 RMS Volts Module **$650**



7D13

Temperature Mode

1.5 kV Max Common-mode Voltage

Probe Measures Temperature or Voltage

3½ Digit Crt Readout

The 7D13 is a digital multimeter designed for use in all 7000-Series Oscilloscope Mainframes with crt readout. The 7D13 functions in any compartment.

The 7D13 measures dc volts, dc current, and resistance. It also measures temperature from 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 V). Temperature may be measured simultaneously along with any other function. Almost any npn transistor may be used as a separate sensor to make small-space "free air" measurements.

When the 7D13 is used, the character generator traces out a 3½ digit display on the crt and a legend for units like kΩ, mA, °C.

Dc Voltage Range — 0 to 1000 V in four ranges. 3½-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 MΩ on all ranges. Max 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. 3½ 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. Max input is 3 A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range — 0 to 2 MΩ in five ranges. 3½-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. 3½ digit presentation to +150°C. Accuracy (+5°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.

Setting Time — 1.5 s or less (voltage, current, and resistance modes).

Polarity — Automatic indication.

Max 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, at least 100 dB at dc; 80 dB at 60 Hz.

Overrange Indication — When overrange occurs, the readout blinks and the most significant digit displays a 2.

Recycle Time — 5 measurements per second.

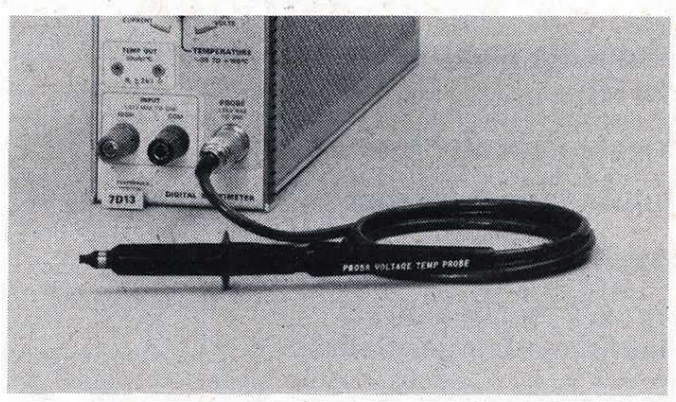
Temperature Out — 10 mV/°C into a load of at least 2 kΩ.

Included Accessories — P6058 Voltage/Temperature Probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 Digital Multimeter **$805**

7D13 OPTION

Order Option 02 without P6058 Probe ..... **Sub $90**



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 tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and five inch "common" (low) strap is provided. There is no external ground on the P6058 body; ground or the low-potential point of the circuit under test is referenced to the common strap, a floating common that has no tie to chassis ground. This lead may be floated at up to 40 V dc above chassis ground. The probe tip may be 500 V above 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.

Dc Voltage Range — 0 to 1000 V. Accuracy is ±0.1% of reading ±1 count.

Max Safe Input — 500 V peak between high and common; 40 V peak between common and chassis ground.

Temperature Range — See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable — 46 in 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.

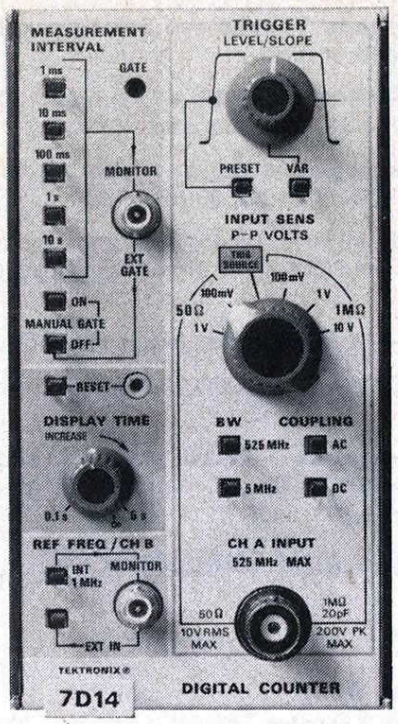
Net Weight — Approx 5 oz.

P6058 Voltage/Temperature Probe
Order 010-0260-00 ..... **$135**

Includes P6058 Probe (010-0259-00): probe retractable hook tip (013-0121-00); 12 in ground lead screw-in (175-0991-00); two miniature alligator clips (344-0046-00).

7D14
7D15

7000-Series Digital Counter and Universal Counter/Timer



7D14

Frequency Measurements Directly to 525 MHz

Trigger Indicator Display

No-warm-up Oscillator

50-Ω and 1-MΩ Inputs

Signal Conditioning via Mainframe Trigger Source

Lit Pushbuttons

The 7D14 is a directly gated digital counter plug-in unit designed for use in all 7000-Series Oscilloscope Mainframes with crt readout. It will function in any plug-in compartment. The 7D14 has three modes of operation: frequency—0 to 525 MHz, frequency ratio (A/B)—0 to 10^5:1 and totalize—0 to 10^8.

The 7D14 counts directly to 525 MHz. The gated approach makes possible "single event" counting which is frequently very desirable in rapid burst measurements. The resolution and accuracy can be improved by increasing the measurement interval.

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 may be displayed on the screen. Those being counted will be intensified.

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. Selective triggering is now possible too.

When the 7D14 is used in a horizontal plug-in compartment, a signal connected to a vertical plug-in may 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. Another advantage is the reduction of circuit loading. One connection to the oscilloscope deflects the vertical and provides the input for the counter.

FREQUENCY MEASUREMENTS

Input — Channel A, 0 to 525 MHz. Upper bandwidth may 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.

Time-base Stability — Within ±0.00005%, 0°C to +50°C ambient temperature.

Long-term Drift — 1 part or less in 10^7/month.

Input Characteristics

	Channel A		Channel B	Internal Trigger Source
	50 Ω	1 MΩ		
Dc-coupled	Dc to 525 MHz	Dc to 525 MHz	Ac-coupling only	Ac-coupling only
Ac-coupled	200 kHz to 525 MHz	5 Hz to 525 MHz	10 Hz to 2 MHz	5 Hz to 525 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	Depends on amplifier plug-in used
Max Voltage	10 V rms	200 V (dc + peak ac) to 5 MHz 50 V (dc + peak ac) 5 MHz to 525 MHz	15 V (dc + peak ac) to 2 MHz	Depends on amplifier plug-in used

*Bandwidth and sensitivity limited by mainframe, sensitivity derated above 150 MHz.

FREQUENCY RATIO

Range — Channel A: 0 to 525 MHz.
Channel B: 10 Hz to 2 MHz.

TOTALIZE

Range — 0 to 10^8.

Gating — Operated manually or with an electrical gate. The external gate input is compatible with the sweep gate from the oscilloscope mainframe. Reset and external gate signals compatible with TTL logic.

MONITORS

Monitor/Ext Gate — Provides crystal-based time markers of +5 V; width 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 — Eight digits with leading zero suppression, positioned decimal, MHz or kHz legend.

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

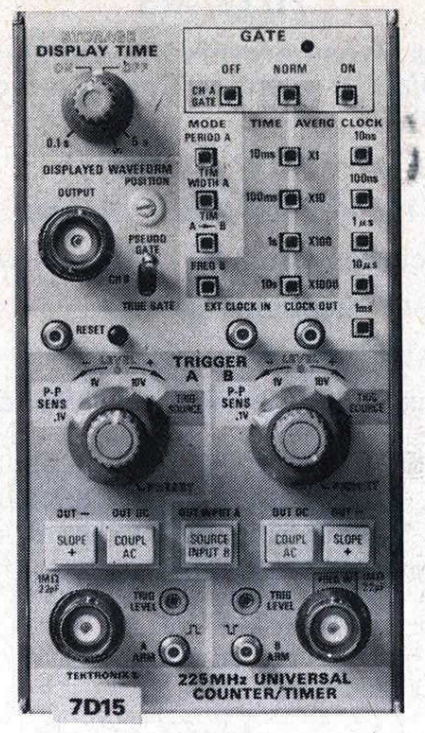
TRIGGERING

Level/Slope Range — + and −0.5 V with INPUT at 100 mV.

Displayed Trigger Indicator — Displayed amplitude of Schmitt trigger output is approx 0.2 div.

Included Accessory — BSM male to BNC female adapter (103-0036-00).

Order 7D14 Digital Counter $1870



7D15

Oscilloscope-controlled Time and Frequency Measurements

10 ns "Single-shot" Time Interval Measurement Resolution

Time Interval Averaging

Crt Display of Counting Interval

10 ps Period Averaging Resolution

Frequency Measurements Directly to 225 MHz

Signal Conditioning via Mainframe Trigger Source

Lit Pushbuttons

The 7D15 is a universal counter/timer designed for use in all 7000-Series Oscilloscope Mainframes with crt readout.

The 7D15 offers all the measurement capabilities of the counter/timer, such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

Three displays, the pseudo gate, Ch B Schmitt trigger output, and true gate, are selectable by a 7D15 front-panel switch and are also available at a front-panel connector.

The 7D15 can also be completely controlled by the oscilloscope's delayed gate. Arming inputs are provided for each channel. By using the delayed B gate to control the start and stop count points, visually selective measurements can be made at any point on the crt display.

Two identical high-speed trigger circuits provide complete signal processing. Identical trigger circuits also allow single-shot time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

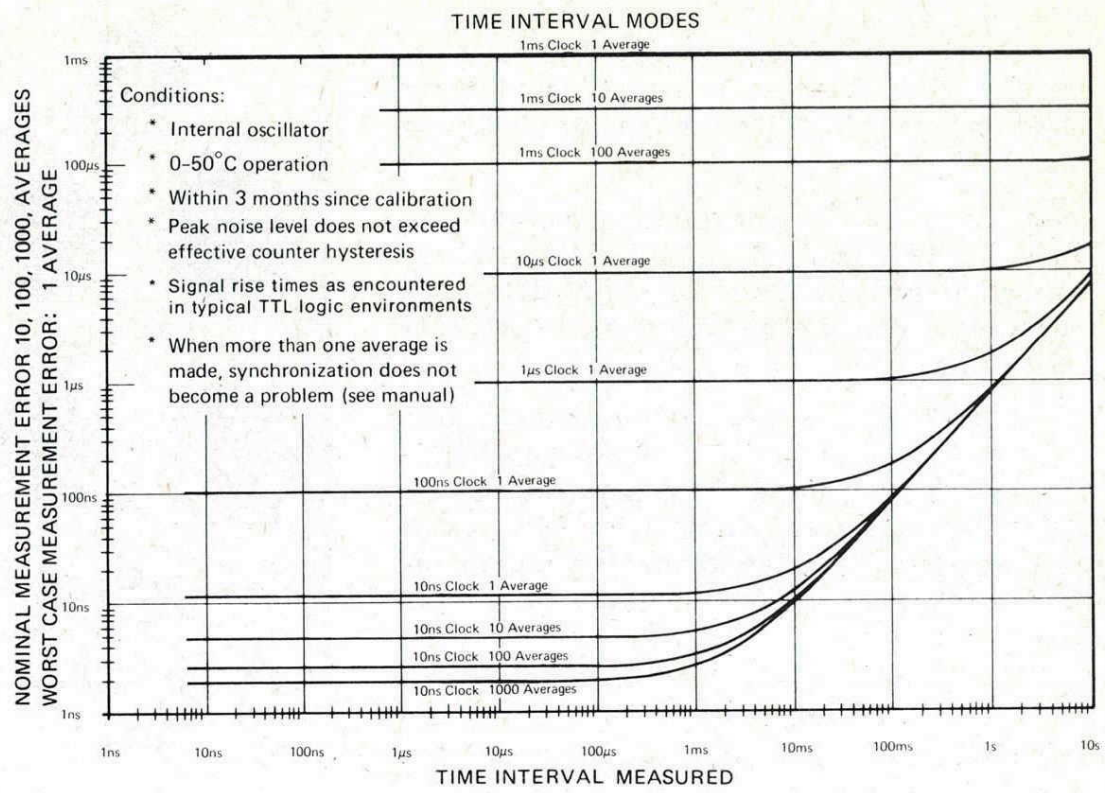
The 7D15 has high resolution because of a 10 ns clock, one of five clock positions obtainable from the front panel. A front-panel Clock Out connector makes the selected

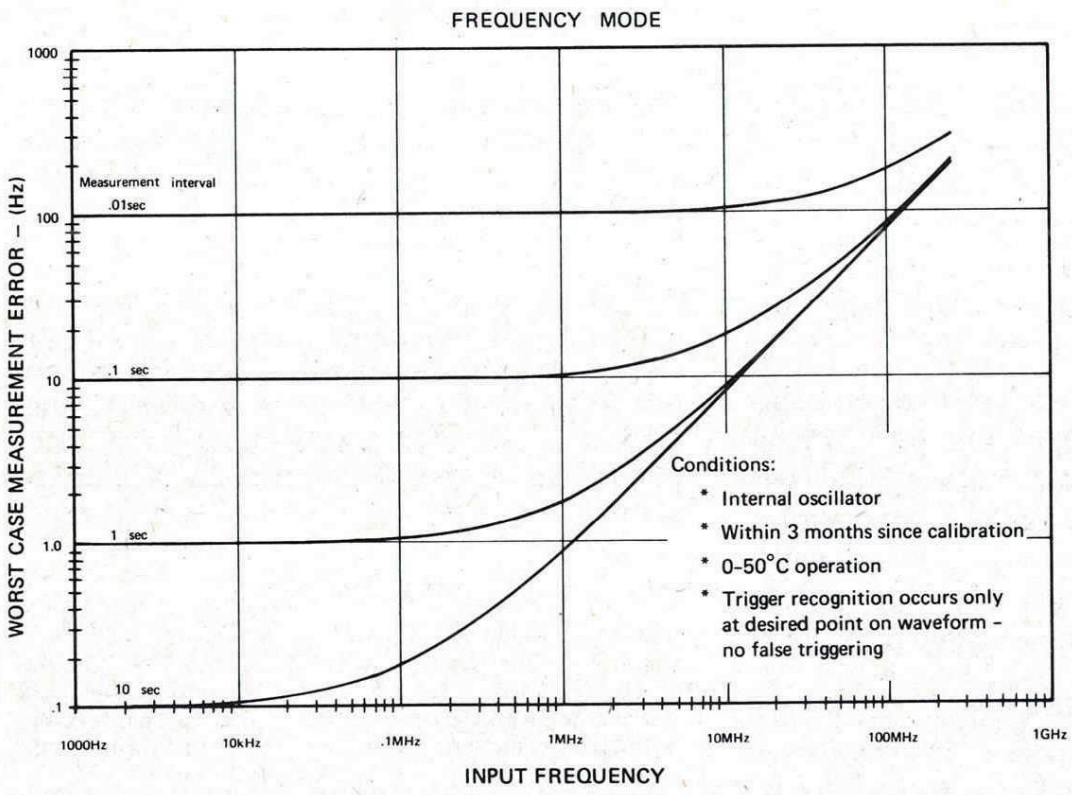
Modes of Operation

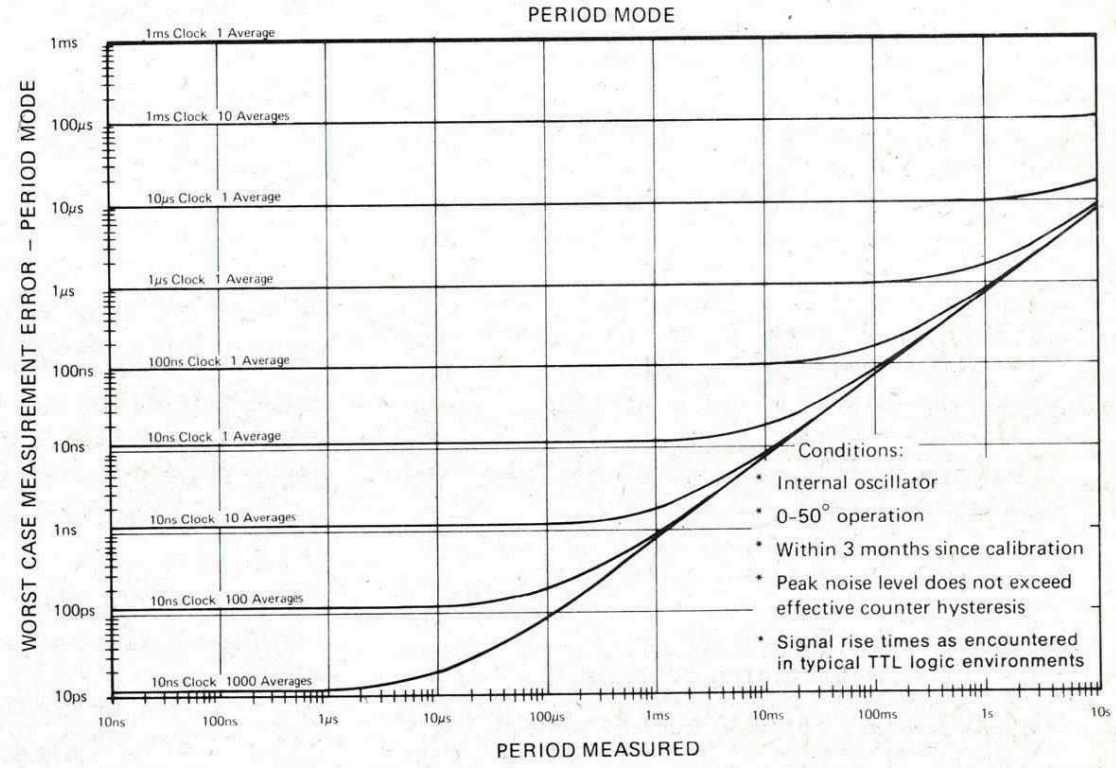
Frequency Mode	Range	Dc to 225 MHz Resolution 0.1 Hz maximum
	Accuracy	$\epsilon_{freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	Range	10 ns to 10^5 seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
	Accuracy	$\epsilon_{period(s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{M} \pm \frac{2E_{npk}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{ck}}{M}$
Time Interval TI and (TI Average) Mode	Range	6 ns to 10^5 seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
	Accuracy Worst Case (Nominal)	$\epsilon_{TI(s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/Ext Clock	Range	10^{-7} to 10^4
Manual Stop Watch	Range	0 to 10^5 seconds
Totalize, Ch B	Range	0 to 10^8 counts

NOTE: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period or time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second). These formulas were used to develop the associated charts.

ACCURACY







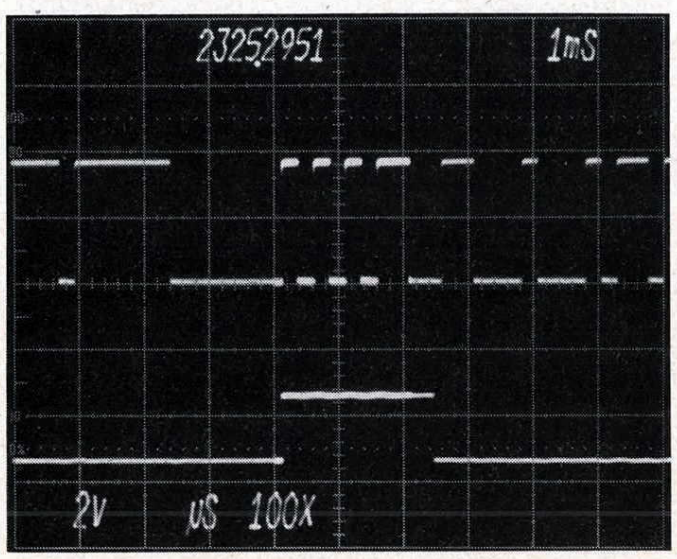


Fig 1. Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise *time interval measurement* from third to seventh pulse on crt display. Counter Ch A is "armed" with leading edge of B gate while Ch B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. Crt readout displays the result of 2325.295 µs.

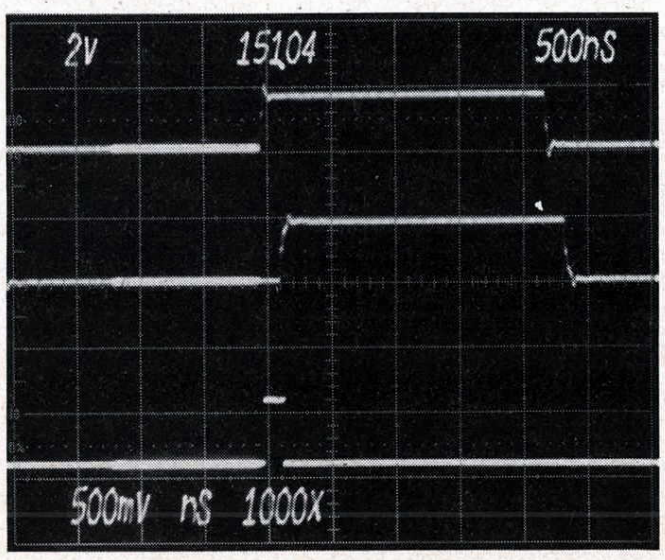


Fig 2. The *propagation delay time* between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. Crt readout displays the result of 151.0 ns.

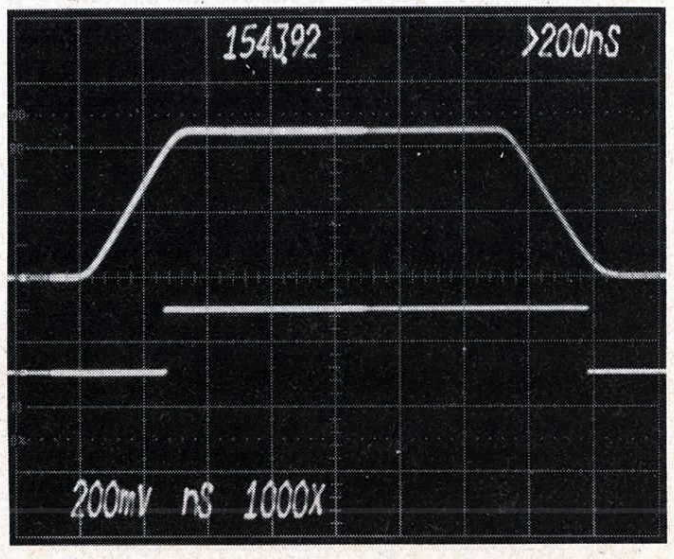


Fig 3. Independent slope and level control allows the user to *visually select* precise points on the waveform where the counter starts and stops. Crt readout displays the result of 1543.9 ns.

7M11
7S11
7T11

7000-Series Dual Delay and Sampling and Sampling Sweep Units

clock signal available at a front-panel connector. This provides a time mark function that is TTL compatible and will drive a 50 Ω load.

The Ext Clock In connector allows an external 1 MHz timing standard to be used for measurements requiring a higher degree of accuracy than that provided by the internal time base.

The 7D15 may be used in vertical or horizontal compartments of 7000-Series Mainframes. It provides a full 8 digit crt display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the crt display.

INTERNAL TIME BASE

Crystal Oscillator — Accuracy: within 0.5 ppm (0°C to +50°C ambient). Long-term drift: 1 part or less in 10^7 per month. Oscillator is temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤ 0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected) — Front-panel switch selects true gate, pseudo gate, or channel B signal out. Position controlled by front-panel screwdriver control.

External Display — Same as internal except position control has no effect.

Display Mode Switch — Allows selection of readout "follow or store."

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a > symbol.

INPUT SIGNAL CH A & B

Frequency Range (CH B only) — Dc-coupled: dc to 225 MHz. Ac-coupled: 5 Hz to 225 MHz.

Sensitivity (CH A and B Inputs) — 100 mV p-p. Trigger source: 0.5 division to 100 MHz, 1.0 division to 225 MHz, or to the vertical system bandwidth, whichever is less.

Input R and C — 1 MΩ and 22 pF.

Triggering (Preset Position) — Automatically triggers at 0 V.

Level Control Range (CH A and B Inputs) — 100-mV range: ±500 mV. 1-V range: ±5 V. 10-V range: ±50 V.

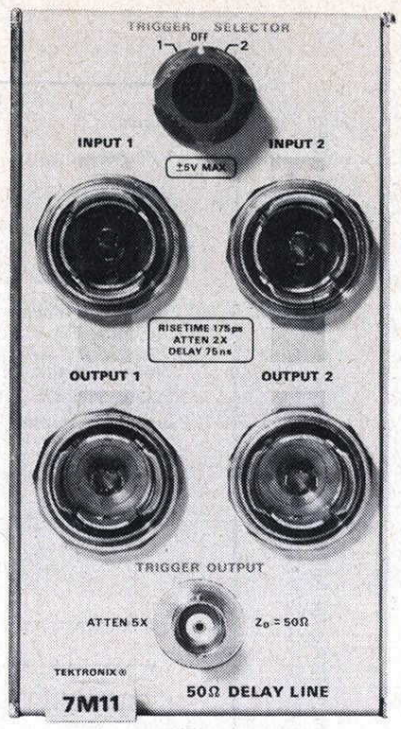
Arming Inputs — Input R and C: 10 kΩ and 20 pF. Sensitivity arm A: logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity arm B: logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

External Clock-In — 20 Hz to 5 MHz.

Reset Front Panel — Reset readies the instrument. All counters are affected, including averaging circuits.

Included Accessories — Two cables RF 44 in (012-0403-00, Sealectro to BNC connector).

Order 7D15 Universal Counter/Timer **$2000**



7M11

75 ns Time Delay

Selectable Trigger Out

175 ps Rise Time

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 at fast time-per-div settings.

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 rise time, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a rise time of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay — 75 ns within 1 ns.

Delay Difference — 30 ps or less between channels.

Rise Time — 175 ps or less.

Attenuation — 2X within 2% into 50 Ω.

Input Impedance — 50 Ω within 2%.

Max Input Voltage — ±5 V rms.

TRIGGER OUTPUT

Rise Time — 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.

INCLUDED ACCESSORIES

10 in BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00).

Order 7M11 Delay Line Unit **$495**

7S11

2 mV/div to 200 mV/div Calibrated Deflection Factors

Plug-in Sampling Heads

The 7S11 is a single-channel sampling unit. The input configuration employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor — 2 units/div to 200 units/div in 7 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 is determined by the plug-in sampling head.

Bandwidth — Determined by the sampling head.

Input Impedance — 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 is 10 kΩ within 1%.

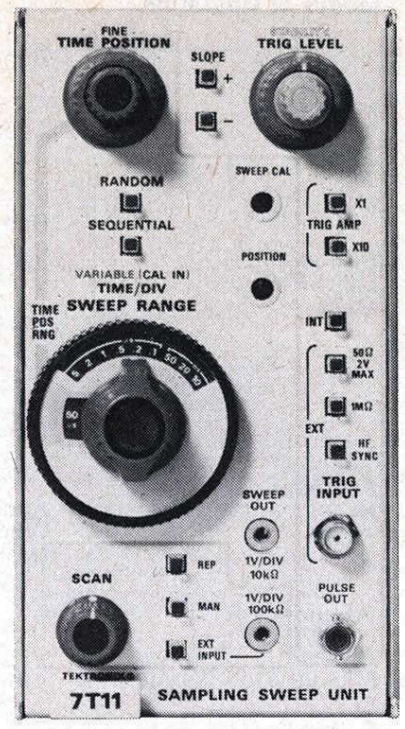
Delay Range — At least 10 ns for comparing two signals in a dual-trace application.

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.

Order 7S11 Sampling Unit without Sampling Head **$920**



7T11

7T11

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. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz.

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 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 12.5 mV to 2 V p-p (dc to 1 GHz) in X1 TRIG AMP, 1.25 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 12.5 mV to 2 V p-p (dc to 100 MHz) in X1 TRIG AMP, 1.25 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 per octave to a min 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 (Sine-wave 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 125 mV to 1 V p-p (referred to the vertical input) in X1 TRIG AMP; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 TRIG AMP.

Random Mode Trigger Rate — 100 Hz min.

Display Jitter — Measured under optimum trigger conditions with TIME/DIV switch clockwise.

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

Pulse Out — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns rise time or less.

*Trigger circuits will operate to dc with pulse triggering, except for HF Sync.

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).

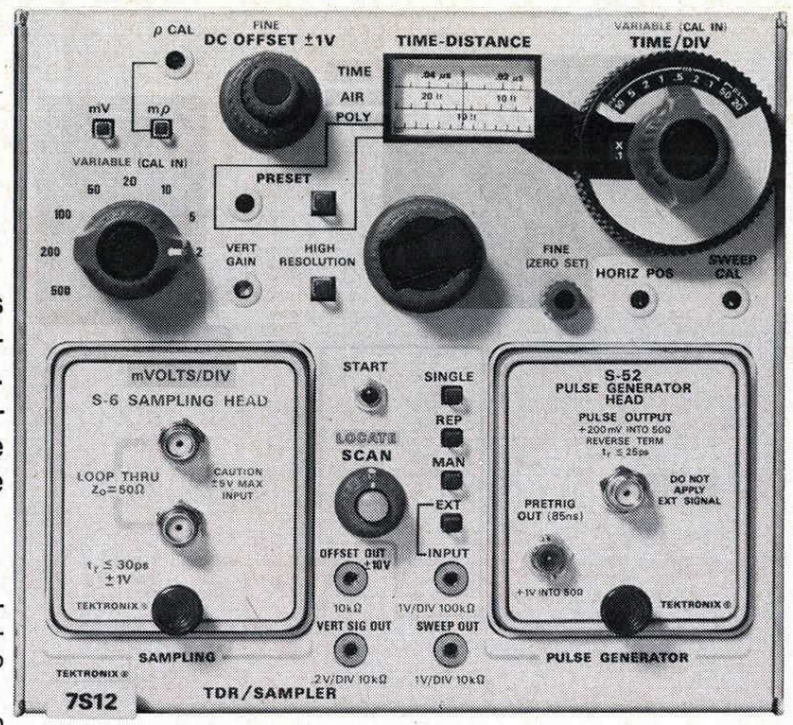
Sweep Out — 1 V/div within 2%. Source R is 10 kΩ within 1%.

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

INCLUDED ACCESSORIES

42-in BNC 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874 adapter (015-1007-00).

Order 7T11 Sampling Sweep Unit . . $2680



7S12

45 ps TDR or 30 ps General-purpose Sampler

6 Plug-in Sampling Heads Available

2 Plug-in Pulse Sources Available

1 Trigger Recognizer Head Available

1 Trigger Countdown Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in for 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 rise time of 45 ps (return from short-circuit termination) and distance range to 290 ft in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 mρ/div to 500 mρ/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air, polyethylene, or your choice of dielectrics. As a long line tdr using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 ft (air line) and discontinuities to twice this distance may be viewed. System rise time with this combination 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 with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pre-trigger signal is not available.

CHARACTERISTICS

System Performance with S-6 and S-52

System Rise Time — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distance to at least 400 ft (air line). Time range is at least 0.9 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 — +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

TDR System Performance with S-5 and S-54

System Rise Time — 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 air line, 3240 ft solid polyethylene. 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 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous between steps.

Resolution — Reflection coefficients as low as 0.001 may 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 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 dielectric having propagation factors from 0.6 to 1.

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.

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); tdr slide rule (003-0700-00).

Order 7S12 TDR Sampling Unit (Tape Dial in Feet) without Sampling Heads $1925

Order Option 03 Tape Dial Change (Meters) . . . . . No charge

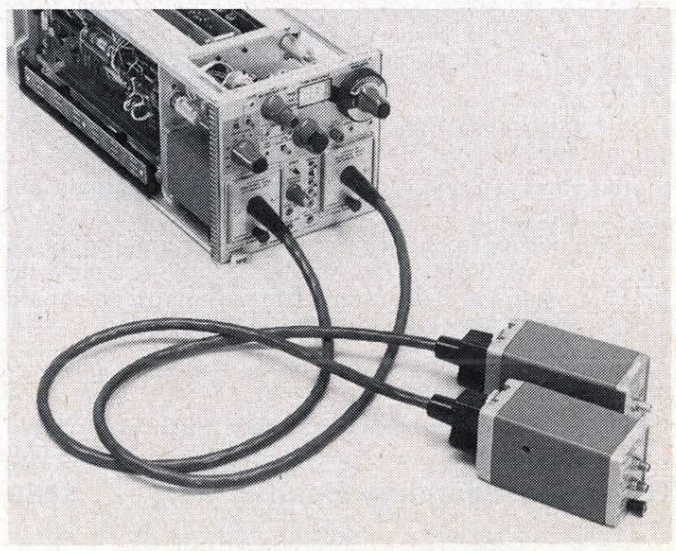
OPTIONAL ACCESSORIES

Patch Cords — 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 in dia. pin.

Red, 8 in, Order 012-0179-00 . . . . . $3.50
Red, 18 in, Order 012-0180-00 . . . . . $3.50
Black, 8 in, Order 012-0181-00 . . . . . $3.50
Black, 18 in, Order 012-0182-00 . . . . . $3.50

Tape Dial (Calibrated in Feet)
Order 331-0273-00 . . . . . $12.50

Tape Dial (Calibrated in Meters)
Order 331-0276-00 . . . . . $12.50

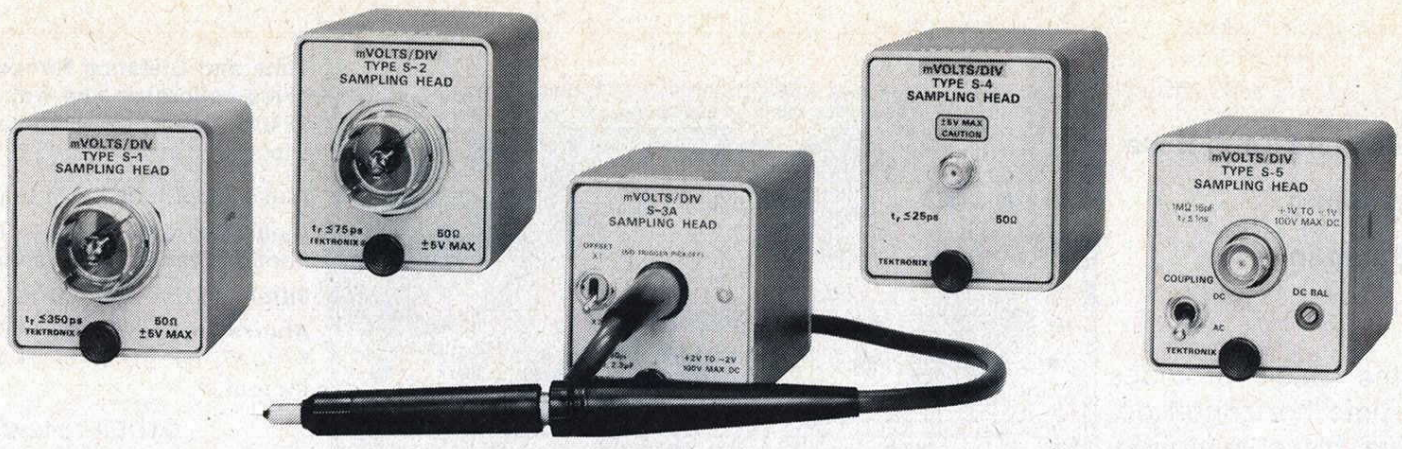


3 ft Sampling-Head Extender, Order 012-0124-00 . $165
6 ft Sampling-Head Extender, Order 012-0125-00 . $170

NOTE: See 1502-1503 Portable TDR Cable Tester on page 183.

S-1/S-2 S-3A/S-4 S-5

7000-Series Sampling Heads



S-1

Dc-to-1 GHz Bandwidth

Clean Transient Response

The S-1 Sampling Head is a low-noise, 350-ps rise time unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Rise Time — 350 ps or less.

Bandwidth — Equivalent to dc to 1 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 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.

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 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.

Included Accessories — 5 ns, 50 Ω RG58 A/U cable (017-0512-00); 10X, 50 Ω GR attenuator (017-0078-00).

Order S-1 Sampling Head $650

S-2

Dc-to-4.6 GHz Bandwidth

Displayed Noise Less than 6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps rise time unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Rise Time — 75 ps or less.

Bandwidth — Equivalent to dc to 4.6 GHz at 3 dB down.

Transient Response — Aberrations as observed with the 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.

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 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.

Included Accessories — 5 ns, 50 Ω RG213/U cable (017-0502-00); 10X, 50 Ω GR attenuator (017-0078-00).

Order S-2 Sampling Head $780

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe, Order (Std) 015-0041-00 ..... $100

P6056 10X Passive Probe, Order (Std) 010-6056-03 ..... $115

P6057 100X Probe, Order (Std) 010-6057-03 ..... $115

Coupling Capacitor, GR874-K, Order 017-0028-00 ..... $60

Power Divider GR874-TPD, Order 017-0082-00 ..... $225

GR to BNC Adapter, Order 017-0063-00 ..... $25

S-3A

Compact, 4.5 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. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Rise Time — 350 ps or less.

Bandwidth (Probe Only) — 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 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 probe attenuators.

Included Accessories — 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½ in ground lead (175-1017-00); 12½ in ground lead (175-1018-00); 3 in 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 (013-0097-01); 50 Ω voltage pickoff (017-0077-01); carrying case (016-0121-01); 3 in elec lead (175-0849-00); 6 in elec lead (175-0849-01).

Order S-3A Sampling Head $965

S-4

25 ps Sampling Head

Dc-to-14 GHz Equivalent Bandwidth

Displayed Noise Less than 5 mV (Unsmoothed)

The S-4 Sampling Head is a 25 ps rise time unit with a 50 Ω input impedance. 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.

Rise Time — 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 from an S-52 Pulse Generator Head are −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, 0%, +10% or less, total of 10% or less p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

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.

Included 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 in wrench (003-0247-00).

Order S-4 Sampling Head $1435

S-5

1 MΩ, 15 pF Input Impedance

Passive Probe

Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns rise time sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 passive probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time — S-5 only, 1 ns or less; with 3.5 ft 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 ft probe, properly compensated): aberrations +5%, −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, 1 V p-p from +1 V to −1 V; ac coupled, 1 V p-p. S-5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

Input Characteristics — S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by approx 10 pF.

Attenuator Accuracy — Probe attenuation is 10X within 3%.

Included Accessories — P6010 probe package (010-0188-00), 50 Ω termination (011-0049-01).

Order S-5 Sampling Head $650

OPTIONAL ACCESSORIES

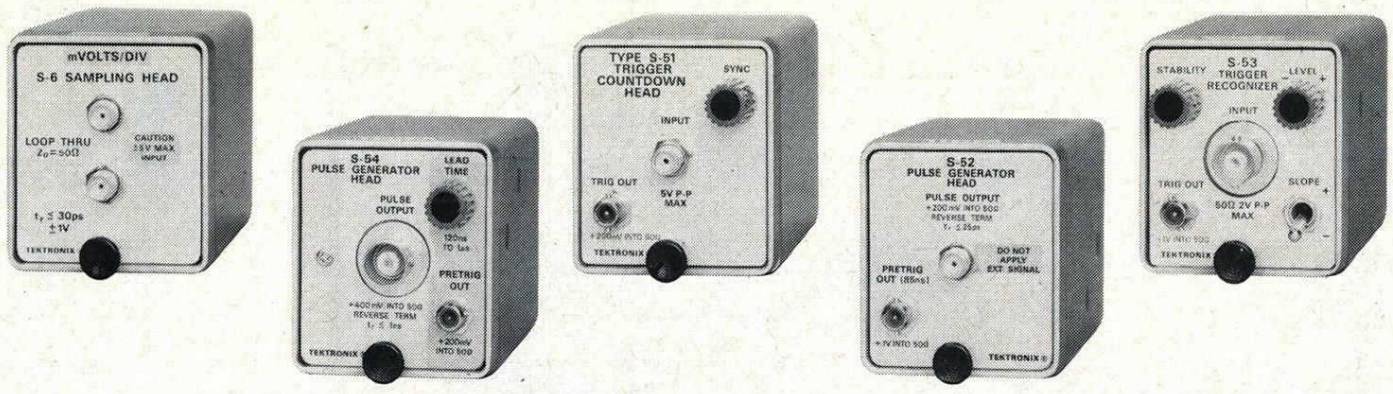
Probe Tip-to-BNC Adapter, Order 013-0084-01 ..... $8

Probe Tip-to-GR Adapter, Order 017-0076-00 ..... $32

Probe Tip-to-GR Terminated Adapter, Order 017-0088-00 ..... $42

7000-Series Sampling, Trigger Countdown, Trigger Recognizer, and Pulse Generator Heads

S-6
S-51/S-52
S-53/S-54



S-6

30 ps Rise Time

Displayed Noise Less than 5 mV (Unsmoothed)

Loop-through Input

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

Rise Time — 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 — Pulse aberrations following the steps are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise — 5 mV or less, measured tangentially.

Signal Range — +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics — Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Max safe overload is ±5 V.

Included 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).

Order S-6 Sampling Head $1345

OPTIONAL ACCESSORIES FOR SAMPLING HEADS with SMA (3 mm) Connectors

2X 50 Ω Attenuator, Order 015-1001-00.....$120
5X 50 Ω Attenuator, Order 015-1002-00.....$120
10X 50 Ω Attenuator, Order 015-1003-00.....$120
50 Ω Termination, Order 015-1004-00 .....$60
2-ns 50 Ω Signal Cable, Order 015-1005-00 .....$70
5-ns 50 Ω Signal Cable, Order 015-1006-00 .....$125
Male-to-GR874 Adapter, Order 015-1007-00 .....$50
Female-to-GR87 Adapter, Order 015-1008-00 .....$55
Male-to-N Female Adapter, Order 015-1009-00 ...$50
Male-to-7-mm Adapter, Order 015-1010-00 .....$175
Male-to-Male Adapter, Order 015-1011-00 .....$20
Female-to-Female Adapter, Order 015-1012-00 ...$16
Coupling Capacitor, Order 015-1013-00 .....$130
50 Ω Power Divider T, Order 015-1014-00.....$200
500-ps 50 Ω Semirigid Cable, Order 015-1015-00 ..$40
SMA T Adapter, Order 015-1016-00 .....$30
SMA Male-to-BNC Female Adapter, Order 015-1018-00 .....$8
1-ns 50 Ω Cable, Order 015-1019-00 .....$75
SMA Male Short-Circuit Termination, Order 015-1020-00 .....$17.50
SMA Female Short-Circuit Termination, Order 015-1021-00 .....$17.50
SMA Male 50 Ω Termination, Order 015-1022-00...$32

With BNC Connectors

50 Ω Feed-through Termination, Order 011-0049-01 .....$25
50 Ω Feed-through (5 W), Order 011-0099-00 .....$40
50 Ω 2X Attenuator, Order 011-0069-02 .....$35
50 Ω 2.5X Attenuator, Order 011-0076-02 .....$35
50 Ω 5X Attenuator, Order 011-0060-02 .....$35
50 Ω 10X Attenuator, Order 011-0059-02 .....$35
50 Ω 18 in, Coaxial Cable, Order 012-0076-02 ....$35
50 Ω 42 in, Coaxial Cable, Order 012-0057-01 ....$15

S-51

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 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the 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.

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 max.

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, BSM type connector. Internal trigger output is at least 100 mV into 500 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.

Order S-51
Trigger Countdown Head $885

S-52

25 ps Rise Time

200 mV into 50 Ω

50 Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer.

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. The pulse width is sufficient for distances up to 32 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

Pulse Output — Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 800 ns, pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, −7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step, +2%, −2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output — Rise time 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.

Output Connectors — Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Included Accessory — 1 ns, 50 Ω semirigid coax delay line (015-1023-00).

Order S-52 Pulse Generator Head $885

SAMPLING HEAD WEIGHTS (Approx)

	S-1		S-2		S-3A		S-4		S-5	
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	1	0.5	1	0.5	3	1.4	1	0.5	0.6	0.3
Shipping	3	1.4	3	1.4	5	2.3	2	0.9	2	0.9
	S-6		S-51		S-52		S-53		S-54	
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	1	0.5	1	0.5	0.8	0.3	0.8	0.3	0.8	0.3
Shipping	2	0.9	5	2.3	1	0.5	1	0.5	1	0.5

S-53

Dc-to-1 GHz Operation

10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12 or for other applications.

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 — Rise time is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

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.

Included Accessories — 42 in, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02).

Order S-53
Trigger Recognizer Head $650

S-54

1 ns Rise Time

Low Aberrations

400 mV into 50 Ω

50 Ω Source

Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line Time Domain Reflectometer unit.

Intended for tdr applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V base line to eliminate base line shift with load changes. A continuously variable front-panel 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 — Rise time 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. Base line level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output — Rise time 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.

Output Connectors — Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Included Accessories — BNC T connector (103-0030-00); 8 in 50 Ω cable (012-0118-00).

Order S-54 Pulse Generator Head $545

7S14 | 7000-Series Dual-trace, Delayed Sweep Sampler

7S14

Calibrated Delayed Sweep

Two-dot Measurements

Dc to 1 GHz Bandwidth

Dual Trace, 2 mV Sensitivity

Crt Readout

Simplified Triggering

Operational Ease of a Conventional Oscilloscope

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in.

Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep.

Front-panel controls are grouped by color, and the control nomenclature is similar to conventional oscillosocpe nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 Vertical (Y), Channel 2 Horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, −4%, total of 6% p-p within first 5 ns, ±1% thereafter, tested with a 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Max Input Voltage — ±5 V.

Input Signal Range — 2 V p-p max within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero, or for any time difference up to at least 1 ns.

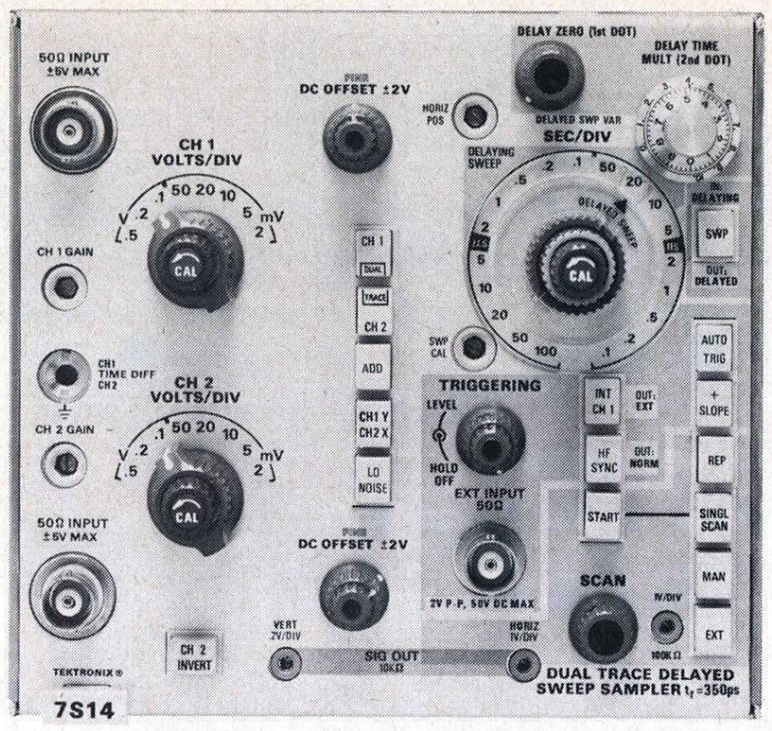
TIME BASE

Scan Modes — Repetitive, single, manual, or external.

Delaying Sweep — May be used as the crt time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10 kΩ source resistance.



DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3%, excluding first one-half div of displayed sweep.

Delayed Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the delaying sweep selected.

Delay Time (2nd Dot) — Adjustable to any position of the time interval represented by 10 div of the delaying sweep selected.

Delay Accuracy — Within ±1% of 10 div when measurement is made within the last 9.5 div.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first one-half div of displayed sweep.

Start Delay — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 div of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from Channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

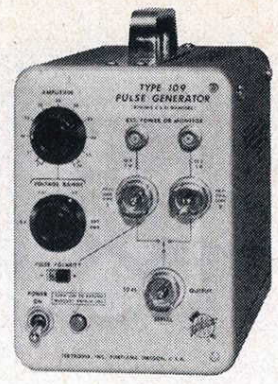
Auto Trigger Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode — For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

Order 7S14 Dual-Trace Delayed Sweep Sampler $2905

109 284 | Fast-Rise Pulse Generators



250-ps Rise Time Pulses

Alternate Pulses of Equal or Different Time Duration

0-55 V Calibrated Variable Amplitude

PULSE CHARACTERISTICS

Characteristics	Performance
Rise time	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-volt input, the output amplitude will be half the external input amplitude.

109 Pulse Generator $1025

70-ps or Less Rise Time Pulse

Sinewave and Squarewave Outputs

OUTPUT CHARACTERISTICS

Pulse Output — 70 ps or less rise time 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. 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. Rise time 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%			
Squarewave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%
	100 ns	±0.05%*	±2%†	±2.5%†	±3%†
Sinewave	10 ns 1 ns	±1%		±20%	

* crystal controlled † 20 ns after transition

284 Pulse Generator $1550

Option 01 Less Cabinet* . . . . . Sub $25

*Mounts in rack adapter listed on page 232.

5000-Series Instruments

5

Pick a 5000-Series Plug-in Oscilloscope for:

Performance Value . . . The 5400 Series is designed for the cost-conscious user as an alternative to the monolithic scope; it gives you 60-MHz bandwidth in both non-store and variable persistence storage mainframes with crt readout.

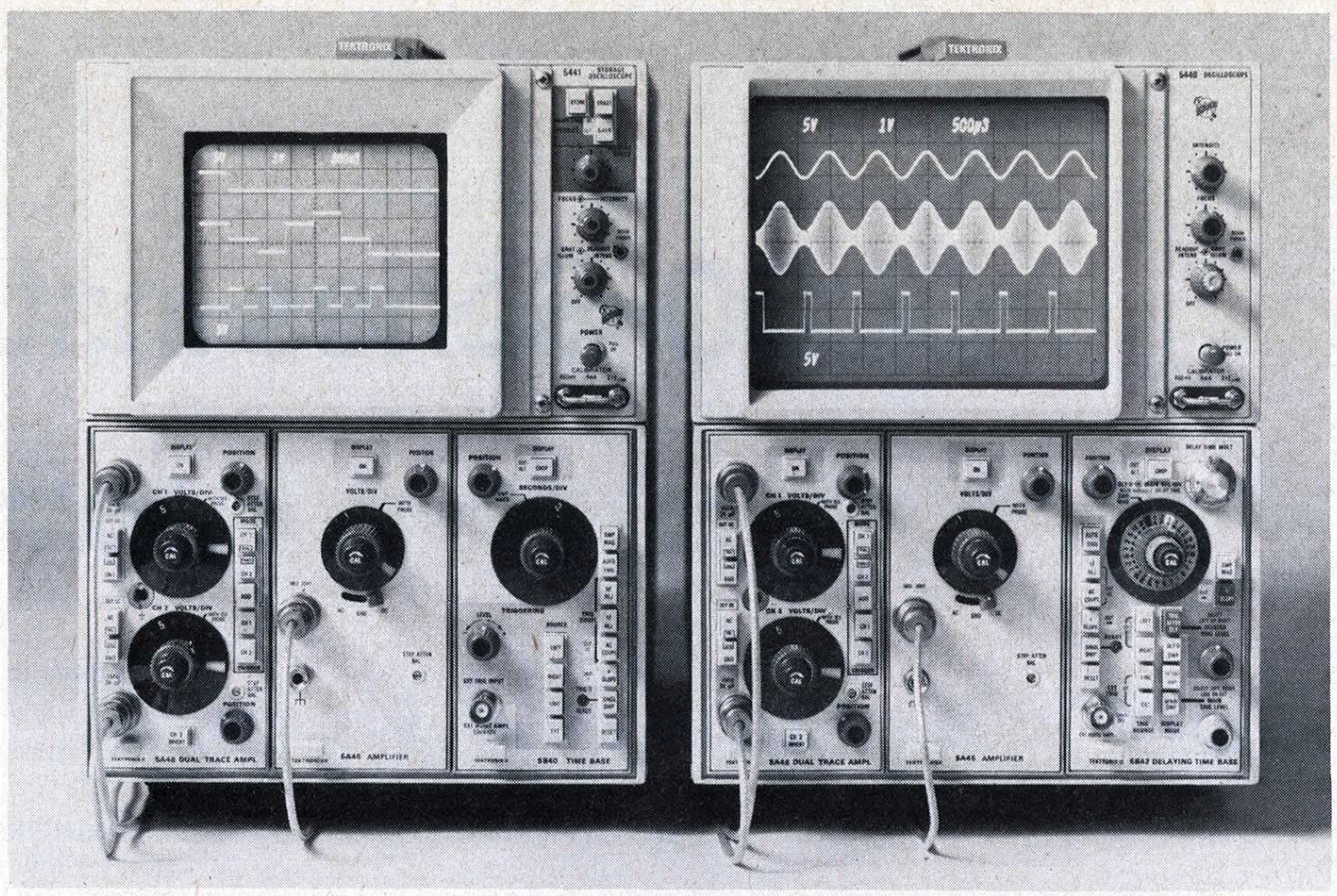
Maximum Flexibility . . . The 5100 Series is ideal for low-frequency applications such as medical and mechanical measurements requiring up to 2-MHz bandwidth; it gives you unparalleled choices in measurement flexibility such as dual-beam, split-screen, bistable storage displays, differential inputs and spectrum analysis.

Expandability . . . With the 5000-Series Plug-in Oscilloscope, you are making a cost-effective investment in current technology—and insuring yourself a share in the future.

The 5000 Series . . . an extra margin of value

5000-Series Reference

Low Cost
2 MHz or 60 MHz Bandwidth
Sampling to 1 GHz
0 to 100 kHz Spectrum Analysis
7 Oscilloscope Models
23 Plug-ins Available
Dual-Beam and Storage Displays
Crt Readout (5400 Series Only)
Large 6½ in Crt (8 x 10 div)
10 μV/div High Gain Differential Amplifier
1 to 8 Trace Capability
Delayed-Sweep Time Bases
Y-T or X-Y Operation
Color-Coded Front Panels
Bench-to-Rack Convertibility



5400-Series

The 5000-Series Oscilloscopes are designed to provide optimum versatility and performance at the lowest possible price.

5100-Series Oscilloscopes

Five 5100-Series Oscilloscopes are available. They include single-beam, dual-beam, and storage displays. The storage display units feature bistable, split-screen storage with burn-resistant phosphor. The dual-beam display units have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drive both beams.

The 5100 Series features 2 MHz mainframes with large 6½″ crts that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. They can be easily converted from bench to rackmount configuration.

To date, 16 plug-ins are available for use with the 5100 Series. Among these are the low-cost 5L4N Spectrum Analyzer for the 0-to-100 kHz frequency range and the 5S14N, a general-purpose, 1-GHz dual-trace sampling plug-in.

5100-Series Dimensions and Weights

	Cabinet		Rackmount	
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.3	13.3
Width	8.4	21.3	19.0	48.3
Length	20.4	51.8	19.0	48.3
Weight (approx)	lb	kg	lb	kg
Net	23.0	10.4	24.0	10.9
Shipping	32.0	14.5	43.0	19.5

5400-Series Oscilloscopes

Two 5400-Series display units are presently available: a single-beam, non-storage display and a variable persistence storage display. Both feature crt readout of plug-in scale factors.

Like the 5100 Series, the 5400 Series features 3 plug-in compartments and bench-mount-to-rackmount convertibility.

The 5400 Series takes a giant step in performance; it offers 60 MHz bandwidth. The 5400 Series is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the crt (except with plug-ins having a suffix N: 5A22N, 5B10N, etc). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The crt readout can also be externally accessed.

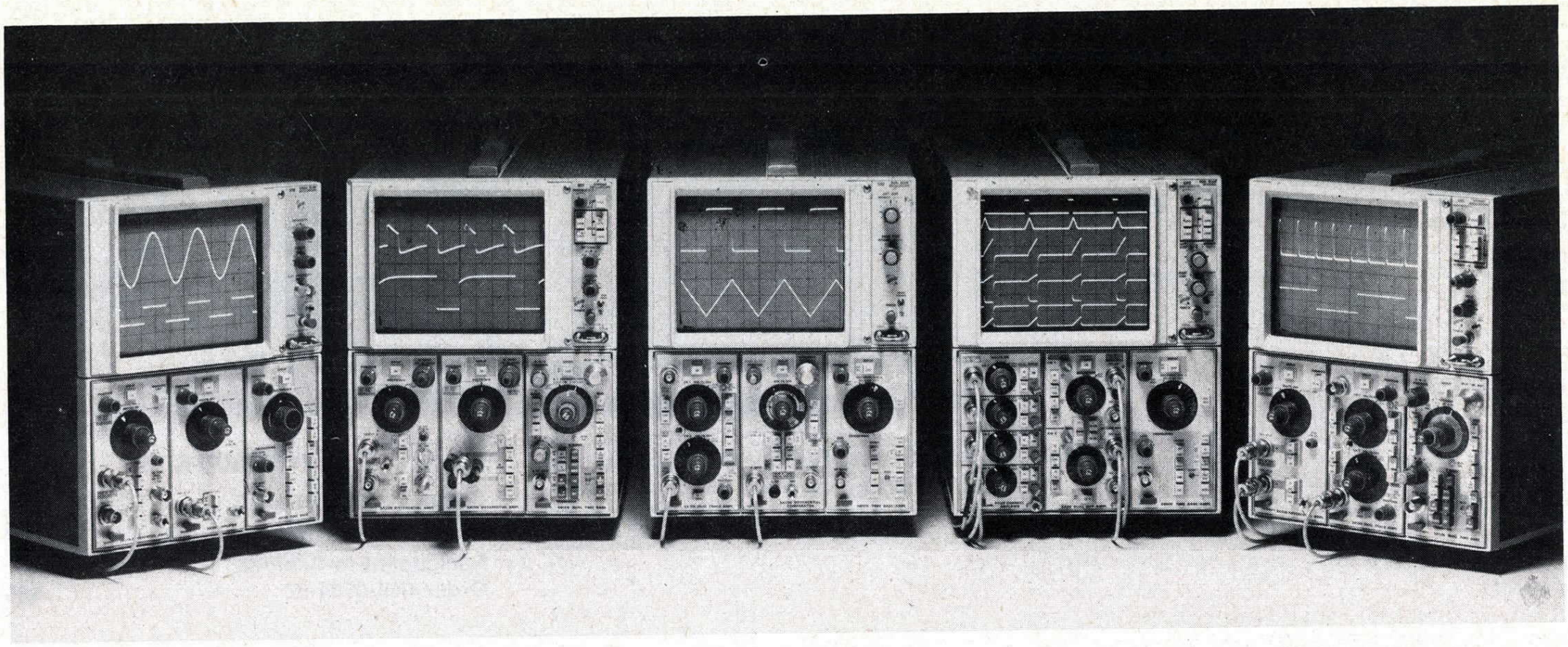
5400-Series Dimensions and Weights

	Cabinet		Rackmount	
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.3	13.3
Width	8.4	21.3	19.0	48.3
Length	20.4	51.8	19.0	48.3
Weight (approx)	lb	kg	lb	kg
Net	25.0	11.3	26.0	11.8
Shipping	34.0	15.4	45.0	20.4

Whether you choose the 2 MHz 5100 Series or the 60 MHz 5400 Series, TEKTRONIX 5000-Series Oscilloscopes always give you the most versatility and performance for your dollar.

MAINFRAMES

Mainframe/ Display Unit	Page	Beams	Storage	Display Size
5110	**96**	Single		8 x 10 div (1.27 cm/div)
5111	**96**	Single	Bistable	8 x 10 div (1.27 cm/div)
5112	**96**	Dual		8 x 10 div (1.27 cm/div)
5113	**96**	Dual	Bistable	8 x 10 div (1.27 cm/div)
5115	**96**	Single	Bistable	8 x 10 div (1.27 cm/div)
5440	**91**	Single		8 x 10 div (1.22 cm/div)
5441	**92**	Single	Variable Persistence	8 x 10 div (0.9 cm/div)



PLUG-IN VERSATILITY

23 plug-ins are now available in the 5000-Series Family. All these plug-ins are compatible with the 5400 Series, and all but seven are compatible with 5100-Series Mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time-base plug-ins include single, dual, delayed sweep units, and a digital delay time base.

Three special-purpose plug-ins are also available. The 5L4N is a spectrum analyzer for the 0-to-100 kHz frequency range. It has 10 Hz bandwidth resolution. The 5CT1N is a semiconductor curve-tracer plug-in. It allows characteristic curves of transistors, FETs, diodes and other semiconductor devices to be displayed on the crt. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of either the 5100 or the 5400 Series to 1 GHz at 2 mV sensitivity.

Back-lighted knob skirts on the plug-ins provide scale-factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended 1X and 10X probes. In addition, the 5400 Series automatically presents correct scale factors on the crt when used with non-N suffix plug-ins. This feature helps reduce human errors and enables photographic recording of measurement conditions.

AMPLIFIERS

Product	Page	Type	Minimum Deflection Factor	Bandwidth —3 dB	Cmrr
5A13N	**99**	Single	1 mV/div	2 MHz	10,000:1
5A14N	**98**	Four	1 mV/div	1 MHz	
5A15N	**98**	Single	1 mV/div	2 MHz	
5A18N	**98**	Dual	1 mV/div	2 MHz	
5A19N	**99**	Single	1 mV/div	2 MHz	1000:1
5A21N	**99**	Single (voltage and current)	50 μV/div 0.5 mA/div	1 MHz	100,000:1
5A22N	**100**	Single	10 μV	1 MHz	100,000:1
5A23N	**98**	Single	10 mV/div	1.5 MHz	
5A24N	**98**	Single	50 mV/div	2 MHz	
5A26	**100**	Dual	50 μV/div	1 MHz	100,000:1
5A38	**93**	Dual	10 mV/div	35 MHz	
5A45	**93**	Single	1 mV/div*	60 MHz	
5A48	**93**	Dual	1 mV/div*	50 MHz	

**Bandwidth is dc to 25 MHz at 1 mV/div and 2 mV/div and 50 MHz at 5mV/div through 10 V/div.*

Time-Base Plug-ins

Product	Page	Type	Sweep Rate	Mag	Single Sweep	Volts/Div Ext Mode
5B10N	**101**		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	**101**	**Dual Delaying**	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B13N	**101**		1 μs to 100 ms			50 mV
5B31	**94**	**Digital Delaying**	0.2 μs to 5 s	X10	Yes	50 mV
5B40	**94**		0.1 μs to 5 s	X10	Yes	50 mV
5B42	**94**	**Delaying**	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes —	50 mV
5B44	**95**	**Dual Delaying**	50 ns to 2 s	X10	Yes	50 mV

Special-Purpose Plug-ins

Product	Page	Description
5CT1N	**102**	Semiconductor Curve Tracer
5L4N	**102**	Low-Cost Spectrum Analyzer
5S14N	**102**	Dual-Trace Delayed Sweep Sampler

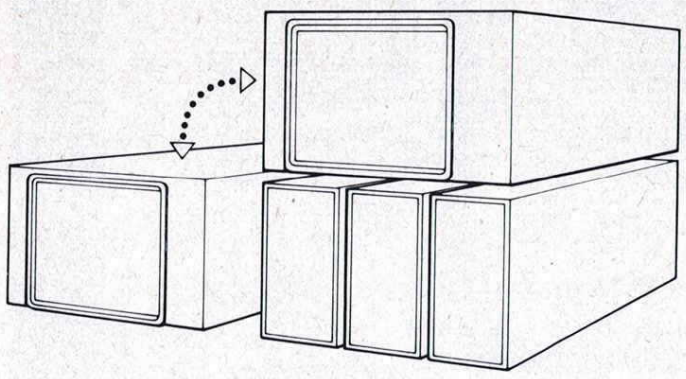
5000-Series Plug-in Dimensions and Weights

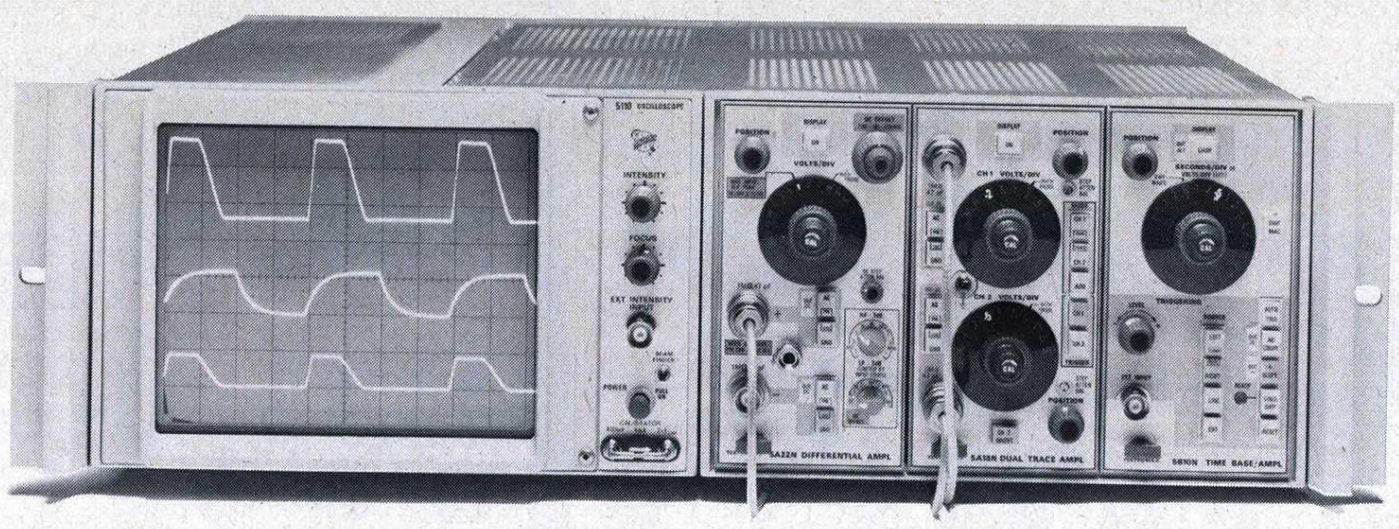
Dimensions	Height		Width		Length	
	in	cm	in	cm	in	cm
Single Width	5.0	12.7	2.6	6.6	12.0	30.5
Double Width	5.0	12.7	5.2	13.2	12.0	30.5
Weight (approx)	**Net**		**Shipping**			
	lb	kg	lb	kg		
Single Width	2.8	1.3	10.0	4.5		
Double Width	5.8	2.6	10.8	4.9		

Rear Panel Signal Outputs, an optional feature for all 5100-Series Mainframes. See page 97.

CONVERTIBILITY: Cabinet-to-Rackmount, Rackmount-to-Cabinet

All 5000-Series Oscilloscopes are available in either cabinet or rackmount configurations. Kits are also available to convert existing units from cabinets to rackmount, or from rackmount-to-cabinet configurations (see conversion kits at right).





All 5000-Series Rackmount Oscilloscopes and cabinet-to-rackmount kits include complete slide out tracks and mounting hardware to interface with standard 19-inch racks.

CONVERSION KITS

Cabinet-to-Rackmount, Order 040-0583-02 . . . . . **$105**

Rackmount-to-Cabinet, Order 040-0584-03 . . . . . **$85**

RECOMMENDED PROBES FOR 5000-SERIES AMPLIFIER PLUG-INS

The following probes are recommended for general use with the listed amplifier plug-ins. These probes automatically program the knob-skirt readout and the crt readout (available only in the 5400 Series) to indicate correct deflection factor. Probe packages include various tips, ground leads and accessories. Probes are also available in different lengths, attenuation ratios, input loading and bandwidths. Special purpose probes, such as high voltage, FET and current probes are available for use with 5000-Series Amplifier Plug-ins. See probe section for complete information.

Amplifier Plug-ins	Probe	Type	Attenuation	Standard Length	Features	Package Number
5A14N 5A15N 5A18N 5A23N	P6060	Voltage	10X	6′	Full bandwidth, low cost, (not compatible with crt readout).	010-6060-03
	P6062B	Voltage	1X/10X	6′	Full bandwidth, switchable attenuation, ground reference button.	010-6062-13
	P6101	Voltage	1X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6101-03
5A13N 5A21N* 5A22N 5A26	P6060	Voltage	10X	6′	Full bandwidth, low cost, (not compatible with crt readout).	010-6060-03
	P6062B	Voltage	1X/10X	6′	Full bandwidth, switchable attenuation, ground reference button.	010-6062-13
	P6101	Voltage	1X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6101-03
	P6055	Voltage	Adjustable to 10X	3.5′ only	Adjustable attenuation. Will give up to 20,000: 1 CMRR when used in pairs. (5A21N, 5A22N and 5A26).	010-6055-01
5A38 5A45 5A48	P6105	Voltage	10X	2 m	Full bandwidth, miniature. Modular construction simplifies repair.	010-6105-03
	P6062B	Voltage	1X/10X	6′	Switchable attenuation (full bandwidth in the 10X position) ground reference button.	010-6062-13
	P6101	Voltage	1X	2 m	Miniature, modular (reduced bandwidth).	010-6101-03

**The 5A21N also provides direct access to current probe P6021. Order 5A21N, Option 01 for 5A21N Amplifier and Current Probe package. See pages 99-100 for complete information.*

CARTS

SCOPE-MOBILE® Carts — For cabinet models, order TEK Lab Cart, Model 3.

CAMERAS

All 5100 Series — C-5B, suitable for repetitive or stored traces.

5100 Storage Instruments, 5440 (with P or R back), 5441 (with G back) — C-59, general purpose.

For full details see Camera Section, page 209.

ACCESSORIES

Blank Plug-in Kit — (040-0818-03)

Blank Panel — (016-0195-02)

Viewing Hoods — (016-0154-00, or 016-0260-00 folding)

Protective cover — (016-0544-00)

For full details see Accessories Section, page 229.

Low Cost

Dc to 60 MHz

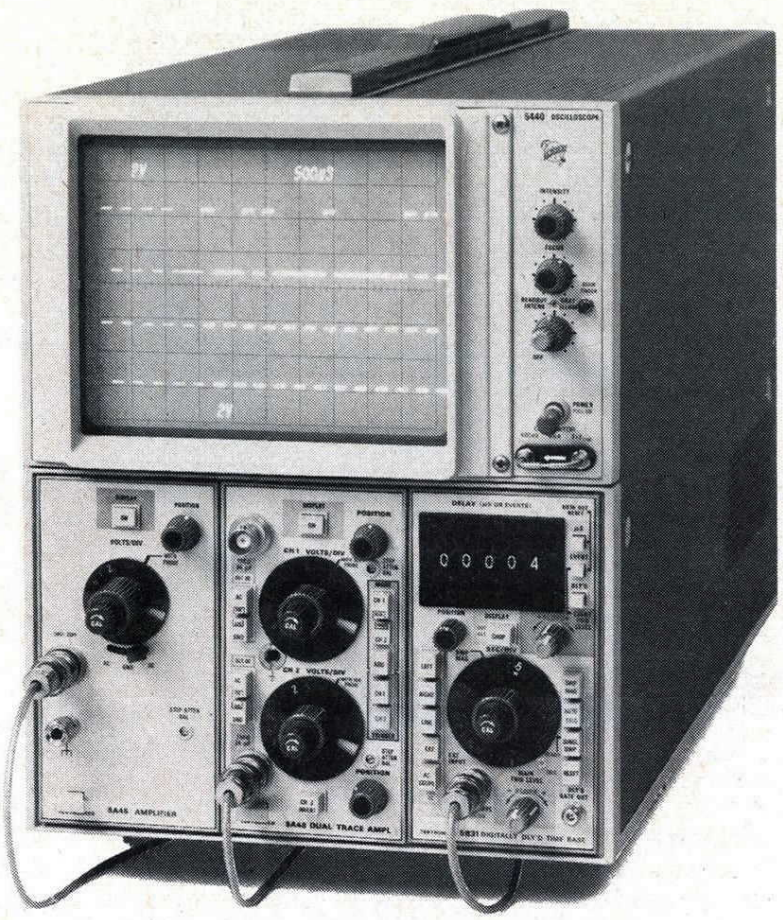
Sampling to 1 GHz

Crt Readout

3-Plug-in Flexibility

Choice of 23 Plug-ins

Bench to Rack Convertibility



The 5440 combines versatility and low cost in a 60 MHz general-purpose, plug-in oscilloscope. It features crt readout of plug-in scale factors, a 3-plug-in mainframe, a choice of 23 plug-ins* and bench to rack convertibility.

Crt readout displays plug-in scale factors on the crt, so measurement time and operator errors are reduced by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc.

All the plug-ins in the 5000 Series are compatible with the 5440.**

The wide variety of plug-ins available lets you configure your oscilloscope to meet your needs today as well as tomorrow: from a single-trace, single time-base configuration for production monitoring, to 4-trace, delayed sweep for logic work, to 4-trace differential amplifiers for transducer measurements, to dual-trace, delayed sweep for general purpose measurements.

If you're looking for a general-purpose oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

**Plug-ins with a suffix N (5A13N, 5B12N, etc) do not provide crt readout.*

***The 5B10N, 5B12N, and 5B13N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

VERTICAL SYSTEM

Channels—Left and center plug-in compartments are compatible with all 5000-Series Plug-ins. Crt readout is not available with plug-ins having a suffix N (5A13N, 5B10N, etc).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz max, determined by plug-in unit.

Chopped Mode—The 5440 will chop between channels at approx 25 to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each amplifier plug-in is swept 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 5440 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5000-Series Plug-ins. Crt readout is not available for plug-ins with a suffix N.

Internal Trigger Mode—Left vertical, center vertical.

Fastest Calibrated Sweep Rate— 5 ns/div, determined by plug-in.

X-Y Mode—Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

Phosphor—P31 Standard, P7 or P11 optional.

Accelerating Potential—15 kV.

External Intensity Input— +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input is ± 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Calibrator—Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is 2 times the line frequency.

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Writing speed can be increased with the TEKTRONIX Writing Speed Enhancer (see camera section for more information).

Writing Speed cm/μs				Camera	Lens
P31 Phosphor		P11 Phosphor			
10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
180	90	245	125	C-59R	f/2.8 0.67 mag
330	160	450	230	* ** C-50R	f/1.9 0.7 mag

**Slight cropping of the graticule corners.*

***Requires optional battery pack (016-0270-00) for operation with the 5440.*

Beam Finder—Intensifies trace and brings it into graticule areas.

Ambient Temperature—Performance characteristics valid from 0°C to + 50°C unless otherwise specified.

Line Voltage Range— 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that max input should not exceed 250 V ac) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max Power Consumption— 100 W at 120 V ac, 60 Hz.

OPTIONS

Option 01 without Crt Readout—The 5440 may be ordered without crt readout. This feature can easily be added later with a conversion kit.

Option 03 User Addressable Crt Readout—An additional crt readout access is available for the operator to program two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches.

Option 04 Protective Panel Cover (Cabinet Model Only)—The 5440 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

For Recommended Cameras — See camera section, page 209.

ORDERING INFORMATION

(Plug-ins not included)

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5¼ in rackmount oscilloscope with slide-out assembly.

5440 Oscilloscope **$1640**

R5440 Oscilloscope (Rackmount) ... **$1690**

OPTIONS

Option 01 without Crt Readout ..... **Sub $400**

Option 03 User Addressable Crt Readout ... **Add $75**

Option 04 Protective Panel Cover (Cabinet Model Only) ..... **Add $25**

Option 76 P7 Phosphor **$35**

Option 78 P11 Phosphor **$35**

Conversion Kits

Cabinet-to-Rackmount, Order 040-0583-02 ..... **$105**

Rackmount-to-Cabinet, Order 040-0584-03 ..... **$85**

Crt Readout, Order 040-0691-01 ..... **$450**

5441
R5441

5000-Series 60 MHz Variable Persistence Storage Oscilloscopes

Low Cost

Variable Persistence Storage

Crt Readout

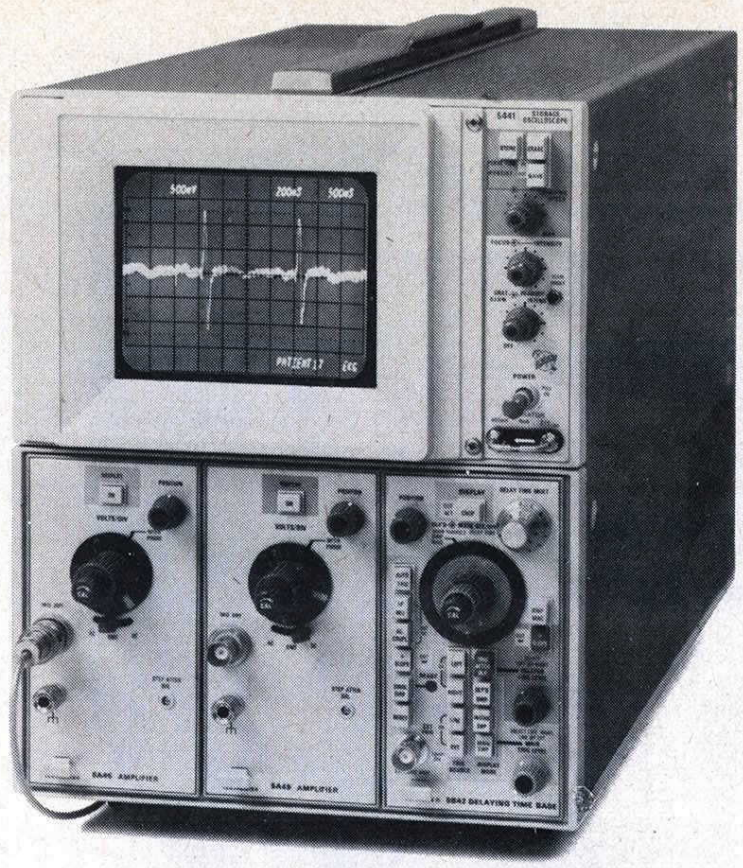
Dc to 60 MHz

3-Plug-in Flexibility

23 Versatile Plug-ins

Bench to Rack Convertibility

5 div/μs Stored Writing Speed



With the 5441 Variable Persistence Storage Oscilloscope, view time at normal intensity can be varied from a fraction of a second to more than 5 minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low-frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000-Series Sampler and Spectrum Analyzer Plug-ins. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the crt.

In spectrum analysis, slow scan rates are used to maximize resolution. With the 5441, it is easy to display a full-scan pattern simultaneously even when the scan rate yields full-scale periods of more than a second.

Like other 5400-Series Oscilloscopes, the 5441 offers crt readout of deflection factors for convenient, error-free measurements and optional user-programmable crt readout of test information for ready identification and easy photographic recording. With the flexibility of a 3-plug-in mainframe and a choice of 23 plug-ins, you can make virtually any measurement from dc to 60 MHz.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5000-Series Plug-ins. Crt readout not available for plug-ins with suffix N.

Deflection Factor—Determined by plug-in.

Bandwidth— 60 MHz max, determined by plug-in.

Chopped Mode—The 5441 will chop between channels at approx 25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each plug-in is swept 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 5441 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5000-Series Plug-ins. Crt readout not available for plug-ins with suffix N.

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate— 5 ns/div, determined by plug-in.

X-Y Mode—Phase shift within 2° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.

Persistence—Continuously variable, may be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

Phosphor—P31.

Accelerating Potential— 8.5 kV.

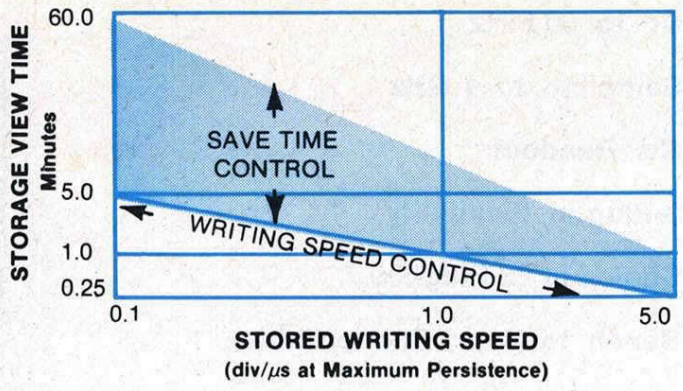
Max Stored Writing Speed—Writing speed greater than 5 div/μs for a view time of 15 s.

Storage View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds or 0.25 minutes with the writing speed control fully CW. Adjusting the stored intensity CCW will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart above).

Save Mode—Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

Erase Time—0.5 s ± 10%.



External Intensity Input— +5 V turns beam on from off condition. —5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C approx 10 kΩ paralleled by approx 40 pF. Max input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Beam Finder—Intensifies trace and brings it into graticule area.

Auto Focus—Reduces the need for manual focusing with changes in intensity after the front-panel FOCUS control has been set.

Calibrator—Voltage amplitude 400 mV ±1%. Current amplitude 4 mA ±1%. Frequency is 2 times line frequency.

Ambient Temperature—Performance characteristics valid from 0°C to +50°C unless otherwise specified.

Line Voltage Ranges— 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Max Power Consumption—100 W at 120 V ac, 60 Hz.

OPTIONS

Option 01 without Crt Readout—The 5441 may be ordered without crt readout. This feature can easily be added later with a conversion kit.

Option 03 User Addressable Crt Readout—Crt readout access allows the operator to program up to two 10-digit words.

Option 04 Protective Panel Cover (Cabinet Model Only)—The 5441 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

Option 05—A 1 div/μs writing speed can be ordered (at a significantly lower price) when a writing speed of 5 div/μs is not required.

For Recommended Cameras — See camera section, page 209.

ORDERING INFORMATION

(Plug-ins not Included)

5441 Oscilloscope $2775

R5441 Oscilloscope (Rackmount) ... $2825

OPTIONS

Option 01 without Crt Readout ..... Sub $400

Option 03 User Addressable Crt Readout .... Add $75

Option 04 Protective Panel Cover (Cabinet Model Only) ..... Add $25

Option 05 Reduce Writing Speed to 1 div/μs ..... Sub $300

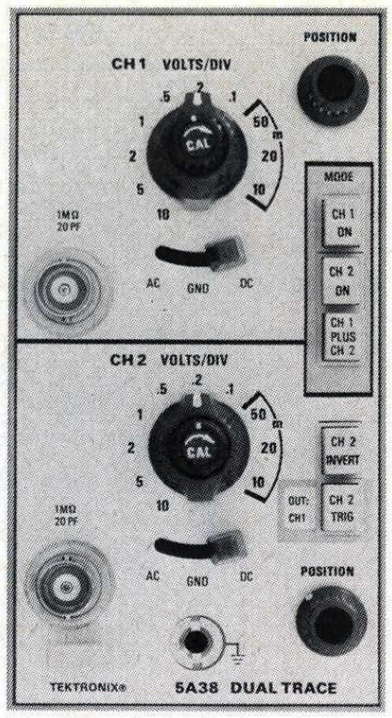
CONVERSION KITS

Cabinet-to-Rackmount, Order 040-0583-02 ..... $105

Rackmount-to-Cabinet, Order 040-0584-03 ..... $85

Crt Readout, Order 040-0691-01 ..... $450

5A38



Low Cost

Dc to 35 MHz Bandwidth

10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in amplifier for use only in 5400-Series Mainframes. It features 10 mV/div sensitivity and crt readout of deflection factor.

Bandwidth—Dc coupled, to ≥35 MHz. Lower end response, ac coupled, ≤ 10 Hz.

Display Modes—Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, and Added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from channel 1 or channel 2.

Rise Time— ≤10 ns.

Deflection Factors—Calibrated deflection factors from 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤ 3% from 15°C to 35°C, 4% from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Common-Mode Rejection Ratio— ≥50:1 up to 1 MHz.

Channel Isolation— ≥50:1 to 35 MHz with both traces displayed.

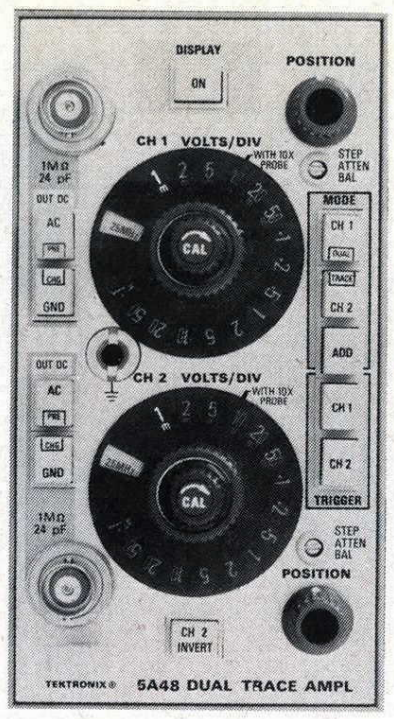
Input R and C— 1 MΩ shunted by approx 20 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max at 1 kHz or less.

Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A38 Dual-Trace Amplifier $440

5A48



Dc to 50 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A48 is a dual-trace 50 MHz plug-in amplifier for use only in the 5400-Series Mainframes. The 5A48 features five operating modes and selectable trigger source.

Bandwidth—Dc coupled, dc to at least 60 MHz at 5 mV/div to 10 V/div, decreasing to dc to 25 MHz at 1 mV/div and 2 mV/div (3 dB down). Ac coupled, 10 Hz or less (1.0 Hz with a 10X probe) at all deflection factors (lower 3 dB point).

Display Modes— Channel 1 only, Channel 2 only (normal or inverted), Dual-trace, Added, Alternated, Chopped (determined by time-base plug-in horizontal compartment). Internal trigger source is selectable from channel one or channel two.

Rise Time—7 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

Deflection Factors — Calibrated deflection factors from 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤5% at 1 mV/div and 2 mV/div, ≤3% from 5 mV/div to 10 V/div from 15°C to 35°C, ≤4% from 5 mV/div to 10 V/div from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Common-Mode Rejection Ratio—≥50:1 from 5 mV/div to 10 V/div, up to 1 MHz. ≥ 20:1 from 1 mV/div to 2 mV/div, up to 1 MHz.

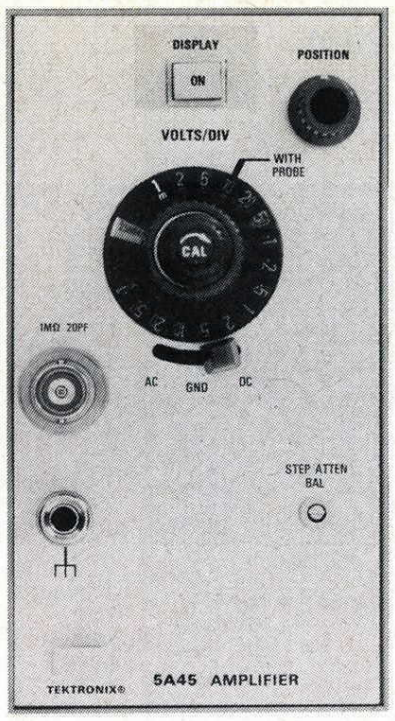
Input R & C— 1 MΩ within 1%, approx 24 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 1 kHz or less.

Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A48 Dual-Trace Amplifier $595

5A45



Low Cost

Dc to 60 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A45 is a single-trace, 60 MHz plug-in amplifier for use only in 5400-Series Mainframes. It features 5 mV/div sensitivity (1 mV/div at 25 MHz) and crt readout of deflection factor.

Bandwidth—Dc coupled, greater than 60 MHz for 5 mV/div through 10 V/div deflection factors, greater than 25 MHz for 1 mV/div and 2 mV/div deflection factors. Ac coupled, lower end response ≤10 Hz (≤1.0 Hz with 10X probe) for all deflection factors.

Rise Time— ≤14 ns, 1 mV/div and 2 mV/div. ≤5.8 ns, 5 mV/div through 10 V/div.

Deflection Factors—Calibrated deflection factors from 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤5% at 1 mV/div and 2 mV/div, ≤3% from 5 mV/div to 10 V/div from 15°C to 35°C, ≤4% from 5 mV/div to 10 V/div from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Input R and C— 1 MΩ, shunted by approx 20 pF.

Max Safe Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 1 kHz or less.

Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

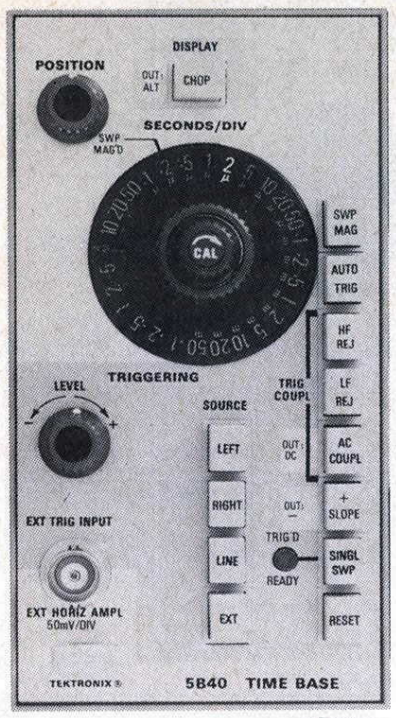
5A45 Single-Trace Amplifier $310

For recommended probes — refer to page 90.

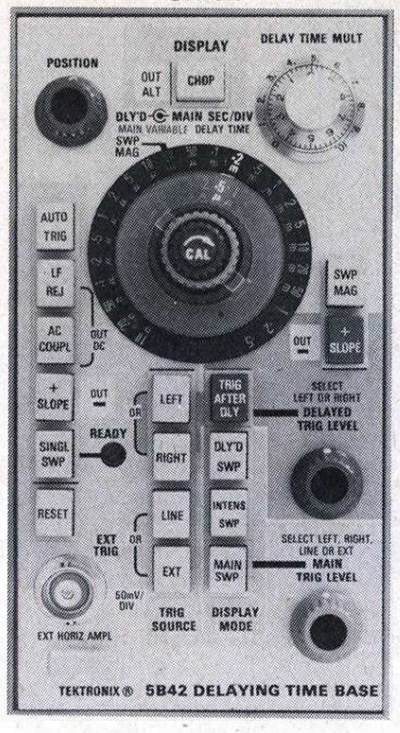
5B40
5B42
5B31

5000-Series Time Bases

5B40

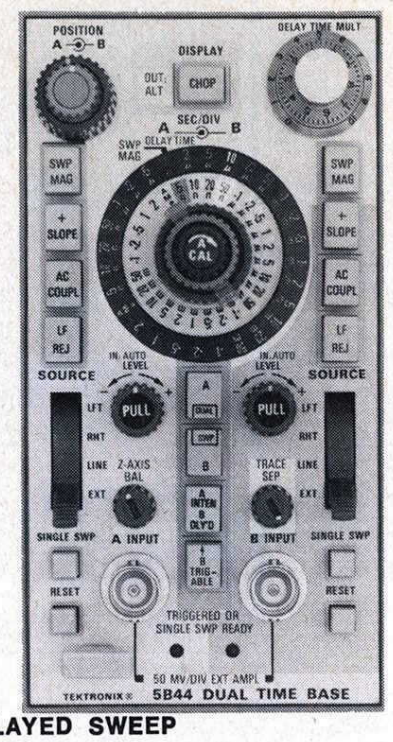


5B42



5B31

5B44



5B40

Low Cost

10 ns/div to 5 s/div Calibrated Time Base

Triggering to 60 MHz

The 5B40 Time Base is designed for use in 5400-Series Mainframes. It features sweep rates from 10 ns/div to 5 s/div and crt readout of the sweep rate selected.

Sweep Rate— 0.1 µs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy—Measured in 5400-Series Oscilloscope over center 8 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 µs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 µs/div and 0.1 µs/div	4%	5%	5%	6.5%

TRIGGERING

Coupling	Frequency Range	Minimum Signal Required	
		Int	Ext
Dc	Dc to 10 MHz 10 MHz to 60 MHz	0.4 div 1.0 div	60 mV 150 mV
Ac	Trigger requirements increase below 50 Hz.		
Lf Rej	Trigger requirements increase below 7.5 kHz.		
Hf Rej	Trigger requirements increase above 50 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces only one sweep.

External Trigger Input—Max input voltage is 350 V dc + peak ac, 350 V p-p ac at ≤ 1 kHz. Input R and C is 1 MΩ paralleled by approx 24 pF. Trigger level range is ≥ ± 1.5 V.

External Horizontal Input—Deflection factor is 50 mV/div ±3%. Input R and C is 1 MΩ paralleled by approx 24 pF. Dc coupled bandwidth is dc to ≤ 2 MHz. The ac coupled lower response is ≤ 50 Hz. Max input voltage is 350 V (dc + peak ac) or 350 V p-p ac at ≤ 1 kHz.

5B42

10 ns/div to 5 s/div Calibrated Time Base

Single-Sweep Operation

Triggering to 60 MHz

The 5B42 Delaying Time Base is designed for use in 5400-Series Mainframes. The 5B42 is designed so that the user may easily operate the time base in the many applications where delayed sweep and sweep rates up to 10 ns/div are required.

Sweep Rate— 0.1 µs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

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
1 s/div to 0.5 µs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 µs/div and 0.1 µs/div	4%	5%	5%	6.5%

TRIGGERING

Coupling		Frequency Range	Minimum Signal Required	
			Int	Ext
Dc	5400 ampl	Dc to 10 MHz	0.4 div	100 mV
	5400 ampl	10 MHz to 60 MHz	1.0 div	400 mV
	5100 ampl	Dc to 2 MHz	0.4 div	100 mV
Ac		Requirements increase below 50 Hz.		
Ac Lf Rejection		Requirements increase below 7.5 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 20 pF. Trigger level range is at least ± 2.5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range—0.2 to 10 times the TIME/DIV setting.

Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 µs to 0.5 s delay time. Within 2% plus 0.2% of full scale for 1 s to 5 s delay time.

Jitter—Less than 0.05% of the time represented by one div of delaying sweep selected.

DELAYED SWEEP

Sweep Rate— 0.1 µs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier.

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
0.1 s/div to 0.5 µs/div	3%	4%	4%	5.5%
0.5 s/div to 0.2 s/div, 0.2 µs/div and 0.1 µs/div	4%	5%	5%	6.5%

TRIGGERING

Coupling		Frequency Range	Min Signal Required
			Int
Dc	5400 ampl	Dc to 10 MHz	0.4 div
	5400 ampl	10 MHz to 60 MHz	1.0 div
	5100	Dc to 2 MHz	0.4 div

EXTERNAL HORIZONTAL INPUT

Deflection Factor— 50 mV/div within 3%.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

5B31

Jitter-Free Digital Delay

Delay by Time or Events

20 ns/div Sweep Rate

Crt Readout

The 5B31 Digitally Delayed Time Base features easy and accurate operation. It adds digital delay to the 5400-Series Oscilloscopes, and may be used only in a 5400-Series Mainframe.

The 5B31 can be used in many applications that call for accurate time delays and/or jitter-free displays, such as analyzing high-jitter digital data, machinery controls or production line testing. Its simple operation is helpful in production and education environments.

The 5B31 can delay by time or by events, and its digital delay system eliminates most in-

herent delay jitter. The delay mode is selected by pushbutton: the highly accurate delay time (from 1 μs to 99,999 μs) or the number of events (up to 99,999) is clearly displayed on thumbwheel dials.

CHARACTERISTICS

Sweep Rate— 0.2 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

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
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div, 2 s/div, and 0.2 μs/div	4%	5%	5%	6.5%

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

TRIGGERING

Coupling	Amplifier Type	Frequency Range	Minimum Signal Required	
			Int	Ext
Dc	5400 Plug-ins	Dc to 10 MHz	0.4 div	100 mV
		10 MHz to 35 MHz	1.0 div	400 mV
		35 MHz to 60 MHz	2.0 div	600 mV
Ac	5100 Plug-ins	Dc to 2 MHz	0.4 div	
		Requirements increase below 50 Hz.		

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 24 pF. Trigger level range is at least ±2.0 V.

DELAY BY MICROSECOND

Delay Range— 0 to 99,999 μs in 1-μs steps.

Differential Time Measurement Accuracy—Within 2 parts in 10^5 plus 1 part in 10^5 per month.

Jitter—Less than 10 ns + 1 part in 10^7 of selected delay.

DELAY BY EVENTS

Delay Range— 1-event steps from 0 to 99,999.

Triggering—Dc coupled from left vert only. Separate slope and level controls provided.

Amplifier Type	Frequency Range	Minimum Signal Required
5400	Dc to 10 MHz	0.4 div
5400	10 MHz to 20 MHz	1.5 div
5100	Dc to 2 MHz	0.4 div

EXTERNAL HORIZONTAL INPUT

Deflection Factor— 50 mV/div within 3%.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

DELAYED GATE OUT

Amplitude—Approx 2.5 V from 50-Ω source will drive one standard TTL load. Rises at end of delay, falls at end of sweep.

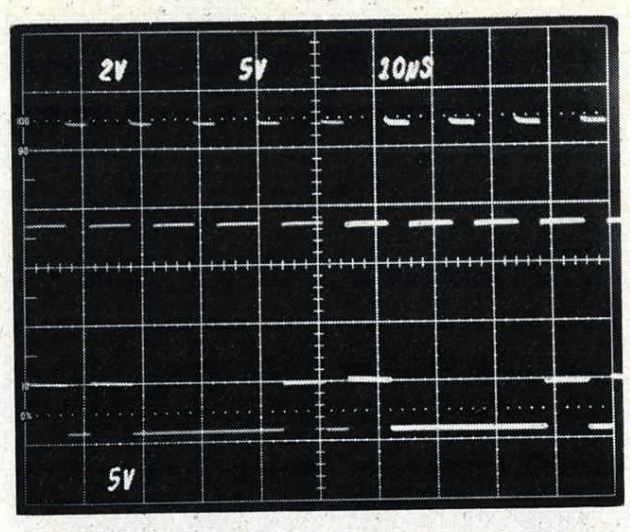


Figure 1. The above waveform shows a pre-set delay of five events such that the intensified zone starts on the sixth event.

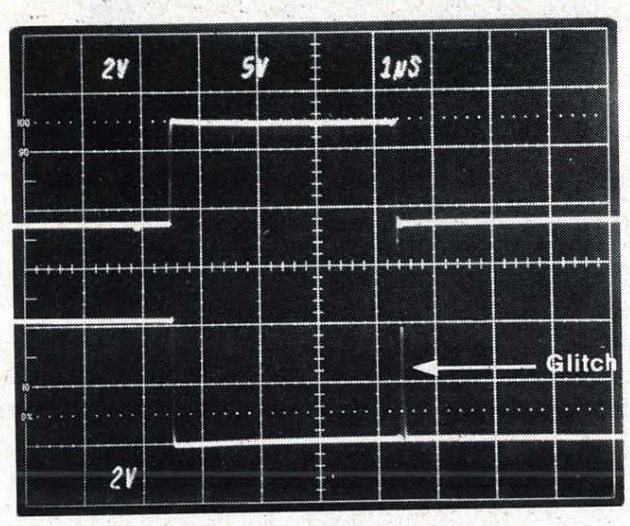


Figure 2. By triggering on a specific event, you can locate a glitch in a waveform. The above photo shows the same waveform as in Figure 1 triggered on the fifth event. Now you can locate the glitch that occurs on the falling edge of the above waveform.

5B44

Two Independent Sweeps

5 ns/div Sweep Rates

Dual Sweep by Sweep Switching Techniques

Crt Readout

The 5B44 Dual Time Base brings fast (5 ns/div) dual sweep display capability to 5400-Series Mainframes.

Sweep switching techniques enable both sweeps to be viewed at the same time. For example, in the "A" intensified, "B" delayed mode, both the intensified and the delayed waveforms are presented at full screen width, with independent control of horizontal and vertical positioning.

Versatile and symmetrical triggering controls let you independently select A and B sweep trigger sources from either left hand or center compartments, or from external inputs. For example, this feature lets you display two asynchronous signals, giving you almost two scopes in one.

The 5B44 also features crt readout and an edge-lighted seconds/div selector switch.

CHARACTERISTICS

The following applies to both A and B sweeps and triggering circuits, unless otherwise noted.

Sweep Accuracies—Measured over the center 8 div for A and B sweeps.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
2 s/div and 0.2 μs/div to 100 ns/div	4%	5%	5%	6.5%
50 ns/div	4%	5%	6%	7%

Sweep Rate— 50 ns/div to 2 s/div in 25 calibrated steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 magnifier. Uncalibrated, continuously variable between steps up to 5 s/div (A sweep only).

TRIGGERING

Coupling	Triggering Frequency Range	Minimum Signal Required	
		Int	Ext
Dc	Dc to 10 MHz	0.4 div	100 mV
	10 MHz to 60 MHz	1.0 div	400 mV
Ac	Requirements increase below 50 Hz.		
Ac LF REJ	Requirements increase below 7.5 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggering, sweep generator produces one sweep. Single sweep on both A and B sweep.

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, paralleled by approx 26 pF. Trigger level range is at least ±2 V. External trigger inputs on both A and B sweep.

EXTERNAL HORIZONTAL INPUTS

Deflection Factor— 50 mV/div ±3%.

Input R and C — 1 MΩ ± 2% paralleled by ≃ 26 pF.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range— X0.2 to X10 the A sweep TIME/DIV setting.

Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μs to 1 s of A sweep rate setting. Within 2% plus 0.2% of full scale for 2 s/div.

Jitter—Less than 0.05% of the delaying sweep TIME/DIV.

ORDERING INFORMATION

5B40 Time Base $410

5B42 Delaying Time Base $730

5B31 Digitally Delayed Time Base $670

5B44 Dual Time Base $920

5110/5111 5112/5113 5115

5000-Series 2 MHz Single-Beam, Dual-Beam, and Storage Oscilloscopes

Low Cost

Dc to 2 MHz

Sampling to 1 GHz

Choice of 16 Plug-ins

Rear Panel Signal Outputs Optional

5110

The 5110 is a single-beam nonstorage oscilloscope featuring a large 6½″ diagonal (1.27 cm/div) crt.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four-channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from our extra low cost basic amplifier and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — P31 standard, P7 or P11 optional.

5111

The 5111 is a single-beam, split-screen, bistable storage oscilloscope with a large-screen, 6½″ diagonal (1.27 cm/div) display.

The 5111 extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and/or photography.

The 5111 is particularly useful for recording low and medium speed displays like those found in audio spectrum analysis, semiconductor curve tracing, sampling, vibration analysis, and the biophysical sciences.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Max Stored Writing Speed — At least 20 div/ms.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

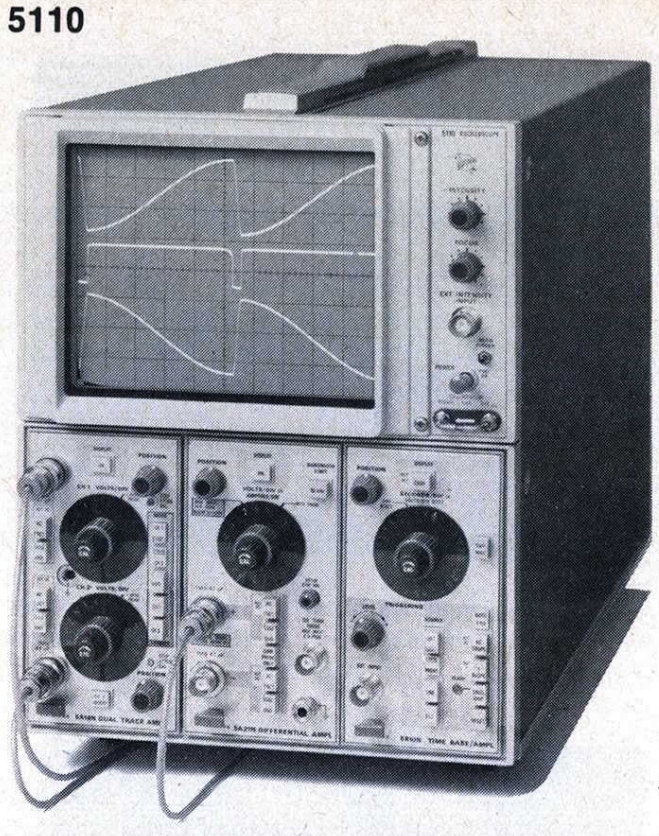
Erase Time — Approx 250 ms.

5112

The 5112 is a dual-beam nonstorage oscilloscope featuring two independent vertical systems referenced against a common horizontal deflection system.

The 5112 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. *Both beams are driven by one set of horizontal deflection plates.*

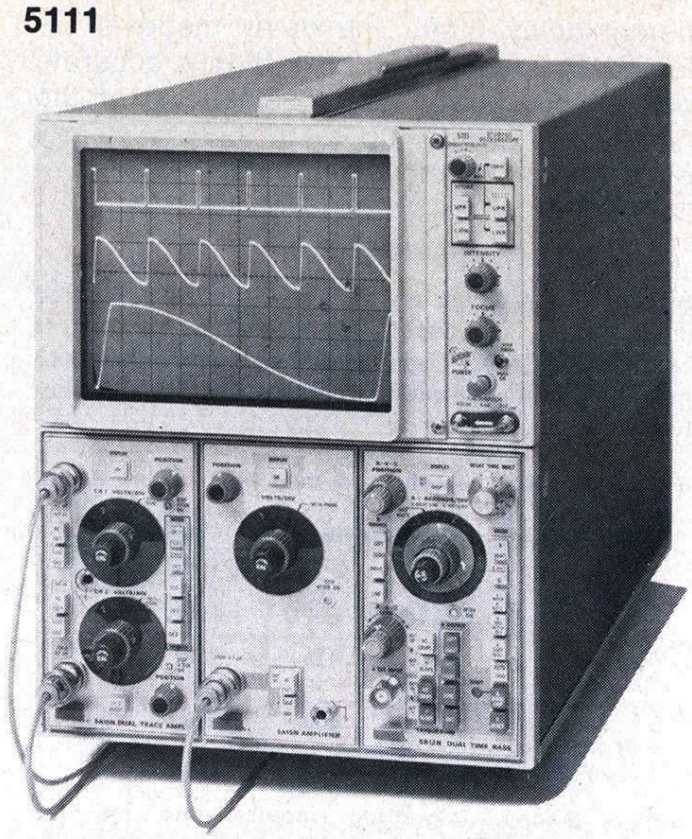
5110



Lowest Cost Single-beam Nonstorage Oscilloscope with Plug-in Configurability

8 Channels at 1 mV/div, 4 Channels at 50 μV/div, 2 Channels at 10 μV/div, with Appropriate Amplifiers

5111



Single-beam Storage Oscilloscope

Bistable, Split-screen Display

Stored Writing Speed ≥20 div/ms

Storage View Time up to 10 hrs at Reduced Intensity

When teamed up with the appropriate differential amplifiers, the 5112 can display up to four channels of high-gain (50 μV) differential information for use in the biophysical, electromechanical, and component testing fields.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — P31 standard, P7 or P11 optional.

5113

The 5113 is a dual-beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms (Option 03 provides 200 div/ms for the center 6 x 8 div). View time is at least 1 hr at normal intensity and can be increased to 10 hr at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. *Both beams are driven by one set of horizontal deflection plates.*

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

Max Stored Writing Speed — At least 20 div/ms. At least 200 div/ms at lower stored brightness (over center 6 x 8 div) with Option 03.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

Option 03 Fast Writing Speed Crt — Increases stored writing speed to 200 div/ms (center 6 x 8 div).

5115

The 5115 is a single-beam bistable storage oscilloscope with a writing speed of at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage view time is at least 1 hr at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hrs at reduced intensity, after which time intensity may be increased to original level. Variable brightness also gives optimum photographic results and allows for the integration of multiple traces.

The 5115 is useful in a wide variety of fields, including education, biophysical engineering, component testing, and industrial electronics.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (1.27 cm/div) parallax-free, non-illuminated graticule.*

Accelerating Potential — 3.5 kV.

Phosphor — Similar to P1.

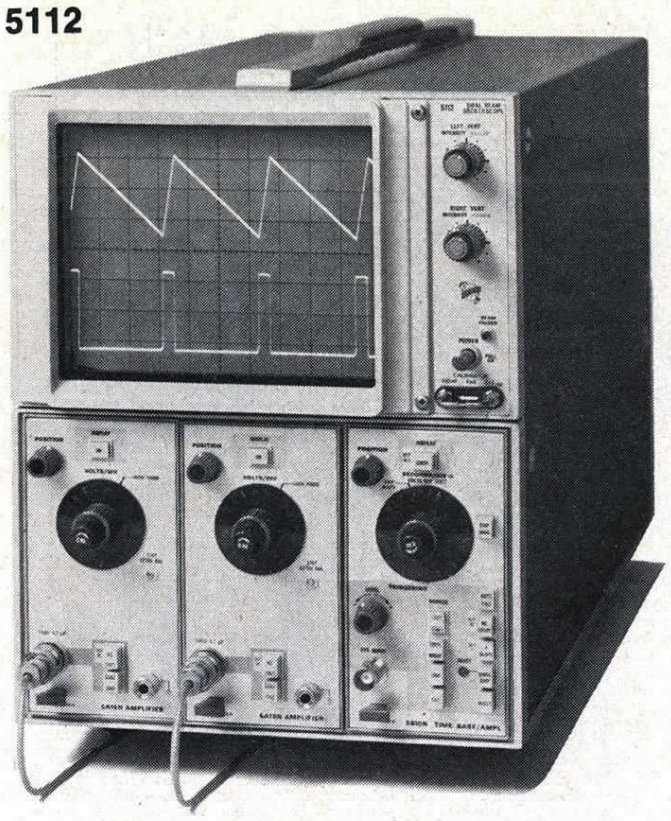
Max Stored Writing Speed — At least 200 div/ms in the normal-mode and 800 div/ms in the enhanced mode.

Storage View Time — At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time — Approx 250 ms.

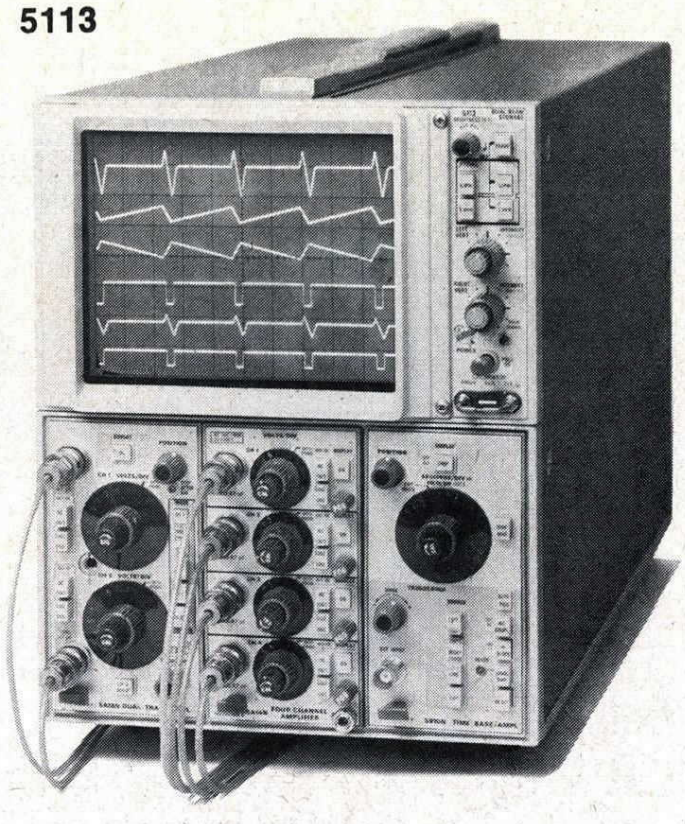
**Illuminated graticule available at extra cost.*

5112



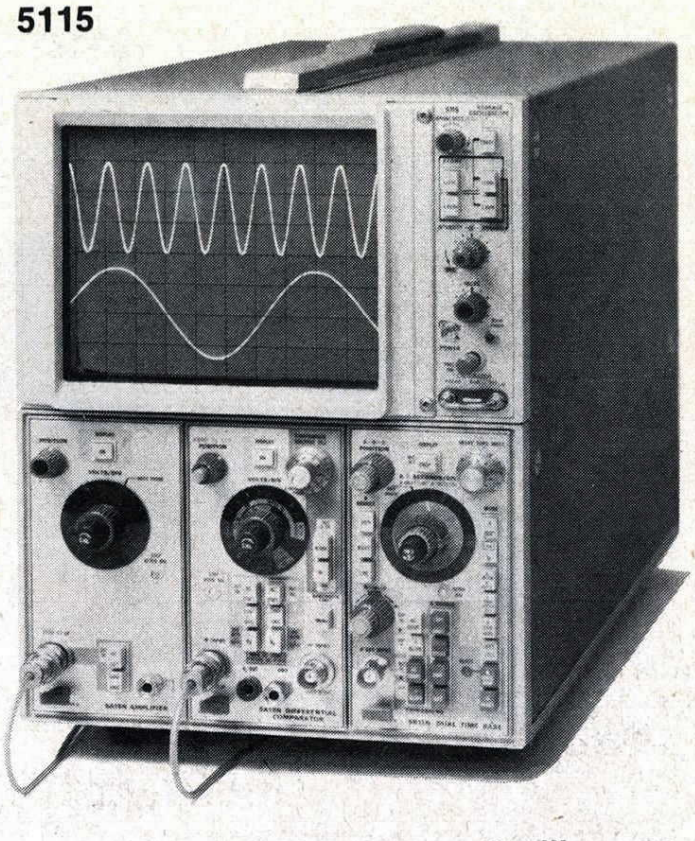
Dual-beam Nonstorage Oscilloscope
Two Independent Vertical Systems
Common Horizontal Deflection System
Can Display Two Single-shot Signals without Time-sharing, or up to Eight Signals in the CHOP Mode

5113



Dual-beam Bistable Storage Oscilloscope
Same Features as 5112, Plus Split-screen Storage. Stored Writing Speed ≥20 div/ms, or ≥200 div/ms with Option 03

5115



Single-beam Bistable Storage Oscilloscope
Fastest Stored Writing Speed in the 5100-Series Line:
≥200 div/ms in Normal-Mode
≥800 div/ms in Enhanced Mode
Storage View Time up to 10 hrs at Reduced Intensity

COMMON CHARACTERISTICS

for 5110, 5111, 5112, 5113, 5115 unless otherwise specified

VERTICAL SYSTEM

Channels — Left and center plug-in compartments compatible with all 5100-Series Plug-ins.

Deflection Factor — Determined by plug-in.

Bandwidth — 2 MHz max.

Chopped Mode — (5110, 5111, 5115) The mainframe vertical amplifier will chop between left and center plug-in compartments, and/or between two or more amplifier channels. The total time segment per channel is ≃5 μs, consisting of ≃3 μs displayed, ≃2 μs blanked. Chop or alternate mode is selected at the time base unit.

Chopped Mode — (5112, 5113) The left and right mainframe vertical amplifiers are dedicated to the left and center plug-in compartments. Each mainframe vertical amplifier will chop between two or more channels in their associated plug-in compartments. No channel switching is necessary between left and center plug-in compartments. The total time segment per channel is ≃5 μs, consisting of 3 μs displayed, ≃2 μs blanked. Chop or alternate mode is selected at the time base unit.

Alternate Mode — (5110, 5111, 5115) Each amplifier plug-in is swept 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 switching to the second amplifier.

Alternate Mode — (5112, 5113) Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel — Right-hand plug-in compartment compatible with all 5100-Series Plug-ins.

Fastest Calibrated Sweep Rate — 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode — Phase shift within 1° from dc to 100 kHz.

OPTIONAL REAR PANEL SIGNAL OUTPUTS

Left and Center Compartments — Two BNC connectors provide access to the crt-related signals from the left and center plug-in amplifiers. Sensitivity: 0.5 V/crt division. Output Impedance: 1 kΩ.

Right Compartment (Sweep) — One BNC connector provides access to the crt-related sweep waveform. Sensitivity: 0.5 V/crt division; positive-going sawtooth, ≥ 5 V. Output Impedance: 1 kΩ.

Right Compartment (Gate) — One BNC connector provides access to TTL compatible gate. Positive-going, coincident with displayed sweep.

X-Y Mode — Crt related X-Y signals are available at the appropriate rear panel connectors when amplifier plug-ins are used in either the left or center compartment and the right compartment to display X-Y information. Sensitivity (X-Y): 0.5 V/crt division. Order Option 07.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics valid from 0°C to +50°C.

Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; (Except that max input should not exceed 250 V ac.) internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Typical Power Consumption — For 5110, 53 W. For 5111, 74 W. For 5112, 67 W. For 5113, 88 W. For 5115, 74 W.

External Intensity Input — +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input ±50 V (dc + peak ac).

Calibrator — Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

Beam Finder — Positions beam on screen regardless of vertical and horizontal position control settings.

ORDERING INFORMATION

(Plug-ins not Included)

Cabinet Model	
5110 Oscilloscope	**$795**
5111 Oscilloscope	**$1490**
5112 Oscilloscope	**$1360**
5113 Oscilloscope	**$2025**
5115 Oscilloscope	**$1565**
Rackmount Model	
R5110 Oscilloscope	**$845**
R5111 Oscilloscope	**$1540**
R5112 Oscilloscope	**$1410**
R5113 Oscilloscope	**$2075**
R5115 Oscilloscope	**$1615**

OPTIONS

Option 02 Protective Panel Cover (Cabinet Models Only) — The cover protects the front panel and knobs during transportation and storage ..... **Add $25**

Option 03 Fast Writing Speed Crt (5113, R5113 Only) ..... **Add $100**

Option 07 Add Rear Panel Signals Out (All Models) ..... **Add $75**

Option 76 P7 Phosphor (5110, R5110, 5112, R5112 Only) ..... **Add $35**

Option 78 P11 Phosphor (R110, R5110, 5112, R5112 Only) ..... **Add $35**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit, Order 040-0583-02 ..... **$105**

Rackmount-to-Cabinet Conversion Kit, Order 040-0584-03 ..... **$85**

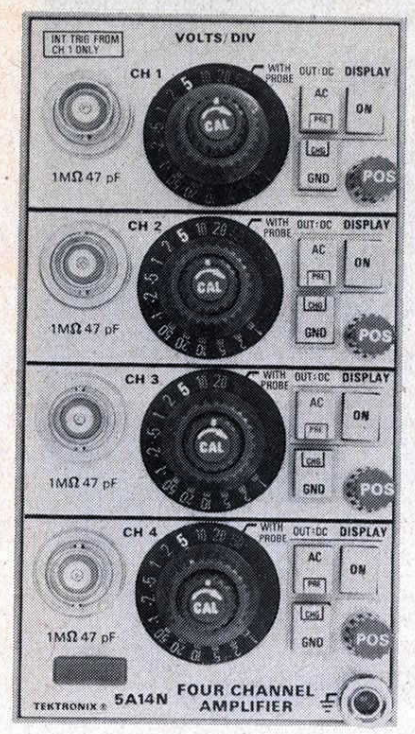
Protective Panel Cover Kit, Order 040-0620-00 ..... **$25**

For Recommended Cameras — See camera section, page 209.

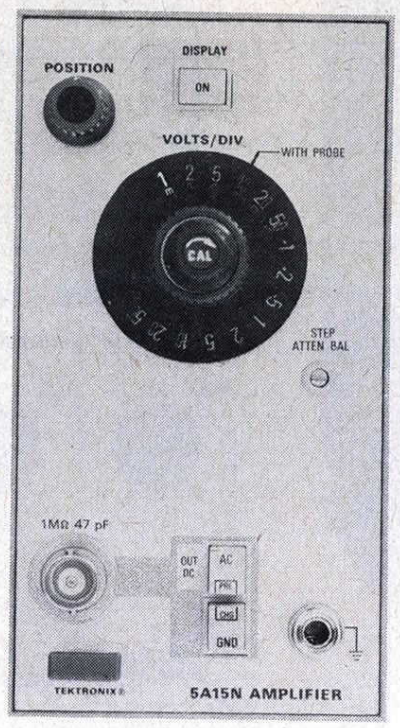
5A14N/5A15N 5A18N/5A23N 5A24N

5000-Series Single-Channel, Two-Channel, and Four-Channel Amplifiers

5A14N



5A15N



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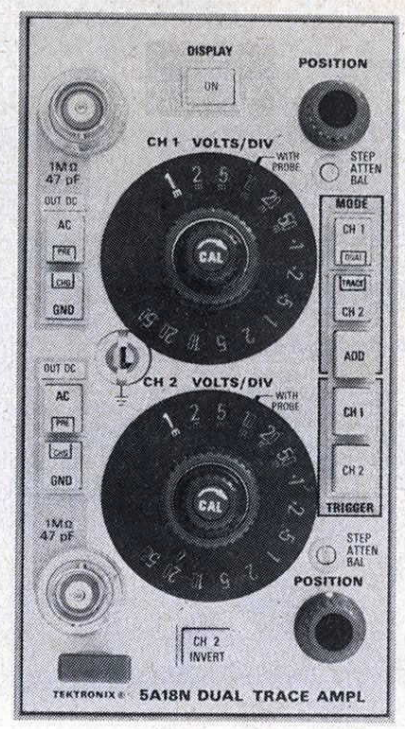
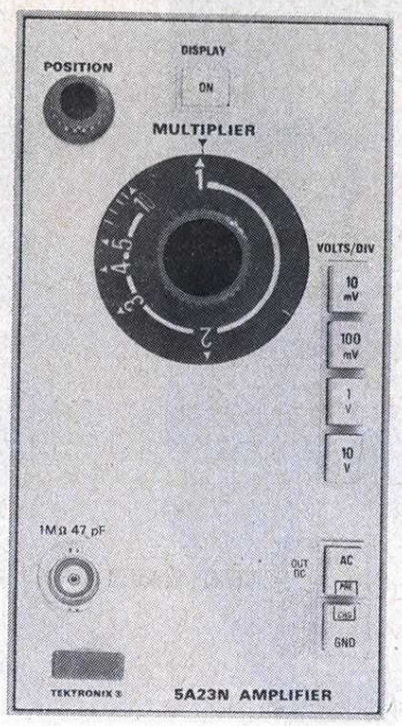
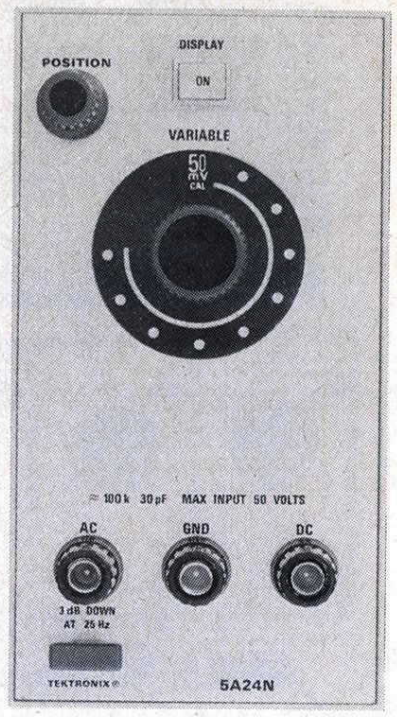


5A23N



5A24N



5A14N

1 mV/div to 5 V/div

The 5A14N Four-Channel Amplifier features simplified front-panel controls and can be used in any 5000-Series Mainframe.

5A14N operating modes are: each channel separately, and alternated or chopped between any combination of channels. Internal trigger is available from channel one only.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at least 1 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1 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%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Ac coupled, 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A15N

1 mV/div to 5 V/div

The 5A15N Single-Channel Amplifier features easy to use front-panel controls and can be used in any 5000-Series Mainframe.

Two 5A15Ns (one must be located in the right-hand compartment) provide versatile X-Y operation when used in a 5100-Series Mainframe.

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%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Ac-coupled, 350 V dc.

5A18N

1 mV/div to 5 V/div

The 5A18N Dual-Trace Amplifier features easy to use front-panel controls and can be used in any 5000-Series Mainframe.

5A18N operating modes include channel one or two only, channels one and two added, channel two inverted and channel one alternated or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

CHARACTERISTICS

Bandwidth — Dc coupled, dc to at last 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%, approx 47 pF.

Max Input — Dc coupled, 350 V (dc + peak ac). Accoupled, 350 V dc.

Chopping Rate — 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A23N

10 mV/div to 10 V/div
Calibrated Deflection Factors

The 5A23N is a general-purpose amplifier for the 5000-Series Oscilloscopes. Featuring low cost and simplicity of controls, it is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000-Series Mainframes for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth — Dc coupled, dc to at least 1.5 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1.5 MHz at all deflection factors.

Deflection Factor — 10 mV/div to 10 V/div within 3% in 4 calibrated decade steps. A lighted multiplier control provides continuous variation between steps, and extends the deflection factor range to 100 V/div. Accuracy is within 5% at X2 and X5 multiplication.

Input R and C — 1 MΩ within 1%, approx 47 pF.

Max Input — 350 volts (dc + peak ac).

5A24N

50 mV/div to 1 V/div

Deflection Factors

Easy to Customize

The 5A24N is a low-cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000-Series Mainframes. It contains mode switching, crt beam positioning, trigger pickoff for basic measurements, and a built-in 3⅜ x 2¾ in soldering pad matrix for use by the customer who wishes to build his own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

Bandwidth — Dc coupled, dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenuator range. Ac coupled, 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

Deflection Factor — 50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/div to at least 1 V/div.

Input R and C — Approx 100 kΩ, approx 30 pF.

Max Input — 50 volts (dc + peak ac).

ORDERING INFORMATION

5A14N Four-Trace Amplifier	**$860**
5A15N Single-Trace Amplifier	**$200**
5A18N Dual-Trace Amplifier	**$440**
5A23N Single-Trace Amplifier	**$175**
5A24N Single-Trace Amplifier	**$110**

For recommended probes — refer to page 90.

5A13N

Dc to 2 MHz Bandwidth
1 mV/div to 5 V/div
10,000:1 Cmrr
10,000 Div Effective Screen Height

The 5A13N is a differential comparator plug-in amplifier for the 5000 Series. It incorporates a number of performance features that makes it particularly versatile, especially in multitrace combination with other 5000-Series Amplifier Plug-ins. The following operational areas describe the functions of the 5A13N.

Conventional Mode — As a conventional amplifier, the 5A13N has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at 2 MHz or 10 kHz for best displayed noise conditions during low-frequency applications. The plus or minus inputs allow normal or inverted displays.

Differential Mode — As a differential amplifier, the 5A13N maintains its conventional features and provides a balanced input for applications requiring rejection of a common-mode signal. The cmrr is 10,000:1 from dc to 20 kHz, decreasing to 100:1 at 2 MHz. The unit rejects up to 15 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 350 V rejection capability above 100 mV/div.

Comparator Mode — As a comparator amplifier, the 5A13N uses its differential capabilities, but provides an accurate positive or negative internal offsetting voltage. A signal of up to ±10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 div by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for applications requiring max resolution. The offset voltage may be externally monitored through a front-panel output.

CHARACTERISTICS

Bandwidth — Dc to 2 MHz. Bandwidth limit mode, dc to 10 kHz. Ac coupled, 2 Hz or less at the lower −3 dB point.

Deflection Factor — 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C — 1 MΩ, approx 51 pF.

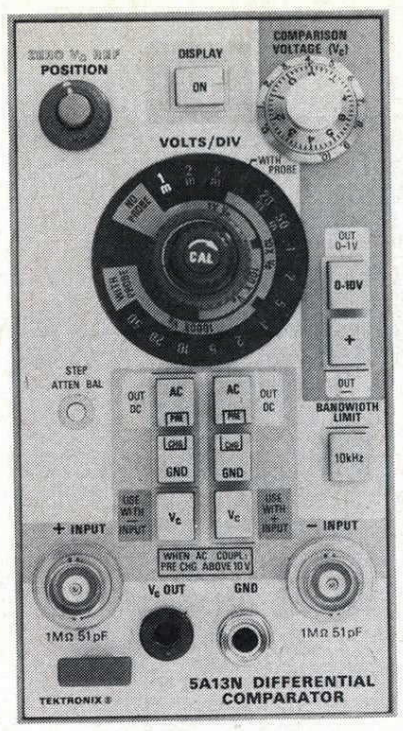
Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	±350 V
Max Ac Coupled Input (Dc Voltage)	±350 V	

Max Input Gate Current — 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Overdrive Recovery — 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after removal of an overdrive signal between +10 V and −10 V, regardless of overdrive signal duration.

5A13N



Internal Comparison Voltage — Ranges, 0 V to ±10 V and 0 V to ±1 V. Accuracy, within 0.2% of dial setting plus 5 mV from ±1 V to ±10 V; within 0.2% of dial setting plus 1 mV from ±25 mV to ±1 V on the 0 V to ±1 V range. From 0 V to ±25 mV, use the on-screen display for greater resolution. Vc output R, approx 15 kΩ.

Common-Mode Rejection Ratio — At least 10,000:1, dc to 10 kHz at 1 mV/div to 50 mV/div dc coupled, with up to 20 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, cmrr is the same as stated for dc coupled. Below 5 kHz ac coupled, cmrr decreases to 400:1 at 10 Hz. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

5A13N Differential Comparator Amplifier $755

5A19N

Dc to 2 MHz Bandwidth
1 mV/div to 20 V/div
Dc Offset

The 5A19N is a low-cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000-Series Mainframe for Y-T displays, or in the right compartment for X-Y displays.

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.

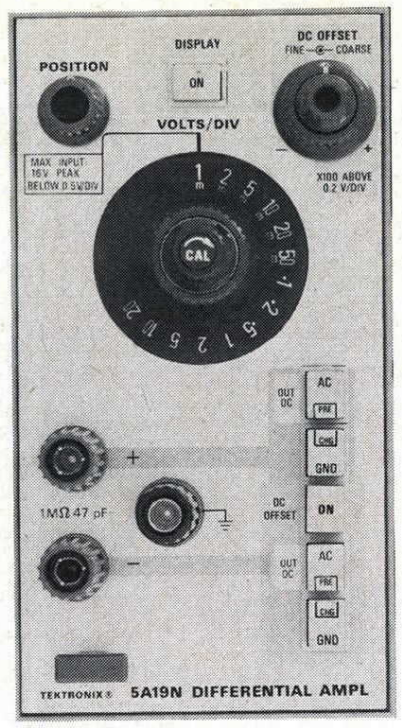
Deflection Factor — 1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 50 V/div.

Input R and C — 1 MΩ within 0.3%, approx 47 pF.

Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±350 V	
Max Ac Coupled Input (Ac Voltage)	±350 V	
Dc Offset Range	+15 V to −15 V	+350 V to −350 V

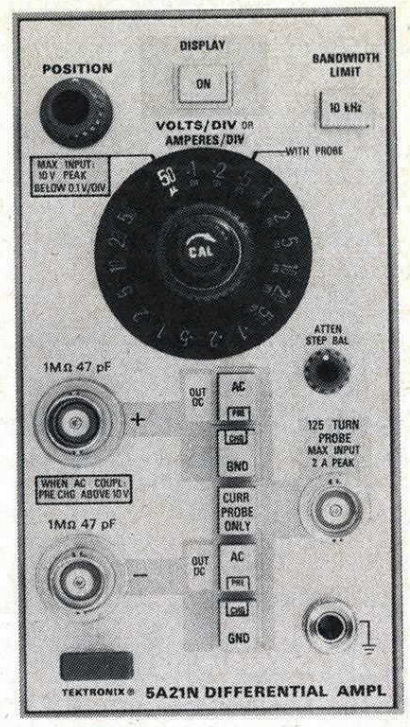
5A19N



Common-Mode Rejection Ratio — Dc coupled, 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

5A19N Differential Amplifier $250

5A21N



5A21N

Dc to 1 MHz Bandwidth
10 kHz Bandwidth Limiter
50 μV/div to 5 V/div
100,000:1 Cmrr
Voltage and Current Probe Inputs

The 5A21N is a 50 μV/div, dc coupled differential amplifier for the 5000 Series. The 5A21N has a current probe input.

VOLTAGE CHARACTERISTICS

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 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 0.15%, approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (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 sine wave, 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 sine wave. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

Additional information on following page.

For recommended probes — refer to page 90.

5A22N
5A26

5000-Series Differential and Dual Differential Amplifiers

CURRENT PROBE INPUT CHARACTERISTICS (with P6021 CURRENT PROBE)

Bandwidth — 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

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.

Max 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 5A21N from 0°C to +50°C.

5A21N Differential Amplifier **$350**

with Option 01 (includes P6021, 5 ft. current probe) **$150**

The 5A21N and 5A22N Differential Amplifiers are available with crt readout at additional cost (crt readout functional in 5400-Series Mainframes only). Contact your local Tektronix Field Engineer for details.

5A22N

Dc to 1 MHz Bandwidth

10 μV/div to 5 V/div

100,000:1 Cmrr

Selectable Upper and Lower −3 dB Points

Dc Offset

The 5A22N is the most versatile of the 5000-Series Differential Amplifiers. It features front panel selectable filtering which enables reduction of undesirable displayed noise; both upper and lower 3 dB points are selectable. Dc offset at full bandwidth is available for viewing signals riding on a dc component such as low-level ripple and noise on a power supply.

These features, together with its high common-mode rejection, make the 5A22N well suited for measurements in difficult low-amplitude, low-frequency areas.

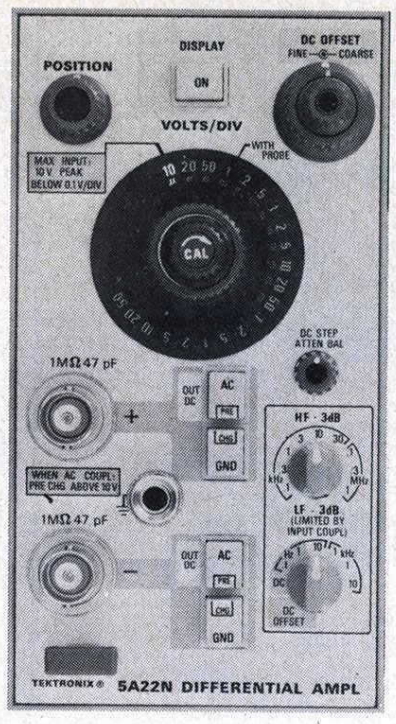
CHARACTERISTICS

Bandwidth — HF −3 dB point: selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate to within 20% of selected frequency; at 1 MHz, bandwidth is down 3-dB or less. LF −3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz accurate to within 20% of selected frequency. Ac coupled, 2 Hz or less.

Deflection Factor — 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Common-Mode Rejection Ratio — Ac coupled, 10 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 from 10 μV/div to 100 μV/div with up to 20 V p-p sine wave, 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 sine wave. Cmrr with two P6060 Probes is at least 400:1 at any deflection factor.

5A22N



Signal and Offset Range

Deflection Factor Settings	10 μV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±10 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or Less)	±12 V	±350 V
Max Ac Coupled Input (Dc Voltage)	±350 V Dc rejection, at least 4×10^5:1	
Dc Offset Range	+0.5 V to −0.5 V	+50 V to −50 V

Input R and C — 1 MΩ within 0.15%, approx 47 pF.

Overdrive Recovery — 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

Max Input Gate Current — 200 pA or less.

Displayed Noise — 20 μV at max bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift with Temperature — 100 μV/°C or less.

5A22N Differential Amplifier **$650**

5A26

Two Differential Amplifiers in One Plug-In

50 μV/div Sensitivity at 1 MHz

100,000: 1 Cmrr

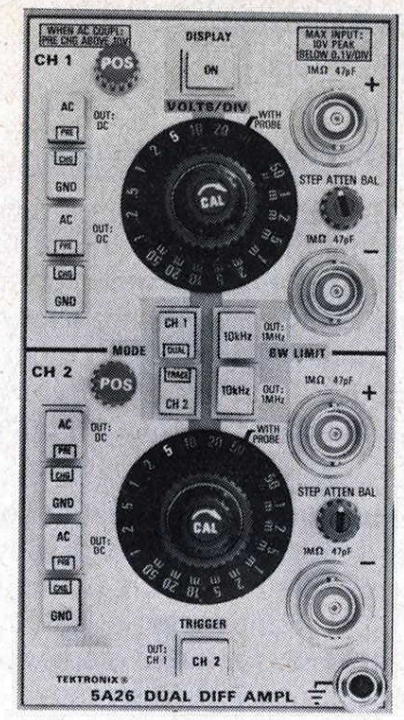
Crt Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000-Series Laboratory Oscilloscopes. It may be used in any 5000-Series Mainframe.

The 5A26 provides 50 μV/div sensitivity at 1 MHz, high common-mode rejection ratio, *crt readout in any standard 5400-Series Mainframe,* trigger-source selection and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

5A26



CHARACTERISTICS

Number of Differential Channels — Two.

Bandwidth — Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 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.

Crt Readout — Crt readout of deflection factors. Functional in crt readout-equipped 5400-Series Oscilloscopes, nonfunctional in 5100-Series Oscilloscopes.

Input R and C — 1 MΩ within 0.15% paralleled by approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 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.

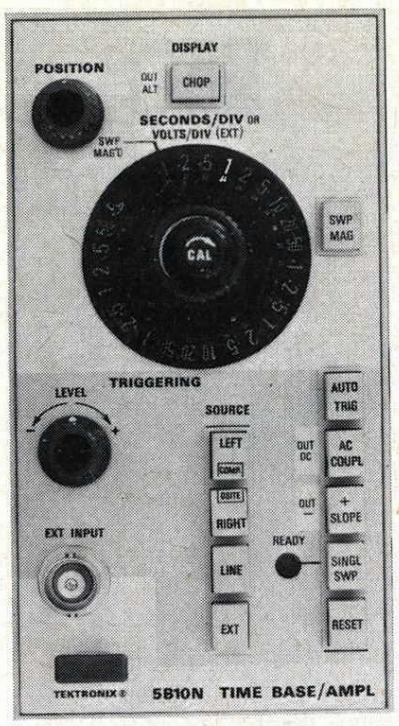
Common-Mode Rejection Ratio

Dc Coupled 50 μV/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sine wave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sine wave
Ac Coupled 50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz
With 2 P6062A Probes	400:1 at 10X probe attenuation

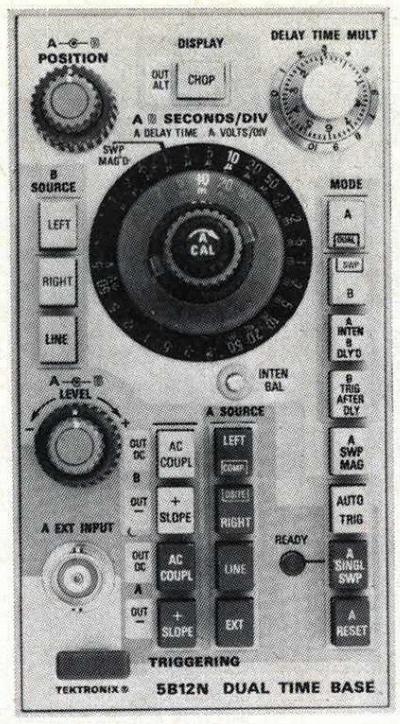
5A26 Dual Differential Amplifier **$670**

For recommended probes — refer to page 90.

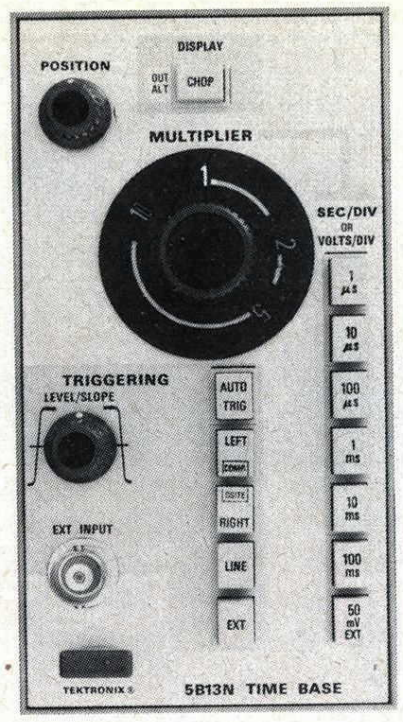
5B10N



5B12N



5B13N



5B10N

100 ns/div to 5 s/div Calibrated Time Base
Single Sweep
Direct Readout X10 Mag
Provides Alternate and Chopped Displays
50 mV/div and 500 mV/div External Input

The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000-Series Oscilloscopes. An external input allows use of the 5B10N as 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 pushbutton selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

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	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

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 — Max input 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%. X10 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%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

ORDERING INFORMATION

5B10N Time Base/Amplifier $305
5B12N Dual Time Base $650
5B13N Time Base $170

5B12N

100 ns/div to 5 s/div Calibrated Time Base
Dual and Delayed Sweep
Direct Readout X10 Mag

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000-Series Oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite 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.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

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 to 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 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div, and 0.5 s/div.

TRIGGERING

The following applies to the A and B trigger except as noted.

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

*A Trigger only.

B sweep operates in triggered or free-run mode after delay time.

Auto Trig — Same as above on signal rates of 15 Hz and above.

The following characteristics apply to the A trigger only.

Single Sweep — Same as for ac and dc coupled.

External Trigger Input — Max input voltage is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by approx 70 pF. Trigger level voltage range is +5 V to −5 V.

DELAYING SWEEP CHARACTERISTICS

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

Delay Time Multiplier Range — 0.2 to 10.2 times the time/div setting.

Delay Time Multiplier Incremental Linearity — Within 0.2%.

Differential Time Measurement Accuracy — Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

Jitter — Less than 0.05% of the time represented by one div of the delaying sweep selected.

EXTERNAL HORIZONTAL MODE

Deflection Factor — 50 mV/div and 500 mV/div accurate to within 3%. X10 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%, approx 70 pF.

Max Input Voltage — 350 V (dc + peak ac).

5B13N

1 μs/div to 100 ms/div Calibrated Time Base
External Horizontal Input

The 5B13N is a low-cost, general-purpose time base for 5000-Series Oscilloscopes.

The 5B13N suits applications such as basic laboratory use by students, production testing, scientific research, and others.

CHARACTERISTICS

Sweep Rates — 1 μs/div to 100 ms/div within 5% in 6 calibrated decade steps. A lighted multiplier control provides continuous, uncalibrated variation between steps and extends the pushbutton-selected rate to at least 1 s/div.

TRIGGERING

Coupling		Sensitivity and Frequency Range
Ac	Int	0.4 div from 50 Hz to 100 kHz, increasing to 1 div at 1 MHz
	Ext	200 mV from 50 Hz to 1 MHz

External Trigger Input — Max input voltage is 200 V (dc + peak ac). Input R and C is approx 100 kΩ paralleled by approx 1000 pF. Trigger-level voltage range is +1.5 V to −1.5 V.

EXTERNAL HORIZONTAL INPUT

Deflection Factor — 50 mV/div, accurate to within 5%. A continuously variable deflection factor multiplier provides variation between 50 mV/div and 0.5 V/div.

Bandwidth — Dc to at least 100 kHz.

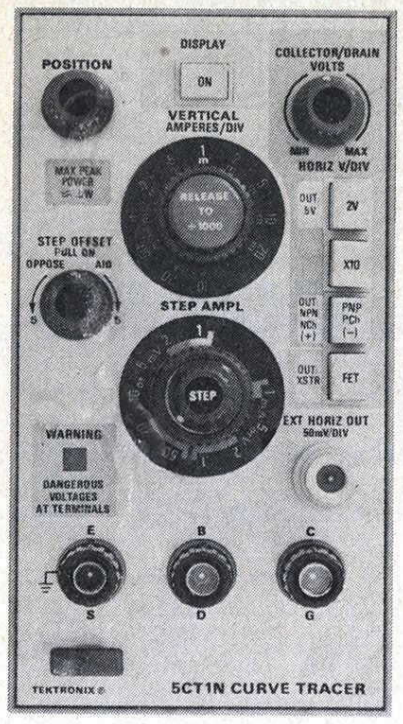
Input R and C — Approx 50 kΩ paralleled by 1000 pF.

Max Input Voltage — 200 V (dc + peak ac).

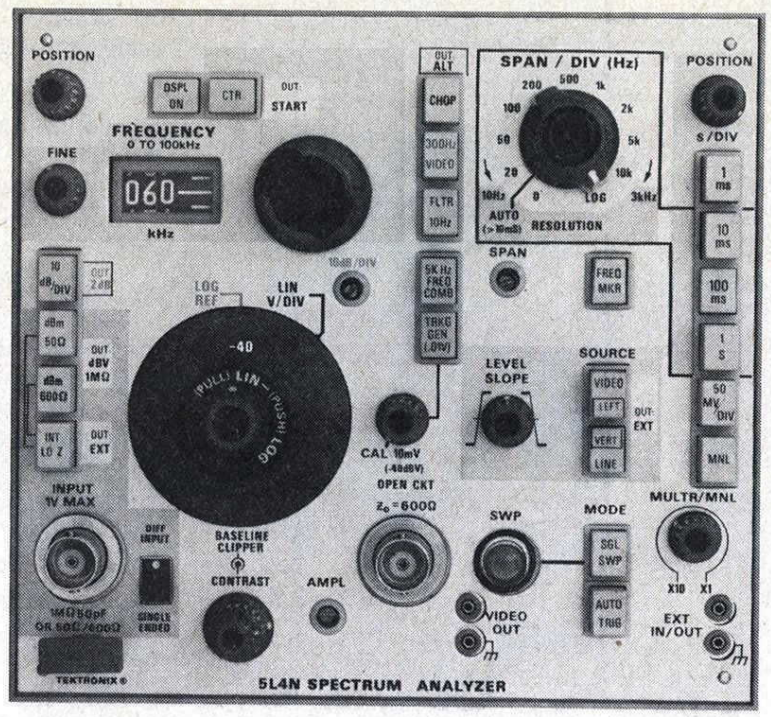
5CT1N
5L4N
5S14N

5000-Series Curve Tracer, Spectrum Analyzer, and Dual-Trace Sampler

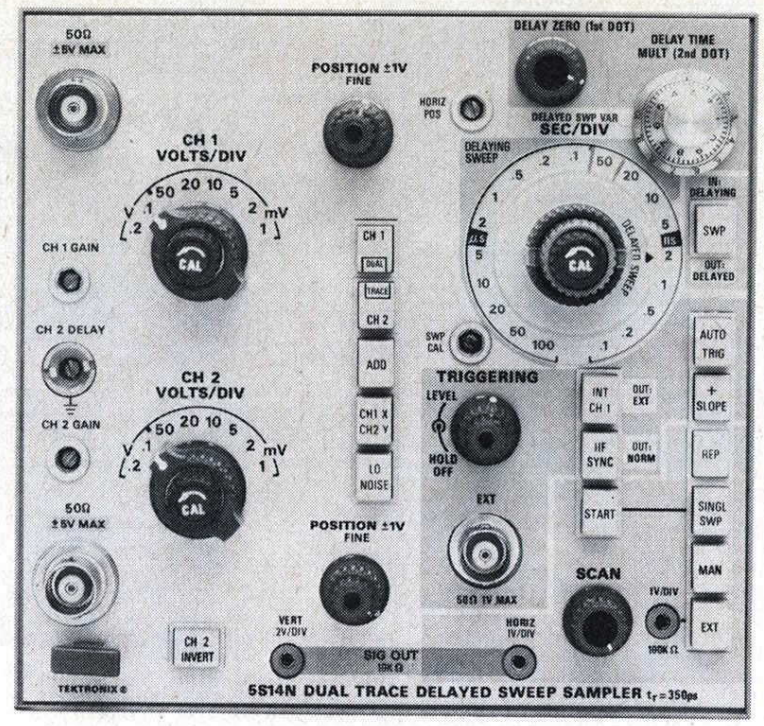
5CT1N



5L4N



5S14N



5CT1N Curve Tracer

• Test Semiconductor Devices to 0.5 W • 10 nA/div to 20 mA/div Vertical Deflection Factors • 0.5 V/div to 20 V/div Horizontal Deflection Factors • For a complete description see page 182.

5L4N Spectrum Analyzer

• Low Cost • 0-100 kHz Frequency Range • Resolution Bandwidth 10 Hz to 3 kHz • Log and Linear-Span Modes • Auto Resolution • For a complete description see page 197.

5S14N Sampler

Dc to 1 GHz Bandwidth
Dual Trace, 2 mV/div Sensitivity
Calibrated Delayed Sweep
Simplified Triggering
Operational Ease of Conventional Oscilloscope
Two-Dot Time Measurements

The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000-Series Mainframes. Combining the sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical amplifier channels provide dual-trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Multiplier Dial by the selected time per division.

AMPLIFIER CHARACTERISTICS

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 vertical (Y), Channel 2 horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc to 1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, tested with 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in 8 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Max Input Voltage — ±5 V.

Input Signal Range — 2 V p-p max within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (tangentially measured). Low noise pushbutton reduces random noise by factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10-kΩ source resistance.

Channel Delay Difference — Adjustable to zero or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

Scan Modes — Repetitive, Single, Manual, or External.

Delaying Sweep — May be used as crt time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by ten div of the Delaying Sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10-kΩ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3% excluding first ½ div of displayed sweep.

Delay Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the Delaying Sweep selected.

Delay Time (2nd Dot) — Adjustable to any portion of the time interval represented by ten div of the Delaying Sweep selected.

Delay Accuracy — Within ±1% of ten div when measurement is made within the last 9.5 div.

DELAYED SWEEP CHARACTERISTICS

Range — 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first ½ div of displayed sweep.

Start Delay — Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by 10 div of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Source — Interval from channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V at instants when either a + slope or a − slope of the triggering signal crosses that level.

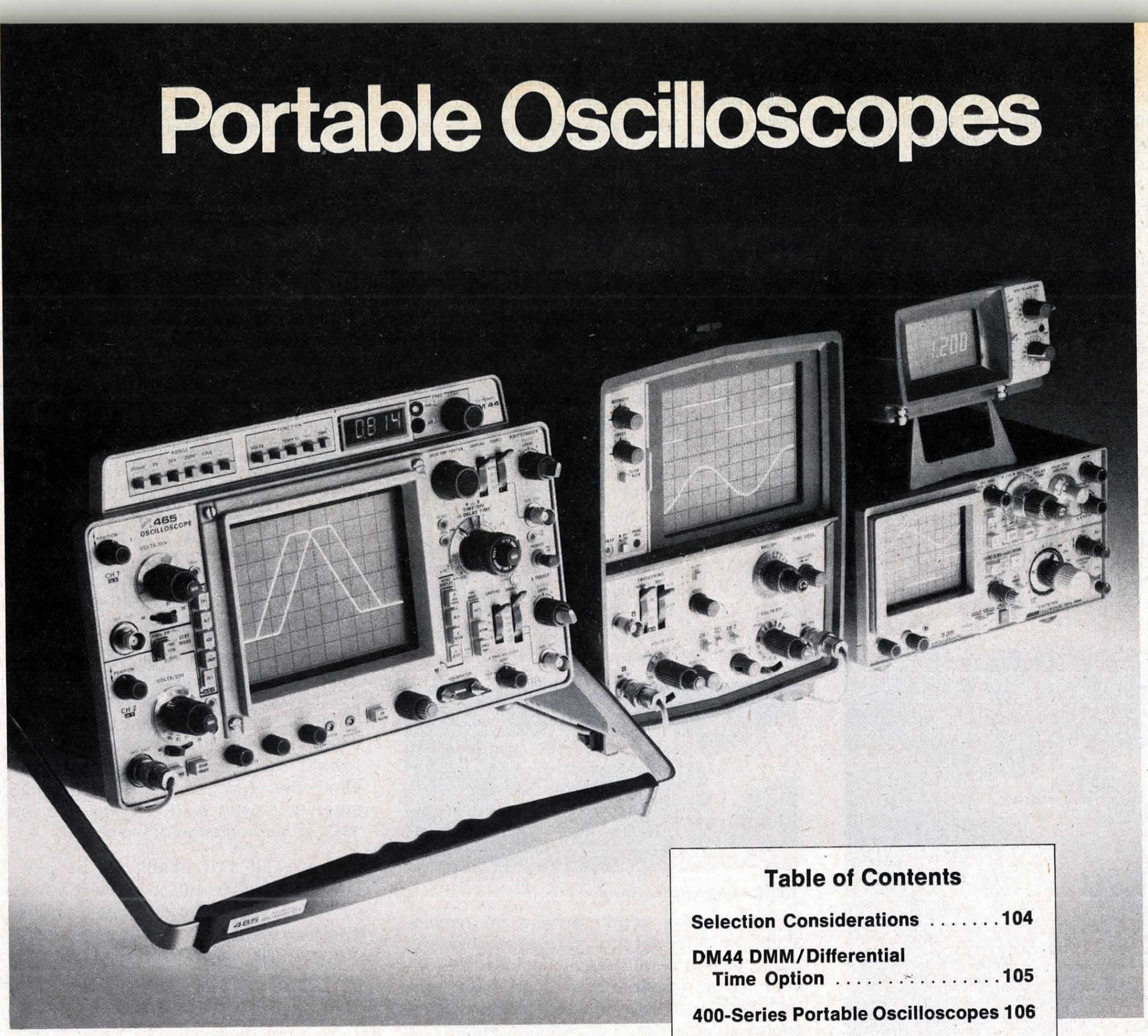
Auto Triggered Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff — Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode — For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

5S14N Sampler **$2470**

Portable Oscilloscopes



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Choose the TEKTRONIX Portable that's right for your application.

For Accuracy and Versatility in the Field, Take One of Our 22 Portable Oscilloscopes.

	Product	Bw	Dual Trace	Delayed Sweep	Fastest Sweep Rate	Other Special Features	Price
Storage Models	466	100 MHz @ 5 mV/div	yes	yes	5 ns/div	3000 div/μs stored writing speed	$5355
	464	100 MHz @ 5 mV/div	yes	yes	5 ns/div	110 div/μs stored writing speed	4375
	434	25 MHz @ 10 mV/div	yes		20 ns/div	Split-screen storage	3480
	314	10 MHz @ 1 mV/div	yes		100 ns/div	Only 10.5 lbs (4.8 kg)	2645
	214	500 kHz @ 10 mV/div	yes		1 μs/div	Only 3.5 lbs (1.6 kg)	1595
	T912	10 MHz @ 2 mV/div	yes		50 ns/div	Low-cost bistable storage	1545
Nonstorage Models	485	350 MHz @ 5 mV/div	yes	yes	1 ns/div	Widest bw in a portable	5725
	475A	250 MHz @ 5 mV/div	yes	yes	1 ns/div	High-performance 250-MHz portable	3800
	475	200 MHz @ 2 mV/div	yes	yes	1 ns/div	Highest gain-bw in a portable	3435
	465	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 100-MHz bw	2495
	465M	100 MHz @ 5 mV/div	yes	yes	5 ns/div	Triservice standard 100-MHz scope	2620
	455	50 MHz @ 5 mV/div	yes	yes	5 ns/div	Cost effective for 50-MHz bw	2055
	335	35 MHz @ 10 mV/div	yes	yes	20 ns/div	Only 10.5 lbs (4.8 kg)	2175
	305	5 MHz @ 5 mV/div	yes		0.1 μs/div	Autoranging DMM	1725
	221	5 MHz @ 5 mV/div			100 ns/div	Only 3.5 lbs (1.6 kg)	1190
	213	1 MHz @ 20 mV/div			400 ns/div	DMM/Oscilloscope @ 3.7 lbs (1.7 kg)	1595
	212	500 kHz @ 10 mV/div	yes		1 μs/div	Low cost for dual trace & battery	1190
	T935A	35 MHz @ 2 mV/div	yes	yes	10 ns/div	Variable trigger-holdoff and differential	1535
	T932A	35 MHz @ 2 mV/div	yes		10 ns/div	Variable trigger-holdoff and differential	1245
	T922	15 MHz @ 2mV/div	yes		20 ns/div	Low-cost dual-trace scope	975
	T922R	15 MHz @ 2mV/div	yes		20 ns/div	Rackmount version of T922	1345
	T921	15 MHz @ 2mV/div			20 ns/div	Lowest-cost TEKTRONIX Portable	795
Time Interval Readout	DM44	Optional, factory-installed, direct numerical readout of time intervals and DMM functions for the 464, 465, 466, 475 and 475A					445

Tektronix offers an unmatched selection of 21 portable oscilloscopes, including six storage models, designed to meet the testing requirements of the electronics industry. These high-quality scopes are used for computer servicing, communication system maintenance, research, education, and production testing.

Your specific measurement needs should guide you in selecting the TEKTRONIX Portable that's best for you. First consider your performance, price and weight requirements. Then choose a model from one of our four oscilloscope lines. Each combines portability, reliability and ruggedness with unique features and capabilities.

400-Series Performance Leaders

Take lab quality into the field with TEKTRONIX 400-Series Portable Oscilloscopes. Choose from nine models including the 350-MHz 485, the widest bandwidth portable available today and the 100-MHz High-Speed Storage 466 with a 3000 div/μs (1350 cm/μs) stored writing speed.

These instruments are backed by our exclusive IC and crt technology, years of reliability testing and continuing commitment to excellence in scope design. All weigh less than 26 pounds (11.8 kg). Various models feature bandwidths from 25 MHz to 350 MHz, dual trace, delayed sweep, high-speed storage, external trigger view, graticule illumination, variable-trigger holdoff and optional battery power with the 1106 Clip-on Battery Pack (when the scope is ordered with Option 07). For easy operation, all have color-coded controls and an automatic volts/div readout (except for the environmentalized 465M). The DM 44 Option, a direct numerical readout available on five models allows simple, quick, and highly accurate differential-time and DMM measurements.

Take advantage of the 400-Series' unique features for your computer servicing, point-of-purchase terminal repair, and communication system maintenance applications. Or use one of the 400-Series Scopes in its rackmount version for your in-plant service or production testing work. Descriptions of these nine lab-quality models begin on page 105.

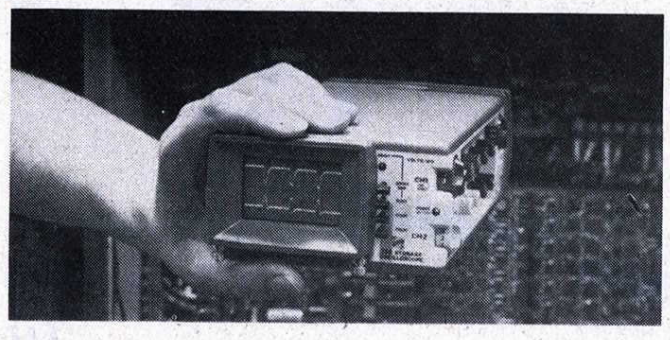
300-Series Portables—Excellent Size/Weight/Performance Combinations

SONY®/TEKTRONIX® 300-Series Oscilloscopes prove that a precision scope can weigh less than 11 pounds (5.0 kg) and still contain many of the high performance capabilities found on our 400-Series Portables. This family features bandwidths from 5 MHz to 35 MHz, long-term storage, delayed sweep, battery operation and low power consumption.

Sony/Tektronix Corporation builds these portables tough to withstand the strains of high altitude and extreme humidity. Two models are especially designed for severe environments and meet the MIL-Std-202C, Method 106B test for humidity.

New this year is the 5-MHz SONY/TEKTRONIX 305/DMM scope that features a built-in DMM plus the portability you require.

Take one of our three 300-Series Scopes with you for servicing medical electronics, on-board ship equipment, or remote computer terminals — wherever light-weight, medium-size scopes are required. Detailed specifications begin on page 116.



200-Series Miniscopes

Have you ever tried carrying an oscilloscope up a ladder and across a catwalk in a processing plant? Or wished that the offshore platform had a nearby ac power outlet? Then you know that for many oscilloscope applications, light weight, small size and battery operation are absolute necessities.

The TEKTRONIX 200-Series Miniscopes are powered by rechargeable, internal NICAD batteries or external ac, and weigh less than 3.7 pounds (1.7 kg) each. These four instruments offer solutions to your measurement requirements that you can hold in your hand.

We designed the 200 Series for portability and ease-of-operation. Then we added the features most useful for remote servicing. Bandwidths range from 500 kHz to 5 MHz. The 214 offers storage capabilities while the 213 combines scope and DMM functions.

Attached color-coded probes and cable storage compartments facilitate scope set-up and operation. Simplified slope and triggering controls make one-hand operation easy. Included neck straps free your hands for other tasks. Rugged impact-resistant cases on these double-insulated instruments afford shock protection and make floating measurements possible. Their 6 x 10 division (0.5 cm/div) crts are easy to read. And with their small, 3 x 5.25 x 9.50 inch (7.6 x 13.2 x 22.6 cm) size, each 200-Series Miniscope fits easily into your briefcase or toolbox.

Examine the features of the four 200-Series models begnning on page 119. We think you'll find that these oscilloscopes really are the perfect traveling companions.

T900-Series Low-Cost Oscilloscopes

T900-Series Oscilloscopes combine low cost with Tektronix quality and reliability. Choose from five bench-top models and one rack-mount. Bandwidths range from 10 MHz to 35 MHz. Family capabilities include dual trace, delayed sweep, variable-trigger holdoff and bistable storage—all at a price your instrumentation budget will appreciate.

We build several features into all our T900 scopes that make them ideal for education, production testing, consumer electronics repair, and general service applications. Their large, bright, 8 x 10 cm crts are especially useful during classroom demonstrations. Simple control design and color-coded front panels make teaching scope operation fast and easy. For television repair, tv triggering capabilities are standard on the non-storage models. At 18 pounds (8.2 kg) or less, the five bench-top models are light-weight, rugged and easy to transport. And to make the price even more attractive, we include 10X attenuation probes with these five scopes.

The T900-Series design focuses on reliability and ease-of-operation. All critical active components are pretested to insure high reliability. Modular circuitry simplifies calibration and repair. A beam finder helps you locate the trace. An external graticule eliminates parallax errors in crucial measurements. And built-in delay line lets you see the leading edge of the signal.

To increase the capabilities of your T900 Instrument while still keeping it a truly low-cost portable, we've developed an inexpensive line of accessories like the C-5B Camera, modular probes, a dust cover and a viewing hood. Accessories begin on page 128. T900 specifications start on page 123.

Accessories to Complete Your Oscilloscope System

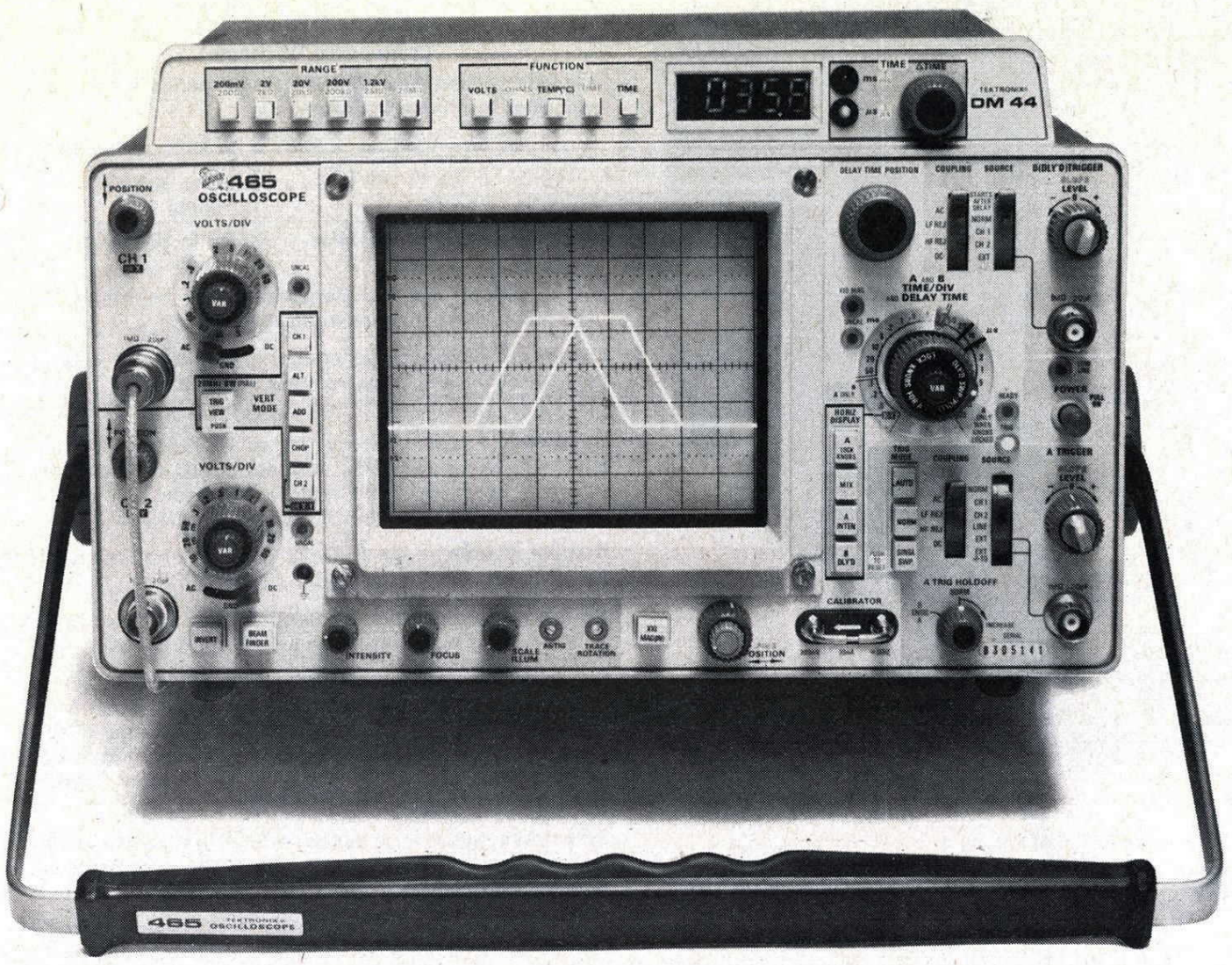
Extend your measurement capabilities with TEKTRONIX Probes, Cameras, Battery Packs and SCOPE-MOBILE® Carts.

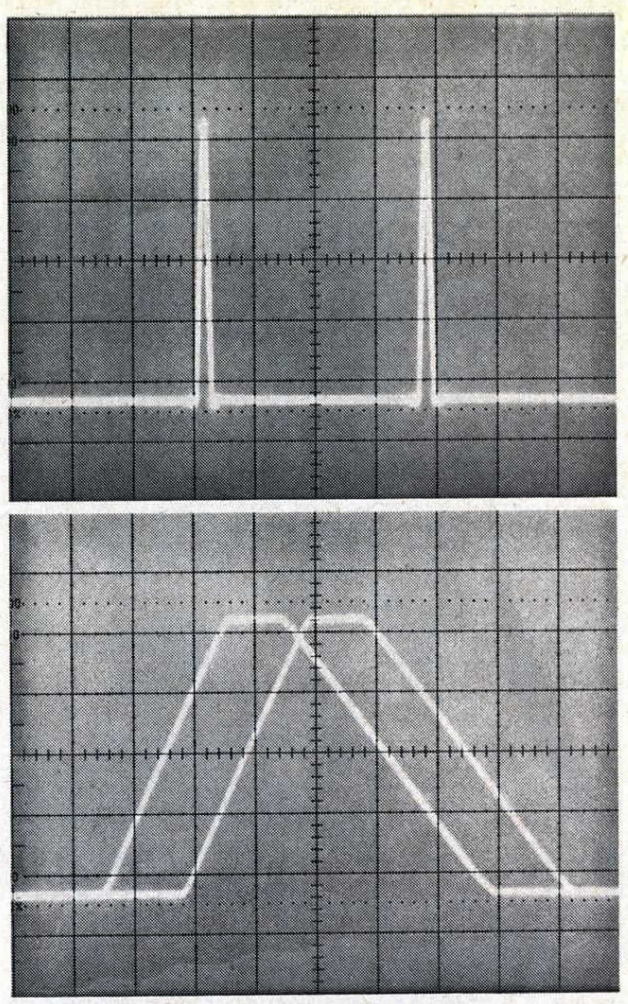
A complete line of voltage, current, temperature, FET and logic probes are designed to work efficiently with your TEKTRONIX Oscilloscope. Scope cameras let you record the results of your work. Two battery packs can power your oscilloscope where line power isn't available. And a SCOPE-MOBILE® Cart makes transporting your test equipment easy.

Recommended probes, cameras, carts and accessories are included in the ordering information for each oscilloscope. For complete information on battery packs, see page 128. For all other accessories, page 209.

To find out more about how Tektronix Portable Oscilloscopes will satisfy your performance, applications, service and price requirements, contact your nearest Tektronix Field Office (p. 248). Ask your Field Engineers for a demonstartion of how we can satisfy your applications needs.

Or, mail the reply card at the back of this catalog and tell us what we can do for you —literature, planning assistance or a demonstration. For even faster service, call us toll-free within the Continental U.S. at 1-800-547-1512.





DM 44 DIFFERENTIAL-TIME/DMM OPTION

1% timing measurements were never this easy! With the DM 44 Option, available on five TEKTRONIX 400-Series Portables, time intervals can be read directly from the 3½ digit LED screen. Simply use the Delay Time control and the Δ time dial to position intensified spots at the beginning and end of the interval you wish to measure(A). Next, switch to delayed sweep and use the Δ time dial to superimpose the end of the interval on the beginning (B). Then read its differential time or frequency from the 3½ digit LED panel (C). It's that simple. Time intervals are accurate to 1% and the frequency of periodic waveforms can be read out with 2% accuracy by simply pushing the 1/Time button.

Compare the DM 44 sequence with the measurement technique you may now be using. Calculating the interval from the crt may take 10 times as long.

Voltage, resistance, and temperature measurements are also much easier with a DM 44-equipped 400-Series Oscilloscope. The DM 44 measures dc voltage with 0.1% accuracy, resistance with 0.3% accuracy, and temperature from −55°C to 150°C. Previously, you would have needed a separate DMM and digital thermometer in addition to your oscilloscope. Now, these features are combined in one small, inexpensive, integral package.

The DM 44 is available as a factory-installed option on the 464, 465, 466, 475 and 475A Portables. It adds Delta Delayed Sweep and independent DMM capabilities to these 400-Series Scopes. First, consider your bandwidth, sensitivty, storage, and price requirements. Then specify the DM 44 Option for simple and accurate digital measurements.

DM 44 CHARACTERISTICS

Timing Measurements

Differential Time Delay Accuracy —

+15°C to +35°C	−15°C to +55°C	
used with 464, 465, 466, 475, and 475A	used with 464, 465, and 466	used with 475 and 475A
within 1% of reading ±1 count	within 2.5% of reading ±1 count	within 1.5% of reading ±1 count

1/Time Accuracy —

+15°C to +35°C	−15°C to +55°C	
used with 464, 465, 466, 475, and 475A	used with 464, 465, and 466	used with 475 and 475A
within 2% of reading ±1 count	within 3.5% of reading ±1 count	within 3% of reading ±1 count

Dc Voltage

Ranges — 0-200 mV, 0-2 V, 0-20 V, 0-200 V, 0-1.2 kV.

Resolution — 100 μV.

Accuracy — Within 0.1% of reading ±1 count.

Input Resistance — 10 MΩ for all ranges. Removal of an internal strap increases resistance to approximately 1000 MΩ on 200 mV and 2 V ranges.

Normal-Mode Rejection Ratio — At least 60 dB at 50 Hz and 60 Hz.

Common-Mode Rejection Ratio — At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz.

Recycle Rate — Approximately 3.3 measurements/s.

Response Time — Within 0.5 s.

Maximum Safe Input Voltage — ±1200 V dc + peak ac between + and common inputs or between + and chassis. ±500 V (dc + peak ac) common floating voltage between common and chassis.

Resistance

Ranges — 0-200 Ω, 0-2 kΩ, 0-20 kΩ, 0-200 kΩ, 0-2 MΩ and 0-20 MΩ.

Resolution — 0.1 Ω.

Accuracy —

Range	Accuracy
200 Ω	within 0.25% ±1 count + probe resistance
2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ	within 0.25% ±1 count
20 MΩ	within 0.3% ±1 count

Recycle Rate — Approximately 3.3 measurements/s.

Response Time —

200 Ω through 200 kΩ ranges	within 1 s
2 MΩ ranges 20 MΩ ranges	within 5 s

Maximum Safe Input Voltage — 120 V rms between + and common inputs.

Temperature Using P6430 Probe

Range — −55°C to +150°C

Accuracy —

DM 44 Temp	P6430 Tip Temp	Accuracy: probe calibrated to DM 44	Accuracy: probe not calibrated to DM 44
+15°C to +35°C	−55°C to +150°C	±2°C	±6°C
−15°C to +55°C	−55°C to +125°C	±3°C	±8°C
	+125°C to +150°C	±4°C	±8°C

INCLUDED ACCESSORIES

One pair, Test Leads (003-0120-00), one P6430 Temperature Probe (010-6430-00).

ORDERING INFORMATION

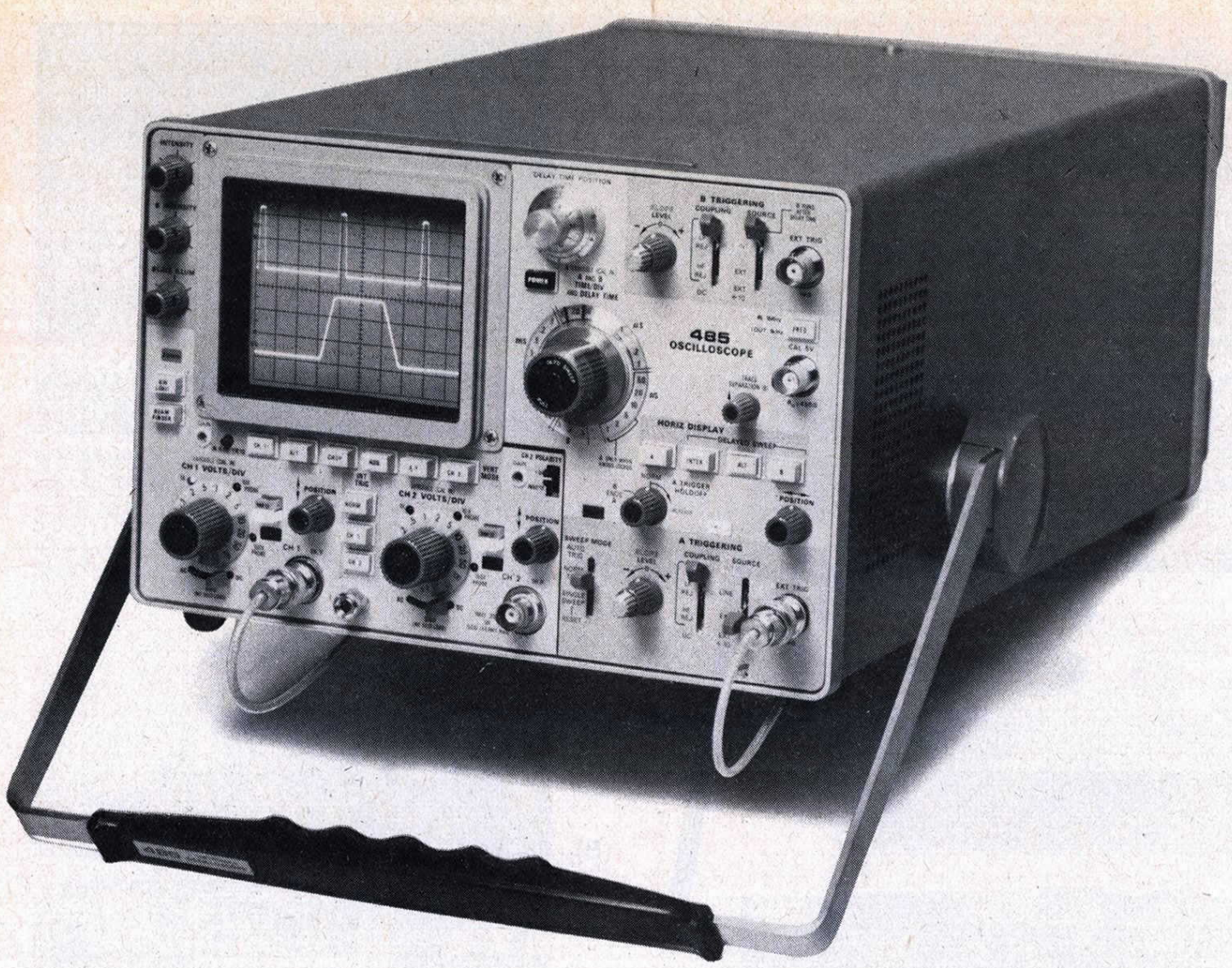
465 DM 44 ..... $2940
475 DM 44 ..... $3880
475A DM 44 (Order 475A Option 44) . $4245
466 DM 44 ..... $5800
464 DM 44 ..... $4820

Option 01, delete temperature probe (for 475A order Option 45) ..... Subtract $85

Modification kits for field conversion of existing 464s, 465s, 466s, 475s, and 475As to DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

400-Series Portable Oscilloscopes

350 MHz Dual Trace Oscilloscope



350 MHz at 5 mV/div

1 ns/div Sweep Rate

3.0 div/ns Writing Speed

1 MΩ and 50 Ω Input Impedances

Input Protection 50 Ω Internal

Automatic Deflection Factor Readout

Pushbutton Ext Trigger View

Battery Operation (Optional)

Weighs ≈21 lb

At just 21 pounds, the 1 ns/div dual-trace 485 is the only truly portable 350-MHz oscilloscope on the market. This wide bandwidth is one reason why the 485 is highly compatible with today's increasing technology.

Many features contribute to the 485's extraordinary overall performance. Fast 3.0 div/ns writing speed is one, making it especially attractive for use in field research environments.

The 485 features a wide bandwidth at its full 5 mV/div vertical sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ). Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes.

Internal detection circuitry protects the 50 Ω input by automatically disconnecting when the signal exceeds approximately 5 V rms.

You no longer have to mentally compensate for attenuating probes. Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen V/div when the recommended 10X or 100X probes are used.

And you always know exactly where you are in a pulse train when making a delayed sweep measurement. An alternate sweep mode allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, you can view the intensified zone and the delayed display simultaneously.

The external trigger signal can be easily viewed on the 485. A front-panel pushbutton automatically routes the external signal used to trigger Time Base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

On the 485, focus is always correct in single-shot photography. An autofocus circuit eliminates the need to readjust the focus each time the intensity is changed.

When commercial power is not available, use the 1105 Battery Power Supply. It weighs only 19.5 pounds, and lets you take the high-performance 485 virtually anywhere.

Often chosen as a general-purpose scope for computer and electronic servicing environments because of its fast writing speed and wide bandwidth, the 485 can also be found in specialized and unusual applications. For example, to maintain a ground-based laser/radar acquisition system, the 485's alternate sweep switching mode proved an important factor.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source).

	−15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

*Measured at −3 dB. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling 1X probe: 1 kHz or less for 50 Ω, and 10 Hz or less for 1 MΩ. 10X probe: 100 Hz or less for 50 Ω, and 1 Hz or less for 1 MΩ.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Display Modes — Ch 1, Ch 2 (normal and inverted), X-Y (Ch 1-Y and Ch 2-X), ADD (Ch 1 ± Ch 2).

CMRR — Common-mode rejection ratio at least 20 dB at 50 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X, 10X, and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

Selectable Input Impedance — 50 Ω and 1 MΩ impedances are available at a single BNC connector by pushbutton selection.

50 Ω ±0.5%; 1.15:1 or less from 20 mV/div to 5 V/div to 350 MHz, vswr 1.25:1 or less at 5 mV/div to 10 mV/div.

Input R and C — 1 MΩ ±1% paralleled by approx 20 pF.

50 Ω Protection — Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 V. The "disconnected" condition is indicated, and has manual reset.

Max Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approx: 5 V rms continuous 0.1 watt-second for instantaneous voltages of 5 V to 50 V.	
	Ac Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
1 MΩ	Dc Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
	Ac Coupled	500 V (dc + peak ac). 500 V p-p to 1 kHz.

Selectable Input Coupling — Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

Delay Line — Permits viewing leading edge of displayed waveform.

Probe Power — Connectors provide correct voltages for two optional P6201 FET probes.

HORIZONTAL DEFLECTION

Time Base A and B — Calibrated sweep range; 1 ns/div to 0.5 s/div (1-2-5 sequence).

Variable Time Control — Time Base A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div.

Time Base A and B Accuracy, center 8 div

Sweep Rate	+15°C to +35°C	−15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

Horizontal Display Modes — A, intensified, alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2, and 5 ns/div. B ends A for increased intensity in the delayed mode.

Alternate Display Modes — Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed sweep approx 4 div from the A sweep).

CALIBRATED SWEEP DELAY

Delay Time Range — 0 to X10 delay time/div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	± (1% of measurement +0.2% of full scale)
50 ns/div to 1 ms/div	± (0.5% of measurement +0.1% of full scale)
2 ms/div to 0.5 s/div	± (1% of measurement +0.1% of full scale)

Full scale is 10 times the delay time/div setting.

Jitter — 1 part or less in 20,000 of X10 the time/div setting.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for faster than 0.2 s/div.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity

Coupling		To 50 MHz	To 350 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection
	External	20 mV	100 mV
Ac		Signals below 16 Hz are attenuated	
Ac	Lf Reject	Signals below 16 kHz are attenuated	
Ac	Hf Reject	Signals below 16 Hz and above 50 kHz are attenuated	

Jitter — 0.1 ns or less at 350 MHz at 1 ns/div.

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for Ext ÷ 10.

A Sources — Internal, line, external, external ÷ 10.

B Sources — B runs after delay time, internal, external, external ÷ 10.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. Max input voltage; 500 V (dc + peak ac), 500 V p-p to 1 kHz.

X-Y OPERATION

Full Sensitivity X-Y (Ch 1 Vert, Ch 2 Horiz) — 5 mV/div to 5 V/div, accurate ±2%. Y-axis bandwidth identical to Channel 1. X-axis bandwidth is dc to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

DISPLAY

Crt — 8 x 10 div display, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2 div increments. P31 phosphor standard; P11 optional. 21 kV accelerating potential.

Photographic Writing Speed — At least 1.5 div/ns with standard P31 phosphor and at least 3 div/ns with optional P11 phosphor using the TEKTRONIX C-31R Camera and 3000 speed film.

Auto Focus — Automatically maintains beam focus for all intensity settings.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

Z-Axis Input — Rise time ≃15 ns. Input R ≃500 Ω. +0.2 V (dc to 20 MHz) decreases intensity. + 2 V (dc to 2 MHz) blanks max intensity trace.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −35°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes. .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 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).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator — Output resistance is 450 Ω with a rise time (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V ±0.5% into 1 MΩ and 0.5 V ±1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA ±1%. Selectable repetition rates are 1 kHz and 1 MHz ±0.25%. Specifications apply over +15°C to +35°C range.

A Sweep Output — Open circuit, approx 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs — Open circuit, approx 4 V positive-going rectangular pulse; into 50 Ω approx 0.5 V.

Power Requirements — Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 W max power consumption at 115 V. Line frequency 48 to 440 Hz.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**cm**
Height	6.6	16.8	7.0	17.7
Width	12.0	30.5	19.0	48.3
Depth			18.0	45.7
(handle extended)	20.6	52.3		
(handle not extended)	18.5	47.0		
Weights (Approx)	**lb**	**kg**	**lb**	**kg**
Net (with accessories)	24	10.9		
Net (without accessories)	21	9.5	26.2	11.9
Shipping	33	15	54	24.5

INCLUDED ACCESSORIES

50-Ω, 18-inch BNC cable (012-0076-00), two BNC jack posts (012-0092-00), two 50-Ω terminators (011-0049-01), clear filter (386-0118-00), four 3-amp fuses (159-0015-00), accessory pouch (016-0535-00) or (016-0537-00). Rack models also include mounting hardware and slide out assemblies.

ORDERING INFORMATION

485 Oscilloscope **$5725**

R485 Oscilloscope, 7 in Rack Model . **$5850**

485-1 or R485-1 Oscilloscope, without A Ext Trigger Display ..... **Sub $100**

485-2 or R485-2 Oscilloscope, without A Ext Trigger Display and with 50 Ω input only instead of selectable input impedance ..... **Sub $350**

INSTRUMENT OPTIONS

Option 04 Emc Modification ..... **Add $75**

Option 78 P11 Phosphor **$35**

For more information on instrument options, see your Tektronix Field Engineer, Distributor, or Representative.

OPTIONAL ACCESSORIES

Probes —

Input Terminal	Probe Type	Attenuation	Input Impedance	Bandwidth* with 485
50 Ω Input	P6056 6 ft	10X	500 Ω 1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω 1 pF	350 MHz
	P6201 FET 2 Meter	1X	100 kΩ 3 pF	330 MHz
		10X Head	1 MΩ 1.5 pF	
		100X Head	1 MΩ 1.5 pF	
50 Ω or 1 MΩ	P6202 2 Meter	10X 100X Head (optional)	10 MΩ 2 pF	285 MHz
	P6106 2 Meter	10X	10 MΩ 13 pF	250 MHz
1 MΩ Input	P6063B 6 ft	1X Switchable 10X	1 MΩ 12 pF	6 MHz
			10 MΩ 14 pF	200 MHz

Current Probe	Probe Type	Calibration	Insertion Impedance	Bandwidth* with 485
	P6022	1 mA/mV 10 mA/mV (Selectable)	.03 Ω @ 1 MHz Increasing to .2 Ω @ 120 MHz	130 MHz

*Bandwidths are measured at the upper −3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Current Loop Adapter — The adapter provides an accurate 50 mA square-wave calibrator when connected to the 485 voltage calibrator. The rise time is approx 25 ns.

Order 012-0341-00 ..... **$30**

50 Ω 5X Pad — Provides reverse termination for the calibrator.

Order 011-0060-02 ..... **$35**

Folding Viewing Hoods — Folds to 7/16 x 4½ x 7½ in. (1.2 x 11.5 x 19.1 cm).

Order 016-0274-00 ..... **$12**

Folds to 7/16 x 6¾ x 13¾ in. (1.4 x 17.2 x 34.9 cm).

Order 016-0082-00 ..... **$15**

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.

Order 200C **$190**

1105 Battery Power Supply — Provides 2.3 hours of battery operation.

Order 1105 Battery Power Supply **$915**

Rack Adapter — 016-0558-00 ..... **$180**

RECOMMENDED CAMERAS

C-30AP General Purpose Camera — Includes 016-0306-00 mounting adapter.

Order C-30AP **$925**

C-31R High Speed Camera — Includes 016-0306-00 mounting adapter.

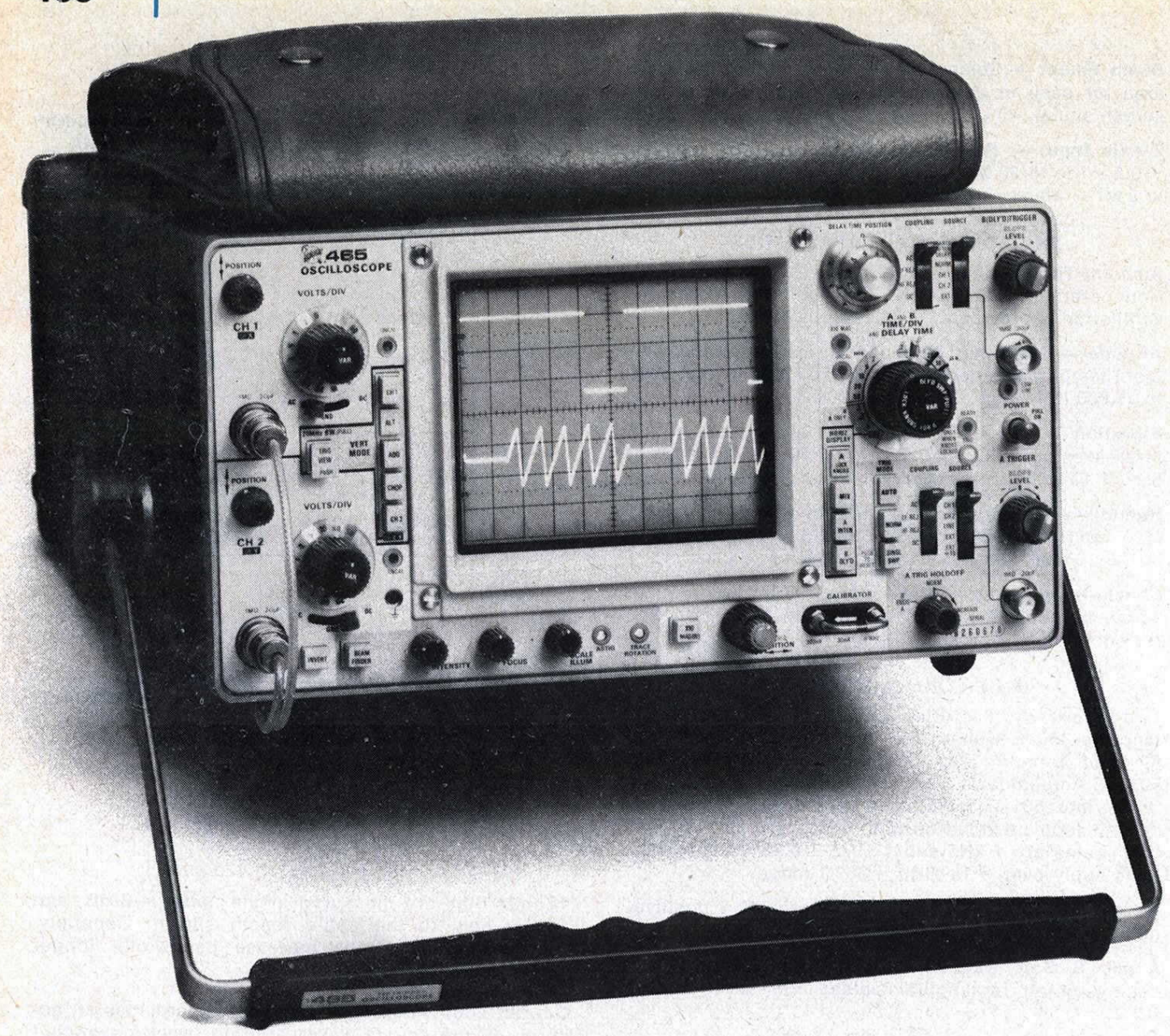
Order C-31R **$1100**

For further information see camera section.

475A
475
465

400-Series Portable Oscilloscopes

250-MHz, 200-MHz, and 100-MHz Dual-Trace Oscilloscopes



Except for the TIME/DIV and VOLTS/DIV controls, the 465 pictured above is identical in appearance to the 475 and 475A.

1 ns/div Sweep Rate (475) (475A) with X10 Sweep Magnifier

5 ns/div Sweep Rate (465) with X10 Sweep Magnifier

Trigger View

Versatile Trigger Selection

Battery Operation (Optional)

Weighs ≈22¾ lb

All three of these TEKTRONIX Portables feature high performance and light weight for making complex measurements in the field.

1) The 475A provides a 250 MHz bandwidth at 5 mV/div. It features wider bandwidth than the 475, plus a more concise spot size and trace for particular applications.

2) With 200 MHz at 2 mV/div, the 475 features better sensitivity than the 475A. This bandwidth/sensitivity combination is useful in a wide variety of measurements.

3) The 465, long considered the industry standard, features 100 MHz at 5 mV/div.

Both the 475 and 475A offer 1% (1 ns/div) timing accuracy, which can be critical in servicing computers. The 465 can be found in numerous service applications, and has proved to be one of the most popular oscilloscopes available.

All three oscilloscopes are light, compact, and rugged for portability and durability, yet each contains a large, bright 8 x 10 cm crt. Operation has been simplified by single-function pushbuttons, control knob design, layout, and color-coordinated front panels.

Determining deflection factors used to be error-prone and costly. Now, it's a problem of the past... readout lights behind knob skirts automatically indicate the proper probe tip deflection factors for recommended 1X and 10X probes.

Measuring with respect to ground is important in many applications. This is controlled at the probe when dc-coupled by simply pressing the small ground reference button on recommended probes.

You can choose from the 1105 or 1106 Battery Packs. Both are small and light weight, and provide a ready solution for making accurate measurements in difficult environments such as conducted emc, ground loops, power line fluctuations or where line power is nonexistent.

Applications for these three instruments are widespread. The 475 performs tests and measurements aboard flight test aircraft, in both stationary and portable modes. The 465 troubleshoots radio/remote-controlled cranes. The 465 is also used to maintain mini-computers for one of the nation's largest department store chains. And a leading computer hardware manufacturer uses the 465 because of its wide bandwidth.

CHARACTERISTICS

All characteristics are common to the 465, 475 and 475A except where indicated.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth* and Rise Time — (at all deflection factors from 50 Ω terminated source)

	−15°C to +40°C	+40°C to +55°C
465	Dc to 100 MHz, 3.5 ns	85 MHz, 4.1 ns
475	Dc to 200 MHz, 1.8 ns	175 MHz, 2.0 ns
475A	Dc to 250 MHz, 1.4 ns	250 MHz, 1.4 ns

*Measured at −3 dB, Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

Deflection Factor at BW
465 — 5 mV/div to 5 V/div
475 — 2 mV/div to 5 V/div
475A — 5 mV/div to 10 V/div

1-2-5 sequence, accurate ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div (465/475) to at least 25 V/div (475A). In cascade mode sensitivity is approx 1 mV/div (465); approx 400 μV/div (475); and approx 2.5 mV/div (475A). Cascaded bandwidth is at least 50 MHz (465/475/475A) when signal out is terminated in 50 Ω.

Display Modes — Ch 1; Ch 2 (normal and inverted), alternate, chopped (465 — approx 250 kHz rate, 475/475A — approx 1 MHz rate), added; X-Y (Ch 1-X, Ch 2-Y).

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz (50 MHz for 475/475A) for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

Probe Power (475/475A only) — Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

465

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends max sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends max sweep rate to 5 ns/div.

475/475A

Time Base A and B — 0.01 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends max sweep rate to 1 ns/div.

Variable Time Control — Time Base A (465/475/475A provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C		−15°C to +55°C	
	465	475/475A	465	475/475A
Unmagnified	±2%	±1%	±3%	±2%
Magnified	±3%	±2%	±4%	±3%

Horizontal Display Modes — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by delay-time position control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range

465 — 0.2 to X10 delay time/div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

475/475A — 0 to X10 delay time/div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
over one or more major dial divisions	±1%
less than one major dial division	±0.01 major dial division

Jitter — 1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling —

Coupling		465		475		475A	
		To 25 MHz	At 100 MHz	To 40 MHz	At 200 MHz	to 40 MHz	At 250 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection	0.3 div deflection	1.5 div deflection	0.3 div deflection	2.0 div deflection
	External	50 mV	150 mV	50 mV	250 mV	50 mV	250 mV
	External ÷ 10	500 mV	1.5 V	500 mV	2.5 V	500 mV	2.5 V
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					

465 Jitter — 0.5 ns or less at 100 MHz and 5 ns/div.

475 Jitter — 0.2 ns or less at 200 MHz and 1 ns/div.

475A Jitter — 0.2 ns or less at 250 MHz and 1 ns/div.

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷ 10.

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷ 10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

465

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

475, 475A

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert) — 2 mV/div to 5 V/div (475), 5 mV to 10 V/div (475A) accurate ±3%. Bandwidth is dc to at least 3 MHz. Phase difference between amplifiers is 1° or less from dc to 1 MHz.

DISPLAY

Crt — 8 x 10 cm display. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 phosphor standard; P11 option. 18 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A pre-set intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Filtered forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 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).

Shock — Operating and nonoperating: 30 g's ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — (465) Ch 1 vertical signal is dc to at least 50 MHz (−3 dB), and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ. (475/475A) Ch 2 vertical signal is dc to at least 50 MHz (−3 dB), and approx 10 mV/div terminated into 50 Ω, and approx 20 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quick-change line voltage selector provides six ranges; 110 V, 115 V, 120 V. 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, 75 watts (465) or 100 watts (475, 475A) max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

Dimensions	Cabinet in	Cabinet cm	Rackmount in	Rackmount cm
Height (w/o pouch)	6.2	15.7	7.0	17.7
Width (with handle)	12.9	32.8	19.0	48.3
Depth (with panel cover)	18.1	46.0	18.0	45.7
Depth (handle extended)	20.3	51.6		
Weights (approx)	**lb**	**kg**	**lb**	**kg**
Net (without panel cover)	22.8	10.3	29.4	13.3
Net (with panel cover and accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

INCLUDED ACCESSORIES

Two P6105 10X probes (010-6105-03) (465 only), two P6106 10X probes (010-6106-03) (475/475A only), blue accessory pouch (016-0594-00), clear pouch (016-0537-00), blue crt light filter (337-1674-00), clear crt light filter (337-1674-01), BNC male to ground wire (134-0016-01), two 1½-amp fuses (159-0016-00), one ¾-amp fuse (159-0042-00). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouches.

ORDERING INFORMATION

465 Oscilloscope **$2495**
475 Oscilloscope **$3435**
475A Oscilloscope **$3800**
R465 Oscilloscope **$2620**
R475 Oscilloscope **$3560**
R475A Oscilloscope **$3925**
465 DM 44 ..... **$2940**
475 DM 44 ..... **$3880**
475A DM 44 (order 475A Option 44, see following instrument options).

INSTRUMENT OPTIONS

Option 01, delete temperature probe on DM 44. (for 475A order Option 45) ..... **Sub $85**
Option 04, Emc Environmental ..... **Add $125**
Option 05, Tv Sync Separator (465 only) ..... **Add $185**
Option 07, Ext Dc Operation ..... **Add $180**
Option 07 cannot be ordered with DM 44.
Option 44, Built-in DMM (475A only) ..... **Add $445**
Option 45, Built-in DMM without temperature probe (475A only) ..... **Add $360**
Option 78, P11 Phosphor **$35**

Modification kits for field conversion of existing 465s, 475s, or 475As to Option 04, Option 07, or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 465	475	475A
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz	6 MHz	6 MHz
	Switchable 10X	10 MΩ 14 pF	90 MHz	145 MHz	160 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	100 MHz	185 MHz	220 MHz
	100X Head	10 MΩ 2 pF	100 MHz	185 MHz	220 MHz
	Ac Head	10 MΩ 4 pF	100 MHz	185 MHz	220 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 465**	**475**	**475A**
P6022 5 ft	1 mA/mV 10 mA/mV (Selectable)	.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz	125 MHz	160 MHz

*Bandwidths are measured at the upper −3 dB and apply only to the cable length shown. Generally shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Folding Polarized Viewing Hood — Order 016-0180-00 ..... **$23**
Collapsible Viewing Hood — Binocular **Order 016-0566-00** **$13**
Protective Cover — Waterproof, blue vinyl **Order 016-0554-00** **$18**
Mesh Filter — Improves contrast and emc filtering **Order 378-0726-01** **$33**
SCOPE-MOBILE® Cart — Occupies less than 18 in aisle space, has storage area in base **Order 200C** **$190**
1106 Battery Pack (for use with Option 07) **$675**
1105 Battery Power Supply **$915**
Rack Adapter — 016-0556-00 ..... **$160**

RECOMMENDED CAMERA

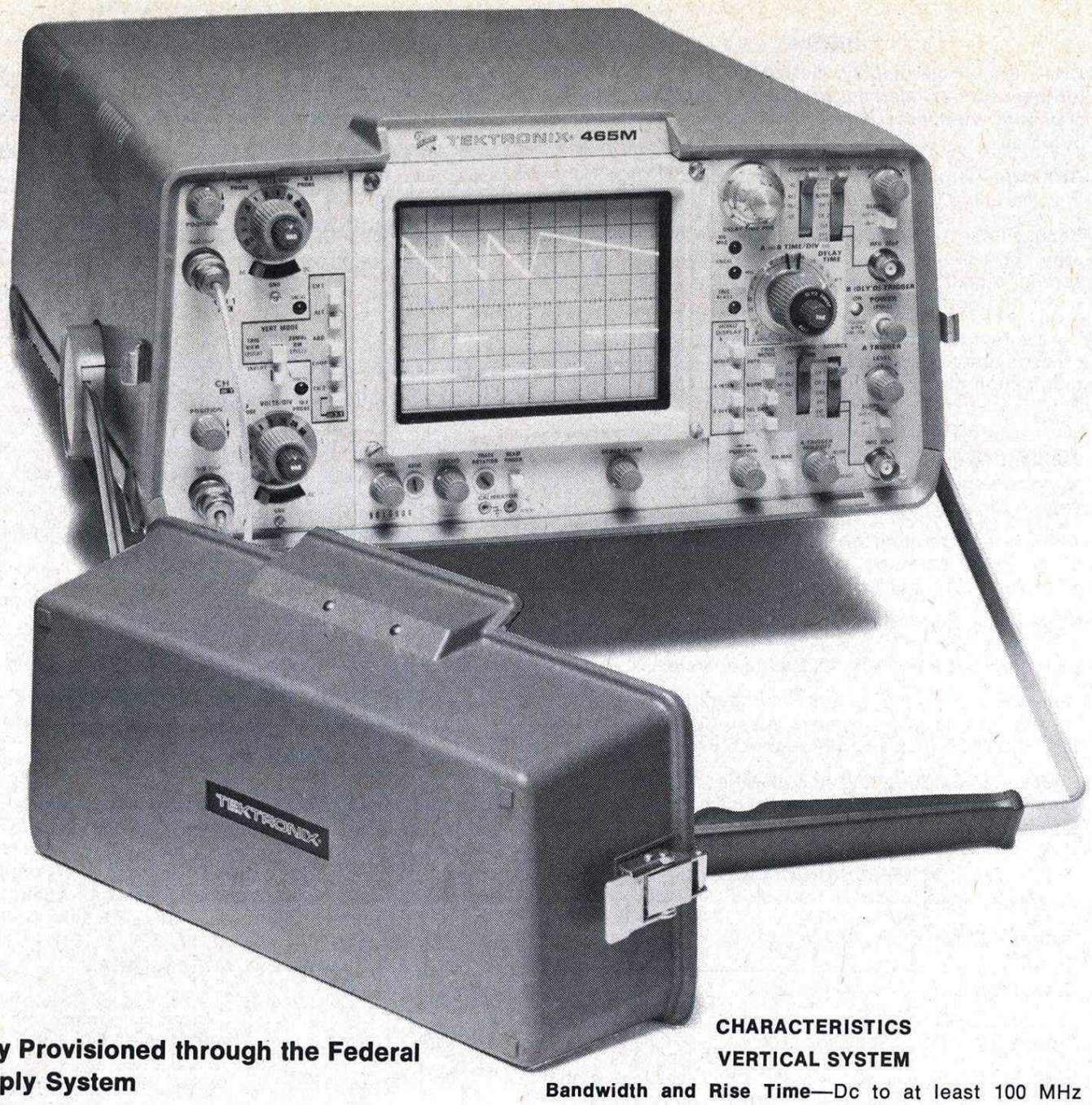
C-30AP Option 01 General Purpose Compact Camera
Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30AP Option 01 ..... **$945**

For further information see camera section.

465M (AN/USM 425 (V)1)

400-Series Portable Oscilloscopes

100 MHz Dual Trace, Delayed Sweep Oscilloscope



Fully Provisioned through the Federal Supply System

Meets MIL-T-28800, Type II, Class 4, Style C for the Environmental Conditions Listed

100 MHz at 5 mV/div, Dual Trace, Delayed Sweep

Accepted and Specified by All Branches of the Military and by Several Civil Agencies

If you're a contractor involved in designing and specifying systems for the government, here's a 100-MHz oscilloscope that should top your recommended support equipment list—the TEKTRONIX 465M Portable Oscilloscope.

The TEKTRONIX 465M is the AN/USM-425 (v) 1 tri-service standard 100-MHz portable oscilloscope. The instrument is accepted, fully provisioned, and supported throughout the Federal Supply System. Because the MIL manuals and support documentation are already complete, your required paper work is greatly reduced and it's much simpler for the government to accept your recommendations.

You can now order the 465M directly from your Tektronix Field Engineer with the AN/USM 425 (v) 1 nomenclature by simply specifying option 49. This assures, in most cases, the fastest possible delivery of your AN/USM 425 (v) 1.

CHARACTERISTICS

VERTICAL SYSTEM

Bandwidth and Rise Time—Dc to at least 100 MHz (−3 dB) and rise time 3.5 ns or less for dc coupling and −15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Bandwidth Limit Mode—Bandwidth limited to 20 MHz.

Deflection Factor—5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Dc accuracy: ±2% 0°C to 40°C; ±3% −15°C to 0°C, 40°C to 55°C. Uncalibrated, continuously variable between settings, and to at least 12.5 V/div.

Common-Mode Rejection Ratio—25:1 to 10 MHz; 10:1 from 10 to 50 MHz, 6 cm sinewave. (ADD Mode with Ch 2 inverted.)

Display Modes—Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

Input R and C—1 MΩ ±2%, approx 20 pF.

Max Input Voltage—Dc or ac coupled: ±250 V dc + peak ac at 50 kHz, derated above 50 kHz.

Cascaded Operation—(Ch 2 Out into Ch 1), Bandwidth, dc to at least 40 MHz. Sensitivity, approx 1 mV/div when terminated in 50 Ω at Ch 1 input with both Ch 1 and Ch 2 V/div switches set to 5 mV/div.

HORIZONTAL DEFLECTION

Time Base A—0.5 s/div to 0.05 μs/div in 22 steps (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Time Base B—50 ms/div to 0.05 μs/div in 19 steps (1-2-5 sequence). X10 mag extends maximum sweep rate to 5 ns/div.

Accuracy—

	Unmagnified	Magnified
+20°C to +30°C	±2%	±3%
−15°C to +55°C	±3%	±4%

Mixed Sweep Accuracy—A Portion—±4%
B portion—±2%.

Horizontal Display Modes—A, A intensified by B, B delayed by A, and mixed.

CALIBRATED SWEEP DELAY

Calibrated Delay Time—Continuous from 0.1 μs to at least 5 s after the start of the delaying A sweep.

Differential Time Measurement Accuracy—for measurements of two or more major dial divisions:
+15°C to +35°C 1% + .1% of full scale
0°C to +55°C additional 1% allowed.

Jitter—1 part or less in 20,000 (0.005%) of 10X the A TIME/DIV switch setting.

TRIGGERING A AND B

A Trigger Modes—Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: A bright baseline is displayed in the absence of input signals. Triggering is the same as normal-mode above 40 Hz. Single: (Main time base only). The sweep occurs once with the same triggering as normal. The capability to re-arm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for rearming.

A Trigger Holdoff—Increases A sweep holdoff time to at least 10X the TIME/DIV settings, except at .2 s and .5 s.

Triggering Sensitivity and Coupling—

Coupling		From 30 Hz to 25 MHz	At 100 MHz
Dc	Internal	0.3 div	1.0 div
	External	50 mV	150 mV
Ac	Attenuates signals below		30 Hz
Ac Lf Reject	Attenuates signals below		15 kHz
Ac Hf Reject	Attenuates signals below		50 kHz

Jitter—0.5 ns or less at 100 MHz and 5 ns/div, −15°C to +55°C.

Trigger View—View external and internal trigger signals; Ext X1, 100 mV/div, Ext ÷ 10, 1 V/div.

Level and Slope—Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0 V and −1.0 V on either slope of the trigger signal.

A Sources—Ch 1, Ch 2, NORM (all display modes triggered by the combined waveforms from Ch 1 and 2), LINE, EXT, EXT ÷ 10.

B Sources—B starts after delay time; Ch 1, Ch 2, NORM, EXT, EXT ÷ 10.

X-Y OPERATION

Sensitivity—5 mV/div to 5 V/div in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/div.

X Axis Bandwidth—Dc to at least 4 MHz.

Y Axis Bandwidth—Dc to 100 MHz.

X-Y Phase—Less than 3° from dc to 50 kHz.

SIGNAL OUTPUTS

A Gate—Approx 5.0 V positive-going pulse.

B Gate—Approx 5.0 V positive.

DISPLAY

Crt—5 in, rectangular tube; 8 x 10 cm display; P31 phosphor.

Graticule—Internal, non-parallax; illuminated. 8 x 10 cm markings with horizontal and vertical centerlines further marked in 0.2 cm increments. 10% and 90% markings for rise time measurements.

Graticule Illumination—Provides variable illumination from 0 to greater than optimum illumination.

Beam Finder—Limits the display to within the graticule area and provides a visible display when pushed.

Z-axis Input—A female BNC connector is provided to permit intensity modulation over the dc to 15 MHz range. At optimum intensity, intensity modulation is accomplished with a Z axis input of from −5 V (to intensify) to +5 V (to blank). Continuous operation maximum input shall be ±50 V (dc + peak ac).

ENVIRONMENTAL

EMI—Complies with the following limits as specified in MIL-T-28800B. CE01 (10 kHz to 20 kHz only), CE03, CS01, CS02, CS06, RE01 (relaxed 10 dB at fundamental, third harmonic, and fifth harmonic of the power source frequency), RE02 (limited to 1 GHz), RS01 and RS03 (limited to 1 GHz).

Ambient Temperature—Operating: −0°C to +55°C. Non-operating: −62°C to +85°C.

Altitude—Operating: to 15,000 feet. Max operating temperature decreased 1° C/1,000 ft above 5,000 ft Non-operating: to 50,000 ft

Vibration—Operating: along each of the three major axes:
a. cycling 5 to 25 to 5 Hz for 10 min at 0.025 in p-p;
b. cycling 25 to 55 to 25 Hz for 5 min at 0.020 in p-p;
c. dwelled at 55 Hz for 10 min at 0.020 in p-p.
Total vibration time 75 min.

Humidity—5 cycles (120 hours) referenced to MIL-E-16400F (operating and non-operating).

Shock—Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks each direction per axis for a total of 18 shocks.

OTHER CHARACTERISTICS

Calibrator Output Voltage—1.0 V ±1.0% −15°C to +55°C. Frequency approx 1 kHz.

Channel 2 Signal Output—Through main module Ch 2 OUT connector. Output voltage: approx 50 mV/div into 1 MΩ, approx 25 mV/div into 50 Ω. Output resistance: approx 50 Ω. Bandwidth: dc to at least 40 MHz into 50 Ω.

Power Requirements—100 V to 132 V rms, 200 V to 264 V rms. 48 Hz to 440 Hz. Maximum power consumption 60 watts at 115 V, 60 Hz.

Dimensions	in	cm
Height (with feet)	7.05	17.91
Width (with handle)	13.65	34.67
Width (without handle)	12.50	31.75
Depth (including panel cover)	24.45	54.58
Depth (handle extended)	24.10	61.10
Weight (approx)	**lbs**	**kg**
Net (without cover and accessories)	24.0	10.9
Net (with panel cover, modules, and accessories)	27.0	12.2
Shipping	34.2	15.5

Transportation—Meets the limits of National Safe Transit Committee test procedure 1A with a 30-in drop.

Included Accessories—One accessory and cover assembly (200-2055-01), one 1X probe (010-6101-00), two 10X probes (010-6104-00), three pincer tips (013-0107-03), two UHF male to BNC female adapters (103-0015-00), two BNC male to UHF female adapters (103-0032-00), one T connector (103-0030-00), one BNC male to dual binding post adapter (103-0035-00), three probe tip adapters (103-0051-01), three banana tips (134-0013-00), three 6″ leads with spring clips (175-0124-01), three hooked probe tips (206-0105-00), one blue filter (337-2122-00), one clear filter (337-2122-01), three miniature alligator clips (344-0046-00), one power cord (161-0118-00).

ORDERING INFORMATION

465M Portable Oscilloscope **$2620**

Option 49AN/USM 425 (v) 1 nomenclature .. **No Charge**

OPTIONAL ACCESSORIES

Probe—P6022 Current Probe, 5 ft cable with termination.
Order 015-0135-01 ..... **$250**

Folding Polarized Viewing Hood
Order 016-0180-00 ..... **$23**

Mesh Filter—Improves contrast and emi filtering.
Order 378-0726-01 ..... **$33**

SCOPE-MOBILE® Cart—Occupies less than 18 in of aisle space.
Order 200-C **$190**

1105 Battery Power Supply—Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply **$915**

Rack Adapter (Cradle Mount) Kit—Rack height 7 in, depth 18¾ in, width 19
Order 040-0825-00 ..... **$215**

RECOMMENDED CAMERA

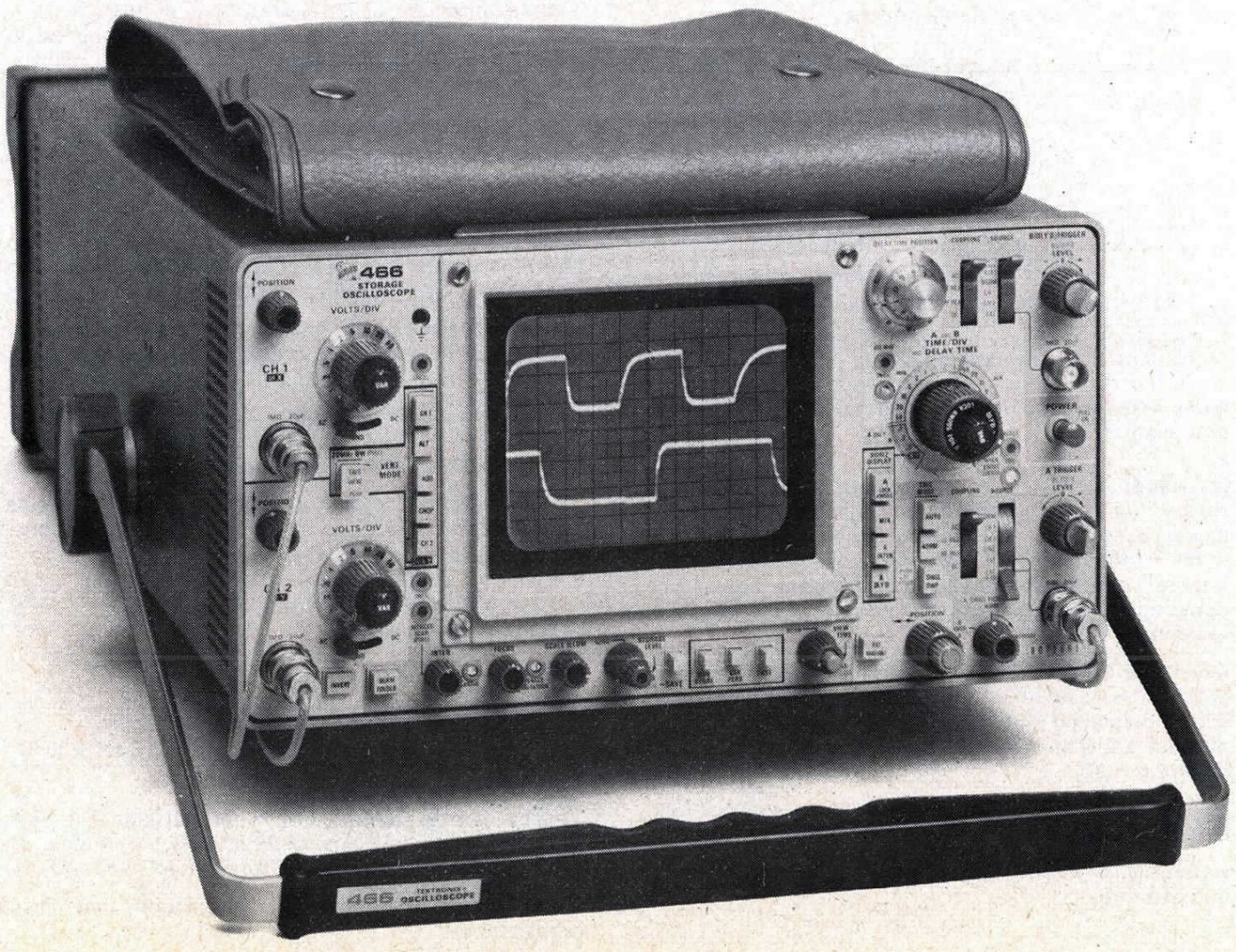
C-30AP Option 01 General Purpose Camera—Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30AP Option 01 Camera **$945**

For further information see camera section.

400-Series Portable Oscilloscopes

100-MHz Storage Oscilloscopes

466
464



100 MHz at 5 mV/div

5 ns/div Sweep Rate with X10 Sweep Magnifier

Variable Persistence and Fast Mesh Transfer Storage Modes

3000 div/μs Stored Writing Speed (466)

Battery Operation (Optional)

Third Channel Trigger View now available on 466 and 464

Weighs ≈26 lb

The 466 and 464 Portable Storage Oscilloscopes are both designed to display non-repetitive or slow moving signals. And with the exception of stored writing speed on the 466, both instruments offer similar performance.

Operating in a reduced scan mode, the stored writing speed of the 466 is 3000 div/μs (1350 cm/μs) making it our fastest portable storage oscilloscope available. The lower cost 464 doesn't offer a reduced scan mode and stores at 110 div/μs. Both instruments feature two modes of storage — variable persistence and fast transfer.

The bright 8 x 10 cm crt on both instruments comprises 0.90 cm/divisions. In the 466, reduced scan graticule is superimposed over the center of the main graticule, measuring 8 x 10 divisions with 0.45 cm/division. All graticules are etched onto the inner face of the crt to eliminate parallax problems.

Third channel trigger view option is now available for the 466 and 464. This option allows the simultaneous display of channels 1 and 2 with the external trigger.

TEKTRONIX P6062B Probes provide operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

Light weight plus the ability to use optional, external dc power makes both the 466 and 464 sufficiently portable for virtually all field measurement applications. The snap-on 1106 Battery Pack is also useful in isolating these oscilloscopes from noisy or intermittent power sources.

CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — at all deflection factors from 50 Ω terminated source.

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, ≤3.5 ns	Dc to 85 MHz, ≤4.15 ns

*Measured at −3 dB down. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch. Lower −3 dB point, ac coupling 1X probe; 10 Hz or less. 10X probe; 1 Hz or less.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence); accurate ±3%. Uncalibrated, continuously variable between steps and to approx 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Cascaded bandwith is at least 50 MHz when signal out is terminated in 50 Ω.

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (approx 250 kHz), added, X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 20 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 20 pF.

Max Input Voltage —

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends sweep rate to 5 hs/div.

Variable Time Control — Time Base A — Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy — full 10 cm

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, mixed sweep, A intensified, B delayed. B ends A for increased intensity in the delayed mode.

Calibrated Mixed Sweep — Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy —

Delay Time Setting	+15°C to +35°C	−15°C to +55°C
over one or more major dial div	±1%	±2.5%
less than one major dial div	±0.01 major dial div	±0.025 major dial div

Jitter — 1 part or less in 50,000 (0.002%) of X10 the A sweep time/div setting.

TRIGGERING A and B

A Trigger Modes — Normal (sweep runs when triggered), automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz). Single sweep (sweep runs one time on the first triggering event after the reset selector is pressed). Lights indicate when sweep is triggered and when single sweep is ready.

A Trigger Holdoff — Adjustable control permits a stable presentation of repetitive complex waveforms. At least 10:1 variation.

B Trigger Modes — B starts after delay time (starts automatically at the end of the delay time), B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity and Coupling —

Coupling		To 25 MHz	At 100 MHz
Dc	Int	0.3 div deflection	1.5 div deflection
	Ext	50 mV	150 mV
	Ext ÷ 10	500 mV	1.5 V
Ac	Ac Lf Reject	Requirements increase below 60 Hz	
		Requirements increase below 50 kHz	
	Ac Hf Reject	Requirements increase below 30 Hz and above 50 kHz	

Jitter — 0.5 ns or less at 100 MHz and 5 ns/div (X10 mag).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with external ÷ 10 source).

Level and Slope — Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform. Level adjustment through at least ±2 V in external, through at least ±20 V in external ÷ 10.

A Sources — Norm, Ch 1, Ch 2, line, external and external ÷ 10.

B Sources — Starts after delay, norm, Ch 1, Ch 2, and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

Third Channel Trigger View Specifications (Option 10)

Deflection Factor (Dc trigger coupling only)

EXT	100 mV/div ±5%
EXT ÷ 10	1 V/div ±5%

Delay difference (to CH 1 or CH 2) 3.5 ±1 ns

Trigger point is approximately center screen.

Risetime ≤5 ns.

Abberration <10% peak-to-peak.

X-Y OPERATION

Full Sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers in 3° or less from dc to 50 kHz.

DISPLAY

Crt — 8 x 10 div display, each div is 0.9 cm (normal); 0.45 cm/div (reduced scan). 8.5 kV accelerating potential, normal-mode, 10 kV reduced scan. P31 phosphor.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal. A preset intensity level provides a constant brightness.

Z-Axis Input — Dc coupled, positive-going signal decreases intensity; 5 V p-p signal causes noticeable modulation at normal intensity; dc to 50 MHz.

STORED WRITING SPEEDS

	466	464	Storage* View Time
Full Scan (Center 6 x 8 div; 0.9 cm/div)			
FAST	150 div/μs	110 div/μs	>15s
VARIABLE PERSISTANCE	0.5 div/μs	0.5 div/μs	>15s
Reduced Scan (Center 8 x 10 div; 0.45 cm/div)			
FAST	3,000 div/μs	Reduced Scan not available on 464	>15s
VARIABLE PERSISTANCE	3 div/μs		>15s

*These times are at full-stored display intensity; they can be extended at least 25 times using reduced intensity in SAVE Display Mode.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C. Forced air ventilation is provided.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 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).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator —

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Vertical Signal Output — Ch 1 vertical signal is dc to at least 50 MHz and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — Positive gates from both time bases (approx 5 V).

Power Requirements — Quick-change line voltage selector provides six ranges: 110 V, 115 V, 120 V, 220 V, 230 V, and 240 V, each ±10%. 48 to 440 Hz, 100 W max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07.

Dimensions	in	cm
Height (w/o pouch)	6.2	15.9
Width (with handle)	13.0	33.0
Depth (with panel cover)	21.7	55.0
Depth (handle extended)	23.5	59.7
Weights (approx)	**lb**	**kg**
Net (without panel cover or accessories)	26.0	11.8
Net (with panel cover and accessories)	29.8	13.5
Shipping	41.5	18.8

INCLUDED ACCESSORIES

Two P6062B Probes (010-6062-13), blue accessory pouch (016-0535-02), clear pouch (016-0537-00), crt light filter (337-1674-01), two 1½ amp fuses (159-0016-00), one ¾ amp fuse (159-0042-00), adapter, ground wire (134-0016-01), viewing hood (016-0592-00).

ORDERING INFORMATION

466 Storage Oscilloscope **$5355**

466 DM 44 Storage Oscilloscope/ Multimeter **$5800**

464 Storage Oscilloscope **$4375**

464 DM 44 Storage Oscilloscope/ Multimeter **$4820**

INSTRUMENT OPTIONS

Option 01, delete DM 44 temperature probe (466 DM 44, 464 DM 44 only) . . . . . **Sub $85**

Option 04, Emc Environmental . . . . . **Add $125**

Option 05, Tv Sync Separator . . . . . **Add $185**

Option 07, Ext Dc Operation (Option 07 cannot be ordered with DM 44) . . **Add $180**

Option 10, Third Channel Trigger View . . . . . **Add $75 (Option 10 cannot be ordered with Option 05)**

Modification kits for field conversion of existing 466s and 464s to Option 07 or DM 44 equipped scopes are available. These are typically more expensive than when the option is ordered with the instrument. Contact your Tektronix Field Engineer, Distributor, or Representative for information.

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 464/466
P6063B 6 ft	1X	1 MΩ 105 pF	6 MHz
	Switchable 10X	10 MΩ 14 pF	90 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ 2 pF	100 MHz
	100X Head	10 MΩ 2 pF	
	Ac Head	10 MΩ 4 pF	
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 464/466**
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz

*Bandwidths are measured at the upper —3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

OPTIONAL ACCESSORIES

1106 Battery Pack (used with Option 07) **$675**

1105 Battery Power Supply **$915**

Mesh Filter — Improves display contrast in high ambient light. **Order 378-0726-01** **$33**

Protective Cover — Waterproof vinyl. For 464/466 **Order 016-0365-00** **$19**

Folding Viewing Hood — Order 016-0592-00 . . . **$11.50**

Folding Binocular Hood — Order 016-0566-00 . . . . **$13**

Polarized Collapsible Viewing Hood — Order 016-0180-00 . . . . . **$23**

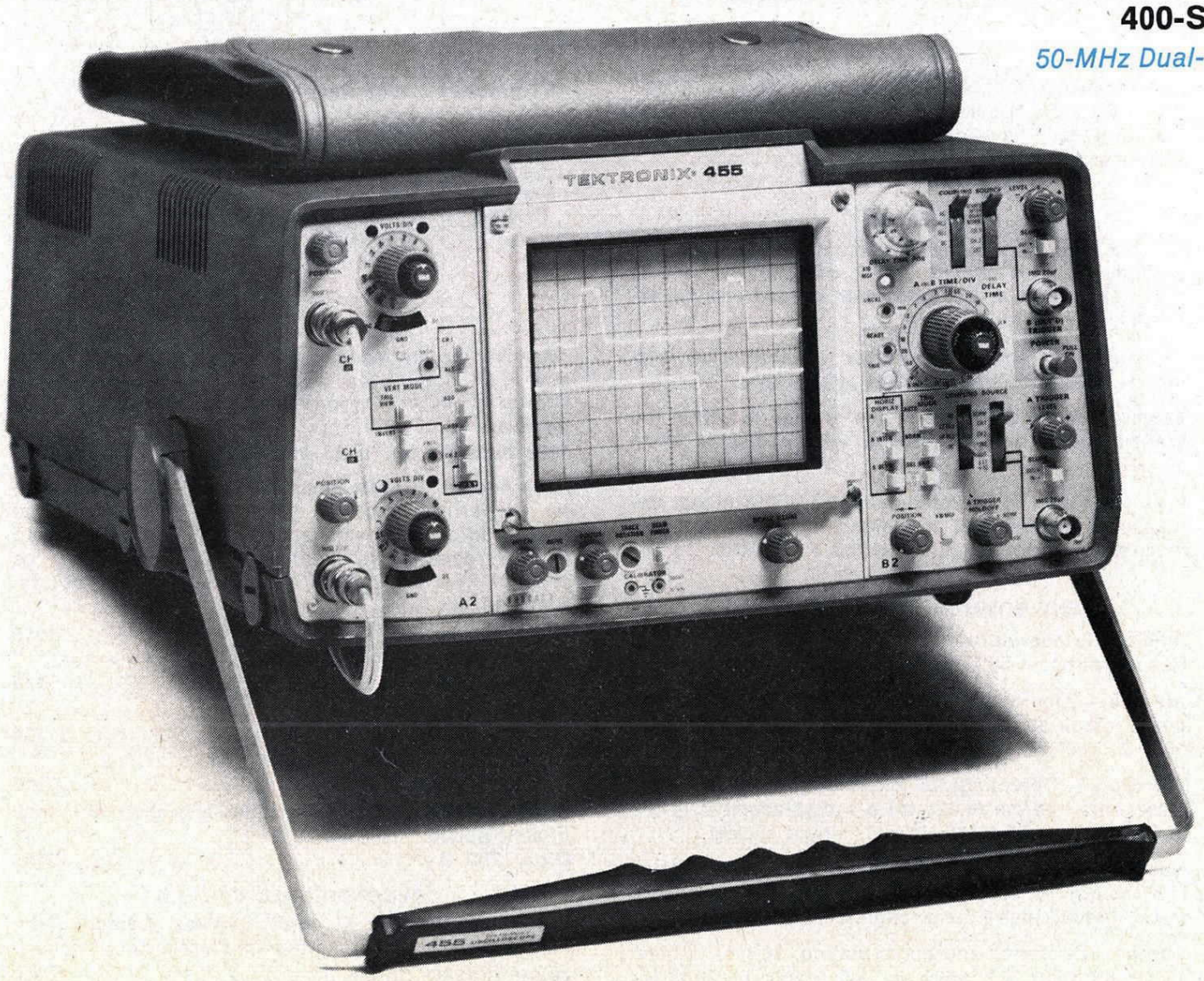
SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base. **Order 200C** **$190**

RECOMMENDED CAMERA

C-30AP Option 01 General Purpose Camera — Includes 016-0301-00 mounting adapter/corrector lens. **Order C-30AP Option 01** **$945**

Camera Adapter — Mounts C-30A Series Camera to 464/466 Oscilloscopes. **Order 016-0301-00** **$85**

For further information see Camera section.



400-Series Portable Oscilloscopes

50-MHz Dual-Trace, Delayed Sweep Oscilloscope

50 MHz at 5 mV/div

5 ns/div Sweep Rate with X10 Sweep Magnifier

Trigger View

Dual-Trace, Delayed Sweep

Battery Operation (Optional)

The 455, the 400-Series value leader, is a rugged and economical portable that retains the high performance of the 400-Series.

Special features of the 455 let you check trigger signal presence and timing at the push of a button, without moving the probes. Errors in amplitude readings are minimized through lighted vertical deflection factor readout. 1X and 10X probes are automatically accounted for by the readout. If the 455's modular probes should become damaged, the probe tip, cable or compensation unit can be quickly and inexpensively replaced. A large 8 x 10 cm display permits easy viewing, yet the control area remains uncrowded.

An important 455 option, adding to versatility, is the snap-on 1106 Battery Pack.

Modular design means easy serviceability. Vertical amplifier and time-base modules

can be quickly removed for ready access to all components, making repairs faster and less costly.

Calibration time is reduced with the 455. A minimum number of adjustments, made possible by actively trimmed networks, simplifies procedures and saves calibration time.

The 455 is extremely easy to operate, thanks to well-laid-out, color-coded controls. This means minimum operator training time, plus easier, faster, more error-free measurements.

The value leading 455 is an economy/performance, general-purpose oscilloscope. Though its price is moderate, it accommodates most measurements required in digital service.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Rise Time — Bandwidth dc to at least 50 MHz and rise time 7.0 ns or less, at all deflection factors from 50-Ω terminated source. Lower —3 dB point, ac coupling 1X probe: 10 Hz or less. 10X probe: 1 Hz or less.

*Measured at —3 dB.

Deflection Factor — 5 mV/div to 5 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. In cascade mode sensitivity is approx 1 mV/div. Cascaded bandwidth is at least 20 MHz, when signal out is terminated in 50 Ω.

Display Modes — Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two lighted indicators beside the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2%, approx 20 pF.

Max Input Voltage —

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Time Base B — 0.05 μs/div to 50 ms/div (1-2-5 sequence). X10 mag extends fastest sweep rate to 5 ns/div.

Variable Time Control — Time Base A, provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, Full 10 Cm —

	+20°C to +30°C	—15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes — A, A intensified by B, B delayed. B ends A for increased intensity in the delayed mode.

CALIBRATED SWEEP DELAY

Delay Time Range — 0.2 to X10 delay time/div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

Differential Time Measurement Accuracy —

Delay Time Settings	+15°C to +35°C
Over one or more major dial divisions	1.5%
Less than one major dial division	±0.015 major dial division

Jitter — 1 part or less in 20,000 (0.005%) of 10X the A sweep time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal Sweep (runs when triggered), single sweep (runs one time on the first triggering event after the single sweep pushbutton is pressed). Automatic (sweep free-runs in the absence of a trigger and for signals below 20 Hz). Lights indicate when single sweep is ready.

A Trigger Hold-off — Adjustable control permits a stable presentation of repetitive complex waveforms.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time) and B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once, following the A sweep delay time, in each of these modes.

Time Base A and B Trigger Sensitivity and Coupling—

Coupling		To 10 MHz	At 50 MHz
Dc	Internal	0.4 div deflection	1.5 div deflection
	External	50 mV	250 mV
	External ÷ 10	500 mV	2.5 V
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		

Jitter — 0.5 ns or less at 50 MHz and 5 ns/div (X10 MAG on).

A Trigger View — A spring-loaded pushbutton overrides other vertical controls and displays the external signal used for A sweep triggering. Provides quick verification of external trigger and time comparison between external trigger and the displayed signal. Deflection factor approx 50 mV/div (0.5 V/div in external ÷ 10 mode).

Level and Slope — Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits triggering on any level between —2 V and +2 V (—20 V to +20 V for external ÷ 10).

A Sources — Norm, Ch 1, Ch 2, line, external, and external ÷ 10.

B Sources — Starts after delay, norm, Ch 1, Ch 2 and external.

External Inputs — R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

Full-sensitivity X-Y (Ch 1 Horiz, Ch 2 Vert) — 5 mV/div to 5 V/div, accurate ±4%. Bandwidth is dc to at least 3 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

DISPLAY

Crt — 8 x 10 cm display, horizontal and vertical center lines further marked in 0.2 cm increments: P31 phosphor standard, P11 phosphor optional. 12 kV accelerating potential.

Graticule — Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder — Compresses the display to within the graticule area and provides a visible display when pushed.

Z-axis Input — Dc coupled, positive-going signal decreases intensity: 5 V p-p signal causes noticeable modulation at normal intensity: dc to 20 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: —15°C to +55°C. Nonoperating: —55°C to +75°C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 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).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V ±1%. Frequency approx 1 kHz.

Vertical Signal Output — Ch 2 vertical signal is dc to at least 20 MHz and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ.

Gate Outputs — (approx 5 V) internally selectable from either A or B time base.

Power Requirements — Quick change line voltage selector provides two ranges: 100 V to 132 V, 200 V to 264 V, 48 Hz to 440 Hz. Power consumption 35 watts at 115 V, 60 Hz. Operation from 12 V or 24 V dc is available with Option 07.

Dimensions	in	cm
Height (w/o pouch)	7.1	17.9
Width (with handle)	13.7	34.7
Depth (with panel cover)	19.5	49.5
Depth (handle extended)	21.7	55.2
Depth (handle not extended)		
Weight (approx)	**lb**	**kg**
Net (without panel cover)	24.0	10.9
Net (with panel cover and accessories)	27.0	12.2
Shipping	34.2	15.5

INCLUDED ACCESSORIES

Two P6105 probes (010-6105-03), blue accessory pouch (016-0339-00), clear pouch (016-0537-00), clear crt filter (337-2122-01), adapter (134-0016-01) ½-A fuses (159-0025-00), two 2-A fuses (159-0021-00), one 1-A fuse (159-0022-00).

ORDERING INFORMATION

455/A2/B2 Portable Oscilloscope . . . $2055

INSTRUMENT OPTIONS

Option 04 Emc Modification ..... **Add $125**
Option 05 Tv Sync Separator ..... **Add $185**
Option 07 External Dc Operation ..... **Add $180**
Option 78 P11 Phosphor **$35**

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 455
P6062B 6 ft	1X Switchable	1 MΩ 105 pF	6.7 MHz
	10X	10 MΩ 14 pF	50 MHz
P6202	10X	10 MΩ 2 pF	50 MHz
FET probe	100X Head	10 MΩ 2 pF	
2 meter	Ac Head	10 MΩ 4 pF	
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 455**
P6022	10 mA/mV 1 mA/mV	.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	47 MHz

*Bandwidths are measured at the upper —3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

1106 Battery Pack (used with Option 07) .... **Add $675**

Rack Adapter (Cradle Mount) Kit — Includes hardware for converting standard 455 to 19 in rack installation. Cradle mount consists of a shelf and a mask to fit over regular instrument panel. Instrument can be slid out from rack. Rack height 7 in, depth 18¾ in, width 19 in.

Order 040-0825-00 ..... **$215**

Protective Cover — Waterproof, blue vinyl.
Order 016-0344-00 ..... **$18**

Folding Viewing Hood — Polarized
Order 016-0180-00 ..... **$23**

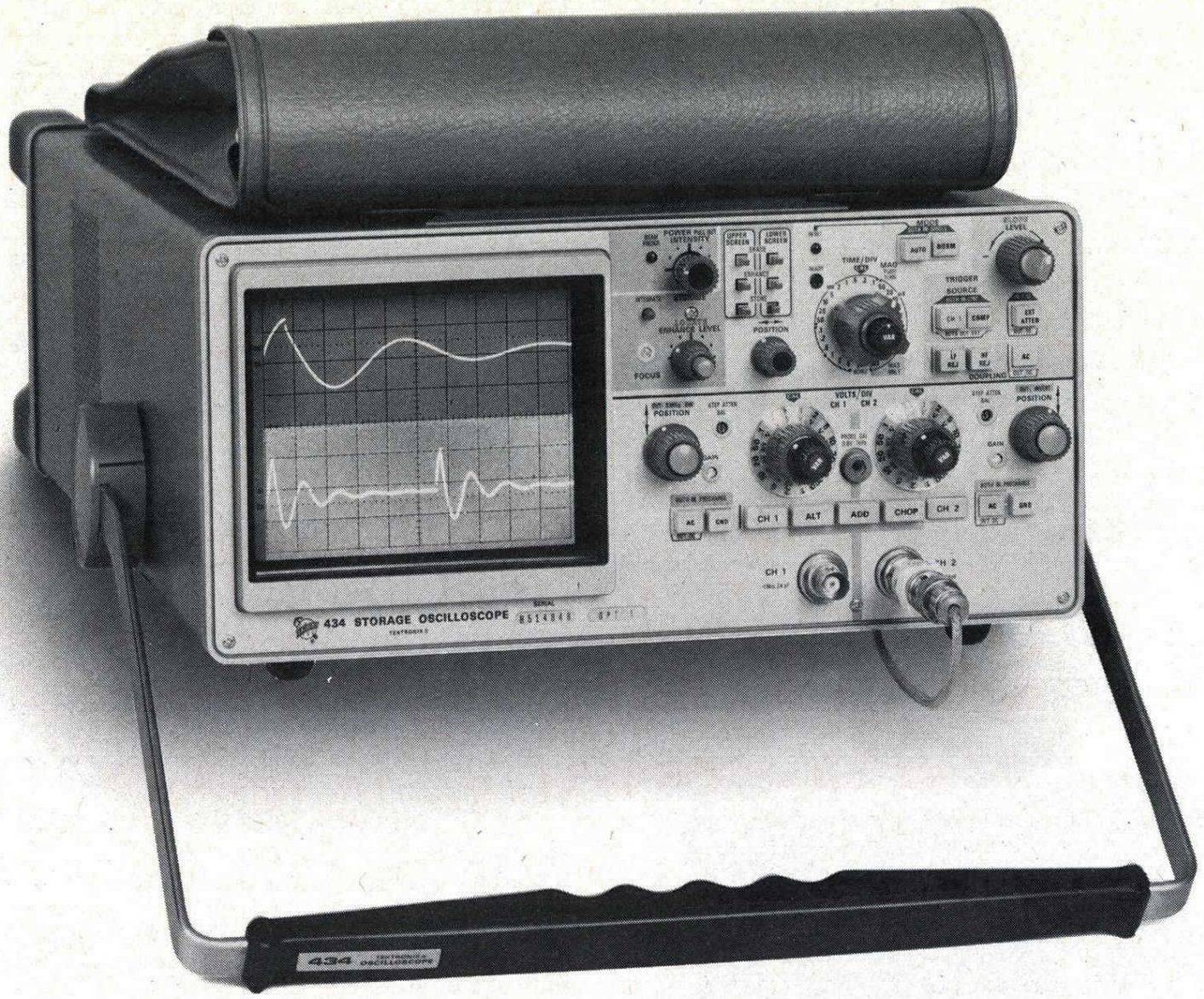
Folding Viewing Hood — Binocular
Order 016-0566-00 ..... **$13**

SCOPE-MOBILE® Cart—Occupies less than 18 inches of aisle space.
Order 200 C **$190**

RECOMMENDED CAMERA

C-30AP Option 01 General Purpose Camera — Includes 016-0301-00 mounting adapter/corrector lens.

Order C-30AP Option 01 ..... **$945**
For further information see camera section.



25 MHz at 10 mV/div

20 ns/div Sweep Rate with X50 Sweep Magnifier

Automatic Volts/div Readout

Direct-Reading Wide-Range Magnifier

Weighs ≈20¾ lb

Battery Operation (Optional)

A bistable, split-screen storage oscilloscope with a 25 MHz bandwidth, the compact 434 fills many needs in the field as well as on a bench.

The 434's split screen operates in three modes: full-screen storage, or upper or lower screen storage, with the other half in a conventional mode.

Vertical scale-factor readout is provided by lighted knob skirts. You save time by not having to calculate the scale factor each time a measurement is made.

The 1105 Battery Power Supply powers the 434 for up to 1.8 hours. Take the 1105 along when required, or forget it when line power is available.

TEKTRONIX 434's have been used for maintaining display boards, video monitors and automatic baggage handling systems for an airline, maintenance of X-ray systems in a hospital and monitoring air-conditioning and heating systems that are hooked into an alarm system in large buildings.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth and Rise Time — (from 50Ω terminated source, with or without 10X probe) Dc to at least 25 MHz at 3 dB down*, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low frequency 3 dB down point with ac coupling is 14 Hz or less (less than 1 Hz with 10X probe).

Deflection Factor — 1 mV/div to 10 V/div, accurate ±3%. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes — Ch 1 only, Ch 2 only (normal or inverted), alternate, chopped (approx 100 kHz), added.

CMRR — Common-mode rejection ratio at least 20 db at 10 MHz for common-mode signals of 6 div or less.

Automatic Scale Factor — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two lighted indicators beside the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2% paralleled by approx 24 pF.

Max Input Voltage — Dc coupled: 250 V (dc + peak ac); ac coupled: 500 V (dc + peak ac). In either mode the max ac is 500 V p-p at 1 kHz or less.

Delay Line — Permits viewing of leading edge of displayed waveform.

*Bandwidth derated to 22 MHz at temperatures above +30°C.

HORIZONTAL DEFLECTION

Time Base — 0.2 μs/div to 5 s/div (1-2-5 sequence). X50 mag extends fastest sweep rate to 20 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to 12.5 s/div.

Time Base Accuracy, Full 10 div —

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±4%	±5%

External Horizontal Input — Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

Modes — Auto trigger (sweep free-runs in absence of triggering signal and provides bright baseline at all sweep rates), normal trigger, single sweep.

Trigger Sensitivity and Coupling —

Coupling		To 5 MHz	At 25 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	50 mV	125 mV
Ac	Requirements increase below 20 Hz		
Ac Lf Reject	Requirements increase below 50 kHz		
Ac Hf Reject	Requirements increase above 50 kHz		

Sources — Ch 1 only, composite line, external and external ÷ 10. External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

Level and Slope — External trigger level range is at least ±2 V or ±20 V in external ÷ 10.

External Inputs — Input R approx 1 MΩ paralleled by 100 pF ÷ 1 or 70 pF ÷ 10. 250 V (dc + peak ac).

DISPLAY

Crt — 8 x 10 div (1 div = 0.975 cm) horizontal and vertical divisions further marked in 0.2 div increments. P1 phosphor. 4 kV accelerating potential.

Graticule — Internal, non parallax; nonilluminated.

Beam Finder — Compresses trace to within graticule area for ease in determining the location of an off-screen signal.

Z-axis Input — Dc coupled, positive going signal decreases intensity, 5 V p-p signal causes noticeable modulation; dc to 20 MHz usable frequency range.

STORAGE FEATURES

Display Modes — Split-screen storage with 3 display modes: storage on either upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display on entire screen. Independent operation of both halves.

Stored Writing Speed (Center 8 Div) **—** Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 01, 500 div/ms, normal; to 5000 div/ms, enhanced).

Erase Time — 300 ms or less.

Locate — When the 434 is operated in the stored mode, the beam can be positioned to the left of the graticule area to determine the vertical position of the next sweep without disturbing a stored display.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C.

Altitude — Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating: to 50,000 ft.

Vibration — Operating: 15 minutes along each of the three axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.6 V ±1.0%, 1 kHz ±1.0% (+20°C to +30°C). Output resistance is 575 Ω.

Power Requirements — Operates on all voltages from 90 V to 136 V and 180 V to 272 V, 48 to 440 Hz, 60 W max. Also operates from 220 V dc to 350 V dc.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**cm**
Height (w/o pouch)	5.6	14.2	5.3	13.3
Width (with handle)	13.0	33.0	19.0	48.3
Depth	18.7	47.5	18.0	45.7
Weights (approx)	**lb**	**kg**	**lb**	**kg**
Net	20.8	9.4	23.1	10.5
Shipping	30.0	13.6	49.0	22.2

Additional information on following page.

434 Portable Bistable Storage Oscilloscope

INCLUDED ACCESSORIES

Two P6105 probes (010-6105-03), accessory pouch (016-0165-00). Rack models also include mounting hardware and slide out assemblies, do not include accessory pouch.

ORDERING INFORMATION

434 Storage Oscilloscope **$3480**

R434 Storage Oscilloscope Rackmount Model **$3605**

INSTRUMENT OPTIONS

Option 01 Increased Writing Speed ..... **Add $75**

OPTIONAL ACCESSORIES

Probes —

Probe Type	Attenuation	Input Impedance	Bandwidth* with 434
P6062A 6 ft	Switch-able 1X	1 MΩ 5 pF	6.7 MHz
	10X	10 MΩ 14 pF	25 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 434**
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	25 MHz

*Bandwidths are measured at the upper —3 dB, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

1105 Battery Power Supply — Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply **$915**

Mesh Filter — Improves contrast and emc filtering.
Order 378-0682-00 ..... **$33**

Portable to Rackmount Assembly — Includes hardware for converting standard 434 to 19-inch rack installation.
Order 016-0272-00 ..... **$150**

Folding Polarized Viewing Hood —
Order 016-0180-00 ..... **$23**

Clear Plastic Crt Filter —
Order 378-0677-00 ..... **$1.50**

SCOPE-MOBILE® Cart — Occupies less than 18 inches aisle space, has storage area in base.
Order 200C **$190**

RECOMMENDED CAMERA

C-30AP Option 01 General Purpose Camera — Includes 016-0301-00 mounting adapter/corrector lens.
Order C-30AP Option 01 ..... **$945**

For further information see Camera Section.

335 300-Series SONY/TEKTRONIX Portable Oscilloscopes

35-MHz Dual-Trace Delayed Sweep Oscilloscope

35 MHz at 10 mV/Div

Small Size, Weighs ≈10.5 lb

1 mV/div Vertical Sensitivity at 25 MHz

Delay Lines Input

Rugged Construction

The portability of the 335 is a big plus in many digital and analog trouble-shooting applications. And it weighs only 10.5 pounds.

1 mV/div (at 25 MHz) vertical sensitivity insures that low level signals from magnetic recording heads, optical read heads, or industrial control transducers can be accurately and easily measured. Delay lines at the inputs let you view the leading edge of the triggering signal. By using a composite of channels 1 and 2 as a trigger source, stable displays of non-time-related signals can be obtained.

Operation from either ac (90 to 132 V, or 180 to 264 V, 48 to 440 Hz) or dc (+11 to +14 V or +22 to +28 V) assures that power can be obtained at nearly any location.

Rugged construction, plus environmental specifications that equal or better those of any portable scope, help the 335 withstand the wide range of temperature and humidity and rough handling it may encounter in field environments.

Color coding and functional layout of the front panel controls make the 335 easy to operate. Combined function controls and side mounting probes lead to small size and an uncluttered control panel.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth and Rise Time — Dc to at least 35 MHz, rise time 10 ns or less. For 1 mV/div to 5 mV/div bandwidth is at least 25 MHz, rise time 14 ns or less. For ac coupling, the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence) accurate ±3%. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — Ch 1, Ch 2 (normal or inverted) alternate, chopped (approximately 300 kHz rate) added, X-Y.

CMRR — Common-mode rejection ratio at least 20 dB at 10 MHz for common-mode signals of 6 div or less.

Input R and C — 1 MΩ ±2% paralleled by approx 24 pF.

Max Input Voltage, ac or dc coupled, 300 V (dc + peak ac). 300 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.2 μs/div to 0.5 s/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Time Base B — 0.2 μs/div to 50 ms/div (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Variable Time Control — Time Base A provides uncalibrated, continuously variable sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated settings.

Time Base A and B Accuracy, center 8 div —

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

Horizontal Display Modes — A only. A intensified by B, B delayed by A, B triggerable after A.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuously variable from 1 μs to at least 5 s after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy —

Delay Time Settings	+15°C to +35°C
between 1.0 and 9.0	
one or more major dial divisions	±2%
less than one major dial divisions	±.02%

Jitter — 1 Part or less in 20,000 (0.005%) of X10 the A time/div setting.

TRIGGERING A AND B

A Trigger Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of a triggering signal and for signals below 20 Hz). Single sweep (sweep runs once on the first trigger signal after the reset button is pushed).

Variable Trigger Holdoff — For the A sweep an adjustable holdoff control permits a stable display of complex waveforms. Sweep holdoff time can be increased at least X10.

B Trigger Modes — B runs after delay time (starts automatically at the end of the delay time). B triggerable after delay time (runs when triggered). The B (delayed) sweep runs once in each of these modes, following the A sweep delay time.

Trigger Sensitivity and Coupling —

Coupling		To 10 MHz	At 35 MHz
Dc	Internal	0.35 div	1.5 div
	External	70 mV	250 mV
	Ext ÷ 10	700 mV	2.5 V
Ac	above requirements increase below 60 Hz		
Ac Hf Rej	requirements increase above 20 kHz		
Ac Lf Rej	requirements increase below 40 kHz		

Trigger Sources — Internal Ch 1, internal Ch 2, internal composite (uses a composite of Ch 1 and Ch 2 signals to produce trigger), external, external ÷ 10, and line. The B sweep can also be started automatically at the end of the time base A delay.

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both Ch 1 and Ch 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-axis Deflection Factors — Variable from approx 20 mV/div to approx 20 V/div. Dc to at least 500 kHz.

Input Impedance — Approx 1 MΩ paralleled by 24 pF.

DISPLAY

Crt — 8 x 10 div (0.6 cm/div) display. P31 phosphor. 12 kV accelerating potential.

Graticule — Internal (non-parallax) non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm.

Z-axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Non-operating: −40°C to +75°C.

Altitude — Operating: to 15,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: to 50,000 ft max.

Vibration — Operating and nonoperating: 15 minutes along each of the three major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Humidity — 5 cycles (120 hours) referenced to MIL-E-16400 F.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V (±1%) approx 1 kHz from 20°C to 30°C.

Power Source — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a max current drain of 2A at +12 V or 1.0A at +24 V.

Dimensions	in	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case and pouch (016-0485-00), external dc cable assembly (012-0406-00), strap assembly (346-0131-00), two A-1 fuses (159-0064-00), two 0.4-A fuses (159-0139-00), two 2-A fuses (159-0107-00), three 0.2-A fuses (159-0080-00).

ORDERING INFORMATION

335 Portable Oscilloscope $1925

OPTIONAL ACCESSORIES

Viewing Hood — Order 016-0297-00 ..... $6.50

Crt Filter — Light blue. **Order 378-2016-00 .... $1.80**

Crt Filter — Light amber. **Order 378-0843-00 ... $1.80**

Crt Mesh Filter — With frame and holder. **Order 378-0063-00 ..... $23**

The SONY®/TEKTRONIX® 335 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 335 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

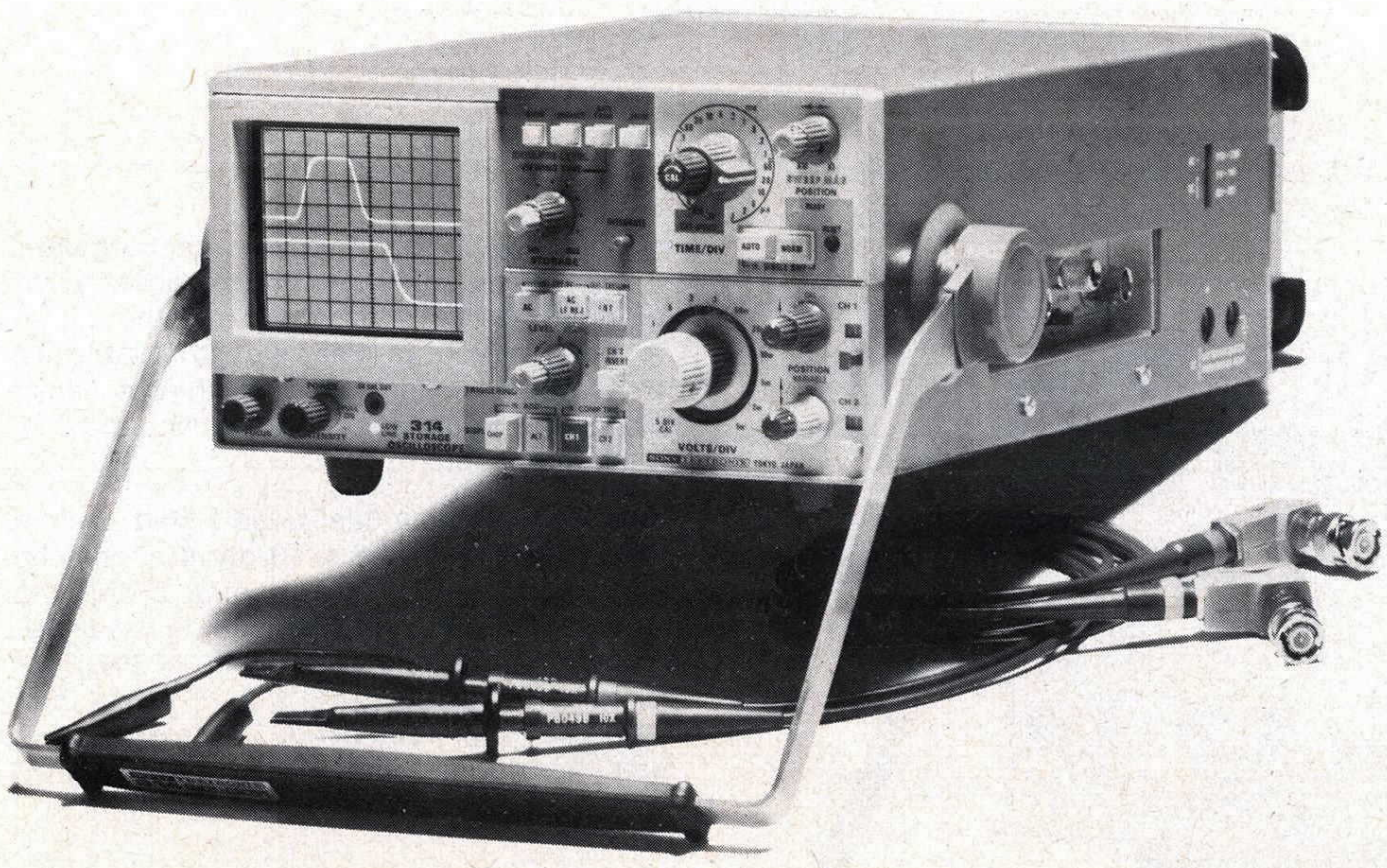
C-30AP General Purpose Camera $925

Camera Adapter — mounts C-30A to 335. Order 016-0327-01 ..... $75

For further information see Camera section.

300-Series SONY/TEKTRONIX Portable Oscilloscopes

10-MHz Dual-Trace, Long-Term Storage Oscilloscope



10 MHz at 1 mV/div

100 ns/div Sweep Rate with X10 Sweep Magnifier

Stored Viewing Time to 4 Hours

Integrate Mode for Intensifying Fast Rise Time, Low Repetition Rate Signals

Operates from Ac Line, 12 V Dc, or 24 V Dc

Small Size, Weighs ≈10.5 lb

The 10.5-pound, bistable storage 314 provides 1 mV/div sensitivity at 10 MHz, with a 4-hour viewing time. With long-term storage, you can use the 314 to monitor signal lines where undesired transients are suspected.

For fast rise time, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Compact size and operation from ac, dc, or external dc source mean that the 314 will easily go wherever you need a storage oscilloscope.

Combined function controls, color coding, and functional front-panel layout make the 314 easy to use. Probes mount on the side, permitting an uncrowded front panel and large crt.

The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An autoerase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer. Other applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 10 MHz. Rise time, 36 ns or less for a 4 div step input. For ac coupling, the lower 3 dB point is 10 Hz or less.

Deflection Factor — 1 mV/div to 10 V/div (1-2-5 sequence), accurate ±3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

Display Modes — Ch 1, Ch 2 (normal or inverted), chopped, alternate, added, and X-Y.

Input R and C — 1 MΩ paralleled by approx 47 pF.

Max Input Voltage — ac or dc coupled, 300 V (dc + peak ac).

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 5 s/div. X10 mag extends sweep rate to 100 ns/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

Time Base Accuracy, center 8 div

Unmagnified	
1 μs/div to 0.2 s/div	±3%
0.5 s/div to 5 s/div	±4%
Magnified	
50 ms/div to 0.5 s/div	±5%
0.5 μs/div to 20 ms/div	±4%
0.1 μs/div and 0.2 μs/div	±5%

314 Dual-Trace, Storage Oscilloscope

TRIGGER

Modes — Normal (sweep generator requires a trigger to generate a sweep). Automatic (minimizes trigger adjustment. Sweep generator free-runs in the absence of a trigger. Single sweep (one sweep is initiated by the first trigger after a reset).

Trigger Sources — Internal: Ch 1, Ch 2 or composite, external.

Trigger Sensitivity and Coupling

Coupling		To 1 MHz	At 10 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	150 mV	500 mV
Ac	requirements increase below 30 Hz		
Ac Lf Reject	requirements increase below 50 kHz		

X-Y OPERATION

Input — X-axis input is via the external horizontal input connection. Both Ch 1 and Ch 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-axis Deflection Factors — Continuously variable from 20 mV/div to 2 V/div. Bandwidth, dc to at least 200 kHz.

Input Impedance — 1 MΩ ±2% paralleled by approx 62 pF.

DISPLAY

Crt — 8 x 10 div (0.6 cm/div) display. P44 phosphor. 2 kV accelerating potential.

Graticule — Internal, non-illuminated. Vertical and horizontal centerlines marked in 5 minor div per major 0.6 cm/div.

Z-axis input — Range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Max input voltage, 50 V (dc + peak ac).

STORAGE FEATURES

Display Modes — Direct view, bistable storage, and non-store modes. Enhance mode to increase stored writing rate in the single sweep mode. Auto erase mode to automatically erase stored display after each sweep. Viewing time before auto erase can be varied from 1 sec or less to at least 5 sec. Integrate mode increases stored brightness of very fast repetitive signals.

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

Erase Time — 300 ms.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: to 20,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 20,000 ft. Nonoperating: 50,000 ft max.

Vibration — Operating: 15 minutes along each of the three major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles.

Humidity — Nonoperating: 5 cycles (120 hours) of MIL-Std-202D, Method 106C. Omit freezing and vibration and allow a post-test drying period at 25°C ±5°C and 20% to 80% relative humidity.

Shock — Operating and nonoperating: 30 g's, ½ sine, 11 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V accurate ±1% from 20°C to 30°C, ±2% from −15°C to +55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 29 W at 115 V. External dc source, +11 V to +14 V or +22 V to +28 V with a max current drain of 1.6 A at +12 V or 0.8 A at +24 V.

Dimensions	in	cm
Height (w/o pouch)	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	13.6	34.7
Depth (handle extended)	17.6	44.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	10.5	4.7
Shipping	17.0	7.6

INCLUDED ACCESSORIES

Two P6149 10X probes (010-6149-03), carrying case and pouch (016-0612-00), external dc cable assembly (012-0406-00); strap (346-0131-00), two 1.6-A fuses (159-0098-00), two 0.8-A fuses (159-0132-00), two 0.15-A fuses (159-0130-00), three 0.16-A fuses (159-0131-00).

ORDERING INFORMATION

314 Storage Oscilloscope $2645

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

RECOMMENDED CAMERA

C-30AP General Purpose Camera $925

Camera Adapter-Mounts C-30AP to 314.
Order 016-0327-01 ..... **$75**

For further information see camera section.

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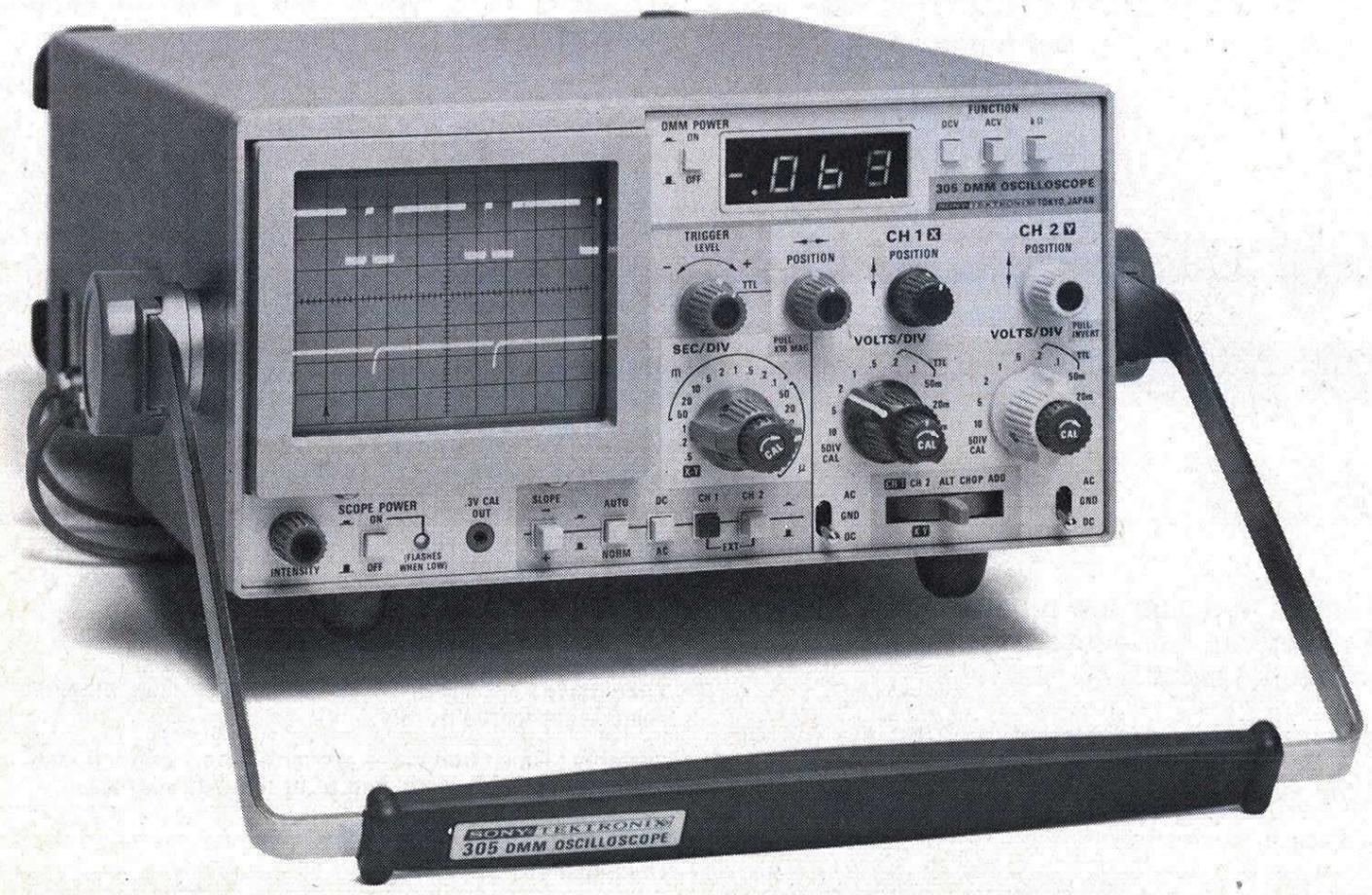
305 | 300-Series SONY/TEKTRONIX Portable Oscilloscopes

A Battery-Powered Oscilloscope and DMM in a Lightweight, Portable Package



5 MHz at 5 mV/div

Dual-Trace

Full X-Y

Weighs ≈10.6 lb.

The 305 Oscilloscope/DMM is the ideal oscilloscope for those who demand portability and multi-function versatility in their test instrumentation.

The SONY/TEKTRONIX 305 combines a 5-MHz oscilloscope with an integral auto ranging DMM and a built-in rechargeable battery pack. Take the 305 instead of multiple instruments when you climb the ladder to maintain your in-plant industrial controls. Or leave the extension cord at your bench when you go on location to service medical instrumentation.

The 305 features a dual-trace 5-MHz oscilloscope with a large 8 x 10 div (0.6 cm/div) crt display and an autoranging DMM with dc and ac volts, and resistance measurement functions—all in a 10.6 lb. (4.8 kg), 4.4 x 9.3 x 14.6 inch (11.2 x 23.6 x 37.1 cm) package. The front panel TTL marker presets the trigger generator for optimum level control on TTL signals.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 5 MHz. For ac coupling, the lower 3 dB point is 10 Hz approx.

Deflection Factor — 5 mV/div to 10 V/div (1-2-5 sequence) accurate +3% from 0°C to +40°C, ±4% through remainder of operating range. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — Ch 1, Ch 2, Chopped, Alternate, Added, Invert Ch 2 and X-Y. Bandwidth in Add mode is dc to at least 4.5 MHz.

Input R & C — 1 MΩ ±2%, paralleled by 47 pF approx.

Max Input Voltage — ac or dc coupled, 250 V (dc + peak ac), or 250 V p-p ac at <1 kHz.

HORIZONTAL DEFLECTION

Time Base — 500 ms/div to 1 μs/div (1-2-5 sequence). X10 mag extends sweep rate to 0.1 μs/div.

Variable Time Control — Uncalibrated, continuously variable between steps and to at least 1.25 s/div.

Time Base Accuracy, center 8 div —

	0°C to +40°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

(excludes first 10 div and all sweep past 90 div in X10 Mag).

TRIGGER

Modes — Normal and Auto (p-p).

TTL Triggering — TTL position of trigger level control presets for optimum triggering from TTL levels, in 50mV, .1 V and .2 V/div or external trigger signals.

Trigger Sources — Internal Ch 1, internal Ch 2, external. Threshold voltage, int (with 10X probe) 1.4 V within ±0.3 V, Ext (with 10X probe) 1.4 V within ±0.2 V.

Trigger Sensitivity in NORMAL-Mode

Coupling	Mode	To 0.5 MHz	At 5 MHz
Dc	Internal	0.3 div.	0.75 div
	External	15 mV	50 mV
Ac	Above requirements increase below 60 Hz		

P-P Auto Operation Sensitivity

Coupling	Mode	500 Hz to 0.5 MHz	0.5 MHz to 5 MHz
Dc, Ac	Internal	0.5 div	1.0 div
	External	35 mV	70 mV

External Trigger — Max Input Voltage: 250 V (dc + peak ac) at 1 kHz or less (same as vertical). Input R and C, approx 1 MΩ paralleled by approx 47 pF.

X-Y OPERATION

Input — X-axis input is via the Ch 1 connector; Y-axis input is via the Ch 2 connector.

X-Y Characteristics — Same as stated for vertical deflection, except deflection factor accuracy is ±4% from 0°C to +40°C over the center 8 div.

X-Axis Bandwidth is dc to 150 kHz.

DISPLAY

Crt — 8 x 10 div (0.632 cm/div) display. P31 phosphor. 2 kV accelerating potential.

Graticule — Internal, non-illuminated.

DMM

DC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 1000 V (autoranging).

Accuracy — Within 0.1% of reading, ±2 counts.

Common-Mode Rejection — >100 dB at dc, 80 dB at 60 Hz with 1 kΩ unbalance.

Normal-Mode Rejection — >30 dB at 60 Hz increasing 20 dB per decade to 2 kHz.

Response — <1 sec plus range step time (<1 sec/step).

Input R — 10 MΩ ±2%.

AC VOLTAGE

Ranges — 2 V, 20 V, 200 V, 700 V, (autoranging).

Accuracy — Within 0.5% of reading, ±10 Counts, 40 Hz to 500 Hz.

Response Time — <5 sec plus range step time (<1 sec/step).

Input impedance — 10 MΩ paralleled by ≃ 70 pF.

RESISTANCE

Ranges — 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ.

Accuracy — Within 0.6% of reading ±3 counts.

Response Time — <5 sec plus range step time (<1 sec/step). Max safe input voltage at DMM Input Connectors—DCV: 1000 V dc + peak ac, between HI and LO inputs or between HI and chassis.

ACV — 700 V RMS if sinusoidal between HI and LO inputs or between HI and chassis, +1000 V dc + peak ac between HI and LO inputs or between HI and chassis, +500 V (dc component) between LO and chassis. kΩ function settling: 100 V (dc + peak ac) between HI and LO inputs.

All Ranges: 500 V (dc + peak ac) between LO and chassis (LO Floating Voltage).

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C (Oscilloscope), 0°C to +55°C (DMM), non-operating: −25°C to +75°C.

Altitude — Operating: to 30,000 feet max, decrease max temperature by 1°C/1000 feet from 5,000 feet to 30,000 feet. Non-operating: 50,000 feet max.

Vibration — 15 min along each of the three major axes, 0.025″ (.06 cm) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 min cycles.

Humidity — Non-operating: 5 cycles (120 hrs) of MIL-E-164000G. Omit freezing and vibration and allow a post-test drying period at +25°C, ±5°C and 20% to 80% relative humidity.

Shock — Operating and non-operating: 30 g's, ½ sine, 11 ms duration. Total of 12 shocks.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V accurate ±1% from 20°C to 30°C ±2% from −15°C to 55°C.

Power Sources — External ac source, 90 V to 132 V or 180 V to 250 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation of 17 W. External dc source +9 V to +32 V.

Charge Time: at least 16 hours for full charge.

Operating Time — Internal NiCd batteries provide ≃1.6 hours of scope and DMM operation, 10 hours of DMM alone operation, or 2 hours of scope alone operation at maximum trace intensity and 20°C to 25°C operating temperature.

Dimensions	in	cm
Height	4.4	11.2
Width (with handle)	9.3	23.6
Depth (handle not extended)	14.6	37.1
Depth (handle extended	18.0	45.8
Weights (approx.)	**lb**	**kg**
Net (without accessories)	10.6	4.8
Shipping	17.1	7.8

INCLUDED ACCESSORIES

Two 10X probes (010-6149-03), one DMM probe package (012-0732-00), one carrying case (016-0401-00), one carrying case cover (200-2260-00), one carrying strap assembly (346-0131-00), one clear crt filter (331-0394-01), one blue crt filter (378-2016-01), one external dc cable assembly (012-0406-00).

ORDERING INFORMATION

305 DMM/Oscilloscope **$1725**

The SONY®/TEKTRONIX® 305 DMM/Oscilloscope is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 305 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Viewing hood **(016-0297-00)** **$6.50**

BNC to binding post adapter **(103-0033-00)** **$4.75**

RECOMMENDED CAMERA

C30AP General Purpose Camera **$925**

Camera Adapter Mount C30A to 335
Order 016-0327-01 ..... **$75**

For further information see camera section.

5 MHz, 5 mV/div to 100 V/div
0.1 μs/div Sweep Rate with X10 Sweep Magnifier
Internal Battery Pack
Integral 1 MΩ probe
Weighs ≈3.5 lb

The 221 miniscope weighs just 3.5 pounds and easily fits into a tool box or brief case; it measures only 3 x 5¼ x 9½ inches. Yet it has the capability needed for on-site service of much of today's complex equipment. This versatile miniscope has a 5-MHz bandwidth, 5 mV/div sensitivity, and 0.1 μs/div sweep rate (using X10 magnifier) packaged in an impact-resistant case.

Internal rechargeable batteries allow at least three hours operation away from external power sources. And the 221 will operate and charge from practically all the world's principal line voltages: 90 to 250 V, 48 to 62 Hz ac, or 80 to 250 V dc (all without making any change to the instrument).

The 1 MΩ low-capacitance probe minimizes circuit loading. And because it's attached, it's always there when you need it. Vertical deflection factors extend from 5 mV/div, allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

A single rotary control on the 221 is used for all trigger level and slope functions. Controls

are side mounted and recessed for protection, yet are easily accessible.

In applications where it is necessary to "float" the oscilloscope to make your measurements, 200-Series Miniscopes can be elevated to 700 V (dc + peak ac) above ground when operated from batteries. Although insulated, caution should be observed when connecting the probe to test points.

The 221 is used in a wide assortment of service applications. For example, in data transmission systems, the 221 is preferred for maintenance and testing of modems because of its ability to see higher frequency noise. It can even help in building roads... by spot checking motors in a road grader's closed loop servo system that controls blade angle, depth of cut and machine direction.

VERTICAL DEFLECTION

Bandwidth — Dc to 5 MHz (−3 dB point) at all calibrated deflection factors. Lower −3 dB point ac coupled is approx 2 Hz.

Deflection Factor — 5 mV/div to 100 V/div, accurate 3% from 0°C to +40°C and ±5% from −15°C to 0°C and +40°C to 55°C. Uncalibrated, continuously variable between steps to at least 300 V/div.

Input R and C — Approx 1 MΩ paralleled by approx 29 pF via attached signal acquisition probe.

Max Input Voltage — 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 200 ms/div, accurate ±3%.

Magnifier — Increases all sweep speeds X10 with a max sweep speed of 0.1 μs/div.

Variable Time Control — Extends minimum sweep rate to approx 0.5 s/div. Continuously variable between calibrated settings.

TRIGGER

Modes — Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity

Mode	To 1 MHz	At 5 MHz
Internal	0.5 div	1 div
External	0.5 V	1 V

X-Y OPERATION

Input — X-axis input is via the external trigger or the external horizontal input.

X-axis Deflection Factor — 1 V/div ±10%, dc to 500 kHz. Sensitivity is increased by a factor of 10 (0.1 V/div) using horizontal magnifier.

Max External Horizontal Input Voltage — 200 (dc + peak ac), 200 V (p-p ac) to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

Input Impedance — Approx 0.5 MΩ paralleled by approx 30 pF.

DISPLAY

Crt — 6 x 10 div (0.5 cm/div) display. P31 phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only), −15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: −40°C to +60°C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one minute cycles. Held for 3 min at 55 Hz.

Humidity — 5 days at +50°C, 95% humidity.

Shock — Operating and nonoperating: 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide at least 3 hours operation at max trace intensity for a charging and operating temperature between +20°C and +30°C. Internal charger charges the batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 to 250 V ac (48 to 62 Hz) or 80 to 250 V dc, 5 W or less.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V rms; or 1.4 x line + (dc + peak ac) not to exceed 350 V.

Dimensions	in	cm
Height	3.0	7.6
Width	5.2	13.3
Depth	9.0	22.8
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.5	1.6
Shipping	≃8.0	≃3.6

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), neck strap (346-0104-00), Two spare fuses (159-0080-00).

ORDERING INFORMATION

221 Oscilloscope, including batteries and probe $1190

INSTRUMENT OPTION

Option 76, P7 Phosphor $35

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $14

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8.00

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... $8.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $5.00

1 MHz at 20 mV/div

0.4 μs/div Sweep Rate with X10 Sweep Magnifier

DMM and Miniscope in One Unit

Compact, Weighs ≈3.7 lb

True Rms Voltage and Current Measurements

Internal Battery

Rugged Construction

The 213 combines a precision 3½ digit digital multimeter and a 1 MHz oscilloscope in one instrument. It is a compact (3 x 5.2 x 8.9 inches) and lightweight (only 3.7 pounds) package that will fit easily into your briefcase or tool kit.

In operation, the light-weight 213 can be hand held, rested on the equipment being tested or carried conveniently on a neck-strap. Operating controls are designed for speedy measurements and easy understanding.

Rugged construction enables the 213 to withstand hostile industrial or transportation environments.

The 213, combining both oscilloscope and DMM functions, fits many on-site service applications. As an example, the 213 is used extensively for preventive maintenance on industrial control systems.

VERTICAL DEFLECTION (VOLTAGE)

Bandwidth — Dc to 1 MHz (—3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (—3 dB point) for 5 mV/div and 10 mV/div. Lower —3 dB point for ac coupling is approx 1 Hz.

Deflection Factor — 5 mV/div to 100 V/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 V/div.

Input R and C — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Max Input Voltage

Input Condition	Max Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
Ac, Dc coupled, 2 V/div to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL DEFLECTION (CURRENT)

Bandwidth — Dc to at least 400 kHz (—3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz (—3 dB point) for 5 μA/div and 10 μA/div.

Deflection Factor — 5 μA/div to 100 mA/div (1-2-5 sequence), accurate ±3%. Uncalibrated; continuously variable between steps to at least 250 mA/div.

Max Input Current — 2 A rms or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

Time Base — 2 μs/div to 500 ms/div (1-2-5 sequence), accurate ±5%.

Variable Magnifier — Increases all sweep speeds to at least X5 with a max sweep speed of 0.4 μs/div.

TRIGGER

Modes — Normal (sweep runs when triggered). Automatic (sweep free-runs in absence of trigger signal or for frequencies below 7 Hz).

Trigger Sensitivity and Coupling — Ac Internal, (auto and normal, 1 MHz) 0.5 div Dc External, 1 MHz, 1 V.

DISPLAY

Crt — 6 x 10 div (0.52 cm/div) display. P43 phosphor is standard.

Graticule — Internal, black line, non-illuminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: (battery only). —15°C to +55°C. Charging or operating from ac line: 0°C to +40°C. Nonoperating: —40°C to +60°C.

Altitude — Operating: to 25,000 ft, decrease max temperature by 1°C/1,000 ft above 15,000 ft. Nonoperating: 40,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. Held for 3 minutes at 55 Hz.

Humidity — 40°C or less, 80% or less relative humidity.

Shock — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide approx 3.5 hours operation at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger charges batteries when connected to an ac line with instrument turned on or off. Dc operation is automatically interrupted when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. External power source, 90 to 136 V ac (48 to 62 Hz). Option 1 allows operation from an external 180 to 250 V ac (48 to 62 Hz) or dc supply. Power consumption, 8 watts or less.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms or 1.4 X line + (dc + peak ac) not to exceed 350 V.

Dimensions	in	cm
Height	3.0	7.6
Width	5.2	13.2
Depth	8.9	22.6
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.7	1.7
Shipping	8.6	3.9

DMM

Provides true rms readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in 5 ranges.

Resolution — 100 μV at 0.1 V full scale.

Accuracy in Dc Mode — For 25°C ±5°C.

Range (Full Scale)

0.1 V	±0.1% of reading ±3 counts. Temp coef is (±0.015% of reading + 0.04% of full scale) per °C.
1 V	±0.1% of reading ±1 count. Temp coef is (±0.01% of reading + 0.01% of full scale) per °C.
10 V and 100 V	±0.15% of reading ±1 count. Temp coef is (±0.015% of reading + 0.01% of full scale) per °C.
1000 V	±0.2% of reading ±1 count. Temp coef is (±0.02% of reading + 0.01% of full scale) per °C.

Accuracy in Rms Mode — For 25°C ±5°. Temperature coefficient (±0.05% of reading +0.1% of full scale) per °C.

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V, 10 V, and 100 V	2%	1%	1%
1000 V	2%	1%	2%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice indicated limit for crest factor of 5.

Input Resistance — 10 MΩ

Input Capacitance — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1000 V ranges.

Settling Time — DC: 1.5 sec to 0.1% of reading. RMS: 2 sec to 1% of reading.

Max Input Voltage —

Dc Coupled	
0.1 V to 10 V	100 V to 1000 V
500 V (dc + peak ac)	800 V (dc + peak ac)
Ac Coupled	
0.1 V to 10 V	
800 V (dc + peak ac)	

DC AND AC CURRENT

Range — 0.1 mA to 1000 mA full scale in 5 ranges.

Resolution — 100 nA at 0.1 mA full scale.

Accuracy in Dc Mode — For 25°C ±5°C.

Temperature Coef — (±0.02% of reading + 0.04% of full scale) per °C. 0.1 mA ±0.5% ±3 counts. 1 mA to 1000 mA ±0.25% ±3 counts.

Accuracy in Ac Mode —

Range	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice the indicated limit for crest factor of 5.

Settling Time — 1.5 sec to 0.1% of reading.

Max Input Current — 2 A rms or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 kΩ to 10 MΩ full scale in 5 ranges.

Resolution — 1 Ω on 1 kΩ scale.

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 kΩ	0.5% ±3 counts
10 kΩ to 1 MΩ	0.5% ±1 count
10 MΩ	1% ±1 count

Settling Time — 2 seconds ±2 counts.

READOUT

Number of Digits — 3½ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (5 characters).

Overrange Capability — At least 200% of full scale.

Overrange Indication — Readout displays scrambled characters.

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), 2 test leads (alligator clip to banana jack) (red 012-0015-00) (black 012-0014-00), neck strap (346-0104-00), 2 power line fuses (159-0080-00), power line plug adapter (option 01 only) (161-0077-01), identification tag (334-2614-00), identification tag (000-7983-00).

ORDERING INFORMATION

213 Miniscope/DMM including batteries and probe $1595

POWER OPTIONS

Option 01, 180 to 250 V ac (48 to 62 Hz) or dc (includes batteries and probe) . . . . . No charge

OPTIONAL ACCESSORIES

Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Incudes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

Order 015-0231-00 . . . . . $14

Probe-tip to BNC Panel Connector Adapter

Order 013-0084-01 . . . . . $8

Probe tip to BNC Cable Adapter

Order 103-0096-00 . . . . . $8.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.

Order 161-0077-01 . . . . . $5

212
214

200-Series Miniscopes

500-kHz Dual-Trace Storage (214) Oscilloscope

500 kHz, 1 mV/div to 50 V/div

Internal Battery

Integral 1 MΩ Probe

Weighs ≈3.5 lb

The 212 and 214 feature similar signal acquisition capabilities: bandwidth to 500 kHz with deflection factors from 1 mV/div to 50 V/div. Both are lightweight (only 3.5 pounds) and compact (3 x 5¼ x 9½ inches). They differ in that the 214 offers storage capabilities. This is useful for viewing non-repetitive or slow moving signals.

Built of impact-resistant plastic and fully self-contained, these miniature portables are perfect for applications in severe environments. And they permit "floating" measurements since they are double insulated and can be elevated to 700 V (dc + ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

Both the 212 and 214 feature integral probes that are color matched with the vertical deflection controls to minimize measurement error. The probes have their own storage space and are part of the instrument — you can't forget and leave them behind. Clip-on 10X attenuators are available for higher voltage applications.

Trigger level and slope functions are simplified to one rotary control on the side of the unit. A convenient neckstrap is an included accessory, freeing both hands to perform other tasks.

In the single sweep mode the 214 can be set to wait for, then record, a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once. When combined with storage, this provides the unique capabilities of automatically waiting for an event and then storing it for subsequent viewing.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower —3 dB point ac coupled is less than 2 Hz.

Deflection Factors — 1 mV/div to 50 V/div (1-2-5 sequence), accurate ±5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Display Modes — Ch 1 only, Ch 2 only, or Ch 1 and Ch 2 chopped (approx chop rate — 40 kHz) from 500 ms/div to 2 ms/div of time base, alternate from 1 ms/div to 5 μs/div of time base.

Input R and C — Approx 1 MΩ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div.

Max Input Voltage (1X probe only)

1 mV/div to 50 mV/div	600 V (dc + peak ac) ac not over 2 kHz.
0.1 V/div to 50 V/div	600 V (dc + peak ac) 600 V p-p ac 5 MHz or less

HORIZONTAL DEFLECTION

Time Base — 5 μs/div to 500 ms/div, accurate ±5%.

Variable Magnifier — Increases each sweep rate X5 with a max sweep speed of 1 μs/div.

External Horizontal Input — (Ch 1) 1 mV/div to 50 V/div ±10%; dc to 100 kHz: X-Y phasing to 5 kHz less than 3°. Input characteristics same as Ch 1.

Max External Horizontal Input Voltage — 50 V (dc + peak ac), 100 V (p-p).

Input Impedance — R and C, 1 MΩ paralleled by approx 30 pF.

TRIGGER

Trigger Modes — Automatic or normal. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Trigger Sensitivity and Coupling

Coupling		to 500 Hz
Dc	Internal (w/composite trigger source)	0.2 div
	Internal (w/ch 2 trigger source)	0.2 div
	External	1 V to 20 V p-p

Single Sweep — Sweep generator produces one sweep when trigger is received. (214 only)

DISPLAY

Crt — Bistable storage, 6 x 10 div (0.52 cm/div) display P44 Phosphor (214 only). P31 Phosphor (212 only).

Graticule — Internal, black line, non-illuminated.

STORAGE FEATURES

Stored Writing Speed — Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

Stored Luminance — At least 8 footlamberts.

Storage Viewing Time — Approx 1 hr.

ENVIRONMENTAL CAPABILITES

Ambient Temperature — Operating: (battery only), —15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating: —40°C to +60°C.

Altitude — Operating: 25,000 ft, decrease max temperature by 1°C/1000 ft above 15,000 ft. Nonoperating: 50,000 ft.

Vibration — Operating and nonoperating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles. Held for three minutes at 55 Hz.

Humidity — 5 cycles (120 hours). 95% relative humidity, referenced to MIL-E-16400F.

Shock — Operating and nonoperating: 150 g's, ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

OTHER CHARACTERISTICS

Power Sources — Internal NiCd batteries provide approx 5 hours operation (approx 3.5 hours in 214 stored mode) at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger charges the batteries when connected to an ac line with instruments turned off. Battery operation is automatically interrupted when battery voltage drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended charge times will not damage the batteries.

A pilot light battery-charge indicator light will extinguish when oscilloscope has about 10 min (5 min for the 214) of operating time remaining in the batteries.

External Ac Source — 110 to 126 V, 58 to 62 Hz, 3 W Can be operated at 104 to 110 V with resulting slow discharge of internal batteries.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms; or 1.4X line + (dc + peak ac) not to exceed 350 V.

Dimensions	in	cm
Height	3.0	7.6
Width	5.3	13.3
Depth	9.5	24.1
Weights (approx)	**lb**	**kg**
Net (without accessories)	3.5	1.6
Shipping	7.0	3.2

INCLUDED ACCESSORIES

Viewing hood (016-0199-01), carrying case (016-0512-00), two 4-A fuses (159-0121-00), identification tags (000-7983-00), identification tag (334-2614-00), carrying strap (346-0104-00).

ORDERING INFORMATION

212 Dual-Trace Oscilloscope, including batteries $1190

214 Dual-Trace Storage Oscilloscope, including batteries $1595

POWER OPTIONS

Option 01 for 220-250 V, (48 to 52 Hz) includes batteries ..... No Charge

Option 02 for 90 to 110 V, includes batteries ..... No Charge

OPTIONAL ACCESSORIES

10X Attenuator Package — A slip-on tip to provide lower circuit loading (4.4 MΩ, approx 20 pF) and higher max input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 ..... $33

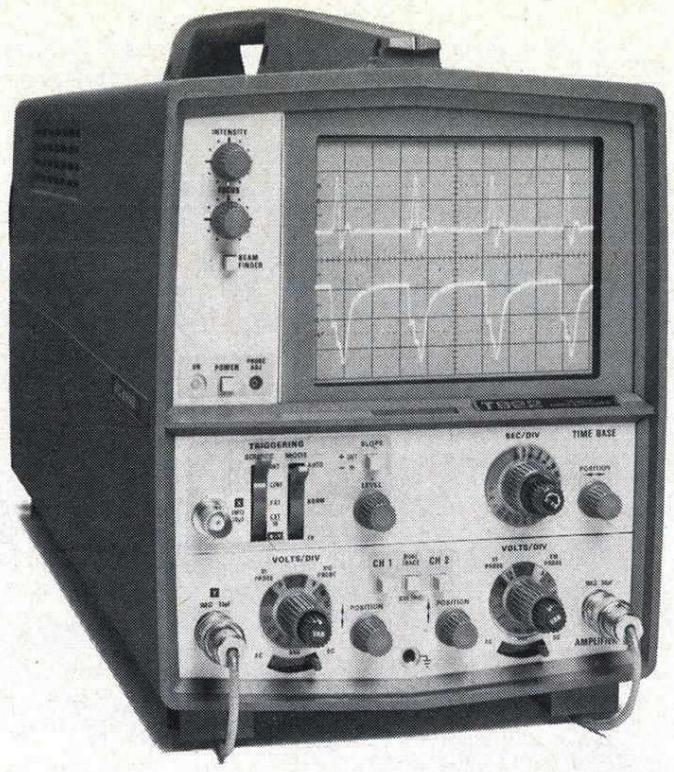
Alligator Clip Kit — A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $14

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $8

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... $8.50

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $5

T921 15 MHz Single-Trace Oscilloscope



T922 15 MHz Dual-Trace Oscilloscope

Dc to 15 MHz at 2 mV/div

20 ns/cm Sweep Rate with X10 Sweep Magnifier

Bright (12 kV) Display

Easy to Use

Regulated Power Supplies

Differential Input Option (T922 only)

Weighs ≈15 lb

The T921 (single-trace) and T922 (dual-trace) Oscilloscopes provide the basic functions of a general-purpose oscilloscope at the lowest price consistent with quality construction and reliable performance. Small and easy to operate, they are an excellent choice for the student's workbench in basic electricity, electronics, and physics classes. The same characteristics suit them well for production line applications wherever electronic components, circuits, or equipment must be tested or calibrated. In the manufacturing and servicing of consumer electronics the T921 and T922 are a cost-effective answer to most test and measurement requirements. As a signal processing, measurement and display device for dynamic transducer measurements, both oscilloscopes offer superior performance at a relatively low cost.

Although lightweight (15 lb) and small (7 x 10 x 19 inches), the T921 and T922 provide an especially bright, high resolution, 8 x 10 cm crt display. Even in high ambient light conditions, low-rep-rate signals are easily viewed. Their features shorten familiarization time and help make day-to-day measurements easier and more accurate. Functionally related controls are color coded for easy identification and grouped together for convenience. Chopped or alternate sweep modes are selected automatically to yield the best display for the selected sweep rate. An option for differential input may be ordered with the T922. In DIFF mode, the T922 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 signal is automatically inverted; the algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the crt.

Measurement accuracy of the T921 and T922 is superior to most similarly priced oscilloscopes. A twelve-step attenuator provides calibrated deflection factors ranging from 2 mV/cm to 10 V/cm. Both models offer 3% vertical amplitude and sweep timing accuracy, with minimal corner shift over a broad vertical dynamic range.

VERTICAL SYSTEM

Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal (T922 only).

Dual Trace (T922 only) — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings ≥1 ms/div, alternate for settings ≤500 μs/div. Trigger is derived from Ch 1 signal only.

Differential Input (T922 Option 01) — Adds Ch 1 and Ch 2 and automatically inverts Ch 2 for a differential display.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ≈250 kHz.

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Max Input Voltage — Dc Coupled—400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled—400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 20 ns/div.

Accuracy —	**Unmagnified**	**Magnified**
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Tv — Provides triggering on tv field when SEC/DIV switch is set at 0.1 ms or slower. Triggers on tv line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

Tv — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈100 mV/div (X10 mag), ≈1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≈1 MΩ.

Input Capacitance — ≈30 pF.

Phase Difference between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≈12 kV.

Z-axis Input — +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 5 MHz. Input impedance ≈10 kΩ.

PROBE ADJUST

Output Voltage — ≈0.5 V.

Repetition Rate — ≈1 kHz.

POWER SOURCE (AC)

Line Voltage Ranges — HI-LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

ENVIRONMENTAL CAPABILITIES

Temperature

Storage — −55°C to +75°C.

Operating — −0°C to +45°C.

Altitude

Storage — To 15,200 meters; 50,000 feet.

Operating — To 4,500 meters; 15,000 feet max. Operating temperature decreased 1°C/304.8 meters (1,000 feet) above 1524 meters (5,000 feet).

PHYSICAL CHARACTERISTICS

Dimensions	**in**	**cm**
Height	10.0	25.4
Width	7.09	18.0
Depth	18.7	47.5
Weight (approx)	**lb**	**kg**
Net (with panel cover)	15.5	7.0
Net (w/o panel cover)	15.0	6.8

INCLUDED ACCESSORIES

Probe — P6006 general-purpose 10X voltage probe for each channel. Provides full bandwidth capabilities for either the T921 or the T922.

T921 — Dc to 15 MHz, Single-Trace, Mono Time Base Oscilloscope (Includes One 10X Probe) $795

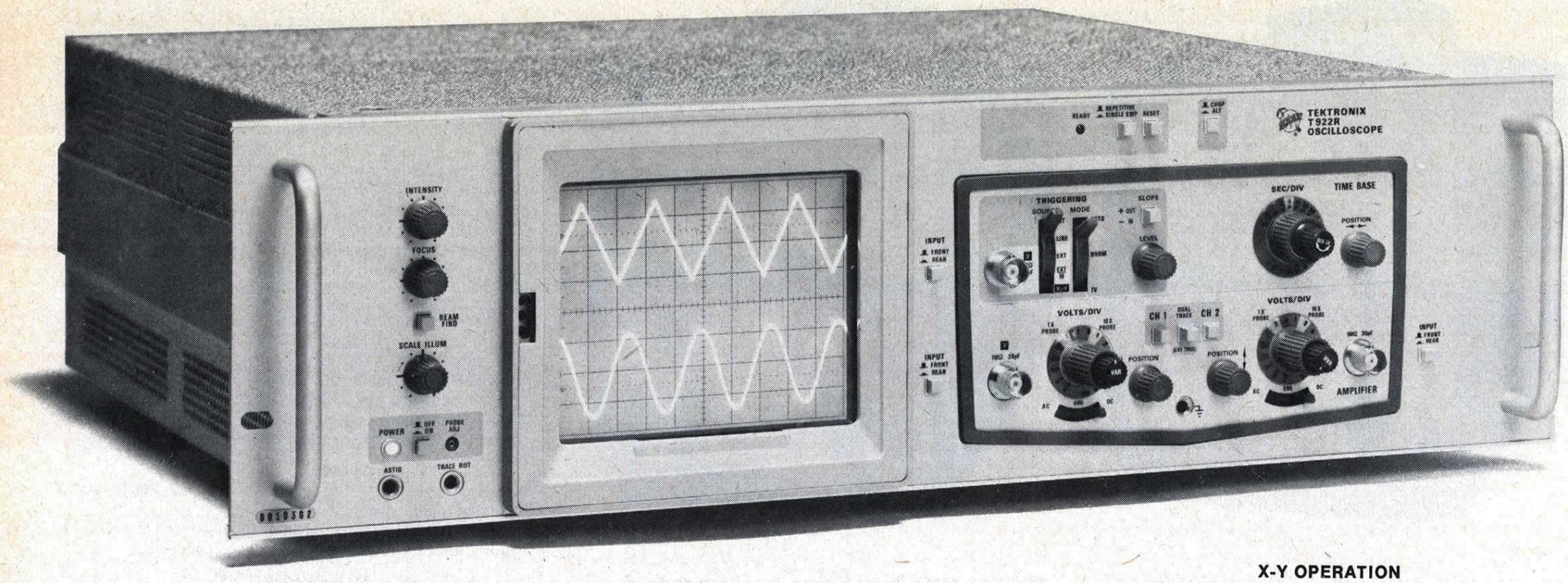
T922 — Dc to 15 MHz, Dual-Trace, Mono Time Base Oscilloscope (Includes Two 10X Probes) $975

Option 01, Differential Input for T922 . . . . . add $50

T922R

T900-Series Oscilloscopes

15 MHz Rackmount



T922R 15 MHz Rackmount Oscilloscope

Dc to 15 MHz at 2 mV/div

Switchable Front and Rear Signal Inputs

Only 13.3 x 48.2 x 43.2 cm, 9.1 kg (5¼ x 19 x 17 in., 20 lb)

Single Sweep Operation

Bright (12kV) Display

The T922R Oscilloscope is our rackmountable version of the popular T922. In addition to standard features like its 15-MHz bandwidth at 2mV/div vertical sensitivity and its 20 ns/div maximum sweep rate with the X10 magnification control, we've added switchable front and rear signal inputs, selectable chop and alternate sweeps, graticule illumination and rear panel outputs (gate out, sweep out and vertical signal out). The T922R fits any standard 19-inch (.48 m) rack and weighs only 20 pounds (9.1 kg). Option 01 adds the differential capability.

Many companies are using the T922R for their production testing applications—often as an inexpensive replacement for aging instruments which require frequent repair and calibration.

T922R SPECIFICATIONS

Seven recessed rear panel BNC connectors provide: Ch 1, Ch 2 vertical signal input, External trigger input, Z-axis input, Sweep Output, Gate Output, Vertical Output.

VERTICAL SYSTEM

Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is manually selectable.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — ≃ 250 kHz.

Input Resistance — ≃ 1 megohm.

Input Capacitance — 30 picofarads.

Maximum Input Voltage — Dc Coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less. Ac Coupled, 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 20 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +40°C	Within 4%	Within 6%

Z-AXIS INPUT

Sensitivity — 5 V signal causes noticeable intensity modulation. Polarity of the voltage causing a decrease in intensity is internally selectable.

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Tv — Provides triggering on tv field when SEC/DIV switch is set at 0.1 ms or slower. Trigger on tv line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

Tv — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Maximum Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≃ 1 megohm.

Input Capacitance — ≃ 30 picofarads.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≃ 100 mV/div (X10 mag) ≃ 1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at −3 dB).

Input Resistance — ≃ 1 megohm.

Input Capacitance — ≃ 30 picofarads.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, illuminated internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≃ 12 kV.

PROBE ADJUST

Output Voltage — ≃ 0.5 V.

Repetition Rate — ≃ 1 kHz.

OUTPUTS

Sweep/Gate Out — Output Voltage is ≃ 5 V positive going into 1 MΩ, ≃ 50 mV into 50 Ω load.

Vertical Output — a composite of Ch 1 and Ch 2 with ≃ 0.5 V output per displayed division into a 1 MΩ load. ≃ 50 mV with 50 Ω load. Bandwidth is at least 1 MHz.

POWER SOURCE (AC)

Line Voltage Ranges — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

PHYSICAL CHARACTERISTICS

Dimensions	in	cm
Height	5.25	13.3
Width	19	48.2
Depth	17	43.2
Weight	**lb**	**kg**
Net	20	9.1

For environmental performance, see T922 information, page 123.

CAMERAS

T922R interfaces to all TEKTRONIX cameras.

ACCESSORIES

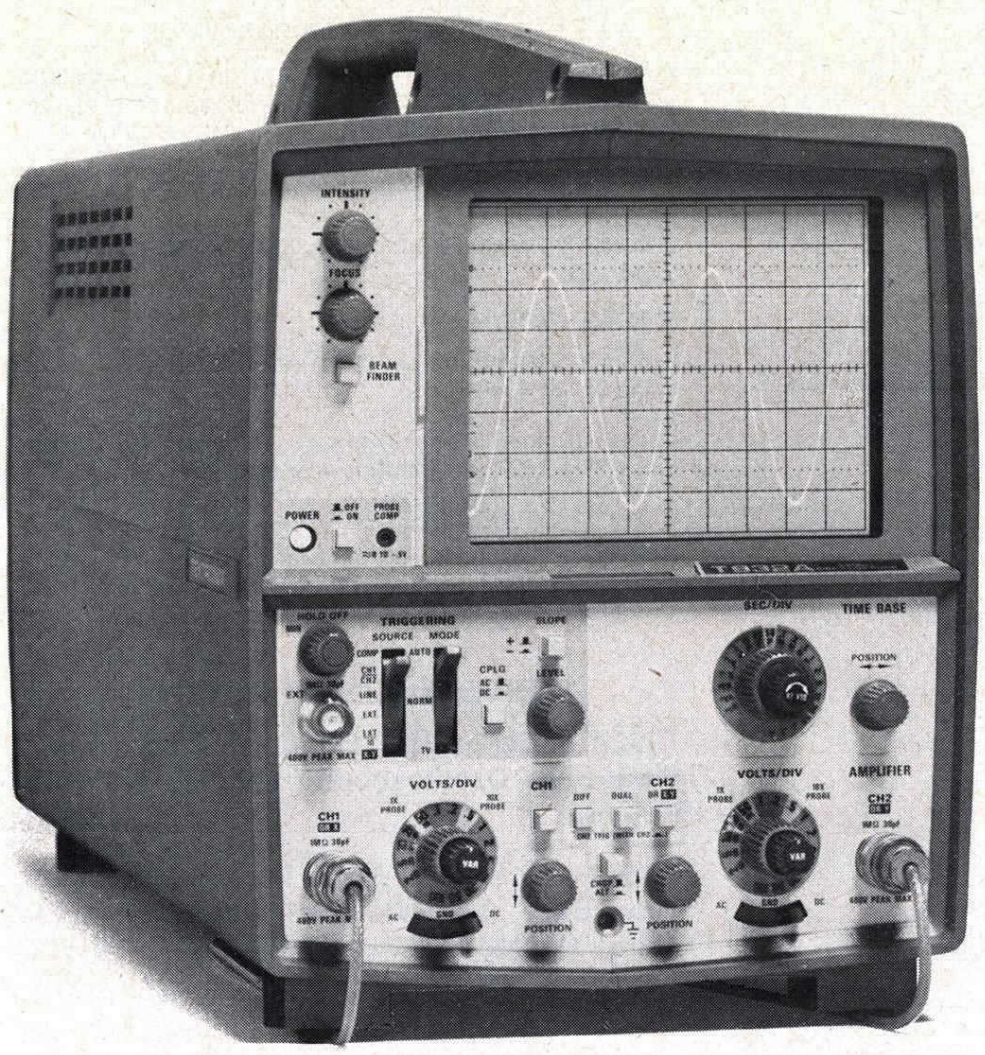
None included as standard equipment.

T922R — Dc to 15 MHz, Dual-Trace, Mono Time Base $1345

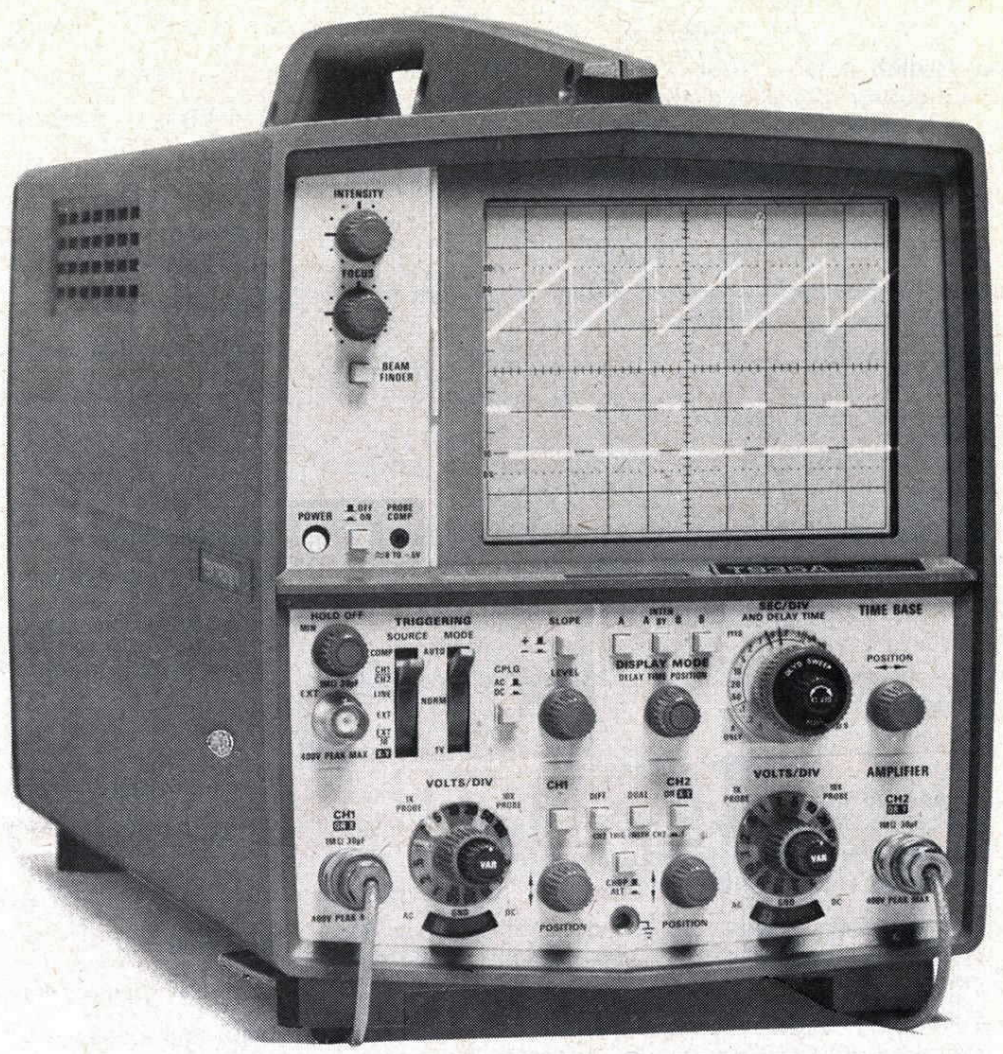
Option 01, Differential Input . . . . . add $50

OPTIONAL ACCESSORIES

Rackmount Hardware Kit
Order 016-0375-00 . . . . . $48



T932A 35 MHz Dual-Trace Oscilloscope



T935A 35 MHz Dual-Trace Oscilloscope with Delayed Sweep

35 MHz at 2 mV/div

10 ns/div Sweep Rate (with X10 Sweep Magnifier)

Differential Display

Full Sensitivity X-Y Capability

Ac and Dc Trigger Coupling

Composite, Ch 1 or Ch 2 Triggering

Selectable Chop/Alternate

Trigger Holdoff

Weighs ≈15 lb

Meet the two newest members of our T900 Oscilloscope Family — the T932A and the T935A. With these models we've added differential and full sensitivity X-Y capabilities, dc trigger coupling, a composite trigger and selectable chop/alternate display modes to the Tektronix line of low-cost portable oscilloscopes.

The T932A and T935A 35-MHz Dual-Trace Oscilloscopes are designed for cost-sensitive applications that require greater measurement capability than the T921/T922 oscilloscopes offer. Typical applications include design, production-line testing, and servicing of digital equipment such as computer peripherals, point-of-purchase data processors, numerical machine controls and consumer electronics.

Other T932A and T935A features seldom found in moderately-priced oscilloscopes include delayed sweep (the T935A) and trigger holdoff capabilites. Displayed signals that do not reveal sufficient detail on the time base A sweep may be selectively expanded using the delayed sweep feature and displayed on the B sweep. The trigger hold-off function permits adjustment of the sweep repetition frequency without changing sweep time per centimeter. Both features are valuable measurement aids, especially in digital design and service applications.

When making measurements which require delayed sweep, the T935A is the logical choice. Except for this feature, it is identical to the T932A.

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Chop — Displays Ch 1 and Ch 2 signals simultaneously (chop rate 250 kHz), triggers on Ch 1 or Ch 2 signal.

Alt — Displays Ch 1 and Ch 2 signals alternately, triggers on Ch 1 or Ch 2 signal.

Diff — Displays difference between Ch 1 and Ch 2 signal; Ch 2 automatically inverted.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 35 MHz (measured at −3 dB).

Rise Time — 10 ns or less.

Chopped Mode Repetition Rate — ≈ 250 kHz.

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

Max Input Voltage — Dc Coupled, 250 V (dc + peak ac) at 1 kHz or less. Ac Coupled, 250 V (dc + peak ac) at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range

A Sweep — 0.5 s/div to 0.1 μs/div in 21 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

B Sweep — (T935A only) 50 ms to 0.1 μs/div in 16 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

Delay Time Position Range — (T935A only) 0.5 to 10 div (uncalibrated).

Delay Time Jitter — (T935A only) One part or less in 10,000 (0.01%) of ten times the SEC/DIV switch setting.

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Tv — Provides triggering on tv field when SEC/DIV switch is set at 0.1 ms or slower. Triggers on tv line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Holdoff — Permits adjustment of time interval between end of sweep and next acceptable trigger to achieve stable displays of complex words.

more on next page.

Coupling

Ac (switch out) — Blocks dc (<60 Hz) component of triggering signal and allows triggering on ac portion of signal.

Dc (switch in) — Passes all components of triggering signal from dc to at least 35 MHz.

Trigger Source

Comp (composite) — Trigger signal is derived from the displayed vertical signal.

Ch 1/Ch 2 (internal) — Trigger signal is derived from either the Ch 1 or Ch 2 signal as described in the vertical mode section.

Line — Trigger signal is derived from the line voltage frequency.

Ext (external) — Trigger signal is derived from the signal applied to the external trigger input.

Ext/10 (external ÷ 10) — External signal is attenuated by a factor of 10.

X-Y — Permits X-Y displays when Ch 2 vertical button is depressed.

Trigger Sensitivity

Auto and Norm —

Ac — 0.5 div internal or 100 mV external from 60 Hz to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

Dc — 0.5 div internal or 100 mV external from dc to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

TV — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 250 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

X-Y OPERATION

(Ch 1-X, Ch 2-Y)

Sensitivity — Same as Ch 1 and Ch 2.

Accuracy — 20 to 30°C—5%.
0 to 45°C—6%.

X-Axis Bandwidth — Dc to at least 2 MHz (measured at −3 dB).

Input Resistance — ≈ 1 MΩ.

Input Capacitance — ≈ 30 pF.

Phase Difference between X and Y Axis Amplifiers — Within 3° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off-screen displays.

Nominal Accelerating Potential — ≈ 12 kV.

PROBE ADJUST

Output Voltage — ≈ 0.5 V.

Repetition Rate — ≈ 1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — ≈ 10 kΩ.

POWER SOURCE (AC)

Line Voltage Ranges — HI—LO range accessible externally; 110-120V, 220-240V line selector visible but not accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

For environmental performance, weights and dimensions, see T922 information on page 123.

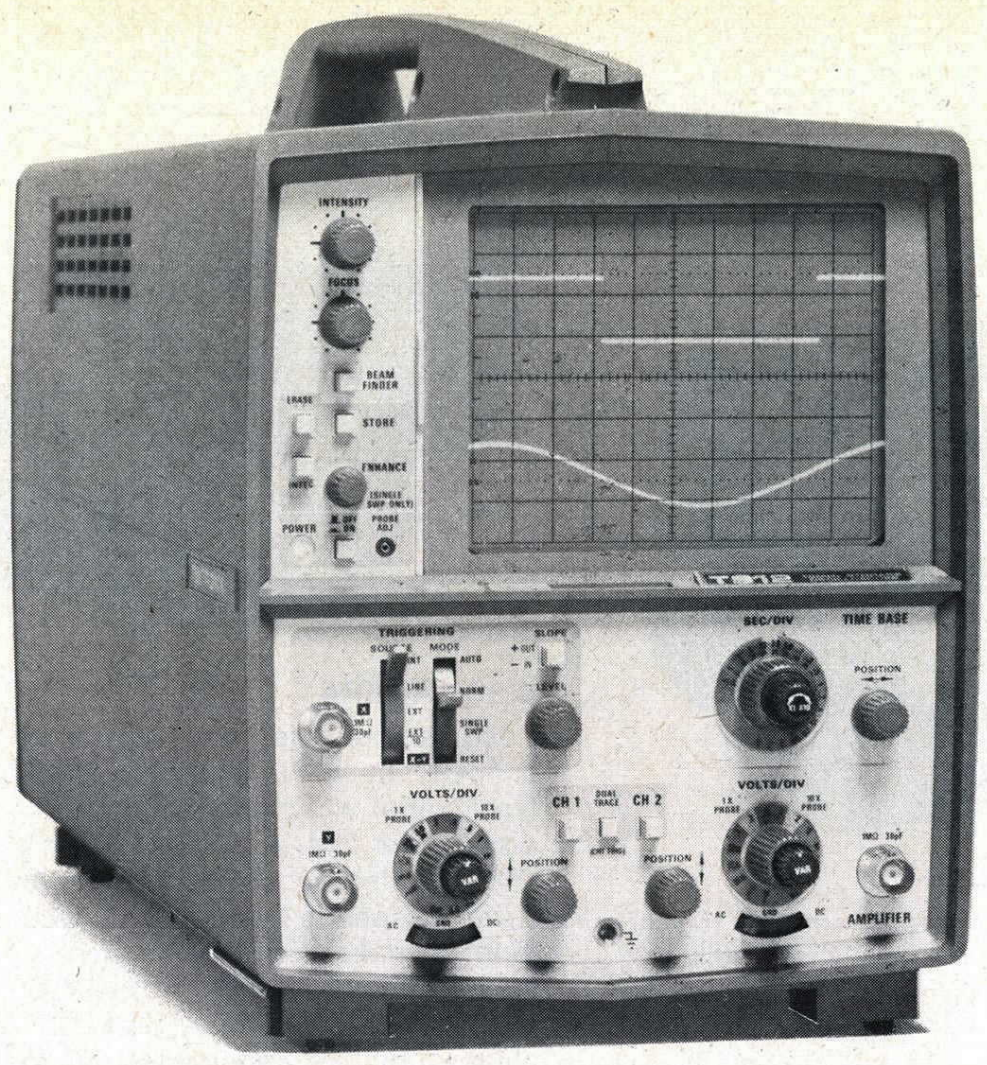
INCLUDED ACCESSORIES

Probes — 2 each. P6108 general-purpose 10X voltage probe provides full bandwidth capability for either the T932A or T935A.

ORDERING INFORMATION

T932A — Dc to 35 MHz, Dual Trace, Mono Time Base Oscilloscope (Includes Two 10X Probes) $1245

T935A — Dc to 35 MHz, Dual-Trace, Mono Time Base (with Delayed Sweep) Oscilloscope (Includes Two 10X Probes) . . . $1535



T912 10 MHz Oscilloscope with Storage

10 MHz at 2 mV/div

250 cm/ms Stored Writing Speed

50 ns/div Sweep Rate (with X10 Sweep Magnifier)

8 x 10 cm Bistable Storage Crt

Weighs ≈17.5 lb

Differential Input Option

The T912 Storage Oscilloscope is well-suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servo-mechanisms, shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes. These include a delay line, which allows you to view the leading edge of fast-rising signals; a 12-step calibrated vertical attenuator; constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimeter; 19 calibrated sweep rates ranging from 0.5 s to 500 ns/cm; 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

The T912 may be ordered with a differential input option. In DIFF mode, the T912 displays the difference between Channel 1 and Channel 2 signals. The Channel 2 signal is automatically inverted: the algebraic sum of the Channel 1 signal and the inverted Channel 2 signal is then displayed on the crt.

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings ≥ 1 ms/div, alternate for settings ≤ 500 μs/div. Trigger is derived from Ch 1 signal only.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 10 MHz (measured at −3 dB).

Rise Time — 35 ns or less.

Chopped Mode Repetition Rate — ≃ 250 kHz.

Input Resistance — ≃ 1 MΩ.

Input Capacitance — ≃ 30 pF.

Max Input Voltage —

Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing edge of displayed waveform.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.5 μs/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 50 ns/div.

Accuracy —

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Single Sweep — Displays one sweep only. Sweep cannot be triggered again until reset.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≃ 1 MΩ.

Input Capacitance — ≃ 30 pF.

POWER SOURCE (AC)

Line Voltage Ranges — HI-LO range accessible externally; 110-120 V, 220-240 V line selector visible but not accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 250 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 65, amps (max) 0.6, at 120 V, 60 Hz.

CRT STORAGE DISPLAY

Writing Rate — At least 25 cm/ms.

Enhanced Writing Rate — At least 250 cm/ms.

Display Area — 8 x 10 cm, internal graticule.

Storage Phosphor — P1.

Beam Finder — Locates off-screen display.

Nominal Accelerating Potential — ≃ 2.76 kV.

PHYSICAL

Weight

With Panel Cover and Accessories — 18.0 lb (8.2 kg).

Without Panel Cover and Accessories — 17.5 lb (7.9 kg).

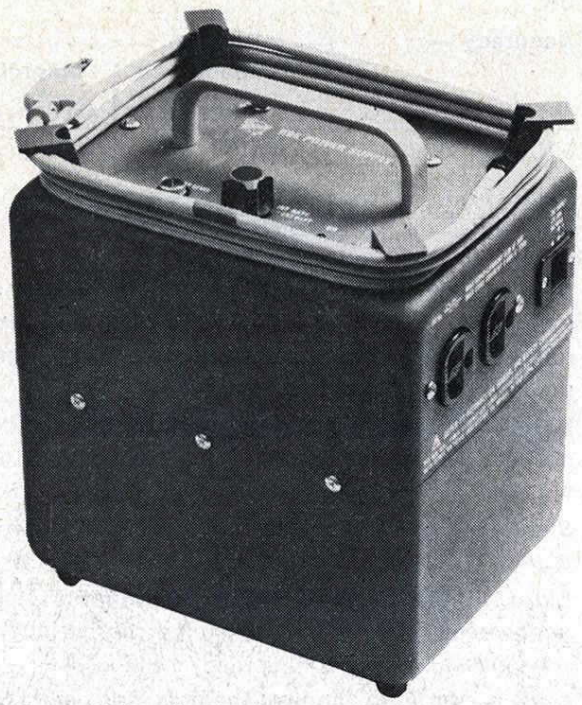
For X-Y operation, probe adjust, Z-axis input, environmental performance and dimensions, see T922 information on page 122.

INCLUDED ACCESSORIES

Probes — 2 each. P6006 general-purpose 10X voltage probes. Provides full bandwidth capabilities for the T912.

T912 — Dc to 10 MHz, Dual-Trace, Single Time Base Storage Oscilloscope (Includes Two 10X Probes $1545

Option 01, Differential Input . . . . . Add $50



Battery Packs

1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field. The 1105 is not recommended for the T912.

Frequency — Square wave, 60 Hz ±10%.

Amplitude — Approx 108 V peak, operating from 24 V dc external or 22 V internal charge. Approx 137.5 V peak, operating from 28 V dc external or 30 V internal charge.

Amplitude (Option 01) — Approx 216 V peak, from 24 V dc external or 22 V internal charge. Approx 275 V peak, operating from 30 V dc external or 28 V internal charge.

Charging Power Source — 100 to 132 V ac, 48 to 440 Hz (or internal connections expand range). Option 01 — 200 to 264 V ac, 48 to 440 Hz (or internal connections expand range).

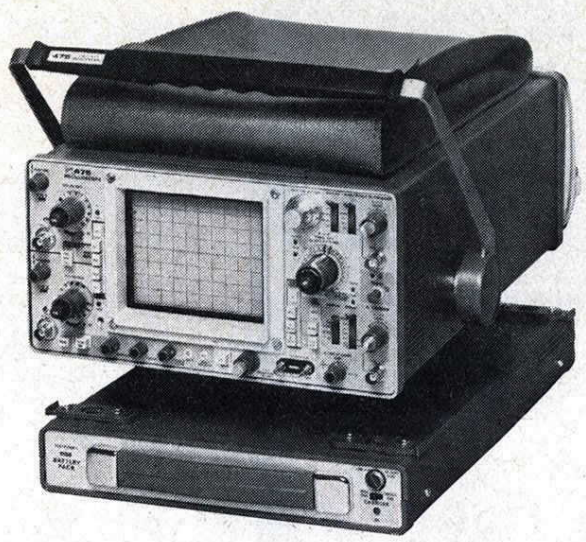
Battery Operating Time — Approx 140 VA hours.

Recommended Max Output Current — 0.9 amp.

Weight — 19.5 lb.

Order: 1105 Battery Power Supply . . . $915

Option 01, 230 V Operation . . . . . No Charge



1106 BATTERY PACK

The 1106 is a convenient, snap-on battery power supply for TEKTRONIX 455, 464, 465, 466, 475 or 475A Oscilloscopes when the scope is ordered with Option 07.

Output Power — 22 to 26 V dc; 140 watt-hours from full charge.

Charging Power Source — 90 to 132 V ac, 50 to 400 Hz; or 180 to 264 V ac, 50 to 400 Hz.

Charging Time — 14 to 16 hours.

Weight — 16 lb.

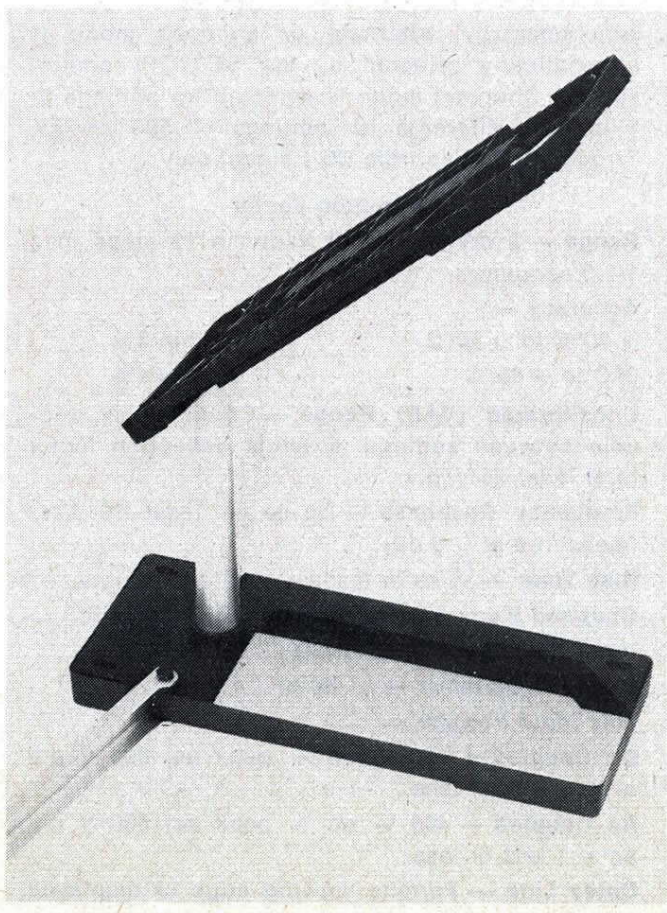
Order: 1106 Battery Pack $675

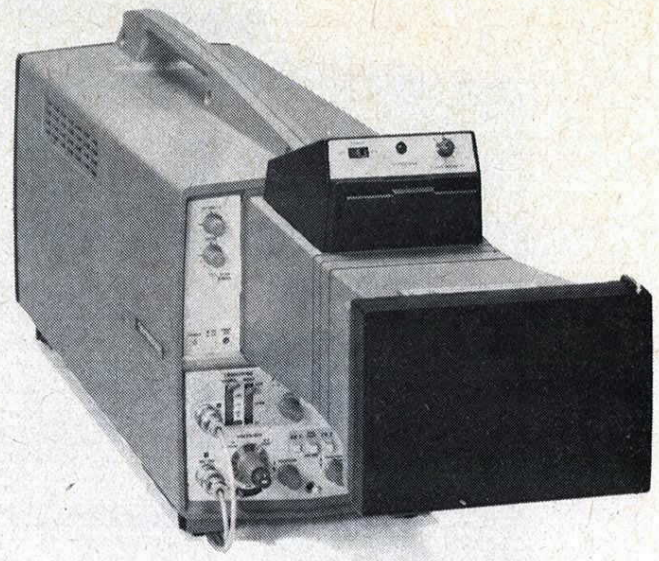
T900 Accessories

209 SCOPE STAND

Supports any benchtop T900 Oscilloscope at convenient angle for viewing and easy access to controls. Quickly disassembled, it forms a lightweight (3 lb) package that can be neatly attached to the bottom of the oscilloscope for easy carrying. Consists of a molded plastic base, support bracket, and a 15 in. aluminum support column.

Order: 209 Scope Stand $70





C-5B CAMERA

Recommended for all T900-Series Oscilloscopes, the C-5B attaches directly to the front panel without adapters and uses Polaroid pack film. A fixed f/16 lens aperture and an electric shutter with continuously variable speeds from .1 to 5 seconds combine to make the C-5B a rugged, low-cost scope camera. Bench model T900 Oscilloscopes use the C-5B Option 03 which includes a built-in Xenon flash unit that flashes to illuminate the graticule when the shutter opens. The T922R uses the C-5B Option 01, without the Xenon flash. Batteries are not included for either version.

Order: C-5B, Option 03 . . . . . $395
C-5B, Option 01 . . . . . $355

VIEWING HOOD

Provides for convenient viewing in high ambient light conditions (except T922R).

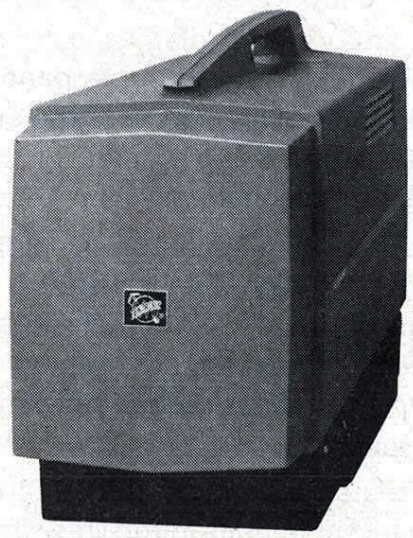
Order: Viewing Hood (016-0377-00) . . . $6.10

PROTECTIVE COVERS

Front Panel Cover

Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side.

Order: Protective front cover (016-0340-00) $18



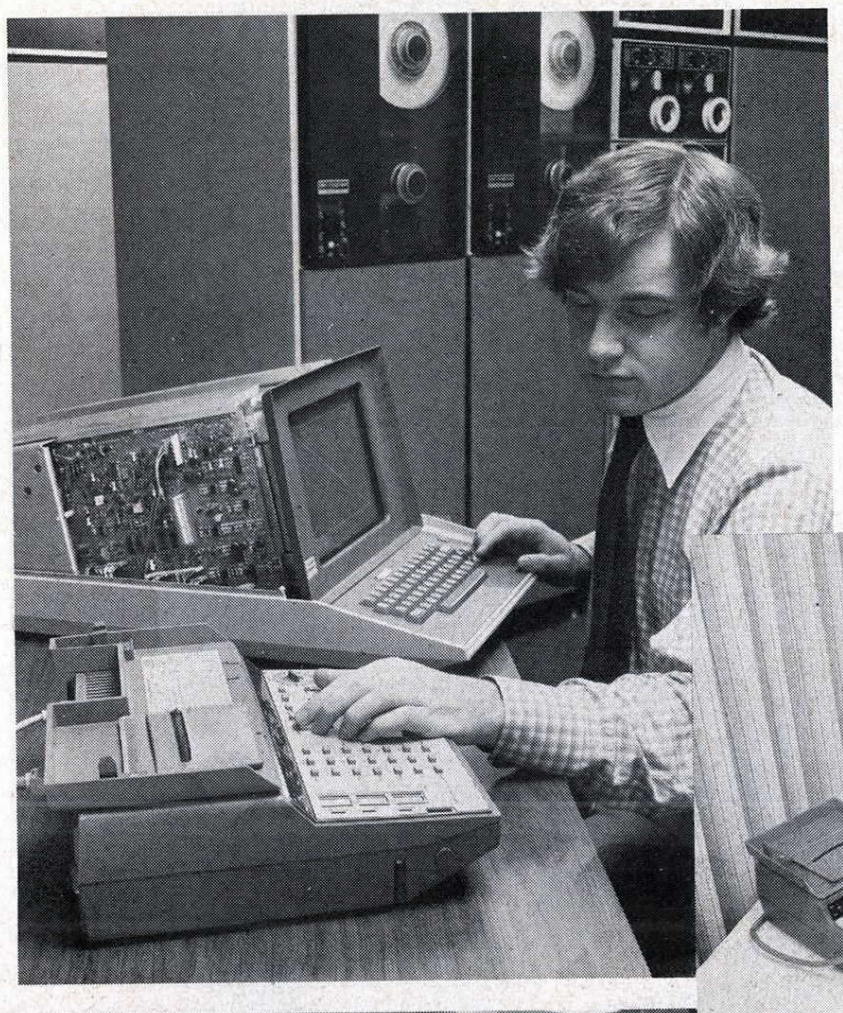
Dust Cover/Rain Jacket (not shown)
Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle.

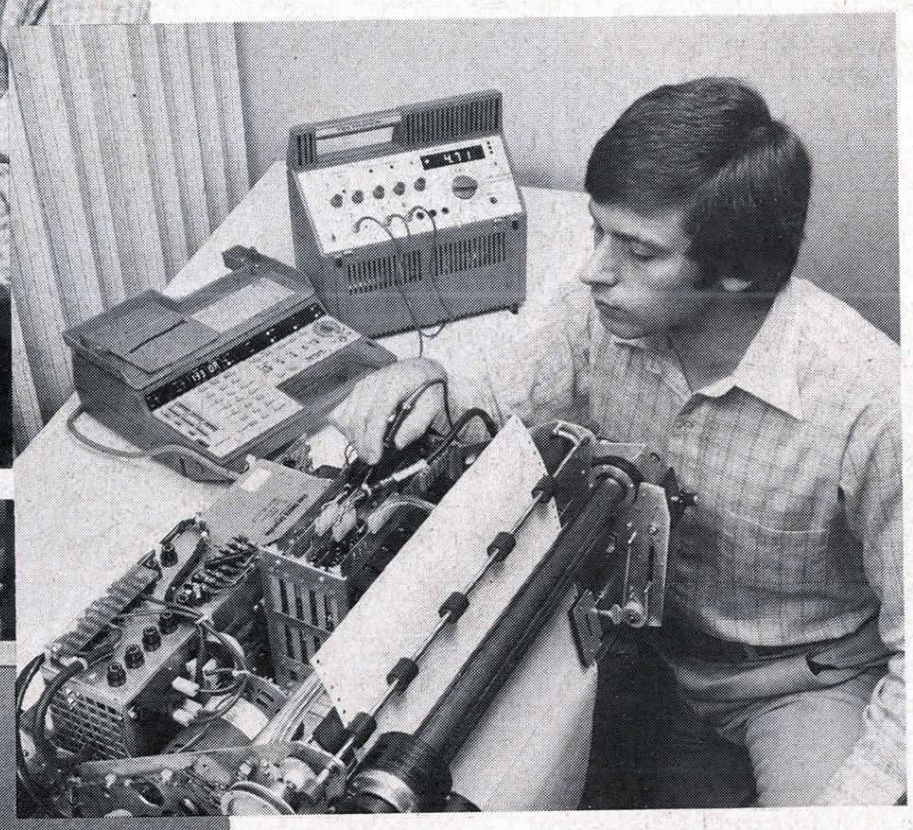
Order: Protective cover (016-0361-00) $18

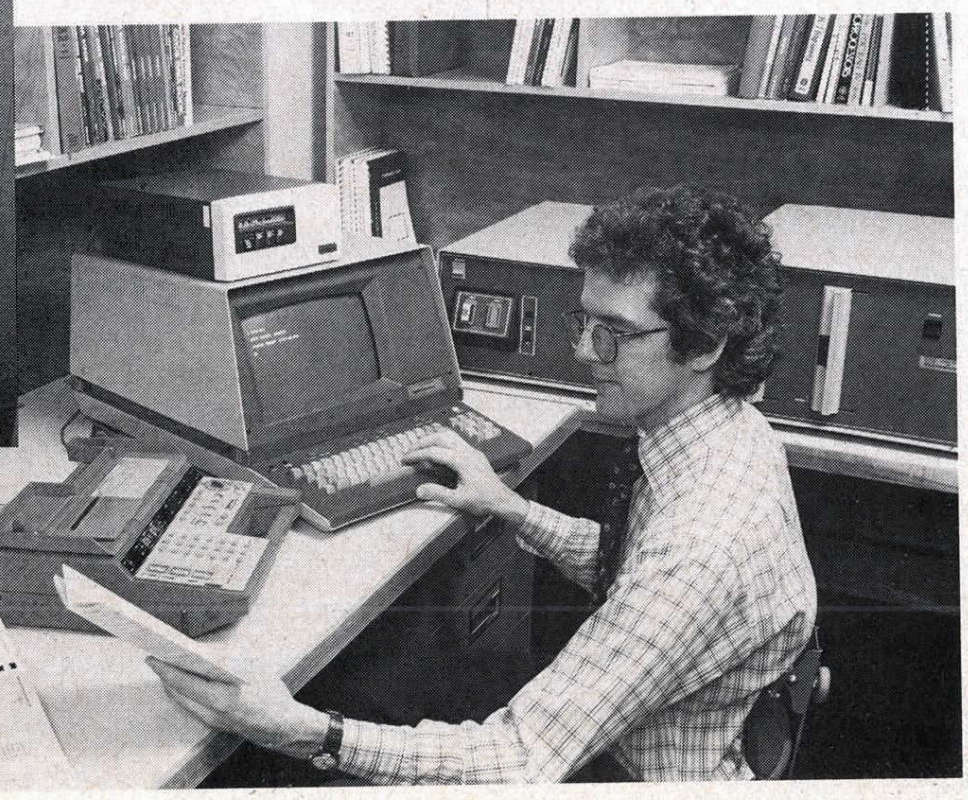
Digital Service Instruments

New Concepts in Digital Service

7







851 | Digital Tester

Designed for digital Field Service Applications

Single Knob Selects 22 Functions

Autoranging On All Functions

LED Display

Logic State Indicators for Each Channel

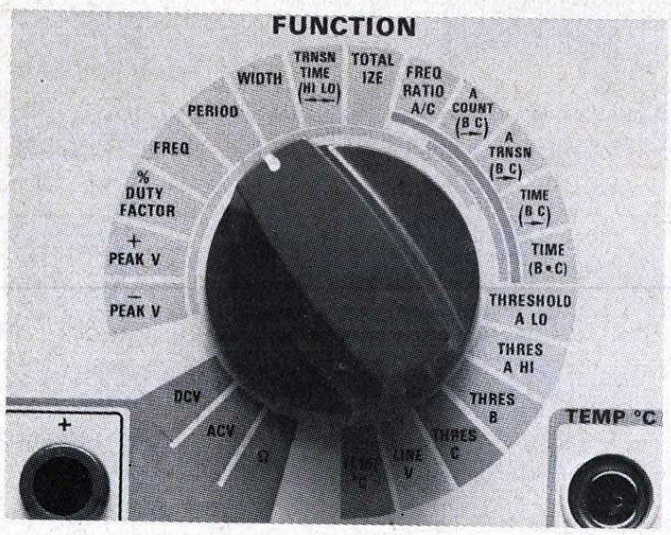
Built-in Self Test

Small and Lightweight

The 851 Digital Tester is an easy-to-operate first-line service tool used to troubleshoot and maintain a wide range of digital equipment.

With this portable digital tester (only 13 pounds, 6 kg), a first-line service engineer can make many of the same measurements that now require an oscilloscope, DMM, counter, timer, logic probe, thermometer and special purpose test equipment.

One knob lets you dial 22 functions to perform a wide variety of tests and measurements. Eleven functions measure timing, two register plus and minus peak voltages, three carry out DMM measurements through separate leads and one reads line voltage at the outlet. Another function allows you to take temperature readings with an optional temperature probe. The 851 also measures its four input thresholds to adjust to the logic levels of the equipment being serviced.



Dial 22 different functions with the turn of this one knob.

All together, these functions allow you to:

Measure system parameters.

Check for signal activity.

Correct synchronization problems in electro mechanical subsystems through adjustment or repair.

Identify boards or component parts of the system in need of replacement.

It's easy. Just dial a function, probe the circuit being examined, and read the results directly from the five-digit LED display (4½ digits for DMM functions). All the functions are completely autoranging and the indicator lights tell you exactly what range is being used.

The capabilities of the 851 make it particularly suitable for servicing computer peripherals, small business systems, and industrial control equipment.

851 DIGITAL TESTER FUNCTIONS

MEASUREMENTS	DIGITAL SIGNAL ANALYSIS	SELF TEST
VOLTAGE	**LOGIC STATE INDICATORS**	**TEST SIGNAL**
PEAK (10 ns to 25 ms)	HI, LO, INVALID, ACTIVE	EXERCISE FUNCTIONS
AC	**% DUTY FACTOR**	ADJUST PROBE
DC	**COUNTING**	**READOUT TEST**
POWERLINE	FREQUENCY RATIO	
INPUT LOGIC THRESHOLDS	EVENTS BETWEEN START AND STOP PULSES	
RESISTANCE (0.1 Ω to 50 MΩ)	TRANSITIONS BETWEEN START AND STOP PULSES	
TEMPERATURE	TOTALIZE	
TIME (20 ns to 10 s)		
PERIOD		
FREQUENCY		
PULSE WIDTH		
INTERVAL		
COINCIDENCE		
TRANSITION		

Electrical

Inputs
(ACV, DCV, Ω)

Resistance and Capacitance — 10 MΩ ±1% and approx 100 pF. Red to black terminal. (Volts only)

Max Safe Input Voltage (≤1 kHz) —

±500 V (peak) red terminal to ground.

±500 V (peak) black terminal to ground.

±500 V (peak) red to black terminal.

±250 V (peak) red to black terminal in Ω function.

Resistance

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ, and 50 MΩ.

Accuracy —
200 Ω, 2 kΩ, 20 kΩ, 200 kΩ: ±0.3% of reading ±4 counts (plus probe resistance).

2 MΩ: ±0.5% of reading ±4 counts.

20 MΩ: ±5% of reading ±10 counts.

50 MΩ: ±10% of reading ±20 counts.

Extended temperature range: add 0.2% on 200 Ω through 2 MΩ and 5% on 20 MΩ and 50 MΩ ranges.

AC Volts
(Average responding RMS calibrated for sine wave.)

Ranges — 2 V, 20 V, 200 V, and 350 V.

Accuracy —
2 V and 20 V:
±0.5% or reading ±4 counts, 40 Hz to 1 kHz.
±2% of reading ±4 counts, 1 kHz to 25 kHz.
>9% full scale.
200 V and 350 V:
±0.5% of reading ±4 counts, 40 Hz to 1 kHz.
Extended temperature range: add ±0.2%.

DC Volts

Ranges — 2 V, 20 V, 200 V, and 500 V.

Accuracy —
2 V, 20 V and 200 V: ±0.1% of reading ±3 counts.
500 V: ±0.15% of reading ±3 counts.
Extended temperature range: add ±0.05%.

Normal-Mode Rejection Ratio
(Dc volts) — ≥60 dB at 50 to 60 Hz. For peak amplitude ≤5X full scale.

Common-Mode Rejection Ratio
(Ac and dc volts — ≥80 dB at dc; ≥60 dB at 50 to 60 Hz; ≥52 dB on 350 V.

Line Voltage

Range — 90 to 132 V and 180 to 250 V.

Accuracy — ±3% of reading.

Temperature

Range — −55° to +150°C.

Accuracy — ±2°C (0.01° resolution). Extended temperature range: add ±1°C.

Inputs
(3 probes; one for each channel A, B, C.)

Resistance and Capacitance — 10 MΩ and approx 12 pF.

Max safe input voltage — ±500 V at probe tip (≤50 kHz)

Threshold Levels
Variable (4 controls) range: ±30 V; setability ±10 mV.

TTL (nominal, in detent position) — Input A LO + 0.7 V; HI + 2.1 V; Input B and C + 1.4 V.

Threshold Error — (Max difference between a displayed threshold voltage or TTL threshold voltage and the actual signal voltage at threshold crossing.) A Input (HI and LO THRESHOLDS): ±100 mV ±2% of threshold voltage ±3% of the signal voltage (p-p) for pulses at least 14 ns wide at the threshold. B and C inputs: ±100 mV ±2% of threshold voltage ±8% of the signal voltage (p-p) for pulses at least 14 ns wide at the threshold.

Extended temperature ranges: add ±20 mV ±2% of signal voltage (p-p).

Input Filter
(Narrow pulse rejection) max input rep rate for pulse rejection = 20 MHz.

Range — off and 50 ns ±20% to >300 ns.
Channel to channel delay mismatch: <100% of setting.

+, − Peak Volts

Range — ±30 V.

Accuracy — ±2% of reading ±3% of p-p signal ±90 mV. Max time between recurrent peaks, 25 ms. Peak amplitude must be maintained for at least 25 ns.
Extended temperature range: add ±1% of reading ±1% of p-p signal ±10 mV.

Frequency

Ranges — 100 kHz (1 Hz resolution), 1 MHz, 10 MHz, and 35 MHz.

Accuracy — ±0.005% of reading ±1 count.

Time Measurements
(Period, pulse width, transition time, time interval, and coincidence time.)

Ranges — 1 ms (10 ns resolution), 10 ms, 100 ms, 1 s, and 10 s.

Minimum Time Interval — 20 ns.

Accuracy — ±0.005% of reading ±1 count ± Trigger Error.

Trigger Error —

$$\pm \frac{\text{Threshold Error}_1}{dv/dt \text{ of signal}^2 \text{ at time start threshold}}$$

$$\pm \frac{\text{Threshold Error}_1}{dv/dt \text{ of signal}^2 \text{ at time stop threshold}}$$

± Input filter setting

Counting
(Totalize, frequency ratio, events count, and transitions count.)

Range — 0 to 99,999

Max Input Frequency — 35 MHz (except 17.5 MHz for transition counting).

Accuracy — ±1 count, ±A Input event or transition frequency multiplied by the Time Interval Trigger Error[3].

Duty Factor

Range — 0 to 100%

Input Freq Range — 40 Hz to 10 MHz.

Min pulse width (HI and LO portions) — 50 ns.

Accuracy —

$$\pm 3\% \pm \frac{\text{Trigger Error}_3 \times 100}{\text{Pulse Period}}\%$$

$$\pm \frac{300 \text{ ns}}{\text{Pulse Width}}\%$$

Display

Readout

Type — 5 digits, fully buffered 7 segment, 0.5″ LEDSs.

Polarity Indication — + for positive readings, − for negative readings.

Overrange Indication — Display flashes.

UP Ranging — Up ranging occurs at 100% of display range.

Down Ranging — Down ranging occurs at 9% of volts and ohms ranges, and 8% of time and frequency.

Range Indicators — LEDs show function ranges in Ω, kΩ, MΩ, MHz, kHz, ms, μs and V.

Logic State Indicators — Red, yellow, and green LEDs show valid and invalid logic state inputs for CH A. Red and green LEDs show logic states above or below the threshold set for CH B and C. Any state change indication is sustained long enough to be visible.

Threshold Lock Indicator (LO > HI) — Red LED indicates when CH A LO and HI thresholds are locked together (LO threshold setting is higher than the HI setting).

Mechanical

Dimensions (approx)	**cm**	**in**
Width	33	13
Height	31	12
Depth	18	7
Weight	**kg**	**lb**
Net	6	13

Power Requirements

Line Voltage Range — 90 to 132 V or 180 to 250 V.

Frequency — 48 Hz to 440 Hz.

Power Consumption — 57 watts max.

Environmental Capabilities

Ambient Temperature — Operating: +15°C to +40°C. Nonoperating: −40°C to +75°C. Extended operating range: +5°C to +50°C.

Altitude — Operating: to 10,000 ft. Nonoperating: to 35,000 ft.

Vibration — Operating: 15 minutes along each of the 3 major axes, .06 cm (0.025 in) p-p displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1 minute cycles. After cycle vibration in each axis, hold frequency steady at 55 Hz for 10 minutes. All major resonances must be above 55 Hz.

Humidity — To 90% at 30°C Tektronix Test Method #1 90% relative humidity at 30°C for 4 hours.

Shock — Two shocks at 30 g's, ½ sine, 11 ms duration, each direction along each major axis. Total of 12 shocks.

EMI — Reference Mil Standard 461A-462 susceptibility as specified. Conducted emission, relax 10 dB. Radiated emission, relax 15 dB <100 MHz and relax 25 dB ≥100 MHz.

[1]See Threshold Error under Threshold Levels.

[2]Refer to the appropriate input (CH A, CH B, or CH C) for the measurement being made.

[3]See Trigger Error under Time Measurements.

INCLUDED ACCESSORIES

Three signal probes (010-0280-00), two DMM probes (012-0732-00).

ORDERING INFORMATION

851 Digital Tester $2145

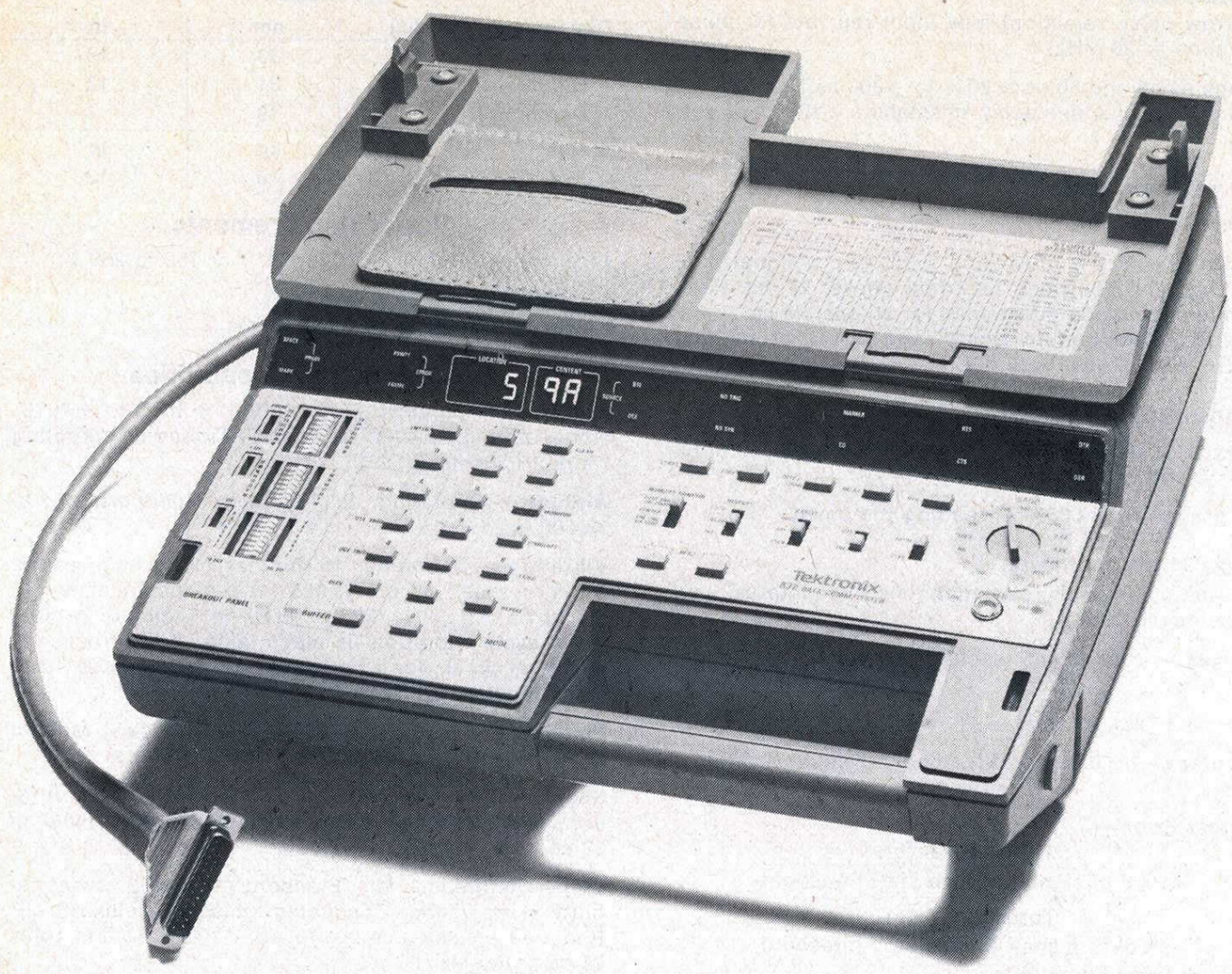
INSTRUMENT OPTION

Option 01 (with temperature probe) ..... Add $135

OPTIONAL ACCESSORIES

Temperature Probe —
Order 010-6430-00 ..... $135

Rain Jacket —
Order 016-0639-00 ..... $15



Microprocessor controlled

Portable and lightweight (11 lbs.)

Easy-to-operate keypad

Built-in self diagnostics

The TEKTRONIX 832 Data Comm Tester is a portable, digital service instrument which can be used to direct the user to possible problems in data communications systems. It can monitor, analyze, test and troubleshoot data communications interfaces that conform to EIA standard RS-232-C, CCITT V.24 or current loop. The 832 operates as a serial data transmission monitor or as a modern simulator for off-line testing of Data Terminal Equipment (DTE).

In MONITOR mode the 832 reads and selectively records DTE data and Data Communications Equipment (DCE) data, as well as recording the status of key interface lines.

In SIMULATE mode the 832 simulates the operation of a modem. The 832 can send a message to the DTE and record its response. This data can be sent directly from the 832 or can be transmitted upon receipt of an expected trigger from the DTE.

ECHO mode is the same as SIMULATE, except the 832 sends back to the DTE (echoes) any character sent by the DTE.

In REPEAT mode the 832 can send data repeatedly to the DTE, or the 832 can be programmed to repeat the transmission only upon receipt of an expected trigger from the DTE.

ELECTRICAL

Data Transmission Timing — Synchronous and asynchronous.

Communications Mode — Half- or full-duplex.

Bits Per Character — 5, 6, 7, or 8.

Data Transfer Rates —
Internal (crystal controlled) — 50, 75, 110, 134.5, 150, 200, 300, 600, 1200, 1800, 2400, and 4800 bits per second. 9600 bits per second at 8 bits per character only. Accuracy — Within 0.5%.
External — Determined by the DCE or DTE clock.

Parity — Odd, even, or none.

Synchronizing Character (SYN), (synchronous mode only) — Programmable to require one character, or two equal characters. If not programmed, defaults to ASCII SYN character.

RTS/CTS Delay, (half-duplex mode only) — Programmable from 0 to 255 ms. If not programmed, defaults to 200 ms. Accuracy — Within 1% ±1 ms.

Stop Bits (asynchronous mode only) — Responds to one or more. Transmits 2.

Trigger — Programmable to require a sequence of 1, 2, or 3 characters.

Trigger Position — Location of last trigger character in Receive Buffer: Post Trig, 000; Center, 127; Pre Trig, 255.

RS-232 CONNECTORS

Inputs (except pins 20 & 24)

MARK or OFF: $-25\ V \leq V\ in \leq +0.75\ V$.
SPACE or ON: $+1.5\ V \leq V\ in \leq +25\ V$.
Input Impedance: $3\ k\Omega \leq Z\ in \leq 7\ k\Omega$.

Inputs (pins 20 & 24)

MARK or OFF: $-25\ V \leq V\ in \leq -3\ V$.
SPACE or ON: $+3\ V \leq V\ in \leq +25\ V$.
Input Impedance: Pin 20 Z in $\geq 40\ k\Omega$.
Pin 24 Z in $\geq 100\ k\Omega$.

Outputs

MARK or OFF: V out -7.5 V.
SPACE or ON: V out $\geq +7.5$ V.
With load impedance: $R_L \geq 3\ k\Omega$.

BREAKOUT PANEL

Probe —
Space: $+3\ V \leq V\ in \leq +25\ V$.
Mark: $-25\ V \leq V\ in \leq V\ in \leq -3\ V$.
Input Impedance: $\geq 50\ k\Omega$.

Marker — MARK or OFF: $-25V \leq V\ in \leq -3\ V$. SPACE or ON: $+3\ V \leq V\ in \leq +25\ V$ (Schmitt input).

+12 Volt Source — +12 V ±1 V (no load). Output Impedance approx 3 kΩ (each pin).

−12 Volt Source — −12 V ±1 V (no load). Output impedance approx 3 kΩ (each pin).

DISPLAY

Buffer CONTENT — 2 hexadecimal digits: 7-segment, LED displays.

Buffer LOCATION — 3 decimal digits: 7-segment, LED displays.

Data Source — DCE, DTE: 2 LED indicators.

Error — Parity, Frame: 2 LED indicators.

No Trig, No Syn — 2 LED indicators.

RS232 Control Lines — DSR, CD, CTS, RTS, DTR, and MARKER: 6 LED indicators.

Probe — Mark, Space: 2 LED indicators.

PHYSICAL

Dimensions (approx.)	cm	in
Width	33	13
Height	10	4
Length	31	12
Weight	**kg**	**lb**
Net	5	11

POWER REQUIREMENTS

Line Voltage Ranges —
115 V — 90 to 132 V.
230 V — 180 to 250 V.

Line Frequency Range — 48 to 440 Hz.

Power Consumption — Approx 15 watts.

ENVIRONMENTAL

Temperature — Operating: 0° to +50°C (+32° to +122°F). Nonoperating: −55° to +75°C (−67° to +167°F).

Humidity — 5 cycles (120 hrs), 30° to 60°C, 95% relative humidity.

Altitude — Operating: To 15,000 feet (4500 m). Nonoperating: To 50,000 feet (15,000 m).

Vibration — Cycle the vibration frequency from 10 to 55 to 10 Hz (linear or logarithmic sweep) for a duration of 15 minutes in each major axes at a displacement of 0.025 inches (0.64 mm) peak to peak. Dwell for 10 minutes in each major axis at any resonant frequency.

Shock — 50 g's, ½ sine, 11 ms duration, three shocks in each major axis for a total of 18 shocks.

INCLUDED ACCESSORIES

RS-232 cable assembly (012-0815-00), jumper set (198-4006-00), power cord (161-0066-00).

ORDERING INFORMATION

832 Data Comm Tester $1595

INSTRUMENT OPTIONS

High-Level Data Link Control (HDLC) option —
Order Option 01 ..... Add $225

Current loop interface option —
Order Option 02 ..... Add $300

OPTIONAL ACCESSORIES

Self Test Adapter —
Order 067-0878-00 ..... $100

Probe tip —
Order 206-0193-00 ..... $6

Miniature Probe Dual Lead Adapter —
Order 015-0325-00 ..... $8

TM 500

a complete family of test and measurement instruments

Concepts	134-137
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Digital Multimeters	142-143
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Amplifiers, Current Probes, Signal Processors	150-152
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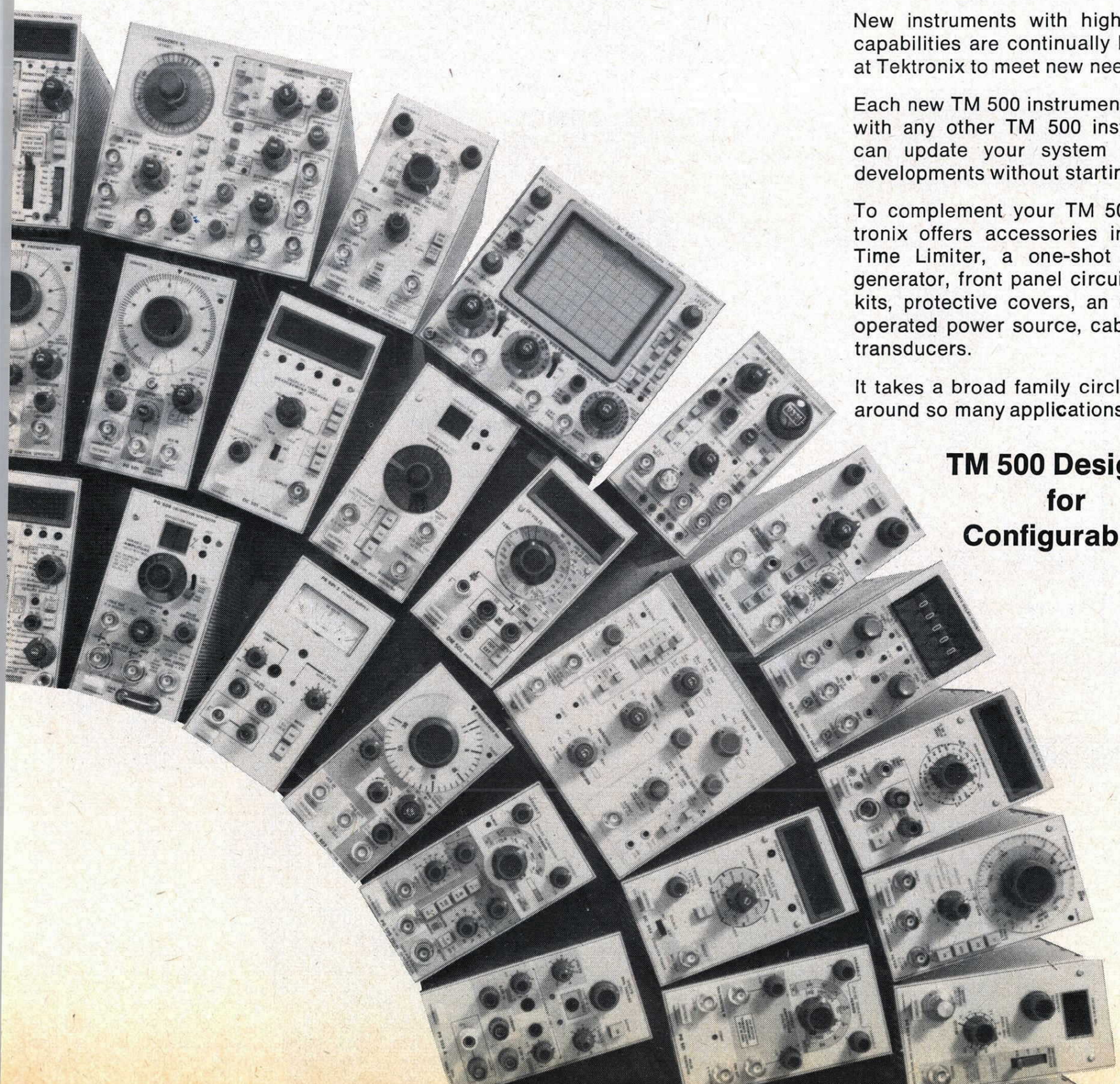
Mainframes and Carts	164-165
Accessories	165-168



TM 500 is a complete family of plug-in test and measurement instruments. Over forty modular instruments and six compact mainframes combine to make TM 500 a performance-packed, highly versatile family.

TM 500 functions run the gamut from DMMs to Word Recognizers. Yet all are related by their mechanical and electrical configurability and, since they are related, they share the same "family" name, TM 500.

They cover a wide range of general purpose and specialized applications, too. With TM 500 instruments and mainframes, multifunction packages can be created to encompass thousands of applications.

When it comes to talent, it's all in the TM 500 family.

TM 500 is also a growing family.

New instruments with higher performance capabilities are continually being generated at Tektronix to meet new needs.

Each new TM 500 instrument is configurable with any other TM 500 instrument, so you can update your system with the latest developments without starting from scratch.

To complement your TM 500 System, Tektronix offers accessories including a Rise Time Limiter, a one-shot manual trigger generator, front panel circuit board adapter kits, protective covers, an external battery operated power source, cables, probes and transducers.

It takes a broad family circle to draw a line around so many applications. TM 500 does it.

TM 500 Designed for Configurability

"Configurability" means a mouthful.

When the TM 500 approach to test and measurement instrumentation was developed, we combed the dictionary for one word that might describe it.

Though it was unique, it seemed like a simple concept: A variety of compact, interchangeable instruments that could easily function individually or in combination.

Several words came close to describing this idea. One was **modularity.** Each TM 500 instrument — whether a multimeter or power supply, oscilloscope or logic analyzer — is designed as a plug-in module to fit into TM 500 Mainframes. Instruments are interchangeable in seconds so you can slip together a system for one test, then rematch the set using other modules for a completely different application. Nearly 40 different TM 500 instruments are available.

But **modularity** didn't say enough.

Integrated seemed to get several ideas together. The back of each TM 500 Plug-in has connectors which slide into the connectors of the mainframe's "mother board." The "mother board" allows the user to interface the plug-ins with one another and with other devices external to the mainframe.

We also considered **flexibility.** TM 500 Mainframes can be racked, stacked or rolled around on TEKTRONIX Lab Carts. You can pack up to 5 instruments in a TM 515 Traveler Mainframe which looks (and fits under the seat) like a handsome carry-on flight case. But no single word captured the most popular features of the TM 500 concept, namely the ability to mix and match several mechanically and electrically interfaced instruments quickly and conveniently.

So, we coined our own word.

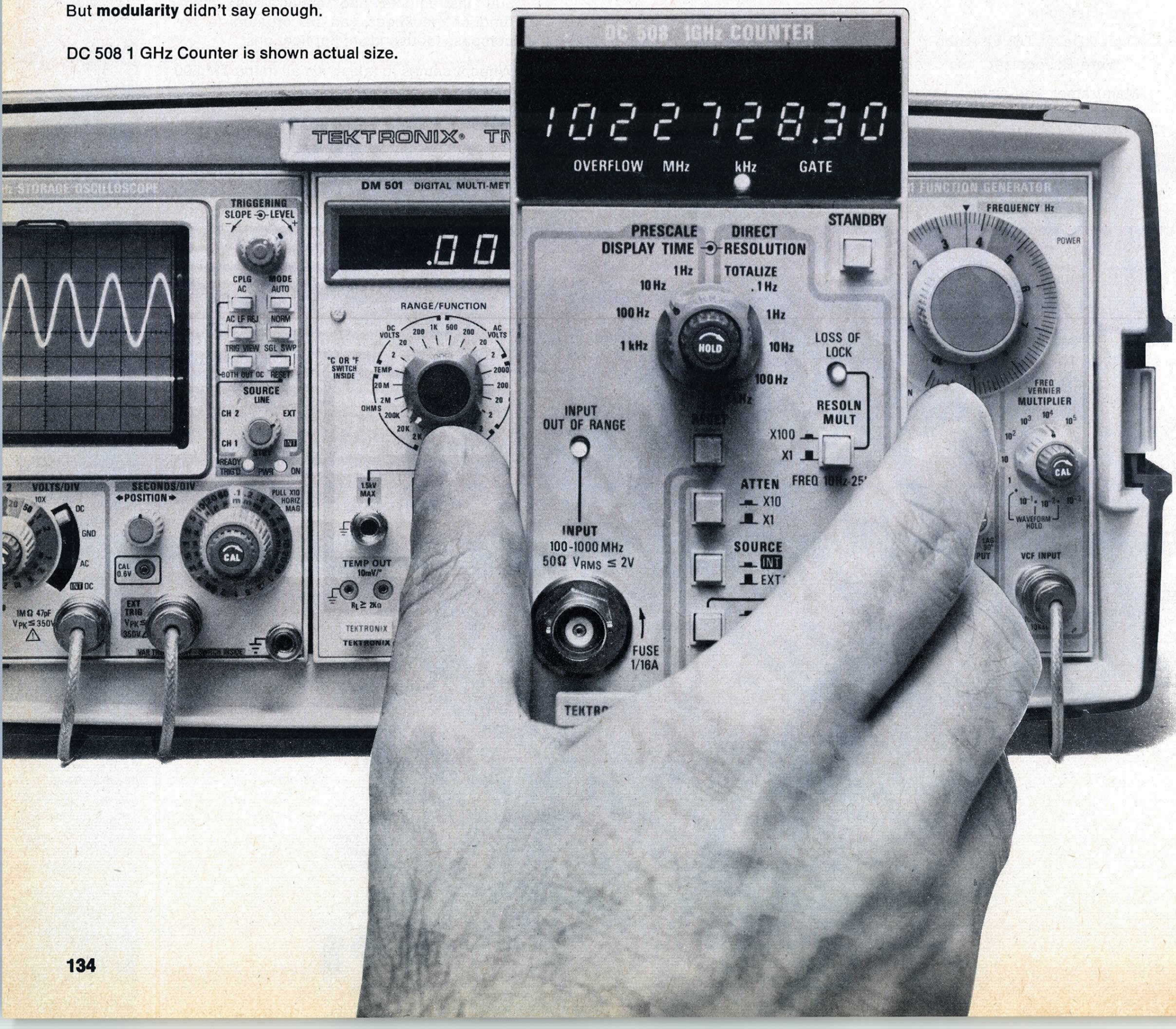
For testing and measuring, **configurability** means just about everything: A logic analyzer with digital delay. A plug-in oscilloscope with function generator, counter/timer and digital multimeter. You name it. The combinations run into the hundreds.

Exactly what configurability can mean to you is something to figure out for yourself.

At any rate, you might just add it to your vocabulary so the next time you get caught up in benchwork or run short of plugs on the floor, you'll be able to describe, in one word, exactly what you need.

TM 500 **Configurability.**

DC 508 1 GHz Counter is shown actual size.



Lots of plug-ins, not a lot of plugs.

Let's start with your work bench.

If you're plugging along with a bench-load of single-function instruments that necessitate picking your way through a maze of spaghetti to set up for a test, maybe it's time to do some spring cleaning.

With the TM 500, you can load up to 6 modular instruments in a single mainframe and build a custom system of instrument interfacing. You can focus on the task to be performed, instead of getting sidetracked with set up.

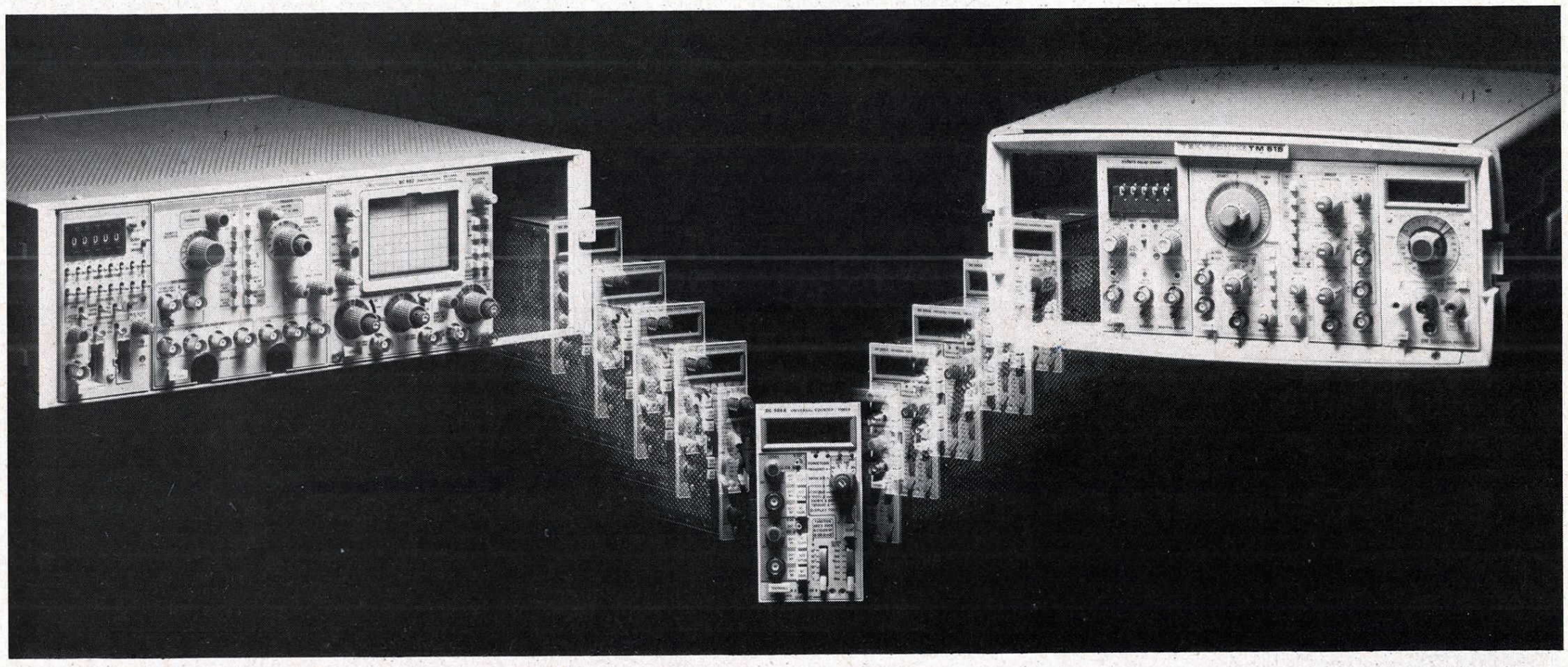
You'll save time and clutter when you have the ability to configure, in seconds, a variety of systems for testing and measuring. You can combine everything from state-of-the-art function generators to workaday digital multimeters to oscilloscopes and word recognizers.

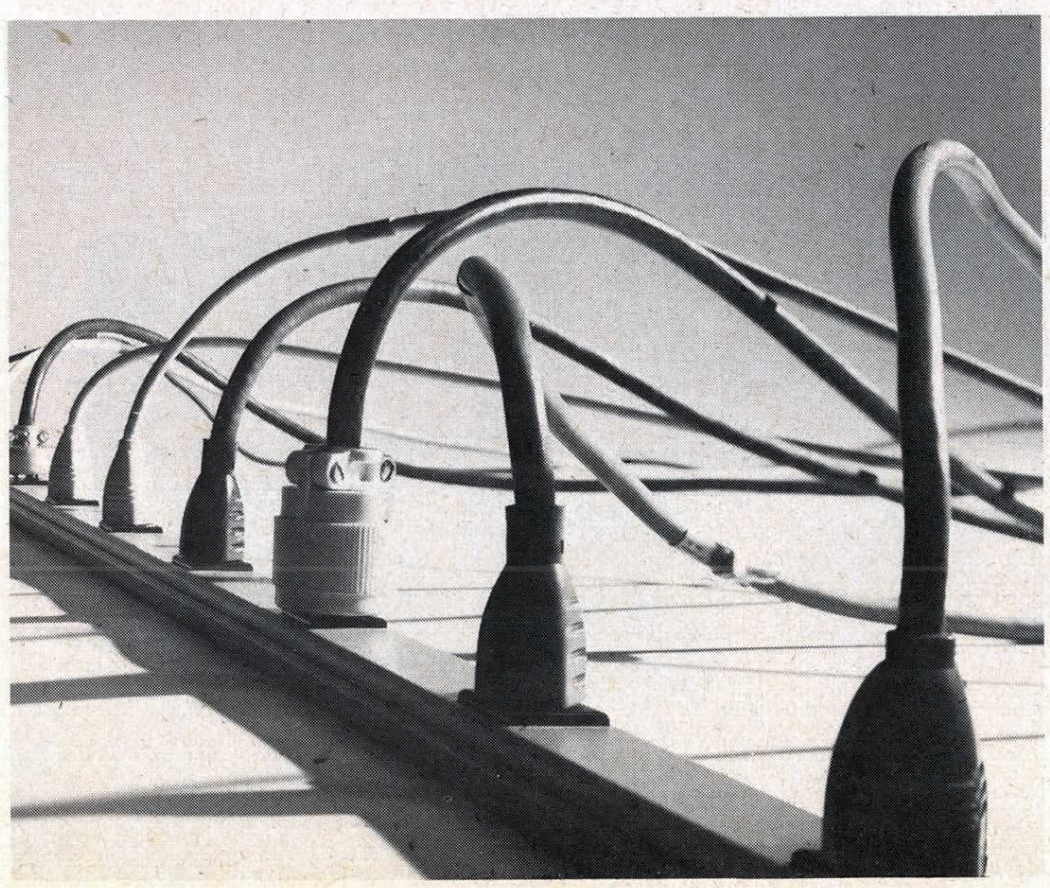
And, if you're keeping a close measure on costs, remember that a significant part of the price of every single-function instrument is its power supply. But with TM 500, one power supply is shared by several instruments, so you can add on more performance capabilities for less money.

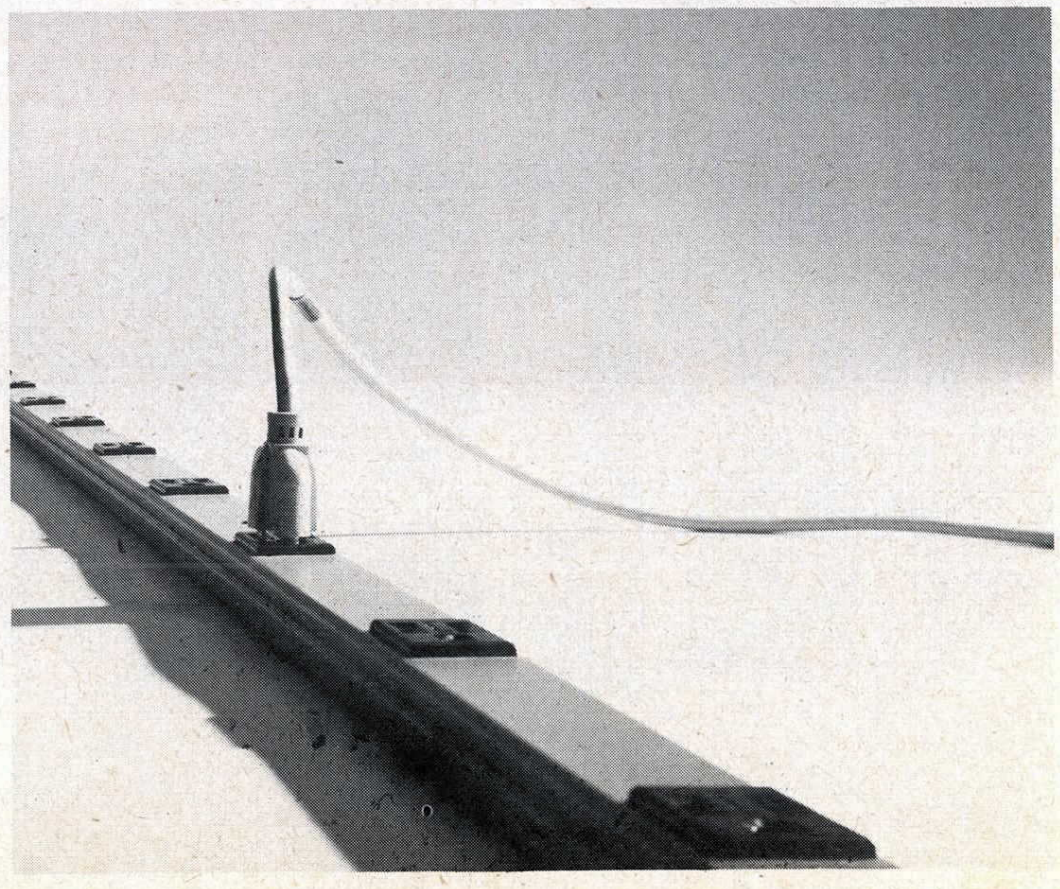
Through electrical configurability and mainframe interfacing, you can create an instrument more powerful than the sum of its parts, like combining two pulse generators with a digital delay module to create a logic system with self-contained burst generation.

TM 500 configurability not only allows you to choose from nearly 40 ready-to-go, compact plug-ins for testing and measuring, but the mainframe also makes room for compatible custom plug-ins you assemble yourself with a TM 500 custom Plug-in Kit.

TM 500 electrical configurability is a neat idea in other ways, too. It gives you lots of plug-ins, not a lot of plugs.







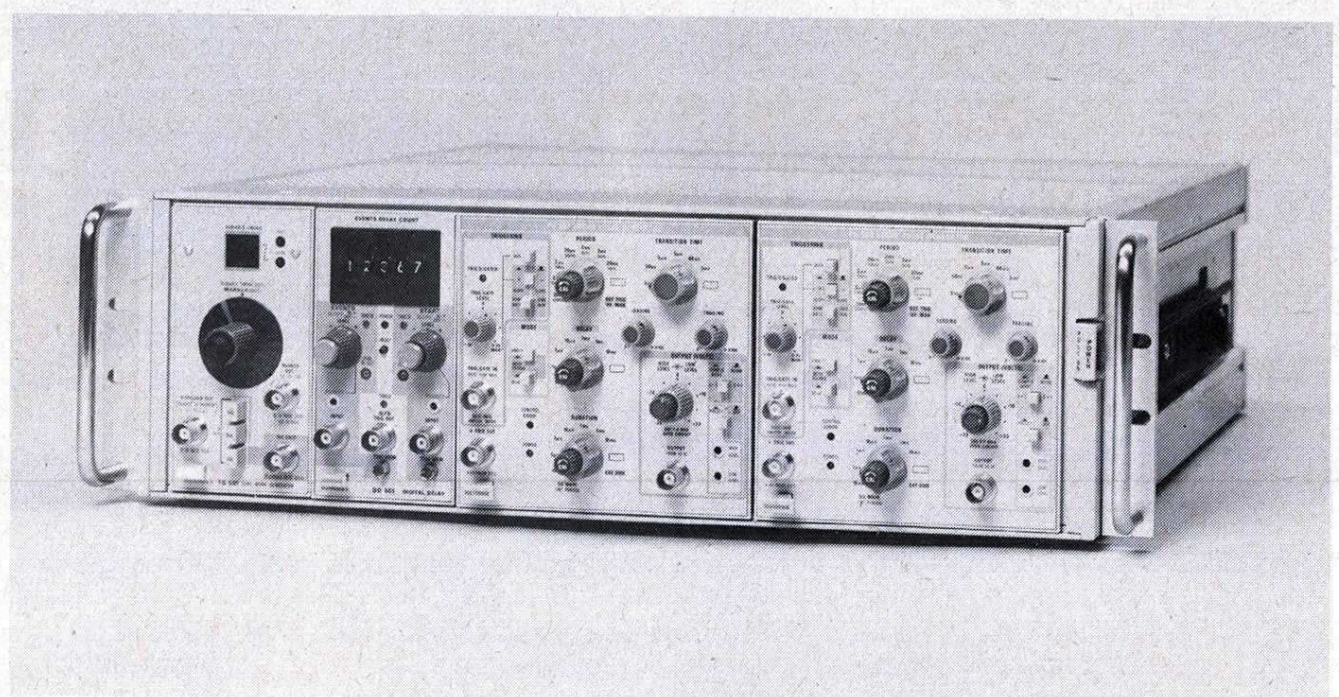
Instrumentation a la carte

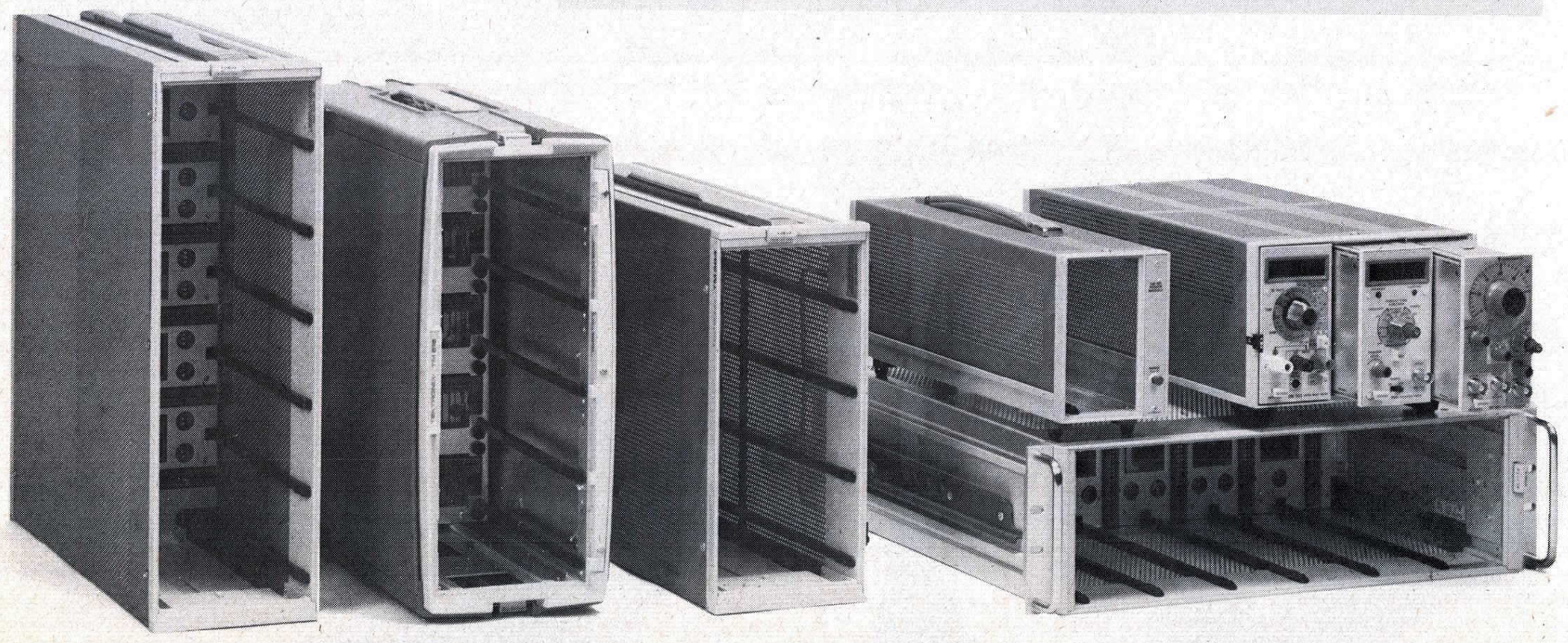
Whether your daily rounds include routine checks on the production floor, periodic R & D measurements at the bench, quality control inspection of in-coming components or on-site customer maintenance, there's a TM 500 Mainframe that gets all your instrumentation together and keeps it close at hand.

TM 500 instruments slide into any one of several power-module mainframes, available in six versions accepting one instrument or combinations of up to six.

Benchtop models, fitted with tilt bails and front panel switches, also sport a tough-tested handle and cord-wrap feet, providing a fair amount of portability, especially if you pick up an optional protective front cover.

If you're set up with a rack or console arrangement, TM 500 Rackmount Mainframes feature a slide out assembly, lateral grips, and powerful ventilation fan.

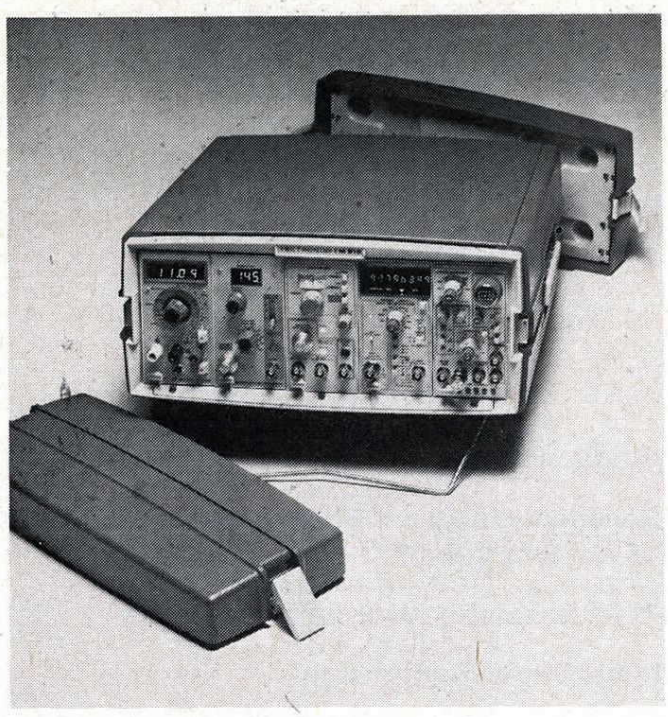


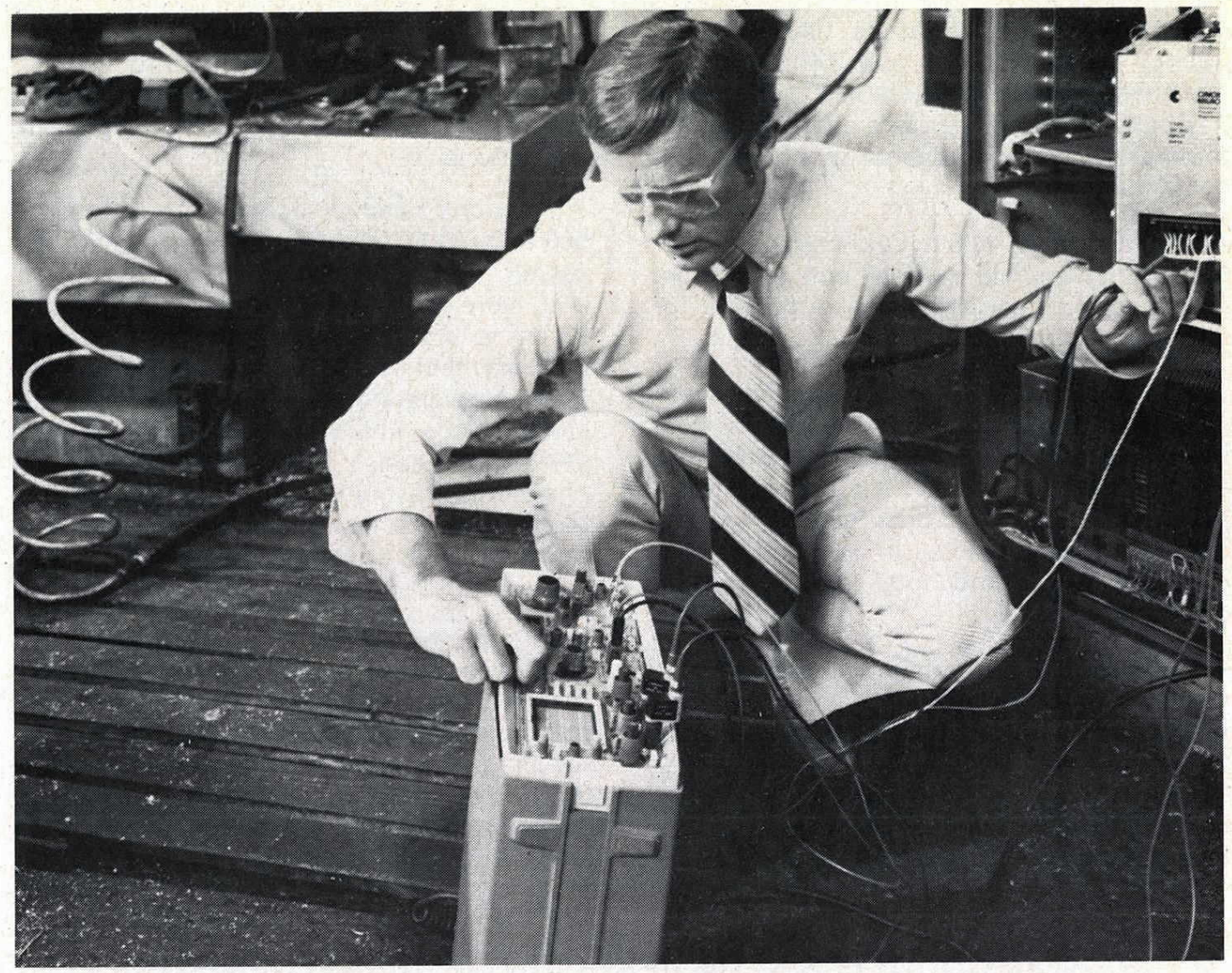


Ultimate Portability—TM 515

The ultimate in modular instrument portability is the TM 515. For on-site applications across town or across the country, you can't beat it. With the front and rear covers snapped in place, it looks like a carry-on flight case.

Pop the covers off and it acts like a benchtop lab with up to five instruments.

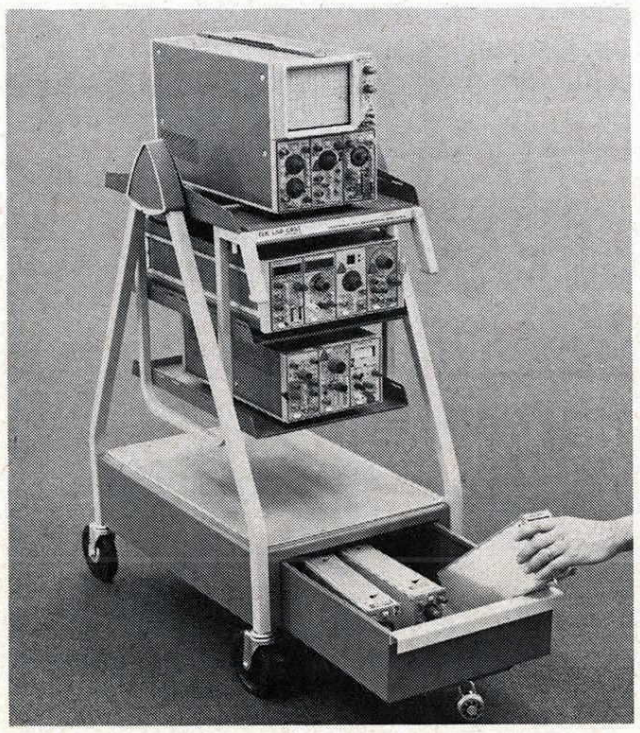




Instruments on wheels

You can set one or more benchtop mainframes in the mounting trays of a TEK Lab Cart, combine them mechanically, even electrically, with monolithic instruments on the same cart and create an extremely versatile rollabout test laboratory. Fully loaded for a variety of applications, you can slip down crowded aisles, across the production floor or into tight quarters, like the confines of an X-ray booth, to deliver everything you need to solve the problem in one trip, not several.

No matter where your work takes you, take TM 500 — racked, packed or ready to roll.



TM 500-Series Test and Measurement System

Comparison of Characteristics

When it comes to accurate time and frequency instrumentation, our TM 500 Counter/Timers always measure up. Their unique flexibility, compact size and easy readability are making testing and measuring more convenient and reliable.

Add our new DC 508 1 GHz counter to our four other versatile models, and you've got a full range of capabilities — a counter for virtually every application.

Our DC 501 and DC 508 Counters can measure frequencies and totalize events from low audio through 110 MHz to 1 GHz. The low-cost DC 504 has a period mode to improve resolution and accuracy of low frequency measurements. In addition to frequency, period and totalize, it has rpm capability.

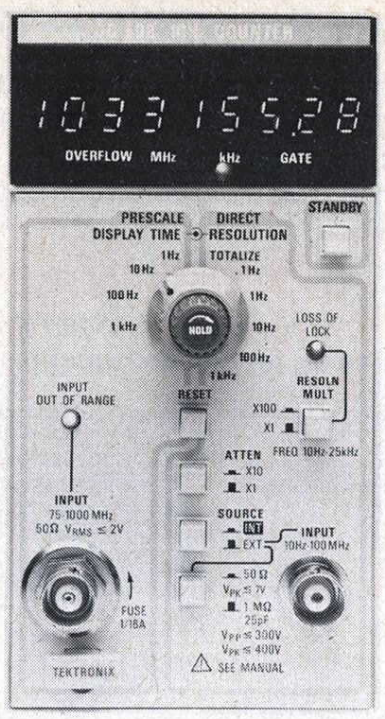
For totalizing and frequency measuring plus single period, period averaging, frequency ratio and time interval capabilities, our Universal Counter/Timers, DC 503 and DC 505A, are the ones to watch. A sophisticated combination of features like the DC 503's time-manual (electronic stopwatch), and the DC 505A's time interval averaging, direct pulse width measurements and unique events A-during-B mode can enhance your level of productivity while decreasing operator fatigue.

The second channel capabilities of the DC 503 and DC 505A Universal Counter/Timers permit measurement of frequency ratios and, more importantly, time intervals, in addition to the frequency and total events measurement of single-channel instruments. Time intervals are measured by the internal clock pulses which occur between a start event on channel A and a stop event on channel B. Resolution and accuracy are determined by the instrument's clock rate, and by whether time interval averaging is available.

Whatever the application from industrial control to research and communications—the TM 500 Counters are designed to cover most measurement needs. And they're built for maximum production with minimum downtime, since replacement is as simple as pulling a plug.

DIGITAL COUNTERS — COMPARISON OF CHARACTERISTICS

	DC 501	DC 503	DC 504	DC 505A	DC 508
Number of Digits	7	7	5	7	9
Frequency Range	110 MHz	100 MHz	80 MHz	225 MHz	1 GHz
Totalize	Yes	Yes	Yes	Yes	Yes
Period	No	Yes	Yes	Yes	No
Period Average	No	Yes	No	Yes	No
Time Interval	No	Yes; 1 μs maximum clock rate	No	Yes; 10 ns maximum clock rate	No
Time Interval Average	No	No	No	Yes	No
Ratio	No	Yes	No	Yes	No
Other	Option 01	Time Manual Option 01	Rpm Option 01	Events A During B, single-jack pulse width, dc trigger level out Option 01	Option 01 Option 07
Price	**$675**	**$795**	**$500**	**$1700**	**$1150**



DC 508
FREQUENCY COUNTER

Frequency up to 1 GHz

Sensitivity to 20 mV Rms Prescale, 15 mV Rms Direct.

X100 Resolution Multiplier to 25 kHz

Input Out-of-Range Light

Nine Digit LED Readout

Front Panel Fuse Protection on Prescale Input

The DC 508 Counter, designed to operate in a TM 500-Series Power Module, measures frequency from 10 Hz to 1 GHz. A nine-digit LED display shows frequency or totalized events from 0 to 999,999,999. The prescaler input allows it to measure frequency from 100 MHz to 1 GHz, and the direct input from 10 Hz to 100 MHz. The decimal point is automatically positioned and leading zeros suppressed. Digit overflow is indicated by a front panel LED. Option 01 includes a high-stability time base, and Option 07 also includes an interface for the TR 502 Tracking Generator/Spectrum Analyzer along with the Option 01 time base. An audio frequency resolution multiplier multiplies the resolution by 100 to 25 kHz. This allows resolution of .01 Hz in 1 second.

DC 508 SPECIFICATIONS

DISPLAY

Nine-digit LED display, leading zeros blanked, automatic decimal point positioning, LED front panel indicators for gate open, overflow, kHz, and MHz.

DIRECT INPUT

Frequency Range — 10 Hz to 100 MHz

Sensitivity — 15 mV rms.

Impedance — Selectable 50 Ω and 1 MΩ paralleled by 25 pF.

Maximum Operating Input Voltage — For 50 Ω is ≤7 V peak. For 1 MΩ 1X attenuation, V peak ≤400 V; V p-p ≤300 V from 10 Hz to 0.75 MHz, V p-p 225/f_{MHz} V from 0.75 MHz to 22 MHz, V p-p ≤10 V above 22 MHz; for a pulse, V peak ≤400 V and dV/dt ≤5 V/ns. For 1 MΩ, 10X attenuation, V peak ≤400 V; V p-p ≤300 V from 10 Hz to 1 MHz, V p-p ≤300/f_{MHz} V from 1 MHz to 6 MHz, V p-p ≤100 V above 6 MHz.

Attenuation — 1X, 10X.

Resolution (without resolution multiplier) — 0.1 Hz with 10 s gate, 1 Hz with 1 s gate, 10 Hz with 100 ms gate, 100 Hz with 10 ms gate, and 1 kHz with 1 ms gate.

Rear Interface Internal Input Sensitivity — 125 mV rms.

Rear Interface Internal Input Impedance — 50 Ω.

Rear Interface Internal Input Maximum Safe Input Voltage — 4 V.

Resolution Multiplier Frequency Range — 10 Hz to 25 kHz.

Resolution Multiplier Multiplication — X100.

Resolution Multiplier Lock Time — ≤5 s.

PRESCALE INPUT (÷8)

Frequency Range — 100 MHz to 1 GHz.

Sensitivity — 20 mV rms from 50 Ω source (−21 dBm).

Impedance — 50 Ω.

VSWR — ≤2.2:1.

Maximum Operating Input Voltage — V peak ≤15 V, V rms ≤2 V (+19 dBm).

Resolution — 1 Hz with 8 s gate, 10 Hz with 800 ms gate, 100 Hz with 80 ms gate, and 1 kHz with 8 ms gate.

Input Protection Voltage — Input fuse opens at ≈9 V rms (+30 dBm).

Input Out-of-Range LED — Indicates voltage or frequency too low for error-free counting.

TIME BASE

Frequency — 10 MHz; may also be used with external time bases with TTL levels at 1, 5, and 10 MHz.

Accuracy — Temperature stability, 0°C to 50°C — $\pm 5 \times 10^{-6}$.

Aging Rate — 1×10^{-6} per year.

OPTION 01 TIME BASE

Frequency — 10 MHz.

Temperature stability, 0°C to 50°C after warmup — Within 0.2 parts in 10^6 after warmup.

Warmup Time — Within ±0.2 ppm of final frequency in less than 10 minutes when cold-started at 25°C.

Aging Rate — ≤1×10^{-8}/day at time of shipping. ≤4×10^{-8}/week after a month of continuous operation. ≤1×10^{-6}/year after two months of continuous operation.

Setability — $\pm 2 \times 10^8$

ACCURACY

The overall DC 508 accuracy is:

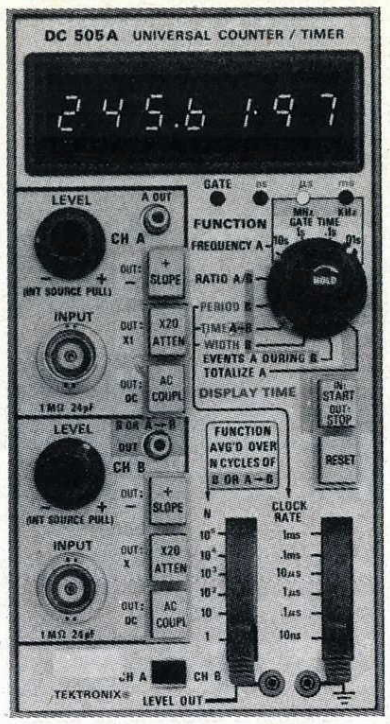
Accuracy (% of reading) = ± (time base accuracy + $\frac{1}{\text{total displayed counts}}$) x 100.

Time base accuracy ≤± [calibration accuracy + temperature stability + (aging rate x time since calibration) + short-term stability].

DC 508 Frequency Counter $1150

Option 01 (Time Base) . . . . . add $200

Option 07 (Includes Option 01 Time Base for use with TR 502) . . . . . add $200



DC 505A
UNIVERSAL COUNTER/TIMER

Dc Output for Accurate Trigger Level Setting with Companion DMM

Direct Counting to 225 MHz

10 Nanosecond Clock Rate

Time Interval Averaging with Resolution to 100 Picoseconds

Two Equal Bandwidth Channels for Time Measurements on Narrow Pulses

Events A During B

The DC 505A is a high-performance universal counter featuring direct counting to 225 MHz. Both channels A and B have equal response for ratio, time interval, and other measurements requiring two channels. The DC 505A provides dc trigger level output both at the front-panel jack and rear interface connector. Any TM 500 Digital Multimeter may be connected via the rear interface to read the DC 505A trigger level setting when the DMM input switch is pushed to the INT position. Alternately, an external voltmeter or oscilloscope may be connected to the front-panel jack to perform this function. The DC 505A can perform virtually any counting-timing function below 225 MHz.

Various functions include conventional frequency operation on channel A, ratio of channel A to B frequency, period of signal B, time interval from channel A start to B stop, width B, events A during B, and totalize. An averaging feature allows measurements to be averaged from 1 to 10^5 times as selected by front-panel controls with the resultant average displayed on the LED readout. Averaging factor and clock rate are independently selectable. Pulse width may be measured directly with single shot resolution to 10 ns. By use of maximum averaging on width or interval measurements of repetitive waveforms, resolution to better than 100 picoseconds is possible. Typical application of the DC 505A is in the design, development, or maintenance of logic circuitry in high speed digital computers. It is a high-performance counter for state-of-the-art design and measurements up to 225 MHz.

Display — 7 digits (7 segment LEDs).

Frequency (A input) — Range: 0-225 MHz, dc coupled. 10 Hz to 255 MHz, ac coupled. Gate Times: 0.01s, 0.1s, 1s, 10s.

Accuracy (A→B) — ±1 count ± time-base error.

Time Interval Resolution — Single event; 10 ns to 1 ms selectable. Repetitive Events: ≤100 picoseconds with 10 ns clock and 10^5 averaging. Clock rate selectable, 10 ns to 1 ms. Averaging factor independently selectable from 1 to 10^5. 5 ns minimum pulse width in either channel.

Time Interval Accuracy — ±1 count ± time base error ± trigger error CH A* ± trigger error CH B* ± channel delay match error (2 ns max) ± slew rate error*** +2 counts (10 ns clock rate only). Best absolute accuracy 3 ns.

Width (B input) — Single pulse: 10 ns to 1 ms, selectable. Repetitive pulses: ≤100 picoseconds with 10 ns clock and 10^5 averaging factor. Clock rate selectable 10 ns to 1 ms. Average factor independently selectable in decades from 1 to 10^5. 2 ns minimum pulse width.

Width Accuracy — ±1 count ± time base error + hysteresis error** ± slew rate error*** + 2 counts (10 ns clock rate only). Best absolute accuracy, 1.5 ns.

Period and Period Averaging (B input) — Resolution: From 10 ns to 1 ms for single period; to 0.1 picosecond max with 10 ns clock and 10^5 averaging. Accuracy: ±1 count ± time-base error ± trigger error† +2 counts (10 ns clock rate only).

Ratio (A/B) — Averaged over 1 to 10^5 cycles of signal at B. Accuracy: ±1 count FREQ A ± trigger jitter CH B†.

Events A during B — Averaged over 1 to 10^5 occurrences of signal at B. Accuracy: ±1 count FREQ A + hysteresis error** ± slew rate error***.

Totalize (A) — 1 to 9,999,999 at max rate of 225 MHz. Front panel start, stop, reset control.

Input Frequency Range (A and B) — 0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled.

Sensitivity, A and B — 150 mV p-p (50 mV rms sine wave) below 150 MHz. 300 mV p-p (100 mV rms sine wave) from 150 to 225 MHz.

Impedance (A and B) — 1 MΩ paralled by 24 pF.

Trigger Level (A and B) — Adjustable ±2.0 V at 1X attenuation.

Max Input Voltage (Aand B) — 1X Atten: 50 V at 10 kHz or less; derate −20 dB/decade to 100 kHz. 5 V from 100 kHz to 225 MHz. 20X Atten: 250 V at 1 MHz or less, derate −20 dB/decade to 50 MHz. 5 V from 50 MHz to 225 MHz.

Attenuation (A and B) — Selectable 1X, 20X.

Standard Time Base Accuracy — Temp stability, 0°C to 50°C after warm-up: ±1 X 10^{-5} (0.001%). Long Term Drift: ±1 X 10^{-5} per month (0.001%). Stability: Adjustable within 1 part in 10^{-7} (0.00001%).

Option 01 Time Base Accuracy — Temp Stability, 0°C to 50°C after warm-up: ±5 X 10^{-7} (0.00005%). Long Term Drift: ±1 X 10^{-7} (0.00001%). Setability: Adjustable within 5 parts in 10^9 (0.0000005%).

Rear Interface Input — Reset, external display scan clock, external time base.

Rear Interface Output — Bcd serial-by-digit plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

NOTES:

* = $\left(\frac{0.01\text{ V}}{\text{dv/dt of triggering edge}}\right) / \sqrt{N}$

** = $\left(\frac{0.1\text{ V}}{\text{dv/dt stop edge}}\right) \pm \left(\frac{0.01\text{ V}}{\text{dv/dt start edge}}\right) / \sqrt{N}$

***Input amplifier slew rate of 10 ns/volt will produce additional error in

(1) Time A → B mode if A and B level controls are not set for corresponding points on waveforms.

(2) Width B and Events A during B modes if B level control is not set at 50% of input pulse height.

† = $\left(\frac{0.01\text{ V}}{\text{dv/dt triggering edge}}\right) / N$

NOTE 1: Accuracies with averaging are dependent on the laws of statistics in Time A → B, Width B, and Events A during B modes.

Additional information on following page.

DC 504
DC 503

TM 500-Series Test and Measurement System

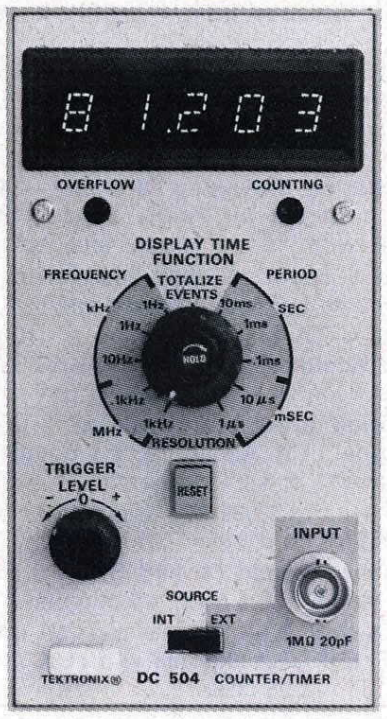
Counter/Timer, Universal Counter

Special Features — A out: Shaped output, after LEVEL and SLOPE selection, of signal into CH A. This output represents what goes into the display of FREQ A, RATIO A/B and TOTALIZE A. Propagation delay from CH A INPUT to A OUT is ≈15 ns.

B or A→B OUT — Shaped output, after LEVEL and SLOPE selection, of either CH B signal or A→B signal. This output represents the continuous signal used in generating the display gating for RATIO A/B, PERIOD B, TIME A→B, WIDTH B, AND EVENTS A DURING B. Logic levels out are the same as for A OUT. Propagation delays from the channel INPUTS TO B or A→B OUT are ≈15 ns.

Included Accessories — 1 cable assembly, RF, 3.5 ft. (012-0532-00)

DC 505A **$1700**
Option 01 (Time Base) . . . . . **add $200**



DC 504
COUNTER/TIMER

Direct Frequency Counting to 80 MHz
Period Measurement for Resolution at Low Frequency
Rpm Counting
5-Digit LED Display
Low Cost

The DC 504 Counter/Timer measures frequency from 0 Hz (with 0.1 Hz resolution) to 80 MHz, period from 1 microsecond to 999.99 seconds, and totalizes events from 0 to 99,999 at a maximum rate of at least 80 MHz. A resolution of 0.1 Hz can be obtained by allowing the more significant figures of the counter to overflow. Five 7-segment light-emitting diodes (LEDs) provide a visual numerical display. The decimal point is automatically positioned and leading zeros are blanked. Digit overflow is indicated by a front-panel LED. Signals to be counted/timed can be applied to either a front-panel BNC connector or to the rear interface connector. Internal switches select frequency or rpm operation, internal time base or external standard, and override display storage.

Display — 5 digits, LEDs.

Display Accuracy — ±1 count ± time-base accuracy (± trigger error in period mode only).

Frequency (or rpm) — Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.

Frequency/rpm (Max Resolution) — kHz Positions: 0.1 Hz, 1 Hz, and 10 Hz (1 rpm, 10 rpm, and 100 rpm).* MHz Positions: 0.1 kHz and 1 kHz (1000 rpm and 10 k rpm).*

Sensitivity — 20 mV rms (56.6 mV p-p) below 15 MHz, 35 mV rms (99 mV p-p) at or below 50 MHz derating to typically <175 mV rms (495 mV p-p) at 80 MHz.

Triggering Level — Adjustable from at least −1.5 V to +1.5 V.

Trigger Source — Internal (rear connector interface) or external (front-panel BNC).

Max Input Voltage — (sine waves, dc + peak ac) ±250 V at 500 kHz or less; derate −20 dB/decade to 25 MHz. ±5 V from 25 MHz to 80 MHz.

Impedance — 1 MΩ paralleled by approx 20 pF.

Coupling — Dc or ac.

Internal Time Base

	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz temperature compensated
Stability (0°C to 50°C) after ½ hour warm-up	≤±1 x 10^{-5}	≤±5 x 10^{-7}
Long-term Drift	≤±1 x 10^{-5}	≤±1 x 10^{-7}
Setability	Adjustable to ±1 x 10^{-7}	Adjustable to ±5 x 10^{-9}

Totalize Events (Resolution) — 1 count.

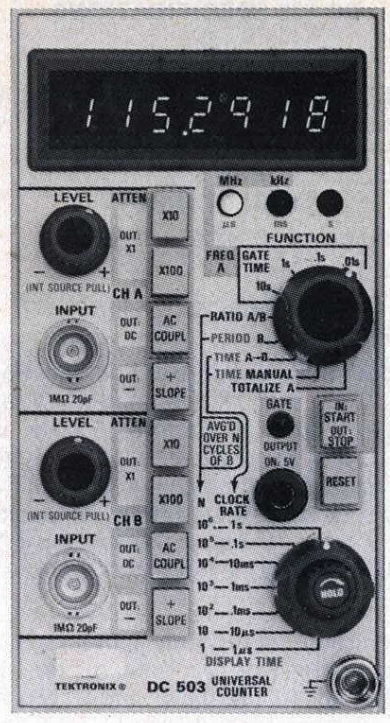
Period (Resolution) — mSec Position: 1 μs and 10 μs. Sec Position: 0.1 ms, 1 ms, and 10 ms.

Display Time — Variable from about 0.1 s to about 10 s. Detent position at cw position of DISPLAY TIME knob provides a HOLD mode.

Data Inputs and Outputs — Available at rear of plug-in for intra-compartment routing in any TM 500 Power Module/Mainframe. Bcd serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

DC 504 Counter/Timer **$500**
Option 01 (Time Base) . . . . . **add $200**

*This assumes that the transducer output is one pulse per revolution.



DC 503
UNIVERSAL COUNTER

Direct Counting to 100 MHz
Six Measurement Functions
Period and Ratio Averaging
Interval Measurement Capability

The DC 503 Universal Counter offers counting to 100 MHz and provides the versatility of six measurement functions: frequency, period, ratio, time A→B, time manual, and totalize. The two channels (A and B) have individual BNC inputs and separate trigger level, attenuator, and coupling mode controls. Seven-digit readout is via seven-segment light emitting diodes (LEDs) with automatically positioned decimal point; leading zeros are blanked. A flashing display indicates register overflow. The low-cost DC 503 offers high performance in a variety of applications. Its interval measurement capability with selectable clock rates is useful for digital equipment design and maintenance, particularly digital control and data communications work. The CH A frequency range of dc to 100 MHz serves in communication and rf use. High resolution measurements of low frequencies are available quickly in the period mode with averaging up to 1 million periods available. TIME MANUAL provides an electronic stop watch function with selectable clock rates. TOTALIZE counts and displays the total number of input events at rates from dc to 100 MHz.

Display — 7 digits (7 segment LEDs)

Frequency (A input) — Range: 0-100 MHz, dc coupled. 10 Hz to 100 MHz, ac coupled. Gate Times: 0.01 s, 0.1 s, 1 s, 10 s.

Accuracy — ±1 count ± time-base error.

Time Interval Resolution (A→B) — Single event: 1 μs to 1 s, selectable. Accurate to ±1 count ± time-base error.

Width (B input) — Resolution, single pulse: Use "tee" connector and Time Interval A→B mode; see above specifications.

Period and Period Averaging (B input) — Resolution: from 1 μs for single period to 1 ps with 10^6 averaging. Accurate to ±1 count ± time-base error ± trigger error/N.

Ratio A/B — Averaged over 1 to 10^6 cycles of signal at B.

Totalize A — 1 to 9,999,999 at max rate of 100 MHz. Front panel start, stop, reset control.

Time Manual — Electronic stopwatch; accumulates and displays time following activation of front panel start button. Clock rates selectable from 1 μs to 1 s.

Input A, Freq Range — 0 to 100 MHz, dc coupled. 10 Hz to 100 MHz, ac coupled.

Input B, Freq Range — 0 to 10 MHz, dc coupled, 10 Hz to 10 MHz, ac coupled.

Input sensitivity (A and B) — 300 mV p-p (100 mV rms sinewave).

Impedance (A and B) — 1 MΩ paralleled by 20 pF.

Trigger Level (A and B) — Adjustable ± 1.5 V at 1X attenuation.

Max Input Voltage (A and B) — CH A 1X Atten: 50 V at 2 kHz or less; derate −20 dB/decade to 10 kHz. 10 V from 10 kHz to 25 MHz; derate −20 dB/decade to 50 MHz. 5 V from 50 MHz to 100 MHz.

CH B 1X Atten: 50 V at 2 kHz or less; derate −20 dB/decade to 10 kHz. 10 V, from 10 kHz to 10 MHz.

CH A 10X and 100X Atten: 500 V at 2 MHz or less; derate −20 dB/decade to 100 MHz.

CH B X10 and 100X Atten: 500 V at 350 kHz or less; derate −20 dB/decade to 10 MHz.

Attenuation (A and B) — Selectable 1X, 10X, 100X.

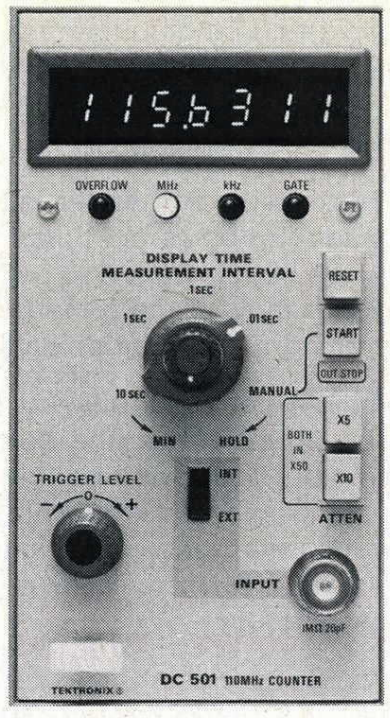
Standard Time Base Accuracy — Temp stability, 0°C to 50°C after warm-up: ±1 X 10^{-5} (0.001%) Long Term Drift: ± 1 x 10^{-5} per month (0.001%) Stability: Adjustable within 1 part in 10^7 (0.00001%).

Option 01 Time Base Accuracy — Temp Stability, 0°C to 50°C after warm-up: ±5 X 10^{-7} (0.00005%). Long Term Drift: ±1 X 10^{-7} per month (0.00001%). Setability: Adjustable within 5 parts in 10^9 (0.0000005%).

Rear Interface Input — Direct count input (50 Ω impedance, resistor may be removed for 1 MΩ input) reset, external display scan clock, external time base.

Rear Interface Output — Bcd serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

DC 503 Universal Counter **$795**
Option 01 (Time Base) . . . . . **add $200**



DC 501
DIGITAL COUNTER

Direct Counting to 110 MHz
7-Digit LED Display
Manual Start/Stop (Totalize)
Auto Range and Time Base Options

The DC 501 Digital Counter directly measures frequency from 10 Hz to 110 MHz and totalizes (counts number of events) from 0 to 9,999,999 at a maximum rate of 110 MHz. Measurement readout is provided by seven-segment LEDs in a seven-digit display. The decimal point is automatically positioned and leading zeros are blanked. Register overflow is indicated by a front-panel LED. Signals to be counted can be applied via a front-panel BNC connector into an impedance of 1 MΩ and 20 pF or via the rear connector into an impedance of 50 Ω and 20 pF. Four gate times of 0.01 s, 0.1 s, 1 s, and 10 s are provided. A standard internal 1 MHz time base is provided with 1 x 10^{-5} accuracy (0° to 50° C) and an aging rate of 1 x 10^{-5} per month. An optional time base with 5 x 10^{-7} accuracy (0° to 50°C) and an aging of 1 x 10^{-7} per month is available at extra cost. Input sensitivity is approximately 300 mV p-p (100 mV rms sine wave) below 110 MHz. An automatic measurement interval option, also at extra cost, automatically selects the gate time (up to 10 seconds) to obtain maximum resolution with any input signal.

Display — 7 digits (7 segment LED's) Storage, leading zero blanked. Overflow, gate open and kHz or MHz indicators.

DIRECT INPUT

Frequency range — 10 Hz to 110 MHz.

Sensitivity — 300 mV p-p (100 mV rms sinewave).

Impedance — 1 MΩ, paralleled by 20 pF.

Triggering Level — Adjustable ±2 V.

Max Input Voltage — 1X Atten: 500 V at 80 Hz or less; derate −20 dB/decade to 250 Hz. 150 V from 250 Hz to 300 kHz; derate −20 dB/decade to 3 MHz. 15 V from 3 MHz to 110 MHz.

5X Atten: 500 V at 600 kHz or less; derate −20 dB/decade to 4 MHz. 75 V from 4 MHz to 110 MHz.

10X and 50X Atten: 500 V at 1.2 MHz or less; derate −20 dB/decade to 8 MHz. 75 V from 8 MHz to 110 MHz.

Attenuation — 1X, 5X, 10X, or 50X.

Resolution — 0.1 Hz with 10 s gate. 1 Hz with 1s gate, 10 Hz with 0.1 s gate, 100 Hz with 0.01 s gate.

STANDARD TIME BASE ACCURACY

Temp Stability, 0°C to 50°C after warm-up — ±1 X 10^{-5} (0.001%)

Long Term Drift — ±1 X 10^{-5} per month (0.001%)

Setability — Adjustable within 1 part in 10^7 (0.00001%)

OPTION 01 TIME BASE ACCURACY

Temp Stability, 0°C to 50°C after warm-up — ±1 X 10^{-7} (0.00005%)

Long Term Drift — ±1 X 10^{-7} per month (0.00001%)

Totalize — Counts events from 1 to 9,999,999 at a max rate of 110 MHz. Start, stop, and reset commands via front-panel pushbuttons.

REAR INPUT

Direct count input (50 Ω impedance, resistor may be removed for 1 MΩ input) reset, external display scan clock, external time base.

REAR OUTPUTS

Bcd serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc.

OPTION 02

Automatically selects optimum measurement interval to fill the display, and displays appropriate kHz or MHz indication. Overflow is indicated for frequencies in excess of 9,999,999 MHz.

DC 501 Digital Counter **$675**
Option 01 (Time Base) . . . . . **add $200**
Option 02 (Auto Measurement) . . . . **add $65**

DM 502
DM 501

TM 500-Series Test and Measurement System

Digital Multimeter

For multiple electronic test functions — voltage, resistance and current measurements — plus compact, easy portability, many engineers are looking to the TM 500 Digital Multimeters.

Our DM 501 and DM 502 Multimeters represent a vast improvement in accuracy, easy readability and simplified use over the traditional volt-ohm-milliammeters. Beyond the usual dc/ac voltage, resistance and dc/ac current functions, both meters offer optional temperature measurement capabilities with your choice of Celsius or Fahrenheit digital readout, at temperatures from −55°C to +150°C.

Both models measure dc voltage to 1000 volts (extendable to 40,000 volts with the accessory probe), and ac voltage to 500 volts dc and ac currents to 2 amps, and resistance to 20 megohms.

Our 3½ digit meter, the DM 502, provides a standard decibel (dB) measurement feature across all ac ranges. Its absolute reference may be selected by internal jumper, with a dynamic range from −60 dB to approximately +56 dB.

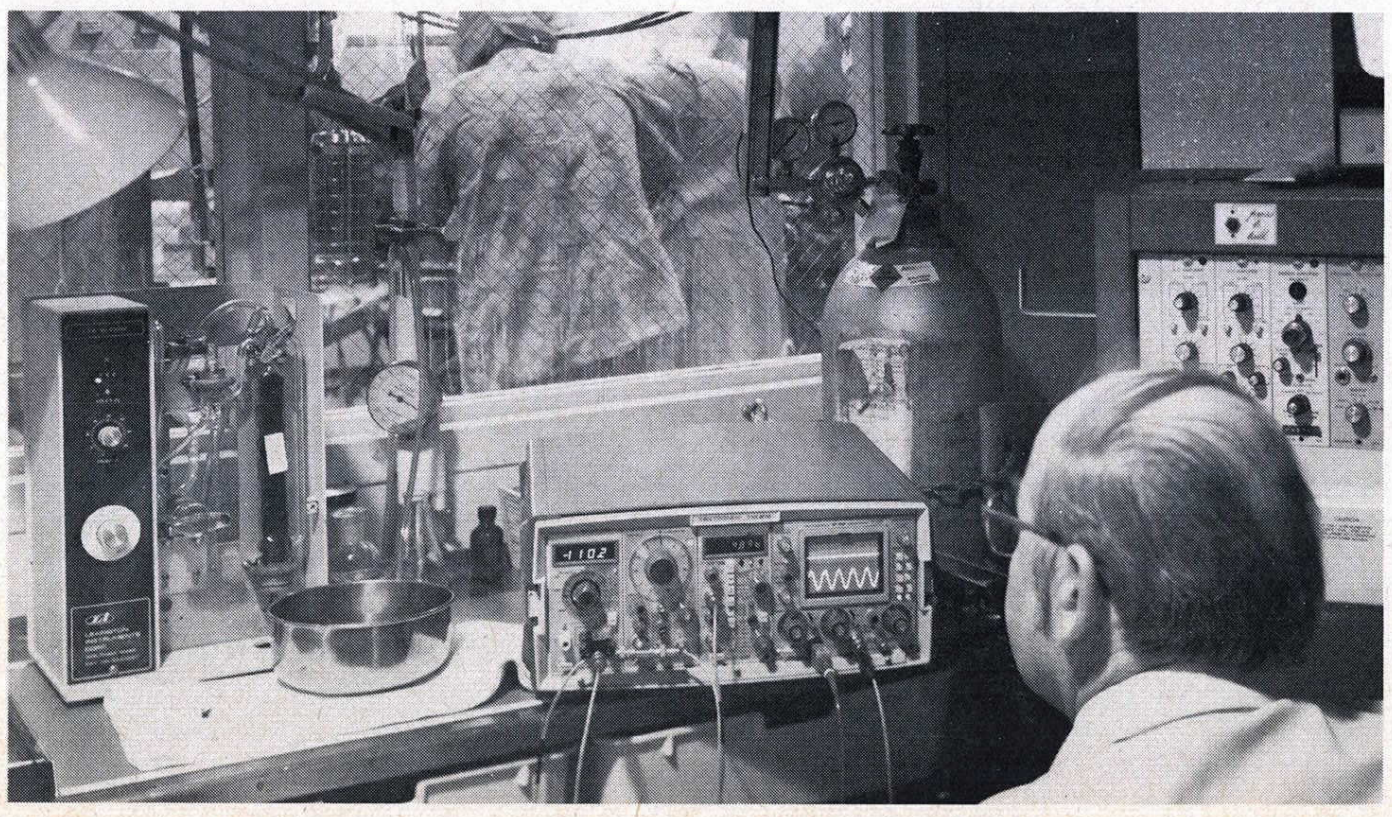
The DM 501, a 4½ digit meter, allows more precise readouts (up to six times better accuracy), while supplying a X10 better resolution. Beyond that, it can measure larger signals at any given resolution level.

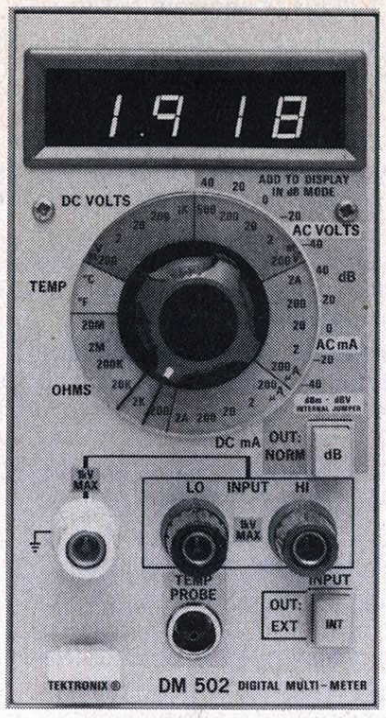
For convenient compactability at the bench and unique portability in the field, our TM 500 Multimeters could well be the answer to all your electronic testing problems. Just plug them into our lightweight, luggage-type TM 515 Traveler Mainframe, and they'll follow you anywhere.

With full-scale precision measuring capabilities backed by Tektronix' design and engineering expertise, these multimeters are designed for almost any test and measurement application.

DIGITAL MULTIMETERS—COMPARISON OF CHARACTERISTICS

	DM 501	DM 502
Number of Digits	4½	3½
Dc Volts — full scale	2 V to 1 kV	0.2 V to 1 kV
Ac Volts — full scale	2 V to 500 V	0.2 V to 500 V
Ac or Dc Current — full scale	2 mA to 2 A	200 μA to 2 A
Resistance — full scale	2 kΩ to 20 MΩ	200 Ω to 20 MΩ
Temperature Probe	Optional	Optional
dB	No	−60 dB to +56 dB
Bcd (Output)	Full Floating	Nonfloating
Input Impedance	10 MΩ	10 MΩ normal; FET input on 0.2 and 2 V scales by internal jumper
Price	**$475**	**$375**





DM 502
DIGITAL MULTIMETER

dB Readings from −60 dB to +56 dB

Seven Functions Including Temperature and dB

0.1% Dc Voltage Accuracy

Autopolarity

The DM 502 Digital Multimeter measures dc and ac voltage and current, dBm, dBV, resistance, and temperature. The ac functions are average responding and rms calibrated. A single front-panel control selects all ranges. Front-panel pushbuttons select dB readout of ac functions in lieu of ac voltage or current and front-panel or rear interface connector input. The dB is obtained by adding the selected dB scale value to the display reading. Readout in dBm or dBV is chosen by an internal jumper. An internal jumper also permits selection of FET input (>1000 MΩ) or 10 MΩ input impedance on the two lowest dc voltage ranges.

The readout is a 3½ digit display using seven-segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch. Polarity indication is automatic. Maximum display at stated accuracy is 1999.

Nonfloating bcd output (referenced to the low input), is available at the rear interface connector if user wired.

DC VOLTAGE

Ranges — 0.2 V, 2 V, 20 V, 200 V, 1000 V.

Accuracy — Within ±0.1% of reading ±1 count.

Common-Mode Rejection — ≥100 dB at dc, ≥80 dB at 50 or 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection — ≥80 dB at 50 or 60 Hz.

Step Response Time — ≤0.5 s.

Input R — 10 MΩ (jumper selectable for >1000 MΩ on 0.2 V and 2 V ranges).

AC VOLTAGE

Voltage Ranges — 0.2 V, 2 V, 20 V, 200 V, 500 V.

Accuracy — Within ±0.5% of reading ±1 count from 40 Hz to 10 kHz. ±1.0% of reading ±1 count, from 20 Hz to 40 Hz and 10 kHz to 20 kHz. Usable to 100 kHz. Typically <10% down between 40 mV and 500 V at 100 kHz.

Response Time — ≤5 s.
Common-Mode Rejection — ≥60 dB at 50 or 60 Hz.
Input R — 10 MΩ paralleled by less than 60 pF.

dB VOLTS AND CURRENT

Scales — +40, +20, 0, −20, −40 dB. Reference is dBV (1 V) or dBm (1 mW dissipated in 600 Ω, 0.7746 V), selected by internal jumper.

Display — ±19.99 dB on any scale, except that the total dynamic range is limited to the range −60 dB to approx +56 dB by a 500 V max input specification.

Accuracy

Display Reading dB	Frequency Range	Max Error
0 to +19.99	20 Hz to 20 kHz	0.5 dB
0 to −10.00	20 Hz to 2 kHz	0.5 dB
	2 kHz to 20 kHz	1.0 dB
−10.00 to −19.99	20 Hz to 2 kHz	0.5 dB
	2 kHz to 7.5 kHz	1.0 dB
	7.5 kHz to 20 kHz	2.0 dB

Response Time — ≤5 s.
Common-Mode Rejection — ≥60 dB at 50 or 60 Hz.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

Accuracy — 200 Ω range: ±0.5% of reading ±1 count +0.1 Ω. 2 kΩ through 2 MΩ range: ±0.5% of reading ±1 count. 20 MΩ range: ±1.0% of reading ±1 count.

Response Time — ≤0.5 s; 20 MΩ range, ≤5 s.

Max Output Current and Voltage — 1 mA max; approx 12 V max.

AC & DC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, 2 A.

Accuracy — Dc current, ±0.2% of reading ±1 count; ac current, ±0.6% of reading ±1 count, 40 Hz to 10 kHz.

Response Time — Dc ≤0.5 s; ac ≤5 s.

Input Impedance — $\left(\frac{0.2\text{ V}}{\text{Range Setting}} + 0.1\right)\Omega$ (<2 kΩ with 200 μA range)

TEMPERATURE MEASUREMENT

Ranges — Celsius: −55°C to +150°C. Fahrenheit: −67°F to +200°F.

Accuracy — With probe shipped with instrument ±2°C (±3.6°F). With any P6430 Probe prior to calibration with instrument, ±8°C (±14.4°F).

The temperature probe functions in all other modes in °C with analog signal out of 10 mV/° at rear interconnect.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 3.33 per second.

Inputs — The max input voltage is 1 kV. The front-panel HI and LO connectors may be floated 1 kV max above ground, the rear inputs 350 V. Current measuring functions are fused at 2.5 A. Ohms functions protected to 120 V rms indefinitely, 250 V rms ½ hour.

Ambient Temperature — Performance characteristics are valid over a temperature range of +15°C to +40°C.

Included Accessories — 1 pair Test Leads (003-0120-00), 1 P6430 Temp Probe (010-6430-00).

ORDERING INFORMATION

DM 502 Digital Multimeter $375

Option 02 without Temp Capability and Probe . . . . . Sub $125

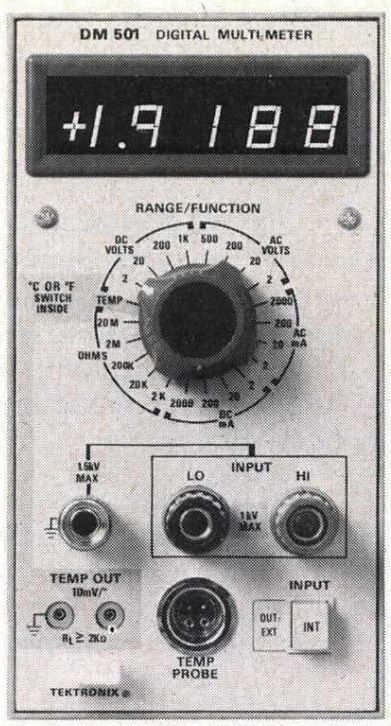
Optional Accessories — Deluxe Test Lead with accessories including push-on spring-loaded hook tip and special IC package tip, high flexibility wire, red, 4 ft.

Order (012-0426-00) $10

As above except black.
Order (012-0426-01) $10

Test lead with alligator clip, 4 ft, black.
Order (012-0425-00) $5.50

High Voltage Probe to 40 kV
Order (010-0277-00) $95



DM 501
DIGITAL MULTIMETER

0.1% Dc Voltage Accuracy

4½ Digit LED Display

Autopolarity

Measures Volts, Current, Resistance, Temperature

Fully Isolated Serial Bcd Output

The DM 501 Digital Multimeter measures dc and ac voltage and current, resistance, and temperature. Dc voltage measurement accuracy is 0.1%. The ac functions are average responding and rms calibrated. A single front-panel control selects all functions and ranges. A pushbutton selects front-panel input or optional rear interface connector input. Temperature measurements are made using a TEKTRONIX P6058 Probe or other suitable sensing devices. Front-panel pin jacks provide external temperature readout, at 10 mV per degree, regardless of the position of the function switch. An internal switch selects calibration in degrees Celsius or Fahrenheit. Readout is a 4½ digit stored display using seven-segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch and leading zeros are blanked. Polarity indication is automatic. A blinking display indicates overrange. Serial bcd output is available at the rear interface connector.

DC VOLTAGE

Ranges — 2 V, 20 V, 200 V, and 1 kV full scale (19999 max reading), accurate within 0.1% of reading ±2 counts.

Resolution — 100 μV on 2 V range.

Common-Mode Rejection — ≥ 100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

Step Response Time — <1 s.

Normal-Mode Rejection — ≥30 dB at 60 Hz increasing 20 dB per decade.

Input R — 10 MΩ, constant.

AC VOLTAGE

Ranges — 2 V, 20 V, 200 V, and 500 V full scale (19999 max reading), average responding, rms calibrated.

Accuracy — Within 0.7% of reading ±2 counts from 40 Hz to 10 kHz; 1.2% of reading ±2 counts from 20 Hz to 40 Hz and 10 kHz to 20 kHz. Usable to 100 kHz. Typically <5% down between 0.4 V and 500 V at 100 kHz.

Resolution — 100 μV on 2 V range.

Response Time — <10 s.

Input R — 10 MΩ paralleled by <100 pF.

AC and DC CURRENT

Ranges — 2 mA, 20 mA, 200 mA, 2 A full scale (19999 max reading), ac rms calibrated, average responding.

Resolution — 100 nA on 2 mA range.

Accuracy — Dc amps, 0.2% of reading ±10 counts; ac amps, 0.6% of reading ±2 counts from 40 Hz to 1 kHz. ±0.6% of reading ±10 counts from 1 kHz to 10 kHz. Usable to 100 kHz.

Input R — $\left(\frac{0.2\text{ V}}{\text{Range Setting}} + 0.1\right)\Omega$

RESISTANCE

Range — 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ full scale (19999 max reading).

Accuracy — Within 0.3% of reading ±2 counts to 2 MΩ, 0.5% of reading, ±2 counts on 20 MΩ scale.

Resolution — 0.1 Ω on 2 kΩ range.

TEMPERATURE MEASUREMENT

Ranges — −55°C to +150°C (−67°F to +302°F selected by internal switch), using P6058 Temperature Probe. The temperature probe functions regardless of the DM 501 mode and provides a front-panel analog signal output of 10 mV/° (into 2 kΩ or greater); thus temperature may be measured simultaneously with any other function. If temperature probe is not desired, order Option 01. If temperature capability is not desired, order Option 02. Note: capability cannot be restored at a later date.

Accuracy — Within 1.5°C (2.7°F) from −55°C to +125°C and within 2.5°C (4.5°F) from +125°C to +150°C.

Resolution — 0.1°C.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 5 measurements/second.

Max Input Voltage — 1 kV. The front-panel HI and LO connectors may be floated 1.5 kV max above ground, the rear inputs 350 V max. Current measuring functions are fused at 3 A. Ohms ranges are fused at 1/16 A.

Ambient Temperature — Performance characteristics are valid over a temperature range of +15°C to +35°C.

Included Accessories — 1 Pair Test Leads (003-0120-00), 1 P6058 Temp Probe (010-0259-00).

ORDERING INFORMATION

DM 501 Digital Multimeter $475

Option 01 without P6058 Temp Probe . . . . . Sub $105

Option 02 without Temp Capability and Probe . . . . . Sub $125

Optional Accessories — Deluxe Test Lead with accessories including push-on spring-loaded hook tip and special IC package tip, high flexibility wire, red, 4 ft.

Order (012-0426-00) $10

As above except black.
Order (012-0426-01) $10

Test lead with alligator clip, 4 ft, black.
Order (012-0425-00) $5.50

High Voltage Probe to 40 kV
Order (010-0277-00) $95

Pulse Generators

TM 500-Series Test and Measurement System

Comparison of Characteristics

Today's complex logic systems require instrumentation equal to their diversified demands. The TM 500 Pulse Generators' highly configurable characteristics allow you to generate more waveforms for broader applications.

Whether you're testing wide-band systems, stimulating living tissue, driving a laser or simulating data transmission signals—these versatile, high-performance pulse generators can readily adapt to your specific needs.

For oscilloscope calibration, there's a specialized generator, the PG 506. For 50 ohm systems, our PG 501 and PG 502 are designed to be compatible with common digital integrated-circuit families (TTL, DTL and ECL), in repetition rates, amplitudes and transition times. And for ECL design and testing, the PG 502, with its 250 MHz repetition rate and pulse top and bottom level independent control, can handle even the most complex functions with ease.

With plug-in adaptability on your bench or out in the field, our PG 508's accurate 50 Ω output impedance delivers clean signals into logic families (TTL, etc.) reactive loads or at the end of an unterminated cable.

The PG 508 is also designed for high-level performance on high impedance circuits (MOS, HTL and CMOS logic). This 50 MHz, multipurpose generator features a control error light, a trigger/gated light, selectable 1 MΩ or 50 Ω trigger input impedance and an expanded trigger level range.

Used separately, or plugged into a powerful system, our TM 500 Pulse Generators offer a wide range of features that add up to unparalleled ease of operation, for even your toughest test and measurement problems.

PULSE GENERATORS — COMPARISON OF CHARACTERISTICS

	PG 501	PG 502	PG 505	PG 508
Rep Rate Range	5 Hz to 50 MHz	10 Hz to 250 MHz	1 Hz to 100 kHz	5 Hz to 50 MHz
Pulse Width Range	10 ns to 100 ms	2 ns to 50 ms	5 μs to 0.5 s	10 ns to 100 ms
Rise and Fall Times	Fixed, ≤ 3.5 ns	Fixed, ≤ 1.0 ns	≤ 1 μs to ≥ 20 ms, Independently variable up to 20:1	5 ns to ≥ 50 ms, Independently variable up to 100:1
Maximum Amplitude	±5 volts across 50 Ω	5 volts in a ±5 V window across 50 Ω	80 volts behind 4 kΩ	20 volts in a ±20 volt window to Hi Z, 10 volts in a ±10 V window to 50 Ω
Output Controls	Independent Amplitude Controls for + and − outputs	Independent pulse top and pulse bottom, complement switch	Amplitude, inversion switch	Independent pulse top and pulse bottom, complement switch
External Trigger and Ext Duration (width)	+1 V, + Slope 50 Ω input Z	+1 V, + Slope 50 Ω input Z	+0.5 V to +10 V, + Slope, 10 kΩ input Z	−3 V to +3 V, + or − Slope, 1 MΩ or 50 Ω input Z
Other	Simultaneous Pos and neg outputs, output LOCKED ON mode	Manual trig, Square-wave Mode, selectable internal 50 Ω Reverse Termination	Delay anywhere along 10-volt input ramp, custom timing positions	10 ns to 100 ms delay, double pulse, three-state trigger/gate light, control error light, manual trigger, manual gate, true 50 Ω output Z, custom timing positions, counted pulse burst with DD 501.
Price	**$475**	**$1750**	**$500**	**$1350**

PG 508 Pulse Generator

5 Hz to 50 MHz Plus Custom Range

Independently Variable Rise and Fall Times

Delay and Double Pulse Capability

20 V Output in a ±20 V Window to Hi Z, 10 V to 50 Ω

Independent Pulse Top and Bottom Level Controls

True 50 Ω Output Impedance for Clean Waveforms

Control Error Light Warns of Improperly Set Switch or Variable Controls

3-State Trigger Light Indicates Proper External Triggering

Selectable 1 MΩ Trigger Input Impedance for Optimum Match to Circuitry — Lets You Use Your Scope Probe

Our PG 508 Pulse Generator combines state-of-the-art capabilities with TM 500 configurability. This means you can use its high-level performance and unique versatility for a broad range of test and measurement applications and for logic design functions in MOS, CMOS, TTL and ECL.

Few pulse generators on the market can match the PG 508 for hardworking control functions plus error- and time-reducing operational ease.

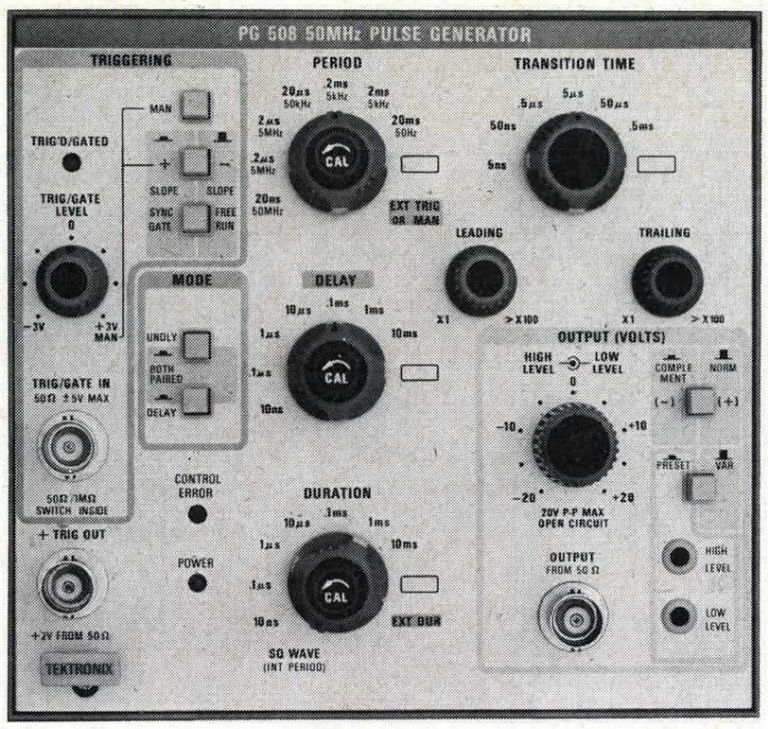
With an output of up to 20 V p-p, the PG 508 features independent controls for output period, delay, duration and transition times. More unusual features include selectable megohm/50Ω, trigger input impedance, a control error light, a 3-state trigger/gate light, and preset or external control of output voltage levels.

By simply pushing the preset button, you can change the output from variable top and bottom level controls to front panel screwdriver adjustments. Or track external supply voltages. So the time you usually spend on repeated setups of commonly used voltage levels, you can spend on your work, without worrying about accidental changes in output. With the power supply tracking mode of the PG 508, the CMOS logic circuits can withstand an accidental increase input of over 0.3 V, into the supply voltage.

The complement mode of the PG 508 allows an effective duty cycle range approaching 100%.

The PG 508's sophisticated array of control functions lets you operate at maximum efficiency with minimum setup error. A control error light indicates improper switch or variable control settings.

Independent rise and fall time controls give you up to a 100:1 difference in rise and fall times. And the times aren't affected by output amplitude level changes.



PG 508
50 MHz PULSE GENERATOR

You can gate the PG 508 with a positive- or negative-going signal, or manually gate it by pressing the MAN button. Or dial up a predetermined number of pulses in a burst, by adding the DD 501's independent digital delay capabilities for counted burst mode.

Applications include simulating data of a given number of bits, or checking logic circuitry malfunctions. The MANUAL button and MAN position in PERIOD then let you add pulses, one by one.

And there's more. With the PG 508's trigger input switched to 1 megohm impedance, you can explore circuitry using a X1 or X10 probe. Or use the PG 508 as a pulse regenerator, logic level translator, or sine wave-to-pulse converter.

The PG 508 also has the output to drive MOS, CMOS, DTL, HTL, I^2L, T^2L or ECL. And its transition time control lets you create a signal that accurately duplicates the circuit drive in most circuits under evaluation.

With control functions and features like these, no wonder the PG 508 is making more than its share of waves in the logic world. When you consider its independent output level controls, external trigger, delay and double pulse capabilities, you'll soon find the PG 508 generating pulses for radar, laser, rf switching and signal processing applications, too.

Pulse Period — $\leq$ 20 ns to $\geq$ 200 ms in seven decade steps plus variable, with overlap on all ranges. Periods longer than 200 ms can be obtained in custom range position. Jitter: $<$ 0.1% + 50 ps.

Pulse Delay — (time between leading transitions in the paired pulse mode) $\leq$ 10 ns to $\geq$ 10 ms in seven decade steps plus variable, with overlap on all ranges. Delays longer than 100 ms can be obtained in custom range position. Duty Factor: delays to at least 70% of pulse periods for periods of 0.2 μs or greater, decreasing to at least 50% for a 20 ns period. Jitter: $\leq$ 0.1% + 50 ps.

Pulse Duration — $\leq$ 10 ns to $\geq$ 100 ms in seven decade steps plus variable, with overlap on all ranges. Durations longer than 100 ms can be obtained in custom range position. An additional position provides durations of approx 50% of the period setting for square wave output. Duty Factor: pulse durations to at least 70% of pulse periods for periods of $\geq$ 0.2 μs, decreasing to at least 50% for a 20 ns period. Jitter: $\leq$ 0.1% + 50 ps.

Pulse Transition Times — Independently adjustable leading and trailing transition times from $<$ 5 ns typical ($<$ 7 ns at some offset and amplitude levels) to $\geq$ 50 ms, measured from the 10% point to the 90% point in six decade steps plus variable. Variable controls with 100:1 range (50:1 on 5 ns) provide overlap on all ranges. Transition times longer than 50 ms are obtainable in the custom range position.

Pulse-Transition Linearity — Deviation from straight line $\leq$ 5% between the 10% and the 90% point for transition times greater than 10 ns.

Pulse Amplitude — Pulse high and low levels independently adjustable over a ±20 V range from a 50 Ω low reactance source. Max pulse amplitude into a 50 Ω load is $\geq$ 10 V p-p; minimum is $\leq$ 0.5 V p-p. Max pulse amplitude into an open circuit is $\geq$ 20 V p-p; minimum is $\leq$ 1.0 V p-p. The preset level controls are adjustable over the same ranges.

Pulse Aberrations — $\leq$ 5%, + 50 mV p-p for pulse levels between + and − 5 volts into a 50 Ω load. May increase to $\leq$ 10%, +50 mV p-p for pulse levels outside this range.

Trigger Output — Amplitude $\geq$ + 2 V from 50 Ω. Source Impedance: 50 Ω. Duty Cycle: internal triggering, $\simeq$ 50%; external triggering: determined by duty cycle of triggering signal.

Trigger/Gate Input — Sensitivity: 80 mV p-p to 10 MHz; 250 mV p-p to 50 MHz. Input impedance: internally selected, 50 Ω or 1 MΩ paralleled by $\simeq$ 20 pF. Max input: ± 5 V peak into 50 Ω, ± 20 V peak into 1 MΩ. Minimum input pulse width: 10 ns. Trigger level range: ± 3 V. Polarity: front panel selectable, + or − slope.

Trig'd Gated Light — Flashing: input triggered at greater than approx a 10 Hz repetition rate or following the input signal at slower repetition rates. On: (Logic True) TRIG/GATE IN input potential above TRIG/GATE LEVEL setting with + SLOPE selected or below TRIG/GATE LEVEL setting with − SLOPE selected. Off: (Logic False) TRIG/GATE IN input potential below TRIG/GATE LEVEL with + SLOPE selected or above TRIG/GATE LEVEL with − SLOPE selected.

Synchronous Gate — Rate generator starts synchronously with the gating signal and completes the last output pulse in progress when the gating signal ends.

Pulse Delay Modes—Undelayed, delayed, and paired. Paired pulse mode limited to 25 MHz. Minimum pulse separation governed by duration duty factor specification.

Fixed Delays — Trig/Gate Input to Trigger Out: $\simeq$ 25 ns. Trigger Out to Pulse Out: $\simeq$ 23 ns in SQ WAVE or EXT DUR modes, $\simeq$ 35 ns in other modes.

Control Error Light — Steady On: indicates invalid operating mode, output is undefined. Flashing: timing control settings selected do not properly define the output pulse because valid limits have been exceeded. Steady Off: indicates valid operation for most control settings.

Counted Burst (with DD 501) — Max PG 508 repetition rate for exact count: 20 MHz. Usable to 50 MHz. Minimum time between bursts: 100 ns.

ORDERING INFORMATION

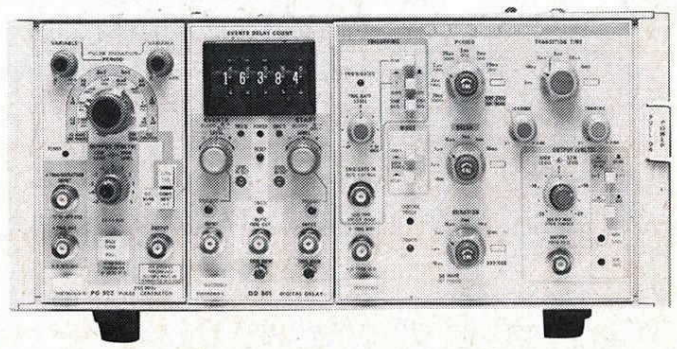
PG 508 50 MHz Pulse Generator $1350

PG 508T 50 MHz Pulse Generator . . . $1540
(includes PG 508, TM 503 Mainframe, and 016-0195-03 blank panel)

For Counted Burst, order the
DD 501 Digital Delay (page 162) **$800**

Suggested 10 in BNC 50 Ω cable (2 req) for interconnecting PG 508 and DD 501:
012-0208-00 . . . . . **$12.00**

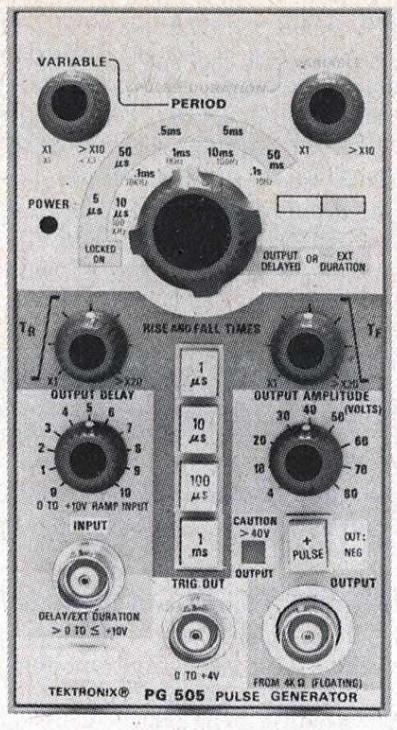
P6062B and P6108 probes are recommended.



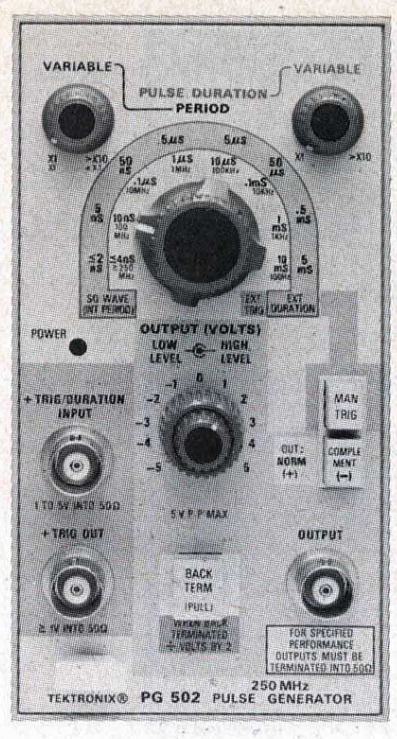
PG 505
PG 502
PG 501

TM 500-Series Test and Measurement System

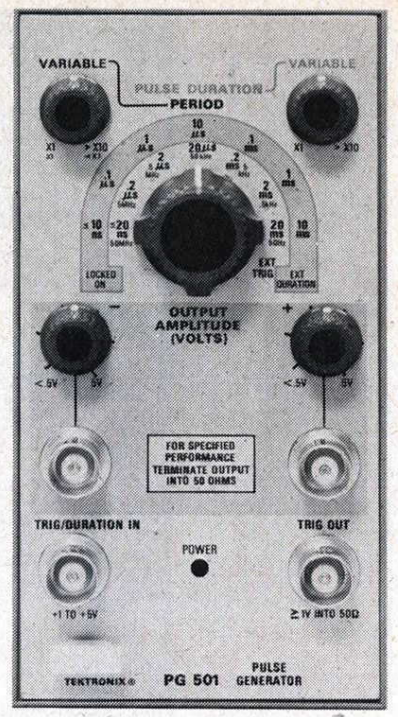
100 kHz, 250 MHz, and 50 MHz Pulse Generators



PG 505
100 kHz PULSE GENERATOR



PG 502
250 MHz PULSE GENERATOR



PG 501
50 MHz PULSE GENERATOR

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1 Hz to 100 kHz

Independently Variable Duration and Period

80 V Output

Variable Rise Time and Fall Time

Delay Mode

The PG 505 Pulse Generator features: floating output; independently adjustable rise and fall times; external control of period or period and duration. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. When driven from an externally supplied 0 to 10 volt ramp, the delay control of the PG 505 permits the output pulse to occur at any selected voltage point on the ramp, thus providing controllable time delay to any set time along the ramp.

Pulse Period — 10 μs or less to 100 ms (within 5%) in decade steps. Continuously variable between steps and to at least 1 s.

Pulse Duration — 5 μs or less to 50 ms (5 μs to 5 ms within 5%, 50 ms within 20%) in decade steps. Continuously variable between steps and to at least 0.5 s.

Duty Factor — (pulse duration/pulse period), 0 to 100%.

Pulse Rise Time and Fall Time — 1 μs or less to 1 ms in decade steps with T_R or T_F controls set at (X1). T_R or T_F control extends time to at least 20 ms. Accurate within 5% with T_R or T_F set at (X1).

Aberrations — Within 5% at max p-p output into 4 kΩ, 20 pF load.

Pulse Amplitude — 4 V or less to at least 80 V from a 4 kΩ source. Polarity selectable for + or − output.

Isolation of Pulse from Ground — 200 V dc.

Trigger Output — 0 to +4 V into 50 Ω.

External Trigger/Duration Input — Accepts TTL level signals.

Delay Mode — Delay range (with respect to delay signal) 0 to 10 V within 5%.

PG 505 Pulse Generator **$500**

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10 Hz to 250 MHz

1 ns Rise Time

5 V Output, ±5 V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 (250 MHz Pulse Generator) features: fast rise and fall time; independent top and bottom pulse levels; and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

Pulse Period — 4 ns or less to 10 ms (within 5% in calibrated positions except 15% on 10 ms range) in decade steps. Continuously variable between steps and to at least 100 ms.

Pulse Duration — 2 ns or less to 5 ms (within 5% in calibrated positions except 15% on 5 ms range) in decade steps. Continuously variable between steps and to at least 50 ms. Square-wave mode approx 50% duty factor.

Duty Factor — At least 50% in normal mode, approx 100% in complement mode. Minimum off time is 2 ns.

Pulse Rise Time and Fall Time — Less than 1 ns.

Aberrations — Within ±5% at 5 V p-p amplitude, except negative transition aberrations may exceed 5% for durations less than 5 ns.

Pulse Top Flatness — Within 2%, beginning 10 ns after transition.

Pulse Amplitude — Pulse high and low levels independently adjustable over a −5 to +5 V range, with pulse amplitude limited between ≥0.5 V and ≤5 V. Complement switch inverts pulse between same two selected voltage levels. Front-panel selectable 50 Ω internal back termination divides output levels by two.

Offset — ±5 V max, depends on amplitude setting.

Trigger Output — At least 1 V into 50 Ω, occurring approx 10 ns prior to pulse output. Duty cycle ≃ 50% when using internal period.

External Trigger/Duration Input — Trigger threshold less than 1 V; reset threshold greater than 0.1 V; max input 5 V. 50 Ω input impedance.

PG 502 Pulse Generator **$1750**

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5 Hz to 50 MHz

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns into 50 Ω

Independent Period and Duration Controls

Trigger Out

Pulse Period — 20 ns or less to 20 ms (within 5% from 0.2 μs to 2 ms and within 15% at 20 ms) in decade steps. Continuously variable between steps and to at least 0.2 s.

Pulse Duration — 10 ns or less to 10 ms (within 5% from 0.1 μs to 10 ms) in decade steps. Continuously variable between steps and to at least 0.1 s.

Duty Factor — At least 70% for periods of 0.2 μs or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Rise Time and Fall Time — 3.5 ns or less.

Aberrations — With 3.5% at 5 V amplitude.

Pulse Amplitude — 0.5 V or less to at least 5 V into 50 Ω load.

Pulse Coincidence (+ and − outputs) — Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output — At least +1 V into 50 Ω load, occurring approx 8 ns prior to pulse output. Duty cycle ≃ 50% when using internal period.

External Trigger/Duration Input — At least +1 not to exceed +5 V (dc + peak ac). Trigger/Duration recognition level, + 1 V or less. Trigger/Duration reset level, +100 mV or less. Minimum on and off time is 10 ns. 50 Ω input impedance.

PG 501 Pulse Generator **$475**

MANUAL (ONE-SHOT) TRIGGER GENERATOR

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501, PG 505, and RG 501.

Order 016-0597-00 . . . . . **$55**

When your test and measurement problems require instrumentation capable of producing a wide variety of waveforms, our TM 500 function generators offer versatility at an affordable price.

Their high frequency coverage and plug-in portability are earning them top marks in communications industries — from audio, video and radio to telecommunications and beyond.

You can use their triangular waveforms with your oscilloscopes to determine the overload (clipping) point of amplifiers. Or use the square waveforms to simultaneously reveal low frequency response (by sag), high frequency response (by rise time), and transient response (by ringing and other aberrations) of amplifiers.

For electronics applications, sine waves display the full frequency response of innumerable devices. And for logic circuitry, pulses and square waves can be used as clock and signal sources.

Beyond that, ramps and triangles create time bases for both oscilloscopes and paper recorders, and test signals for voltage comparators.

At the low frequency end of function generator capabilities, you can set them to work on biological, geophysical and mechanical simulations, or on servo systems, and that's just the beginning.

By applying an external ramp to the vcf (Voltage Controlled Frequency) input, all our function generators can double as sweep generators. With the FG 504, sweep capability is conveniently built in.

For testing broadband amplifiers from subaudio to 40 MHz, these generators provide a full 1000:1 sweep frequency range. And, given the same vcf input fed from a low-level modulating signal, you can produce a frequency-modulated carrier.

For sweeping wide frequency ranges (1000:1 or greater), the FG 504 features logarithmic sweep. This means you can spread out lower octaves, sweep a full range in less time, and produce easy-to-read Bode plots and graphs.

With the FG 501 and FG 504 in burst mode, you can control the starting phase of the output waveform. This gate or burst feature is also highly efficient for testing tone-controlled systems, loud-speaker transient response characteristics and Automatic Gain Control circuits.

If you're generating pulses or ramps, our FG 504's external trigger allows your signal to initiate one complete waveform. Beyond that, its phase lock feature permits an external repetitive signal to control its output frequency.

The FG 504's other high-performance features let you convert digital signals to high or low voltage sine waves, ramps or pulses. Or sine waves to digital signals.

And, you can reference its output frequency to your own frequency standard. Or turn it into a limited frequency synthesizer (locked to your reference frequency), by combining its capabilities with the DD 501's Digital Delay in the "divide by n" mode.

If more waveforms for more applications are what you're after, consider the TM 500 Function Generators' high performance capabilities. At that point, we think you'll agree that they're setting measurement standards for the entire electronics industry.

FUNCTION GENERATORS—COMPARISON OF CHARACTERISTICS

	FG 501	FG 502	FG 503	FG 504
Waveforms	Sine, Square, Triangle, Pulse, Ramp		Sine, Square, Triangle	Sine, Square, Triangle, Ramps & Pulses with variable symmetry
Variable Symmetry	no	no	no	7% to 93% duty cycle
Frequency Range	0.001 Hz to 1 MHz	0.1 Hz to 11 MHz (pulse, ramp 1.1 MHz max)	1.0 Hz to 3 MHz (usable 0.01 Hz to 5 MHz)	0.001 Hz to 40 MHz 0.001 Hz to nominally 4 MHz with variable symmetry
Custom Frequency Range	no	no	With user-installed capacitor	Shipped with capacitor for 20 Hz to 20 kHz range
Dial Accuracy (% of Full Scale)	Within 3%	Within 3% to 1 MHz Within 5% to 10 MHz	Within 5%	Within 3% to 4 MHz Within 6% to 40 MHz
Amplitude Open Circuit	20 V p-p max	10 V p-p max	20 V p-p max	30 V p-p max
Into 50 Ω	10 V p-p max	5 V p-p max	10 V p-p max	15 V p-p max
Output Step Attenuator	no	no	no	0 to −50 dB in 10 dB steps
Open Circuit				
Offset Voltage	±7.5 V dc	±5 V dc	±7.5 V dc	±7.5 V dc
Peak Sig + Offset	±15 V	±10 V	±15 V	±20 V
Into 50 Ω				
Offset Voltage	±3.75 V dc	±2.5 V dc	±3.75 V dc	±3.75 V dc
Peak Sig + Offset	±6 V	±5 V	±6 V	±11.25 V
Output Impedance	50 ohms			
Amplitude Flatness Sine Wave ref 10 kHz	±1.5 dB, 0.001 Hz-1 MHz ±0.5 dB, 20 Hz to 20 kHz	±1.5 dB, 0.1 Hz-11 MHz ±0.5 dB, 20 Hz to 20 kHz	±2 dB, 0.1 Hz to 3 MHz ±0.5 dB, 20 Hz to 20 kHz	±0.5 dB, 0.001 Hz to 40 kHz ±2 dB, 40 kHz to 40 MHz
Square, Triangle	±1 dB ref sine	±3 dB ref sine	±1 dB ref sine	Square wave ±0.5 dB to 20 MHz, ±2 dB to 40 MHz
Frequency Stability (% of Full Scale)	≤0.05% for 10 min, ≤0.1% for 1 hour, ≤0.5% for 24 hours			
Sine Wave Distortion	≤0.5% 1 Hz to 20 kHz ≤1.0% 20 kHz to 100 kHz ≤2.5% 100 kHz to 1 MHz	≤0.5% 10 Hz to 50 kHz Harmonics: ≤ −30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz	≤0.5% 20 Hz to 40 kHz Harmonics: ≤ −30 dB 40 kHz to 1 MHz ≤ −20 dB 1 MHz to 40 MHz
Square Wave Response	≤100 ns rise and fall ≤5% total aberrations	≤20 ns rise and fall ≤3% total aberrations	≤60 ns rise and fall ≤3% total aberrations	≤6 ns fixed 10 ns to 100 ms variable ≤5% + 30 mV aberrations
Triangle Linearity (10% to 90%)	Within 1% 0.001 Hz to 100 kHz Within 2% 100 kHz to 1 MHz	Within 1% 0.1 Hz to 100 kHz Within 3% 100 kHz to 1 MHz Within 5% 1 MHz to 11 MHz	Within 1% 1.0 Hz to 100 kHz Within 5% 100 kHz to 3.0 MHz	Within 1% 10 Hz to 400 kHz Within 5% 400 kHz to 40 MHz typ within 2% 0.001 Hz to 10 Hz
Voltage Controlled Frequency	Up to 1000:1 frequency change with 10 V external signal. Slew rate ≥0.3 V/μs, typically ≥0.5 V/μs.			
Burst/Gate	Input impedance, 1 kΩ. Control signal required +2 V; +15 V max. Bursts are synchronous with gate. Phase continuously variable from −90° to +90°.	Input impedance, 1 kΩ. Control signal required, +2 V; +15 V max. Bursts are synchronous with gate.	Not applicable	Input impedance ≥ 10 kΩ Trigger level −1 V to +10 V Sensitivity 1 V p-p Generator completes integral number of cycles ±80° phase control
Triggered Mode	no	no	no	Single waveform with external or manual trigger
Trigger Output	TTL compatible +2.5 V into 600 Ω	TTL compatible +2.5 V into 50 Ω	TTL compatible +2.5 V into 600 Ω	TTL compatible 0 to ≥ 2 V, 50 Ω Output Z
Phase Lock	no	no	no	100 Hz to 40 MHz
Internal Sweep	no	no	no	Logarithmic or linear 0.1 ms to 100 second duration Separate start-stop frequency dials
Amplitude Modulation	no	no	no	100% with 5 V p-p input
Output Hold Mode	0.001 Hz to 10 Hz	no	no	0.001 Hz to 400 Hz
Price	**FG 501 ..... $550**	**FG 502 ..... $650**	**FG 503 ..... $450**	**FG 504 ..... $1550**

FG 504

TM 500-Series Test and Measurement System

40 MHz Function Generator

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Rise and Fall and Symmetry Controls

Logarithmic or Linear Sweep

Separate Frequency Dials Set Lower (START) and Upper (STOP) Limits of Sweep

Up to 30 V p-p Output

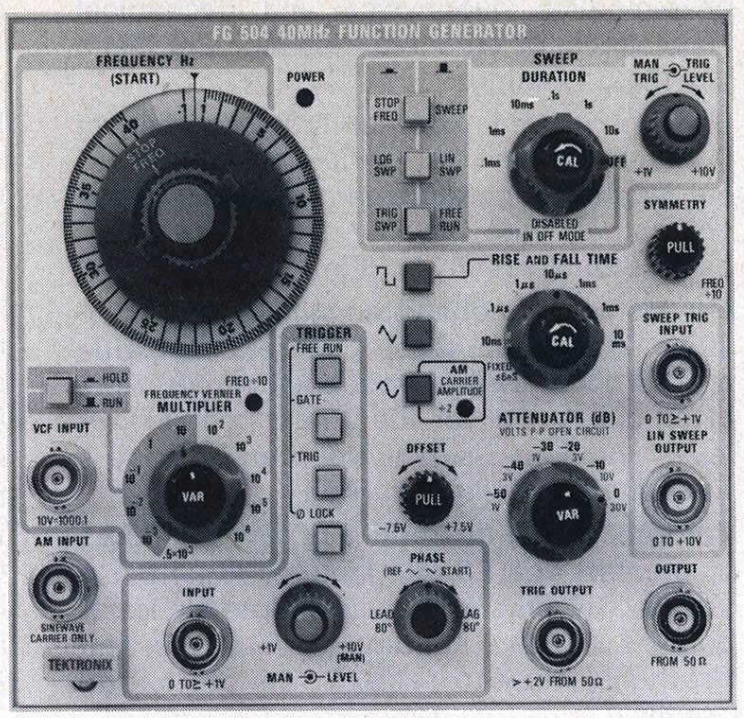
Built-in Attenuator

Am and Fm

Phase Lock Mode

External and Manual Trigger or Gate

Counted Burst with DD 501



FG 504
40 MHz FUNCTION GENERATOR

The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sine waves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be amplitude or frequency modulated by external signals.

The FG 504 also provides trigger output, external voltage control input, and sweep output. (Contact your Tektronix Field Engineer for a data sheet discussing FG 504 applications in detail.)

Frequency Range — Sine, Triangle and Square Waveforms: 0.001 Hz to 40 MHz calibrated range. Ramps, pulses or waveforms requiring use of VARIABLE SYMMETRY control: 0.001 Hz to nominally 4 MHz. Multiplier switch has position for user-determined range by capacitor selection. Maximum frequency on this range is 400 kHz. A 5 μF capacitor provides a full scale frequency of 400 Hz. Instrument shipped from factory with capacitor installed for 20 Hz to 20 kHz range in 0.5 x 10^3 position.

Frequency Resolution — 1 part in 10^6 of full scale setting using the FREQUENCY VERNIER control.

Frequency Stability — ≤0.05% for 10 minutes, ≤0.1% for 1 hour, ≤0.5% for 24 hours. The FREQUENCY Hz dial must be on the calibrated portion. The instrument must be at a constant ambient temperature between 0°C and +50°C and checked after a 1 hour warmup.

Dial Calibration — 1 to 40 Hz calibrated, 0.1 to 1 Hz uncalibrated.

Dial Accuracy — (+15°C to +35°C) Start Dial: Within ±3% of full scale from 0.001 Hz to 4 MHz. Within ±6% of full scale from 4 MHz to 40 MHz. Measurements made at +25°C ±10°C. Stop Frequency Dial: 5% of the difference between the start and stop frequencies plus the FREQUENCY Hz (START) dial error. Stop Dial uncalibrated on the 10^6 MULTIPLIER range.

Maximum Dial, VCF, and Sweep Range —

MULTIPLIER	FREQUENCY RATIO
10^6	500:1
10^5-10^2	1000:1
10^1, 1, 10^{-1}, 10^{-2}	100:1
10^{-3}	40:1

Internal Sweep — Linear or Logarithmic. Accuracy: Limited by Start and Stop Frequency dial specifications. Can be set more accurately using an external frequency monitor. Sweep Duration: 100 s to 0.1 ms in six decades. Variable control overlaps decades. Stop Frequency to Swept Stop Frequency Error: Within 2% maximum from 100 s to 1 ms sweep duration. Within 10% maximum from 1 ms to 0.1 ms sweep duration. Linear Sweep Output: Amplitude: 0 V to +10 V from 1 kΩ. Amplitude Accuracy: Within ±5% from 100 s to 1 ms, within ±10% from 1 ms to 0.1 ms. Sweep Trigger Input: Input Sensitivity: 1 V p-p. Trigger Level: 1 V through 10 V. Maximum Input: +20 V. Manual Trigger: Front panel control.

Voltage Controlled Frequency Input — Nominal sensitivity (Hz/volt) = X 4 MULTIPLIER setting per volt. A positive-going voltage increases frequency. Maximum Frequency: X 40 MULTIPLIER setting. Minimum Frequency: Maximum frequency divided by vcf range of MULTIPLIER setting (see DIAL, VCF, and SWEEP RANGE). Slew Rate: 0.3 V/μs maximum. Input Impedance: 10 kΩ.

Output Amplitude — 30 V p-p into an open circuit, 15 V p-p into 50 Ω.

Amplitude Flatness — Sinewave (reference at 10 kHz): Within ±0.5 dB from 0.001 Hz to 40 kHz. Within ±2 dB from 40 kHz to 40 MHz. Typically within ±0.5 dB to 40 MHz. Triangle (reference at 10 kHz): Within ±0.5 dB from 0.001 Hz to 40 kHz. Within ±2 dB from 40 kHz to 40 MHz. Squarewave (reference at 10 kHz): Within ±0.5 dB from 0.001 Hz to 20 MHz. Within ±2 dB from 20 MHz to 40 MHz. Sine, Triangle and Squarewave Amplitude Match: Within ±1 dB at 10 kHz.

Output Attenuator — Open Circuit Voltages:

ATTENUATOR STEP	MAXIMUM OUTPUT VOLTAGE (p-p)
0 dB	30 V
-10 dB	9.5 V
-20 dB	3 V
-30 dB	950 mV
-40 dB	300 mV
-50 dB	95 mV

Variable −20 dB extends minimum signal amplitude to 10 mV. See square wave aberrations specification. Accuracy: ±0.5 dB/decade.

Offset Range — ±7.5 V into an open circuit, ±3.75 V into 50 Ω. Maximum signal plus offset peak output amplitude of ±20 V into an open circuit and ±11.25 V into 50 Ω. Offset defeatable by front panel control.

Waveforms — Sine, Triangle and Square: Ramps and Pulses by use of the VARIABLE SYMMETRY control.

Variable Symmetry — Duty Cycle Range: 7% to 93%; 20% to 80% on triangle and sine waveforms above 1 MHz. Actuation of VARIABLE SYMMETRY control divides output frequency by approximately ten.

Triangle Symmetry — Within 1% from 10 Hz to 400 kHz, within 5% from 400 kHz to 40 MHz on calibrated portion of FREQUENCY Hz dial. Typically within 2% from 0.001 Hz to 10 Hz.

Triangle Linearity — Within 1% from 10 Hz to 400 kHz, within 2% from 400 kHz to 4 MHz, within 10% from 4 MHz to 40 MHz measured from the 20% to 80% points on the waveform. Typically within 2% from 0.001 Hz to 10 Hz.

Sine-wave Distortion (Total Harmonic Distortion) — ≤0.5% from 20 Hz to 40 kHz. Greatest harmonic at least 30 dB down from 40 kHz to 1 MHz and 20 dB down from 1 MHz to 40 MHz. Typically ≤1% from 0.001 Hz to 20 Hz. Measured under the following conditions: terminated in 50 Ω, at 25°C ±10°C ambient, with zero offset, ≤30 dB attenuation and with FREQUENCY Hz (START) dial set between 4 and 40.

Square wave — Rise and fall time (FIXED): ≤6 ns. Aberrations: ≤5% p-p + 30 mV into a 50 Ω load.

Variable Rise and Fall Time (Square and Pulse Waveforms) — Range: 10 ns to 100 ms in 7 steps measured from 10% to 90% points on waveform. Variable control has ≥10 X range. Period of waveform must exceed combined rise and fall times by ≥20%.

Amplitude Modulation Input — a 5 V p-p signal produces 100% modulation of a sine wave carrier from dc to 4 MHz with <5% distortion at 70% modulation when driven from a source impedance of ≤600 Ω. From 4 MHz to 40 MHz there is <10% distortion at 65% modulation. Distortion specifications valid for modulating frequencies from 20 Hz to 20 kHz. Modulation frequency bandwidth is dc to 100 kHz. A modulating source impedance of ≤10 kΩ ensures proper modulation and divides the output amplitude by 2. Input Impedance: >1 MΩ.

External Trigger/Gate/Phase Lock Input — Input Impedance ≥10 kΩ. Sensitivity: 1 V p-p. Maximum input Amplitude: +20 V. Trigger Mode: (for triggering a single cycle of main generator waveform). Trigger Level: −1 to +10 V. Minimum Period: 75 ns. Maximum Trigger Frequency: ≥20 MHz. Gate Mode: (for gating multiple-cycle bursts of main generator waveform). Minimum Period: 75 ns. Maximum Gated Frequency: ≥20 MHz. Duration of gate determines number of output cycles with integral number of cycles completed. Phase Lock Mode: Frequency Range: 100 Hz to 40 MHz. Capture Range: ±10 major dial divisions from 100 Hz to 4 MHz. ±8 major dial divisions from 4 MHz to 40 MHz. Lock Range: Generator will lock to a changing external signal, without readjusting the PHASE control, within ±10 major dial divisions from 100 Hz to 4 MHz and within ±1 MHz from 4 MHz to 40 MHz Phase Adjustment Range: ±80° from 100 Hz to 4 MHz.

Gate and Trigger Phase Control — Phase Adjustment Range: Triangle and sine waveforms only, ±80° from 0.001 Hz to 4 MHz.

Manual Trigger/Gate — Available at front panel.

Trigger Output — 0 V to ≥ + 2 V from 50 Ω.

Hold Mode — Drift: ≤10% of p-p output amplitude/hour. Range: 0.001 Hz to 400 Hz.

Power Consumption — 48 W from power line.

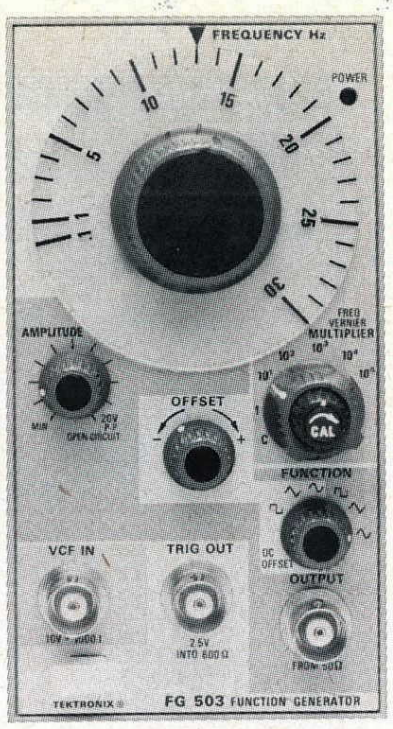
Power Dissipation — 24 W maximum in plug-in.

Performance Conditions — The electrical characteristics are valid if the FG 504 is calibrated at an ambient temperature between +20°C and +30°C, and operated between 0°C and +50°C, unless otherwise noted. Forced air circulation is required above +40°C (TM 515, TM 506, RTM 506 or equivalent).

FG 504 40 MHz Function Generator . . $1550

FG 504T 40 MHz Function Generator . $1740
(includes FG 504, TM 503 Mainframe, and 016-0195-03 blank panel)

DD 501 Digital Delay $800

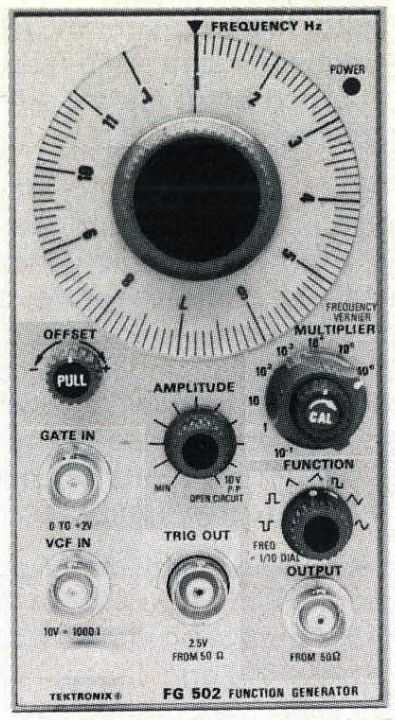


FG 503
3 MHz FUNCTION GENERATOR

1.0 Hz to 3 MHz
Three Waveforms
Vcf

The FG 503 Function Generator provides high-quality low-distortion sine, square, and triangle waveforms. Six decade frequency multiplier steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V p-p can be developed across a 50-ohm load (20 V p-p open circuit). Selectable offset up to 3.75 V dc across 50 ohms (7.5 V dc open circuit) is also featured.

FG 503 Function Generator $450

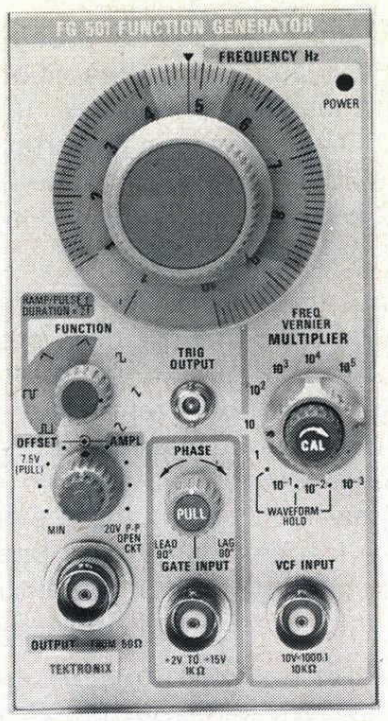


FG 502
11 MHz FUNCTION GENERATOR

0.1 Hz to 11 MHz
Five Waveforms
Vcf and Gated Burst

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. Voltage controlled frequency input permits the FG 502 to be used as a sweep generator. The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireline or radio remote control equipment and in certain phases of the telephone industry.

FG 502 Function Generator $650



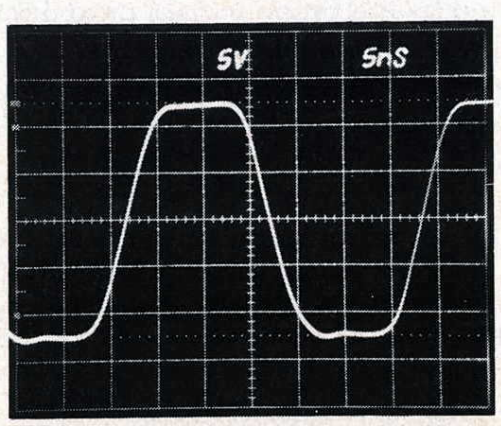
FG 501
1 MHz FUNCTION GENERATOR

0.001 Hz to 1 MHz
Five Waveforms
Vcf and Gated Burst
Hold Mode

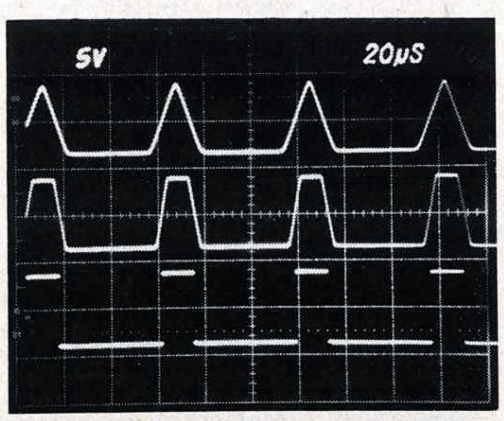
The FG 501 produces low-distortion sine, square, triangle, pulse, and ramp waveforms from 0.001 Hz to 1 MHz. An external vcf input permits control of the output frequency from an external voltage source. Frequency sweep up to 1000:1 ratio may be accomplished by applying a voltage ramp to the vcf input. A hold control allows the operation of the generator to be halted instantaneously at any point in its cycle. Release of the hold will then allow the operation to continue normally. A gate input is provided to allow "burst" or single cycle operation, with the phase of the generator output at the start of the burst controllable over a ±90° range. Output signal voltage is adjustable to 10 V p-p into a 50-ohm load, with dc offset also adjustable up to ±3.75 V into 50 Ω.

FG 501 Function Generator $550

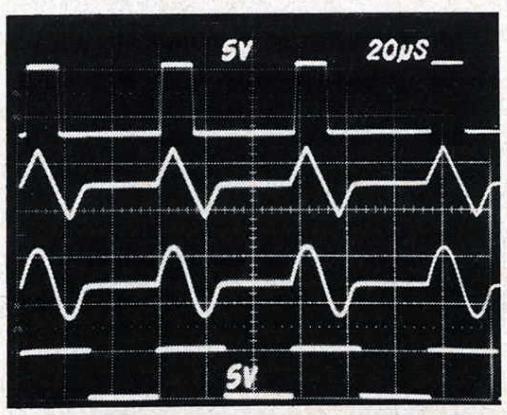
FG 504 OUTPUT WAVEFORMS



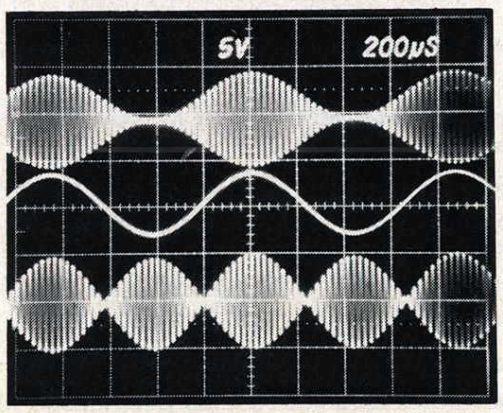
FG 504 30 volt output with 6 ns rise and fall times for superior pulse waveforms.



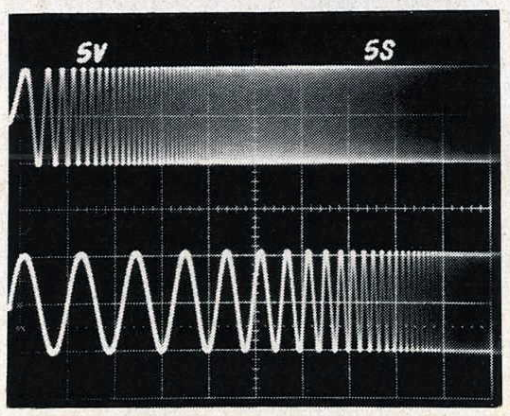
Variable rise and fall times increase pulse waveform flexibility.



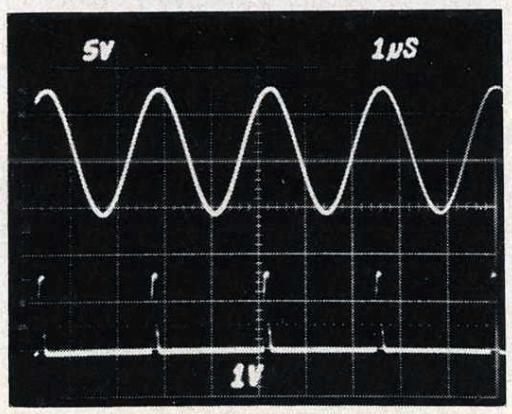
FG 504 completes one waveform when triggered from external signal on bottom trace.



True four quadrant multiplier permits normal am or double sideband suppressed carrier modulation.



FG 504 both linear or logarithmic sweep available for a wide range of sweep applications.



Phase lock allows the FG 504 output (top trace) to lock to virtually any periodic input waveform.

P6303 AM 503
P6302 AM 502
AM 501

TM 500 Series Test and Measurement System

Current Probe, Differential Amplifier, and Operational Amplifier

When it comes to solving electrical measurement and analysis problems our TM 500 Signal Processor offer some unique capabilities. Their compact portability and plug-in flexibility allow complete lab instrumentation setups to be built within stringent space and budget limitations.

You can put these versatile electrical signal alteration devices to work on a broad range of applications: preamplification of low-level signals and addition or removal of dc offset; filtering noise and signals outside your spectrum of interest; integration, differentiation and summing of multiple signals; and impedance transformation and post amplification (obtaining higher amplitude drive from low-amplitude signal sources).

The AM 503 is designed to work specifically with the P6303/P6302 Current Probes. It is calibrated in 12 steps. The knob skirt is illuminated to indicate current per division.

In addition, the AM 503 incorporates a feature that limits the bandwidth requirement to 5 MHz, allowing elimination of unwanted transients. Ac and dc coupling is provided.

For optimum performance, both probe systems should be used with an oscilloscope which meets a minimum bandwidth requirement. The P6302/AM 503 System is recommended for use with a 75 MHz or greater bandwidth scope. The 80 MHz SC 504, a TM 500 Plug-in Oscilloscope is compatible with this system and can be combined in the same mainframe. The P6303/AM 503 should be used with a minimum 15 MHz bandwidth scope, for example the SC 502.

Both the P6402/AM 503 and P6303/AM 503 Current Probe Systems have a wide variety of applications from SCR and power supply measurements to medical applications. Each of the probes utilize inductive coupling, eliminating the need to break the circuit under test.

The versatile AM 502 Differential Amplifier (for maximum rejection of common-mode noise signals) lets you control gain, dc offset, low-frequency and high-frequency response. You can also use the AM 502 with single-ended input.

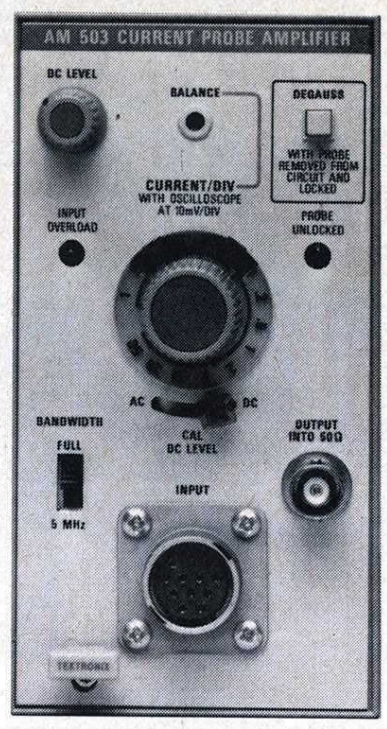
The AM 502's adjustable dc offset allows high amplification even when low-level signals have a dc component up to one volt . . . its variable dc offset feature simply lets you cancel the signal's dc component. Another high-performance feature is the AM 502's dc-to-1 MHz bandwidth. Switch-selectable high-pass and low-pass filters can reduce the noise bandwidth when you don't need the full frequency range.

For most electronic and many electro-mechanical applications, the AM 501 Operational Amplifier's output power (±40 Volts and ±50 mA across 800 ohm loads) is more than adequate. This high-output unit features front-panel connectors that let you change configurations by selecting feedback components, quickly and easily.

So, the AM 501 is easily set up for differentiation, integration, summing and impedance transformation problems. Or, if you want a given configuration to be relatively permanent, you can hardwire its feedback components internally.

Our AF 501 Bandpass Filter/Amplifier features a center frequency that's one-knob tunable over the entire audio range—from 3 Hz to 35 kHz. It's switch-selectable in broad (Q=5) and narrow (Q=15) bandwidths. It also provides sine wave generation to 35 kHz and flat signal amplification to 50 kHz.

The AF 501's capabilities are extremely versatile. You can select amplification from 1 to 500 in a 1-2-5 sequence in both filter and flat modes. Or use its signal output pulse to drive counters and oscilloscopes or to trigger stroboscopic lamps. Or, take advantage of its oscillator mode when you want the output frequency to equal the center-tuned frequency in the filter modes.

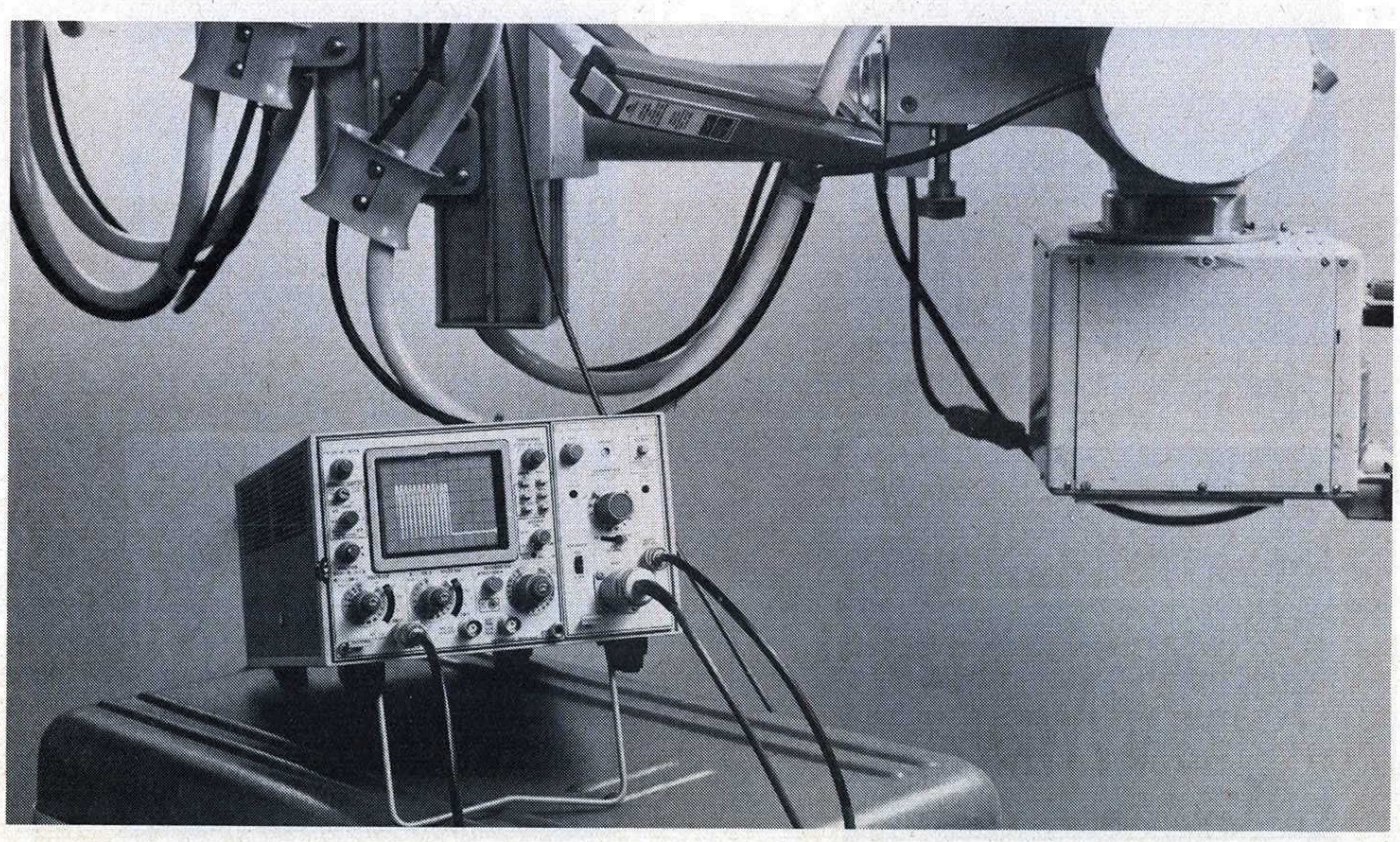


AM 503
CURRENT PROBE AMPLIFIER

Displays Current/div Signals on an Oscilloscope

Current Range, Maximum Current, and Bandwidth Determined by the Probe Used

The AM 503 is a plug-in modular current-probe amplifier that operates in TM 500 Mainframes. It allows display of current/division on any oscilloscope with 10 mV/div sensitivity, 50 ohm or 1 megohm input, and (for performance to full specifications) at least 75 MHz when using the P6302 or 50 MHz when using the P6303. The amplifier attenuator is calibrated in 12 steps with a 1, 2, 5 sequence, and the knob-skirt is illuminated to indicate current per division. The current range, maximum current rating, and bandwidth are determined by the particular probe in use. Bandwidth can be set to FULL (where it is limited by the probe in use) or to 5 MHz. Coupling may be switch selected to ac or dc. Ac coupling offers a convenient means of measuring low-amplitude ac signals on a high-level dc current. A front-panel indicator warns of input current overload.



The 10-MHz SC 503 when combined with P6303/AM 503 forms a light-weight, easily transportable current measurement system.

ELECTRICAL CHARACTERISTICS

(AM 503 Current Probe Amplifier with P6302 Probe or P6303 Probe)

Maximum Input Current — 20 A (dc + peak ac) for P6302. 100 A (dc + peak ac) for P6303.

Maximum Voltage for Current Under Test (Bare Conductor) — 500 V (dc + peak ac) for P6302. 700 V (dc + peak ac) for P6303.

Bandwidth (−3 dB) — Dc to at least 50 MHz with P6302. Dc to at least 15 MHz with P6303.

Rise Time (Full Bandwidth) — 7 ns or less with P6302. 23 ns or less with P6303.

Deflection Factor — 1 mA/div to 5 A/div for P6302. 20 mA/div to 50 A/div for P6303. In a 1, 2, 5 sequence for both probes.

Attenuator Accuracy — Within 3% of indicated CURRENT/DIV for both probes.

INCLUDED ACCESSORIES WITH AM 503

50 Ω cable w/BNC (012-0057-01), 50 Ω terminator (011-0049-01).

AM 503 Current Probe Amplifier $675

P6303
DC CURRENT PROBE

100 A Ac and Dc Current Measurements
Dc to 15 MHz Bandwidth
Peak Pulse Measurements to 500 A
Ac or Dc Coupling
1 inch by 0.830 inch Jaw Opening
One-hand Operation

This new clamp-around probe satisfies requirements for current measurements to 100 A from dc to 15 MHz. Equipped with a convenient pistol grip, the P6303 can easily be clamped to cables up to 0.830 in. Other measurement parameters of the probe include: 100 amps continuous and 500 amps peak.

By combining an oscilloscope, such as our SC 504, with your P6303/AM 503 Current Probe Amplifier in a TM 500 Mainframe you will have a convenient and compact high current amplification/measurement system.

P6303 Current Probe
Order 010-6303-01 .....$675

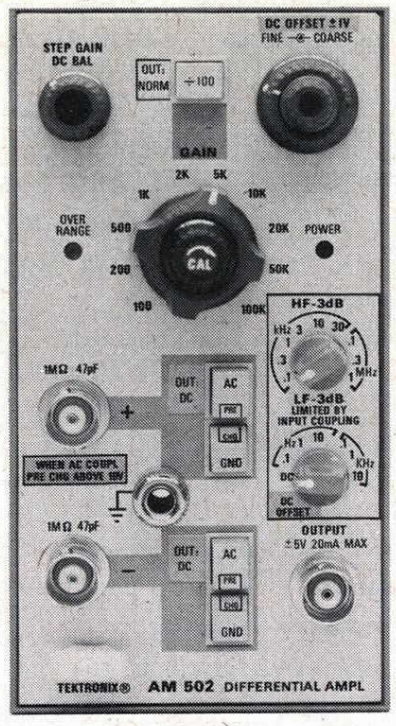
P6302
CURRENT PROBE

1 mA to 20 A Current Measurement Range
50 A Peak Pulse Measurements
Dc to 50 MHz Bandwidth

When a P6302 Current Probe is used with the AM 503 Current-Probe Amplifier, the current range is from 1 mA to 20 A. Maximum current is 20 A (dc + peak ac). Peak pulse maximum is 50 A not to exceed a product of 100 A μs. The probe operates through inductive coupling with no electrical contact. A flick of your forefinger operates the sliding jaw in the insulated probe tip. Just put the probe tip around the conductor under test for immediate current readings.

Included Accessories — 5 inch ground lead (175-0124-01), 3 inch ground lead (175-0263-01), two alligator clips (344-0046-00).

P6302 Current Probe
Order 010-6302-01 .....$325



AM 502
DIFFERENTIAL AMPLIFIER

1-to-100,000 Gain
100 dB Cmrr
Selectable Upper and Lower −3 dB Points
Dc-to-1 MHz Bandwidth
Adjustable Dc Offset

The AM 502 Differential Amplifier features: wide bandwidth; high cmrr; and selectable calibrated gain and filtering. Well-suited for general-purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, displays, or processing devices. In the unity gain mode, it can be used as a signal conditioner. Input dc offsetting to ±1 V is provided.

AMPLIFIER

Gain — 100 to 100,000, 1-2-5 sequence, accurate within 2%. 1X gain obtained by 100X attenuation.

Frequency Response — From dc (if ac coupled, 2 Hz or less at −3 dB point) to 1 MHz with GAIN set to 20 k or less. Upper −3 dB point reduces to 500 kHz at 50 k gain, 250 kHz at 100 k gain.

HF −3 dB POINT — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. (Also limited by frequency response at gains of 50 k and 100 k.)

LF −3 dB POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz.

Dc Offset — At least + or − 1 V to offset signal dc component.

Normal-Mode Cmrr — At least 100 dB, dc to 50 kHz, range, ±5 V.

÷ 100 Mode Cmrr — At least 50 dB, dc to 50 kHz, range, ±50 V.

Max Input Voltage — Normal mode dc coupled: 15 V (dc + peak ac). ÷ 100 Mode dc coupled: 350 V (dc + peak ac). Ac coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C — 1 MΩ paralleled by approx 47 pF. Input impedance can be increased to FET input via a simple internal jumper change.

OUTPUT

Max Output — ±5 V, ±20 mA, output resistance is 5 Ω or less.

Min Load Impedance — 250 Ω.

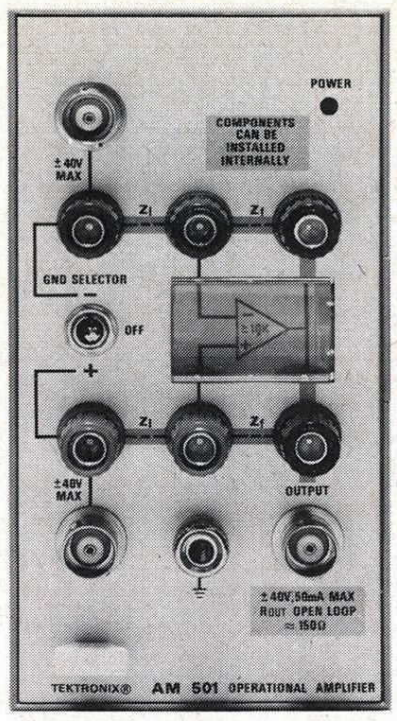
Max Input Gate Current — 50 pA at 25°C.

Max Noise — 25 μV or less (tangentially measured).

Overrange — Front-panel lamp indicates most overrange conditions.

Max Voltage Drift — 100 μV/°C.

AM 502 Differential Amplifier $800



AM 501
OPERATIONAL AMPLIFIER

±40 V, 50 mA Output
Open Loop Gain 10,000
50 V/μs Slew Rate
Symmetrical Differential Design

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well-suited as a post-amplifier or offset-generator for signal sources, including the TM 500 Modules. Components may be added externally or internally making it ideal for teaching operational amplifier theory.

OPERATIONAL AMPLIFIER

Open Loop Gain — At least 10,000 into 800 Ω load.

Unity Gain Bandwidth — At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio — At least 10,000 to 1 at 60 Hz.

Slew Rate — At least 50 V/μs into a 800 Ω load.

INPUT

Common-Mode Input Voltage Range — At least ±40 V.

Input Leakage Current — Less than 500 pA at 20°C.

Equivalent Input Drift — Less than 100 μV/°C.

Equivalent Input Noise — Less than 10μV rms.

Max Differential Input Voltage — 80 V.

OUTPUT

Voltage Range — At least ±40 V.

Current Limit — At least ±50 mA.

Open Loop Output R — Approx 150 Ω.

AM 501 Operational Amplifier $395

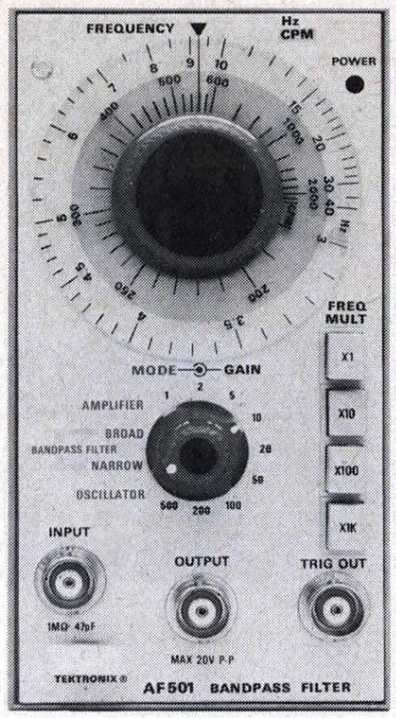
OPTIONAL ACCESSORY

Terminal Accessory Adapter Kit
(013-0146-00) $15

AF 501
AM 511

TM 500-Series Test and Measurement System

Bandpass Filter Amplifier and Preamplifier



AF 501
BANDPASS FILTER/AMPLIFIER

Tunable Bandpass Filtering to 35 kHz

Signal Amplification to 50 kHz

Sine-wave Generation to 35 kHz

Strobe Trigger Synced to Oscillator or Filter Output

Dial Readings in Hz or Cycles per Minute

The AF 501 is a Bandpass Filter/Amplifier, ac-coupled amplifier and sine-wave generator combined in a single TM 500-Series Module. Used alone or in conjunction with other TM 500-Series Instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical measurement domain, the AF 501 can be used as a manual-sweep spectrum analyzer for complex sound and vibration signals. Single-frequency tuning facilitates isolation of 1X rpm signals in dynamic balancing, or viewing higher order disturbances on a crt monitor. An output pulse, synced to the filter or oscillator output signal, is available for triggering a stroboscope or oscilloscope and for frequency counting. And, of course, the AF 501 can be used in any application calling for a conventional sine-wave generator, ac-coupled amplifier, or bandpass filter.

BANDPASS FILTER

Center Frequency Range — 3 Hz to 35 kHz in 4 decade steps.

Frequency Dial Error — <5% dial setting between 3-20, <10% dial setting between 20-30.

Frequency Multiplier — X1, X10, X100, X1 k.

Phase Shift — <10° at tuned frequency below 5 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Max Filter Attenuation — >70 dB.

Filter Selectivity — Broad: Q = 5 ±1.
Narrow: Q = 15 ±5.

Bandwidth at Half-power Points —

$$\Delta F_{-3\,dB} = \frac{\text{center frequency}}{Q}$$

Gain Range — 1-500; 1-2-5 sequence.

Gain Accuracy — ± 3 dB (Broad), ± 5 dB (Narrow).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Max Dc Input Voltage — ± 100 V.

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

Output Current—20 mA p-p max (at 20 V p-p).

Output Impedance — <1 Ω.

AMPLIFIER

Gain — 1 to 500; 1-2-5 sequence.

Gain Accuracy — ±3%.

Bandwidth — <0.5 Hz to >50 kHz (at 3 dB point).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Noise — <25 mV rms (referred to output).

Output Voltage — 20 V p-p (max freq times amplitude = 400 V kHz).

OSCILLATOR

Sine Wave Out Range — 3 Hz to 35 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Output Amplitude — 1, 2, or 5 V p-p ±20%, depending on gain position.

Waveform Distortion — <3%.

Output Current — Max 50 mA p-p.

Output Impedance — <1 Ω (within 50 mA output current limit).

TRIGGER OUTPUT

Pulse Amplitude — >10 V.

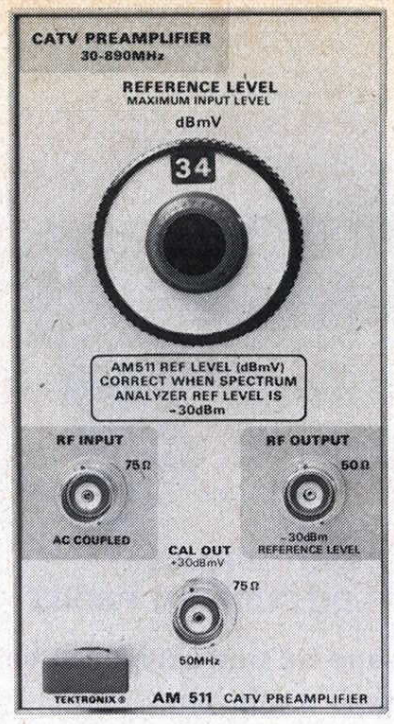
Pulse Duration — 10 ±5 μs.

Min Signal Required — 500 mV, p-p

Rise and Fall Time — <1 μs.

Output Impedance — ≈50 Ω.

AF 501 Bandpass Filter/Amplifier $600



AM 511
PREAMPLIFIER

For Use with 7L12 or 7L13 Spectrum Analyzers

Reference Level Selectable in 1 dB or 10 dB Steps

30 to 890 MHz Frequency Range

The AM 511 is a plug-in preamplifier for use with the 7L12 or 7L13 Spectrum Analyzers. It plugs into a TM 500 Power Module to meet the need of those who require a preamplifier for use with the 7L13.

The AM 511 applications include signal to noise, radiation, and field intensity measurements to FCC specifications on CATV, television, and fm installations. It is also useful in servicing and making measurements on radio systems and increasing sensitivity for emc measurements within the 30 to 890 MHz frequency range.

ELECTRICAL CHARACTERISTICS
(with 7L12 or 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — (AM 511/7L12) ±1.0 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, −2.5 dB over the full frequency range. (AM 511/7L13) +1.0 dB, −1.5 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, −2.5 dB, over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode. The following characteristics apply at 50 MHz.

Sensitivity	Resolution Bandwidth
−90 dBmV	30 Hz
−80 dBmV	300 Hz
−73 dBmV	3 kHz
−65 dBmV	30 kHz
−55 dBmV	300 kHz
−45 dBmV	3 MHz

Noise figure for the AM 511 is no greater than 5 dB.

Intermodulation Distortion — (AM 511/7L12 or AM 511/7L13) Imd products and harmonics from two signals within the frequency span of the AM 511 are 70 dB or more down from the reference level for third order intermodulation with two signals at the reference level (full screen).

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV Calibrator at 50 MHz. Max deviation from this reference is 0.2 dBmV +0.01 dBmV per dB deviation from the +30 dBmV AM 511 reference level. This is equivalent to: ± (0.2 dBmV ± 0.01 [dBmV Ref Lvl −30 dBmV]).

Input Impedance — 75 Ω with a vswr of 2:1 or better with 10 dB or more attenuation (between 50 MHz and 300 MHz).

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω at 25°C.

AM 511 CATV Preamplifier $675

SIGNAL PROCESSORS—COMPARISON CHART

	AF 501 Tunable Bandpass Filter/Amplifier	AM 501 Operational Amplifier	AM 502 Differential Amplifier
Amplification range	1 to 500 in 1-2-5 steps	Depends on feedback components; open loop gain 10,000	1 to 100,000 in 1-2-5 steps
Input impedance	1 MΩ	Depends on feedback components	1 MΩ normal; FET input by internal jumper
Bandwidth control	Center frequency tunable 3 Hz to 35 kHz; Q=5 or 15	Depends on feedback components; max gain-bandwidth product 5 MHz	Independent switch-selected high-frequency and low-frequency filters
Maximum output	20 V p-p (Bandpass filter)	±40 V, ±50 mA with 800 Ω load	±5 V, ±20 mA, ouput resistance 5 Ω or less
Other features	Functions as audio oscillator, narrow or wide bandwidth tunable filter and flat audio amplifier	Use as inverting or noninverting amplifier, follower, summing amplifier, integrator, differentiator, etc, by appropriate feedback R and C	Coarse and fine control of up to ±1 V of internal dc offset, ac or dc coupling, single-ended or differential input, 25 μV equivalent input noise at full bandwidth
Price	**$600**	**$395**	**$800**

For plug-in portability, compact size and state-of-the-art capabilities, many of today's broadcasting, computer time-sharing, and telephonic communications specialists are turning to our TM 500 Audio and Ramp Generators.

The SG 502 audio oscillator features extremely low sine wave distortion (less than 0.35% over a 20 Hz to 50 kHz audio range, and not more than 0.1% over its 5 Hz to 500 kHz coverage). Plus wide-range flat response for critical audio and communications systems and component testing.

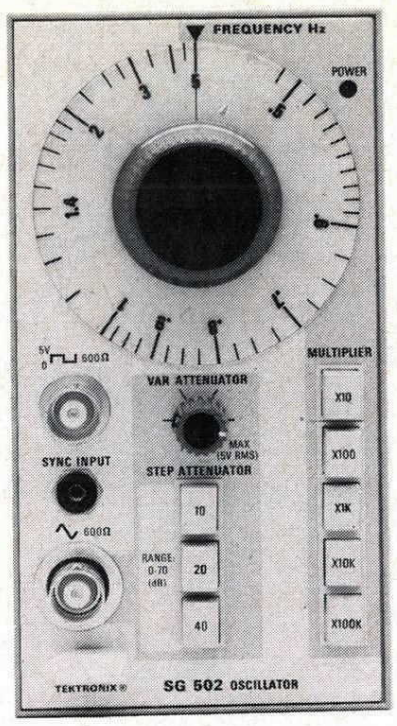
Other high-performance features of the SG 502 include a flat output amplitude within ±0.3 dB over the entire range, a 600 ohm output impedance, 70 dB amplitude control available in 10 dB steps, and 40 dB variable attenuator plus a simultaneous fixed amplitude square wave.

And, like the rest of our TM 500 Family, the SG 502 is highly configurable. When you add its capabilities to those of our DM 502 and DC 504, you get a compact, multifunction, audio frequency communications package.

The RG 501 Ramp Generator provides single or repetitive ramps of controllable amplitude and duration, excellent linearity, and short retrace time. And like the SG 502, the RG 501 can fit into several TM 500 packages when combined with our TM 500 Function Generators, the PG 505 Pulse Generator, crt monitors, or an X-Y recorder.

The RG 501's output provides an ideal time base for a monitor or recorder. Used with the PG 505, it permits a delayed pulse to be triggered at any selectable point along the ramp. And used with any of our function generators, where vcf (Voltage Controlled Frequency) input is fed by the RG 501's output, it generates a linear frequency sweep width of up to 1000:1.

As you can see, these generators offer high-level capabilities when used alone, and versatility when plugged into a powerful TM 500 system of your own design.



SG 502
OSCILLATOR

RG 501
RAMP GENERATOR

5 Hz to 500 kHz Sine and Square Waves

Extremely Low Distortion Sine Wave

5 V Rms Open Circuit—600 Ω Source

0-40 dB Output Variable Plus 0-70 dB in 10 dB Steps

SINE WAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response — Flatness is 0.3 dB over entire range (1 kHz reference).

Attenuation — Selectable from 0 dB to 70 dB in 10, 20, and 40 dB steps with pushbuttons. Accurate within 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion — Less than 0.035% from 20 Hz to 50 kHz. Less than 0.1% over the remaining frequency range.

Hum and Noise — Less than 0.1% of rated output.

Max Output Voltage — 5 V rms open circuit; 2.5 V rms into 600 Ω.

Output Impedance — 600 Ω, single ended.

SQUARE WAVE

Frequency Range — Same as sine wave. The square wave switches on the 0° phase of sine out.

Rise and Fall Time — 50 ns or less.

Amplitude — +5 V, fixed, open circuit.

Output Impedance — 600 Ω, single ended.

SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 kΩ.

Measurements made at rated output and terminated in 600 Ω.

SG 502 Oscillator **$475**

10 μs to 10 s Ramp Duration

Plus or Minus Output

10-V Amplitude

Scope-type Trigger Functions

Gate Out, TTL Compatible

RAMP

Ramp Duration — Decade ranges of 10 μs to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude — Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Gate — From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Fall time is 100 ns or less. Gate source impedance is nominally 160 Ω.

Ramp Output Characteristics — Minimum load resistance, 3 kΩ; max load capacitance, 300 pF.

TRIGGERING

Auto Triggering — Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering — Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 kΩ. 50 V (dc + peak ac) max input.

Internal Triggering — Same as external except that the trigger source is via the rear interface.

Line Trigger — Triggers at line frequency.

Trigger Level Range — ±1 V.

RG 501 Ramp Generator **$375**

Optional Accessory — Manual (One-Shot) Trigger Generator.

Order 016-0597-00 ..... **$55**

PG 506, TG 501
SG 503, SG 504

TM 500-Series Test and Measurement System

Oscilloscope Calibration Instruments

Downtime is one problem no production manager can afford . . . and the time service engineers spend transporting oscilloscopes from the job site to the calibration bench is wasted time. In the end, for a production house or manufacturing unit, the production line is the bottom line.

These TM 500 Oscilloscope Calibration Instruments offer the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks and widest frequency range of leveled sine waves available today.

In addition to its crystal-controlled mode, the TG 501 provides a variable mode. This means you can quickly adjust and accurately align the time mark spacing to your oscilloscope's graticule marks, and read the percentage timing error directly off the TG 501's digital display.

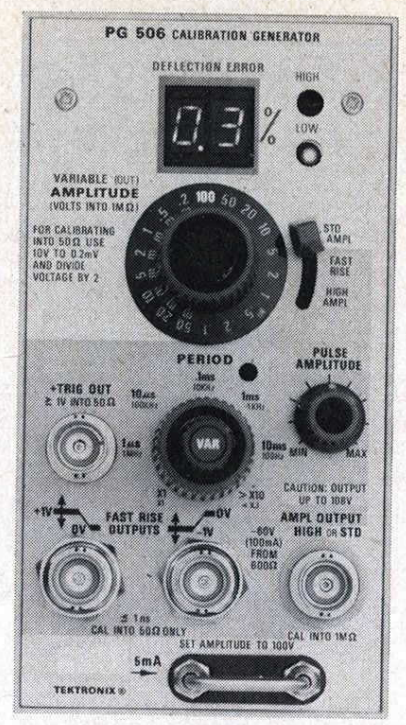
Our PG 506 Calibration Generator offers TM 500 portability plus state-of-the-art performance features. With the PG 506 in the amplitude calibration mode, you can generate a 1 kHz square wave and vary its amplitude around the calibrated level until the square wave aligns with your oscilloscope's vertical graticule divisions. At that point, you can read the scope deflection error right off the PG 506's digital display in percentage high or low.

TM 500 leveled sine wave generators, SG 503 and SG 504, round out a scope calibration and verification package. These generators provide leveled sine wave generator for bandwidth checks (−3dB points) and triggering performance checks.

The SG 503 is a general-purpose leveled sine-wave oscillator providing variable output from 250 kHz to 250 MHz. The SG 504 provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands.

Another TM 500 module, the SG 502 Oscillator, could also benefit calibration applications where verification of low frequency roll off in ac modes and performance measurement of low frequency reject triggering modes is required.

For features that allow time and error reducing on-the-job oscilloscope evaluation, our TM 500 Calibration Instruments are the best value on the market today.



PG 506
CALIBRATION GENERATOR

Three Square-Wave Output Modes

10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 is a calibration generator for oscilloscopes with three modes of square-wave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. For checking attenuator performance and transient response of oscilloscopes, simultaneous plus and minus low-level, fast rise (1.0 ns) square waves or high amplitude (60 volt), extremely clean square waves are available at frequencies from 10 Hz through 1 MHz. A 5 milliamp calibration current loop is useful for current probe calibration. In the amplitude calibration mode, a 1 kHz square wave is generated whose amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope vertical graticule divisions; scope deflection error is then read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance.

AMPLITUDE CALIBRATOR MODE

Period — Fixed at approx 1 ms or dc.

Amplitude — From 100 V p-p to 200 microvolts p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 5 V p-p to 100 μV p-p into 50 Ω.

Error Readout Range — ±7.5%.

Error Readout Resolution — 0.1%.

PULSE MODES

Period — 1 μs to 10 ms (within 5%) in decade steps with the VARIABLE control in CAL position. VARIABLE extends period to at least 100 ms.

Symmetry — Approx 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST RISE OUTPUTS

Rise Time (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and — output connectors.

Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

PG 506 Calibration Generator $1695

TUNNEL DIODE PULSER

The Tunnel Diode Pulser (067-0681-01) provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 ohms, while rise time is ≤125 ps; aberrations are <1% in a 1 GHz system.

Order 067-0681-01 . . . . . $130

PRECISION VOLTAGE DIVIDER

Designed for use with the PG 506 in the STANDARD AMPLITUDE mode, this 0.4 divider allows your oscilloscope to display a constant 4 divisions when checking amplitude calibration from 20 μV/div through 1 V/div. It also allows the PG 506 to be more conveniently used with oscilloscopes that cannot display 5 divisions of amplitude.

Input Z — 50 Ω with output load ≥100 kΩ.

Max Input — ≤5 V rms.

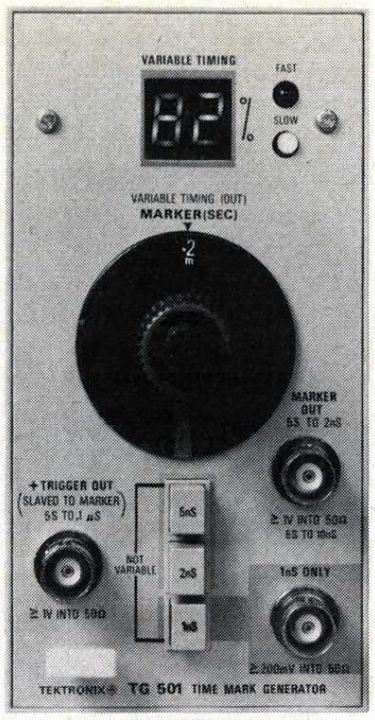
Output — 0.4 x PG 506 Amplitude.

Voltage Accuracy — ±0.4%.

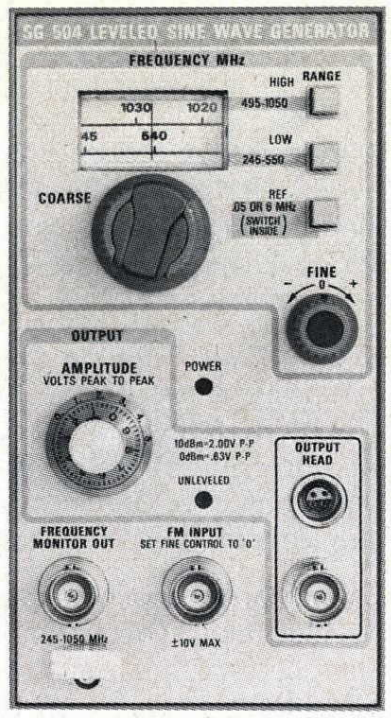
Order 015-0265-00 . . . . . $55

OSCILLOSCOPE CALIBRATION INSTRUMENTS CHART

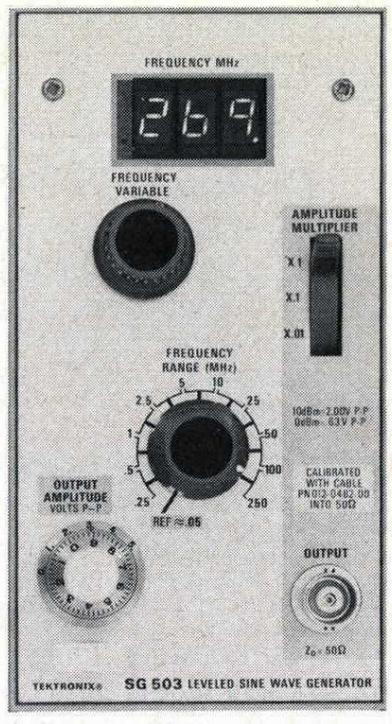
	PG 506 Calibration Generator	TG 501 Time Mark Generator	SG 503 Signal Generator	SG 504 Signal Generator
Primary functions	Amplitude calibration 200 μV to 100 V	Time-base calibration 1 ns to 5 s	Bandwidth calibration 250 kHz to 250 MHz	Bandwidth calibration 245 MHz to 1050 MHz
Secondary functions	Rise time and transient response testing, attenuator compensation testing	Testing oscilloscope nonlinearity	General leveled rf signal source	General leveled rf signal source with frequency modulation capability



TG 501



SG 504



SG 503

TIME MARK GENERATOR

Marker Outputs, 5 s to 1 ns

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from five seconds to one nanosecond. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display which indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 01
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50° C) after ½ hour warm-up	within 1 part in 10^5	within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Settability	adjustable to within 1 part in 10^7	adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — To ±7.5%.

Timing Error Measurement Accuracy — Device under test error is indicated to within one least significant digit (to within one displayed count).

TG 501 Time Mark Generator $1325

Option 01, 5 MHz Time Base . . . . . Add $200

SIGNAL GENERATOR

Leveled, Variable Output

245 MHz to 1050 MHz

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V peak-to-peak into 50 ohms.

Frequency Range — Low band: 245 MHz to 550 MHz. Highband: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

Frequency Accuracy — ±2% of dial indication.

Amplitude Range — 0.5 V to at least 4.0 V p-p.

Amplitude Accuracy — (at reference) Within 3% of indicated amplitude.

Flatness — ±4% of amplitude at reference frequency.

Harmonic Content — 2nd harmonic at least 25 dB down; 3rd and all higher at least 40 dB down.

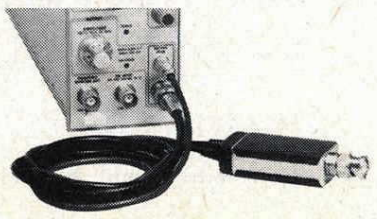
Fm Input — Frequency range: dc to 100 kHz. Deviation sensitivity: ±9 V produces from ±0.05% to ±0.4% deviation of carrier, depending on output frequency.

Frequency Monitor Output — ≥0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

Rear Card Edge Connections — Address fm input, frequency monitor output, and amplitude control.

SG 504 Signal Generator (Includes Leveling Head) $2295

Replacement Leveling Head, Order (015-0282-00) $250



SIGNAL GENERATOR

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a leveled output amplitude which is variable from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage into 50 ohms is variable from 5 mV to 5.5 V peak-to-peak.

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Accuracy — Within ±0.7 of least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

Amplitude Accuracy — (50 kHz reference) Within 3% of indicated amplitude on (X1) range, 4% on (X0.1) range, and 5% on (X.01) range.

Flatness — (p-p) From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X0.1 and X0.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

Other — Rear edge card connection available to address the leveling circuit.

Standard Accessory — Precision 50 Ω cable 3 ft long. (012-0482-00).

SG 503 Signal Generator $1325

PS 503A

TM 500-Series Test and Measurement System

Power Supplies

R & D design engineers require power supplies that are flexible enough to equal their imagination . . . and compact enough to allow a complete, custom-designed test system to fit neatly on a crowded workbench.

Our TM 500 Power Supplies can do just that, and more. Beyond supplying voltages for experimental or breadboard circuits and devices, their unique modularity lets you add units as needed, to keep your instrumentation up to date.

To insure convenience in your test system TM 500 Digital Multimeters can be rear interfaced to provide a monitoring of any power supply voltage. The power supply voltage of the PS 501-1, PS 501-2 or PS 503A will be digitally displayed on the digital multimeter through this rear connector. A convenience when testing or measuring, the rear interface capability allows the engineer to accurately look at his voltage requirements. The TM 500 Power Supplies provide up to three independent voltages from one plug-in instrument. And each features a fixed 5-volt-at-1-amp supply for logic circuits or indicators plus one or two variable supplies.

Other features that are standard with the PS 501-1 and PS 501-2 include a floating 0-to-20 volt output and adjustable current limiting from 0 to 400 milliamps with constant current operation above the limiting setting.

For accurate setting and adjustment of the output voltage, our PS 501-1 precision supply features a multiturn potentiometer with mechanical digital readout. The PS 501-2 also features a meter giving analog readouts of voltage and current load on the panel front.

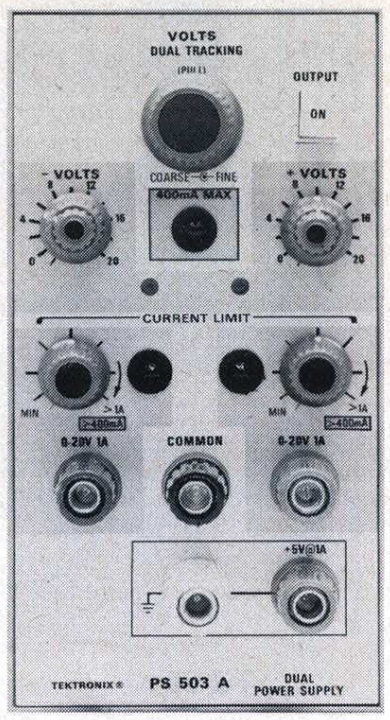
Our PS 503A provides a dual −20 to 0 and 0 to +20 volt variable supply plus a 5 volt 1A independent supply. And you can vary its −20 and +20 volt supplies in a tracked mode, or set each individually.

In the tracking mode, varying the plus and minus supplies in proportion to the voltage ratio set on their individual controls, is a simple, one-knob operation. In the nontracking mode, you can set each supply independently to any voltage — from 0 to 20 V.

In the high-power compartment of our TM 504 or TM 506, these two variable outputs can each supply up to 1 amp. And in any other compartment of a TM 500 Mainframe, they'll provide up to 400 mA.

Beyond that, since all three variable supply terminals are floating, you can ground any one of them. Or use the two outside terminals as a 0-to-40 volt supply. And both the positive and negative variable supplies have their own current limiting.

Since most active devices and transducers and many electromechanical components require direct current, you can well imagine that the application possibilities for these TM 500 Power Supplies are virtually unlimited. Their highly configurable characteristics and their compact, easy portability are aiding research and design engineers in their test and measurement work.



PS 503A
TRIPLE POWER SUPPLY

Independent + and − Controls

Dual Tracking Voltage Control

0 to ±20 Vat 1 A (in high-power compartment)

Fixed Output + 5 V @ 1 A

Remote Resistance Programming

Over-voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 Mainframe, the PS 503A provides up to 1 amp from both + and −, 0 to 20 volt supplies.

±20 V FLOATING SUPPLIES

Output — 0 to ±20 V dc with respect to the common terminal or 0 to 40 V dc across the + and − terminals. Outputs can be varied independently or at a constant ratio.

Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the VOLTS DUAL TRACKING control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

Current Limit — Adjustable from less than 100 mA to 1 A (high-power compartment) or less than 40 mA to 400 mA (standard compartment) on each supply.

Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

Indicators — Individual voltage indicators and current limiting indicators for both + and − supplies. Non-high-power compartment (400 mA) indicator.

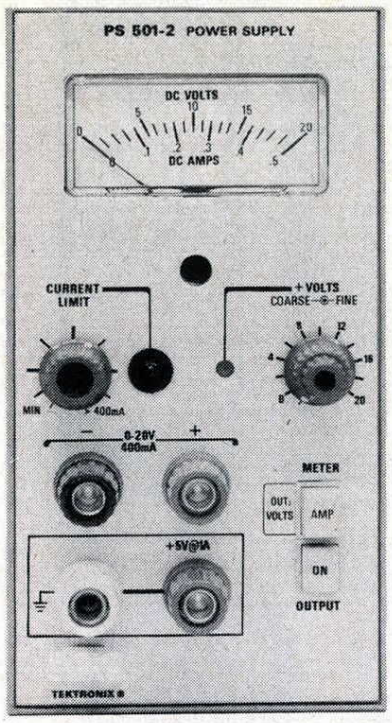
PS 503A Power Supplies $400

POWER SUPPLIES—COMPARISON OF CHARACTERISTICS

	PS 501-1	PS 501-2	PS 503A
Voltage/Current #1	+5 V @ 1 A	+5 V @ 1 A	+5 V @ 1 A
Voltage/Current #2	0-20 V @ 400 mA	0-20 V @ 400 mA	0 to +20 V @ 1 A*/400 mA**
Voltage/Current #3	No	No	0 to −20 V @ 1 A*/400 mA**
Current limit	<40-400 mA	<40-400 mA	<100 mA-1 A* 400 mA**
Min resolution	1.6 mV	10 mV	10 mV
Foldback current	No	No	No
Over voltage protection	No	No	Yes
Line regulation	<5 mV††	<5 mV††	<5 mV†††
Ripple & noise p-p	0.5 mV††	0.5 mV††	0.5 mV†††
Others	Multiturn pot with digital readout	Meter for voltage or current	+ − outputs independent, or dual tracking at ratio set by individual knobs
Price	**$325**	**$300**	**$400**

*In high-power (right-hand) compartment of TM 504 or TM 506.
**In any standard mainframe compartment.

†Refers to output #1
††Refers to output #2
†††Refers to output #2 and #3



PS 501-2
POWER SUPPLY

Floating Output, 0-20 V

0 to 400 mA

Precise Regulation

Low Ripple and Noise

Fixed Output + 5 V @ 1A

Dual-Range Meter Readout

Output — 0 to 20 V dc.

Current Limit — <40 mA to 400 mA.

Minimum Resolution — 10 mV.

Line Regulation — Within 5 mV for a ±10% line voltage change.

Load Regulation — Within 1 mV with a 400 mA load change.

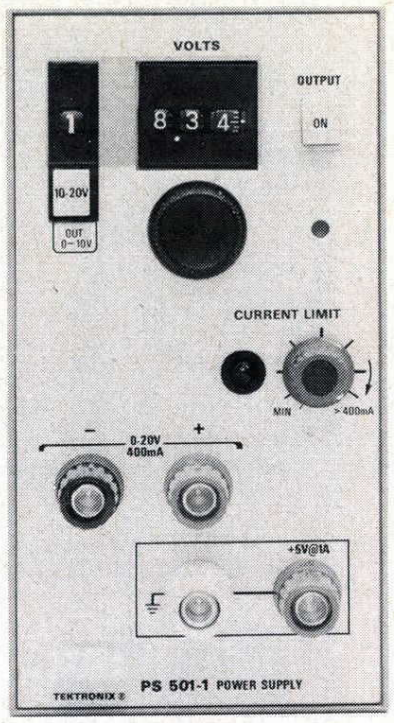
Ripple and Noise — 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Transient Recovery Time — 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400-mA change in output current.

Meter — Dual range, 0 to 500 mA or 0 to 20 V dc. Accuracy, ±2% of full scale.

PS 501-2 Power Supply $300



PS 501-1
POWER SUPPLY

Floating Output, 0-20 V

0 to 400 mA

Precise Regulation

Low Ripple and Noise

Fixed Output + 5 V @ 1A

Output — 0 to 20 V dc.

Current Limit — <40 to 400 mA.

Line Regulation — Within 5 mV for a ±10% line voltage change.

Load Regulation — Within 1 mV with a 400 mV load change.

Ripple and Noise — 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Minimum Resolution — 1.6 mV.
Voltage is selectable within 0.5% +10 mV by a 10 turn potentiometer with a 3 digit in-line dial and range switch.

Transient Recovery Time — 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

PS 501-1 Power Supply $325

CHARACTERISTICS COMMON TO PS 501-1, PS 501-2, PS 503A

20 V FLOATING SUPPLY

Primary Power Input — Determined by power module (TM 501, TM 503, etc).

Output — Floating, isolated from ground, 350 V dc + peak ac.

Stability — (0.1% +5 mV) or less drift in 8 hours at constant line, load, and temperature.

Indicator Lights — Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

Output — 5 V nominal, ±0.2 V at 1 A (20°C to 30°C).

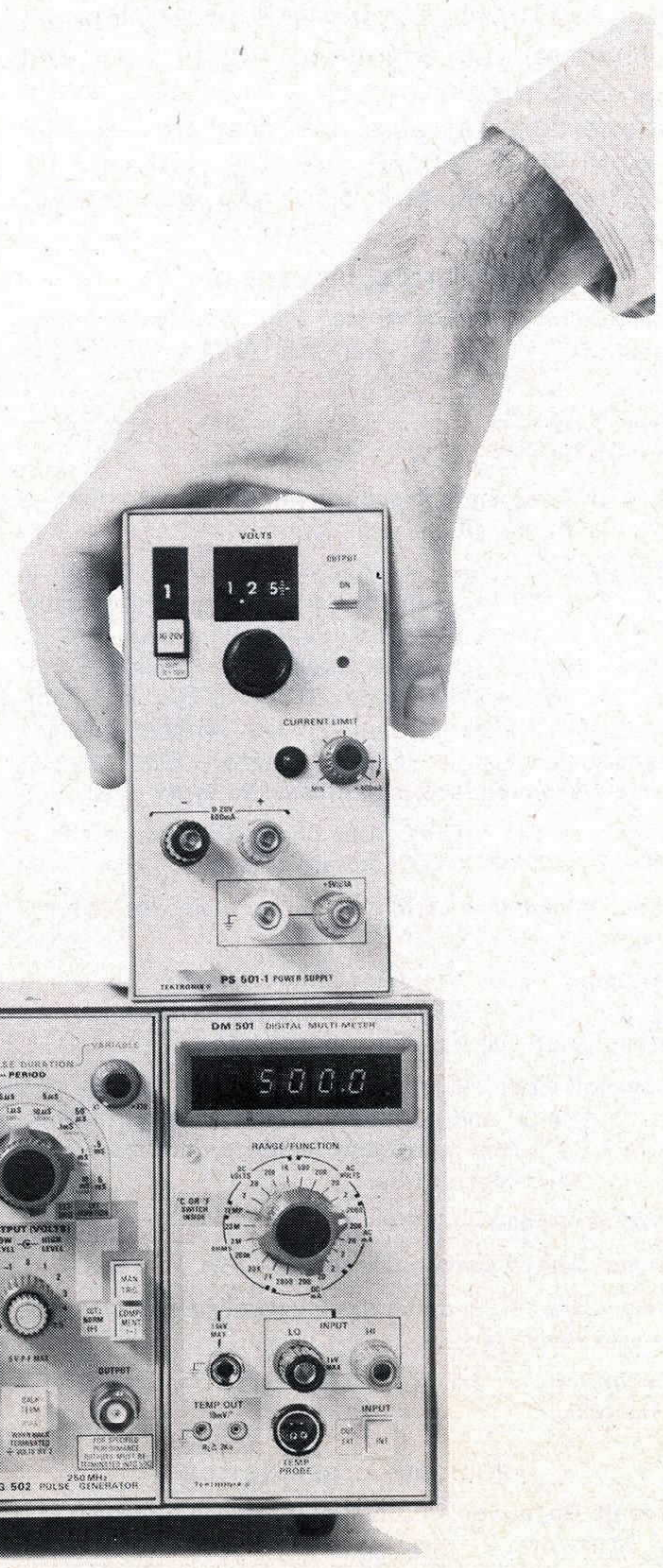
Load Regulation — Within 100 mV with a 1 A load change.

Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less; 100 μV rms or less.

Stability — 0.5% or less drift.

Overload Protection — Automatic current limiting and over-temperature shutdown.



SC 504

TM 500-Series Test and Measurement System

80 MHz Dual-Trace Oscilloscope

80 MHz Oscilloscope

Rear Interface Capability

5 mV/div Max Sensitivity

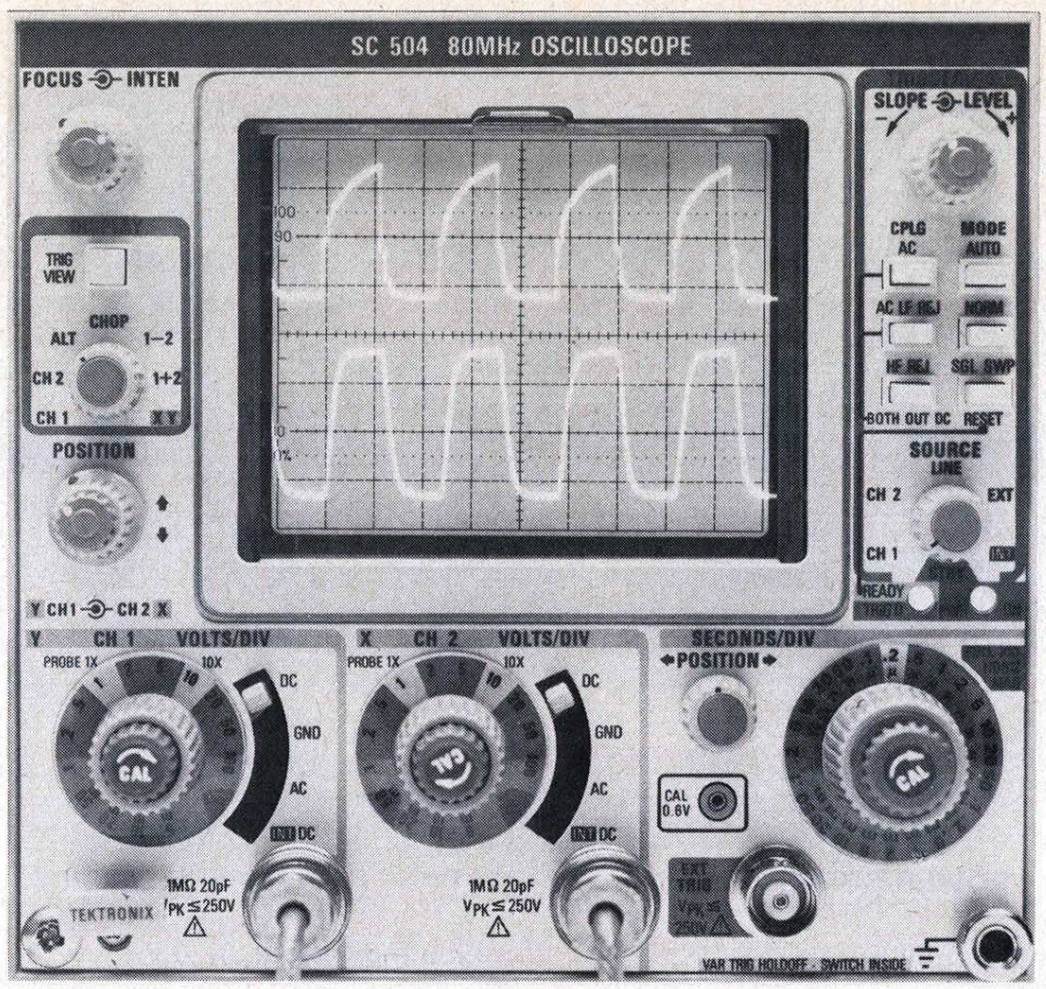
5 ns/div Max Calibrated Sweep Rate

Enhanced Automatic Triggering

True X-Y Capability

The addition of this plug-in scope makes many new configurations possible, especially for those applications demanding higher bandwidth capabilities. A double-wide plug-in, the SC 504 is compatible with all existing TM 500 Plug-ins and multi-compartment Mainframes.

The SC 504 is a general purpose, dual-trace, non-delayed-sweep oscilloscope. It has a high writing speed with a maximum sensitivity of 5 mV/div, and a maximum sweep rate of 5 ns/div (with magnifier). This oscilloscope features Add (CH 1 + CH 2), differential (CH 1 − CH 2), and "true" X-Y modes, and also includes rear interfacing capability (switchable CH 1, CH 2 and ext trig inputs). Enhanced auto triggering, trigger view, and variable trigger holdoff make this oscilloscope very versatile and easy to use. The P6108 and P6062B are the TEKTRONIX Probes recommended for use with the SC 504.



SC 504
80 MHz OSCILLOSCOPE

VERTICAL DEFLECTION

Bandwidth at −3 dB points — Dc to at least 80 MHz from 0°C to 35°C; dc to at least 70 MHz from 0°C to 50°C.

Rise Time — 4.4 ns or less from 0°C to 35°C; 5 ns or less from 0°C to 50°C.

Ac Low Frequency Response (lower −3 dB point) — Without probe, 10 Hz; with 10X probe, 1 Hz.

Deflection Factors — Calibrated Range: 5 mV to 10 V/div, 11 steps in a 1-2-5 sequence. Accuracy: 5 mV to 10 V/div (15°C to 35°C) ±2%, (0°C to 50°C) ±3%; in CH 1-CH 2 (differential) mode, Channel 2 (15°C to 35°C) ±3%, (0°C to 50°C) ±4%. Uncalibrated Range — Continuously variable between calibrated steps. At least 2.5:1 range. Extends maximum deflection factors to at least 25 V/div.

Modes — CH 1, CH 2, Alt., Chop, CH 1 minus CH 2, CH 1 plus CH 2, X-Y. Chop rate at least 250 kHz.

Input R and C — 1 MΩ ±1% paralleled by approximately 20 pF.

Maximum Input Voltage — Dc Coupled: 250 V (dc + peak ac). Ac Coupled: 400 V (dc + peak ac). Ac Component: 500 V p-p at 1 kHz or less.

Common-Mode Rejection Ratios — At least 50:1 up to 1 MHz, and 10:1 from 1 MHz to 10 MHz when using the same attenuator settings; common-mode signal 6 divisions or less.

Position Range — ±6 div.

Signal Delay Between Channels — 1 ns.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, approximately 1 kHz frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.2 s to 50 ns/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 5 ns/div. Uncalibrated (variable) Range — The CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 0.5 s/div.

Sweep Rate Accuracy — Measured over center 8 divisions, excluding first 50 ns and all after the first 100 divisions of magnified sweep.

	15°C to 35°C	
	X1	X10
20 ms/div to 0.2 μs/div	±2%	±3%
0.2 s/div to 50 ms/div	±3%	±4%
0.1 μs/div to 50 ns/div	±3%	±4%

Derate accuracies by an additional 1% from 0°C to 15°C, and 35°C to 50°C.

Trigger Holdoff — CAL (variable) control, if selected by an internal switch, increases trigger holdoff time by a factor of at least 20.

X-Y Mode — Bandwidth: Dc to at least 2 MHz. Deflection Factor, selected by Channel 2 controls and horizontal mag X1, X10 with 5% accuracy. X and Y amplifier phase difference, less than 3° at 50 kHz or less. Input parameters same as Channel 2.

TRIGGER

Trigger Modes — AUTO, NORM, and SGL SWP.

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the peak-to-peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — CH 1, CH 2, LINE, EXT. INT.

Trigger Coupling — AC, AC LF REJ, HF REJ, DC.

Triggering Sensitivity

		Minimum Signal Required	
Coupling	Source	DC to 30 MHz	30 MHz to 80 MHz
Dc	CH 1, CH 2 External Interface	0.4 div. 60 mV 35 mV	1.5 div 150 mV 80 mV
Ac	Requirements increase below approx 50 kHz		
Ac LF REJ	Requirements increase below approx 50 Hz		
HF REJ	Requirements increase above approx 10 kHz		

External Triggering Level Range — ≥ ± 1.4 V.

External Triggering Input — Input R and C — 1 MΩ ±10% paralleled by approximately 24 pF. Maximum Input Voltage — 250 V (dc + peak ac); 250 V p-p at 1 kHz or less.

AUTO Mode — Sweep free runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approximately the p-p range of the triggering signal.

Single Sweep — Triggering requirements are as for normal sweep. When triggered, sweep generator produces one sweep only.

CRT

Phosphor — P31.

Acceleration Potential — Approximately 12 kV.

Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

REAR INTERFACE

CH 1 and CH 2 Vertical Inputs — Selected by CH 1 and CH 2 coupling in INT (interface) position. Input impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 60 pF.

Trigger Input — Selected by TRIGGER SOURCE switch in INT (interface) position. Input impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 40 pF.

Z-Axis Input — Input Impedance: Approximately 1.5 kΩ. +5 V turns beam ON from OFF condition, −5 V turns beam OFF from ON condition.

Channel 1 Output — At least 50 mV/div. Bandwidth: At least 30 MHz. Output Impedance: <50 Ω.

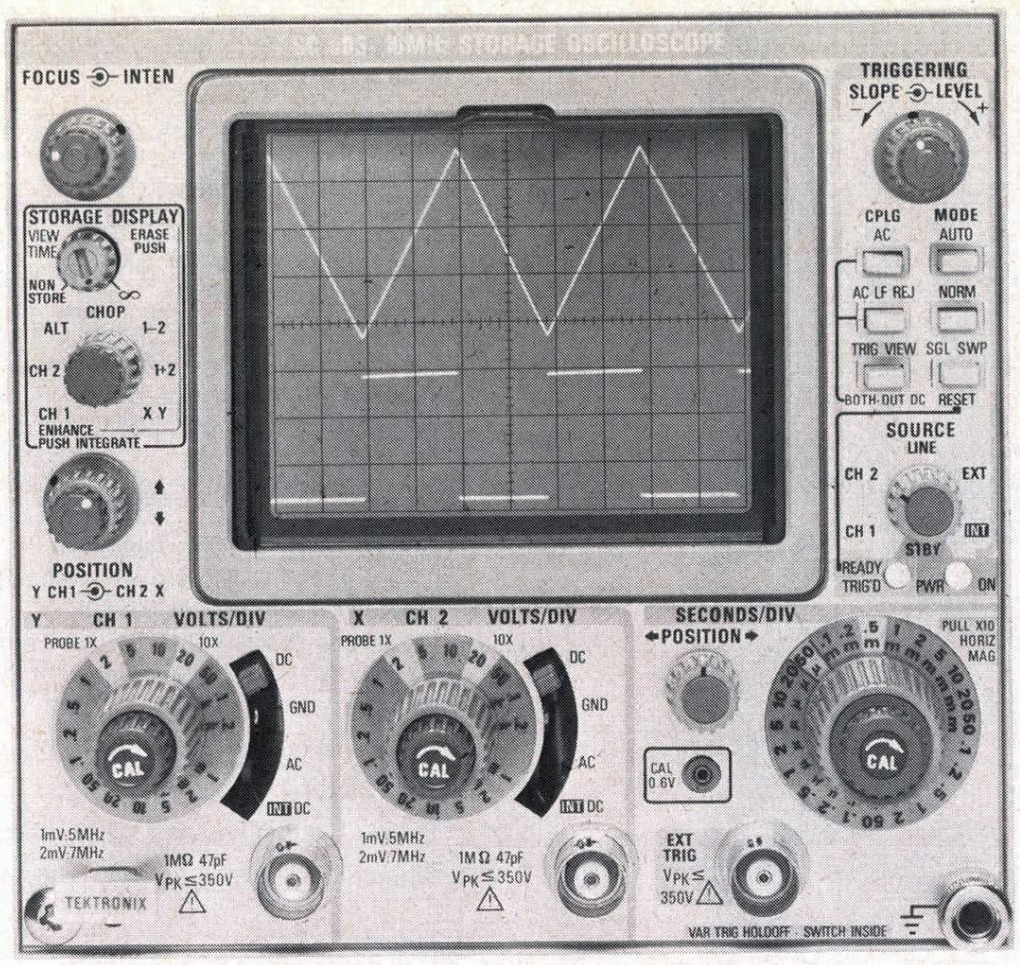
Ramp Output — 0 to +10 V ramp. Output resistance approximately 500 Ω.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating: 0°C to 45°C (to 50°C in mainframes equipped with fan). Nonoperating: −40°C to +75°C.

Altitude — Operating: To 15,000 feet. Nonoperating: To 50,000 feet.

SC 504 Oscilloscope $1900



SC 503
10 MHz STORAGE OSCILLOSCOPE

10 MHz Bandwidth

Bistable Storage Auto-erase

Variable Enhancement and Integration to Increase Writing Speed

Trigger View

Variable Holdoff

Switchable Front/Rear X and Y Inputs

Rear Z Axis Input

A new 10 MHz bistable storage oscilloscope, the SC 503, joins the TM 500 family. The SC 503 is a non-delayed sweep, general purpose storage oscilloscope which is compatible with five of our TM 500 Mainframes, (TM 503, TM 504, TM 515, TM 506 and RTM 506).

Because the SC 503 is a storage oscilloscope, it can be used to display waveforms after the input signal is removed. This feature is particularly useful when measuring slow repetition rates or single-shot signals, important in the biomedical and mechanical measurements fields. Low frequency signals at heart or respiration rates can be stored for detailed analysis. In the mechanical measurements field the SC 503 can "freeze" fast or transient signals from transducers, which is especially useful in pressure and velocity vs. time analysis and shock testing.

Other important storage applications of the SC 503 include measurements of signals in computer peripherals, communication terminals and industrial control systems.

Major features of the SC 503 include; variable enhancement and integration to increase the writing speed of signals with rapid rise times, an auto erase mode which erases the stored signal and automatically retriggers the oscilloscope, and X-Y capability. The X-Y capability allows creation of Lissajous patterns in many cause and effect testing relationships including: acoustic speech testing, nerve potential testing, and optical stimulus response testing. The P6108, P6062B and P6060 are recommended probes for use with the SC 503.

VERTICAL DEFLECTION

Bandwidth at −3 dB point — Dc to at least 10 MHz, (5 mV/div to 20 mV/div); dc to at least 7 MHz (2 mV/div), dc to at least 5 MHz (1 mV/div).

Rise Time — 5 mV to 20 V/div, typically 35 ns or less.

Ac Low-Frequency Response (lower −3 dB point) — Without probe, 10 Hz; with 10X probe, 1 Hz.

Deflection Factors — Calibrated Range: 1 mV/div to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy — 5 mV to 20 V/div (+15°C to +35°C) ±2%, 1 mV/div and 2 mV/div ±5%; (derate accuracy by additional 1% for 0°C to +50°C). Uncalibrated Range: At least 2.5:1 continuously variable between calibrated steps; Extends maximum uncalibrated deflection factor to at least 50 V/div.

Modes — CH 1, CH 2, ALT, CHOP, CH 1 minus CH 2, CH 1 plus CH 2, X-Y.

Input Impedance — 1 MΩ paralleled by approximately 47 pF.

Maximum Input Voltage — 350 V (dc + peak ac), 700 V peak-to-peak ac at 1 kHz or less. Above 1 kHz recommended peak-to-peak ac limit is 250 V to 10 kHz derating to 25 V above 100 kHz.

Common-Mode Rejection Ratio — Typically 50:1 at 1 MHz when using same attenuator setting, in CH 1 minus CH 2 mode.

Delay Line — Permits viewing leading edge of displayed waveform.

Calibrator — 0.6 V, ±1%, approximately 1 kHz frequency.

Position Range — ±6 div.

Channel Isolation — Input isolation: at least 80 dB up to 10 MHz; display at least 50:1 to 10 MHz.

Displayed Noise — Less than 0.2 mV peak to peak at 1 mV/div.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated sweep rates: 2 s to 0.5 μs/div, 21 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 50 ns/div. Uncalibrated (variable) Range provides continuously variable sweep rates, between the calibrated rates, and extends the slowest rate of at least 5 s/div.

Sweep Rate Accuracy —	**+15°C to +35°C**	
	X1	**X10**
2 s/div to 0.5 s/div	±4%	±5%
0.2 s/div to 5 μs/div	±3%	±4%
2 μs/div to 0.5 μs/div	±4%	±5%

Derate accuracy by an additional 1% from 0°C to 15°C and 35°C to 50°C.

Trigger Holdoff — At least 20:1 range internally selectable.

X-Y Mode — Bandwidth: Dc to at least 500 kHz. Deflection Fatcor: Selected by Ch 2 controls and Horizontal Mag X1, X10. Phase Difference: Less than 3° at 50 kHz or less.

TRIGGER

Trigger Modes — AUTO (enhanced), NORM, and SGL SWP (single sweep).

Enhanced Auto Trigger — The trigger circuit automatically adjusts to spread the peak to peak signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Sources — CH 1, CH 2, Line, Ext, Int (rear interface).

Triggering Coupling — DC, AC, AC LF REJ.

Trigger Sensitivity —

Source	Minimum Peak to Peak Signal Required	
	Below 5 MHz	**5 MHz to 10 MHz**
CH 1, CH 2	0.4 div	1.0 div
External	60 mV	150 mV
Interface	35 mV	80 mV

Triggering Level Range — External: At least + and −1.2 V. Internal: At least + and −6.0 divisions.

External Triggering Input — Input Impedance: 1 MΩ, paralleled by approximately 47 pF. Maximum Input Voltage: 350 V (dc + peak ac), 350 V peak-to-peak ac at 1 kHz or less. Above 1 kHz recommended peak-to-peak ac limit is 100 V to 10 kHz derating to 10 V above 100 kHz.

Auto Mode — Sweep free-runs in the absence of a triggering signal. Level control range automatically varies with the triggering signal amplitude for frequencies above 100 Hz.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only.

STORAGE SYSTEM

Stored Writing Speed — Normal: At least 80 div/ms (50 cm/ms). Enhanced: At least 400 div/ms (250 cm/ms).

Erase Time — 400 ms to 600 ms.

Auto Erase Viewing Time — Continuously variable from ≤0.5 s to ≥5 s.

Maximum Recommended Storage Time — Approximately 4 hours.

CRT

Phosphor — P44

Crt Graticule — 8 x 10 div., 0.25 inch/div (0.64 cm/div). Internal graticule lines.

REAR INTERFACE

CH 1 and CH 2 Vertical Inputs — Selected by CH 1 and CH 2 coupling in INT (interface) position. Input Impedance: 50 Ω. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 100 pF.

Trigger Input — Selected by TRIGGER SOURCE switch in INT (interface) position. Input Impedance: 50 Ω when selected, 25 Ω when not selected. Can be customer-modified for input impedance of 1 MΩ paralleled by approximately 60 pF.

Z-Axis Input — Input Impedance: Approximately 1.5 kΩ. +5 V turns beam ON from OFF condition, −5 V turns beam OFF from ON condition.

CH 1 Output — At least 50 mV/div. Bandwidth: At least 4 MHz. Output impedance: 50 Ω.

Ramp Output — 0 to +10 V ramp. Output impedance approximately 500 Ω.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating: 0°C to +45°C (0°C to +50°C in mainframe equipped with a fan). Non-operating: −40°C to +75°C.

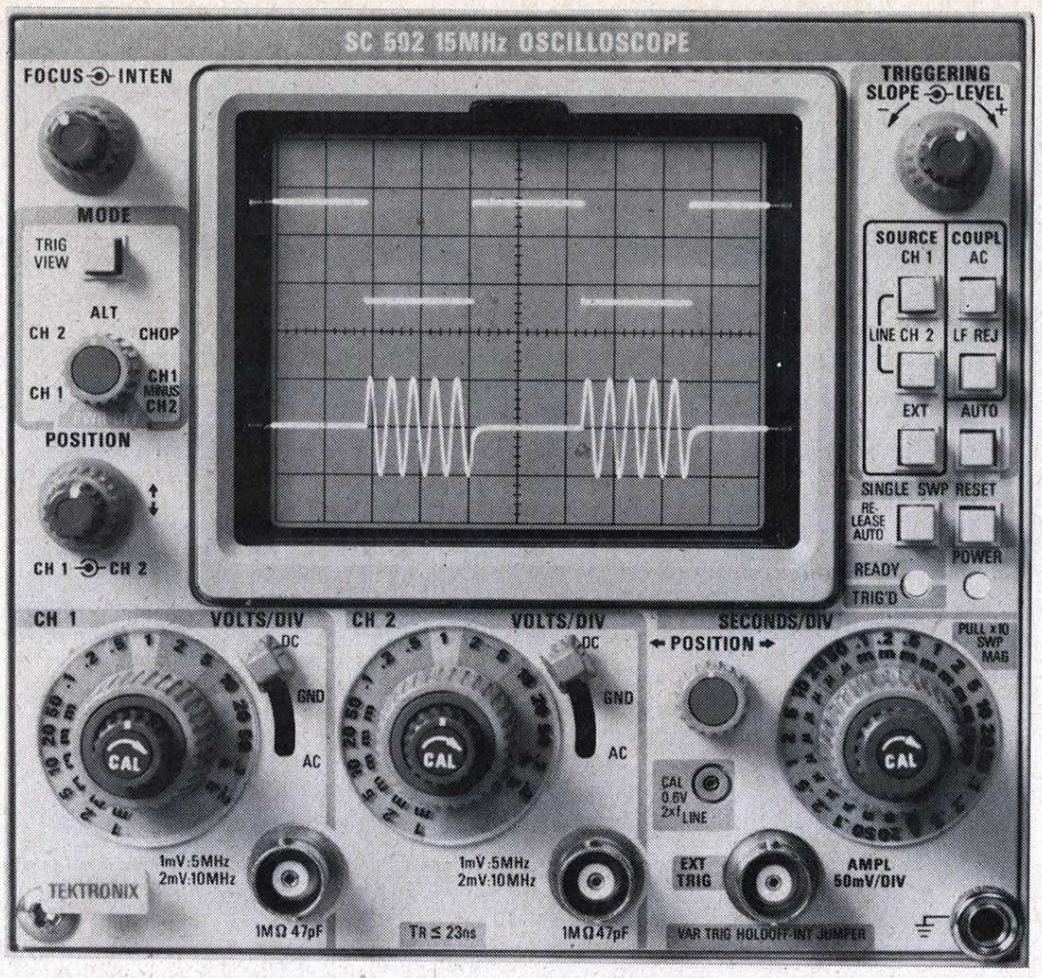
Altitude — Operating: To 15,000 feet; maximum operating temperature decreased by 1°C/1000 feet from 5000 feet to 15,000 feet. Non-operating: To 50,000 feet.

SC 503
10 MHz Storage Oscilloscope $2200

SC 502

TM 500-Series Test and Measurement System

15 MHz Dual-Trace Oscilloscope



SC 502 OSCILLOSCOPE

15 MHz Bandwidth
Dual-Trace
20 ns/div Max Calibrated Sweep Rate
1 mV/div Max Sensitivity
Delay Line
Trigger View
Variable Trigger Hold-off
Enhanced Automatic Triggering

The SC 502 is a compact general-purpose 15 MHz dual-trace oscilloscope designed to operate in any two adjacent compartments of TM 500 Power Module/Mainframes. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.

As with many TEKTRONIX Products, the SC 502 features circuits, sub-circuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disc memories, key-to-tape, printers, plotters, punches, readers, and terminals. The crt of the SC 502 offers a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.

The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interfacing capability of the SC 502 and all TM 500 Instrumentation suggests exceptional applicability to systems of built-in test equipment or rack-mounted installations. And the TM 515 Traveler Mainframe with the SC 502 form a nucleus for sophisticated, compact field service "packages."

TEKTRONIX Probes P6062B and P6108 are recommended for use with the SC 502.

VERTICAL DEFLECTION

Bandwidth at −3 dB points — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

Rise Time — 5 mV to 20 V/div, 23 ns or less.

Ac Low-Frequency Response (Lower −3 dB point) — Without probe, 10 Hz; with probe (10X), 1 Hz.

Deflection Factors — Calibrated range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0° to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends max attenuator step to at least 50 V/div.

Modes — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2. Chop rate at least 250 kHz.

Input Impedance — 1 MΩ within 0.5% paralleled by approx 47 pF.

Max Input Voltage — 350 V (dc + peak ac).

Common-Mode Rejection Ratio (CH 1 minus CH 2 mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — Input isolation: at least 80 dB up to 15 MHz; display related: at least 50:1 up to 15 MHz.

Displayed Noise — 200 μV or less of noise tangentially measured.

Position Range — ±6 div.

Calibrator — Voltage, 0.6 V, ±1%. Frequency, twice the power line frequency.

HORIZONTAL DEFLECTION

Sweep Generator — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div, 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (variable) Range: the CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

Sweep Rate Accuracy — Within 3% unmagnified and within 5% magnified.

Trigger Holdoff — CAL (variable) control, if selected by an internal jumper, increases trigger holdoff time by a factor of at least 20.

External Horizontal Amplifier — Bandwidth: dc coupled, dc to at least 2 MHz; ac coupled less than 50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference, less than 3° at 50 kHz or less. Input Impedance, 1 MΩ within 2% paralleled by approx 47 pF. Max Input Voltage: 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

TRIGGER

Enhanced Automatic Triggering — In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

Trigger Modes — AUTO (enhanced), NORMAL (auto button out), SINGL SWP.

Trigger Sources — CH 1, CH 2, LINE, EXT.

Trigger Coupling — Dc, ac, ac low freq reject.

Trigger Sensitivity	dc to 5 MHz	5 MHz to 15 MHz
Internal		
dc	0.4 div	1.0 div
ac	0.4 div (from 50 Hz). Will trigger below 50 Hz with increased deflection.	1.0 div
LF REJ	0.4 div (from 5 kHz) Will trigger below 5 kHz with increased deflection.	1.0 div
External		
dc	60 mV	150 mV
ac	60 mV (from 50 Hz) Will trigger below 50 Hz with increased signal.	150 mV
LF REJ	60 mV (from 5 kHz) Will trigger below 5 kHz with increased signal.	150 mV

Triggering Level Range — Internal: at least + and −8 div. External: at least + and −1.2 V.

External Triggering Input — Input Impedance: 1 MΩ within 2% paralleled by approx 47 pF. Max Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

Auto Mode — Sweep free-runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approx the p-p range of the triggering signal.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. AUTO pushbutton must be in the OUT position for operation and for setting triggering controls.

CRT

Phosphor — P31.

Deflection — Electrostatic.

Acceleration Potential — Approximately 12 kV.

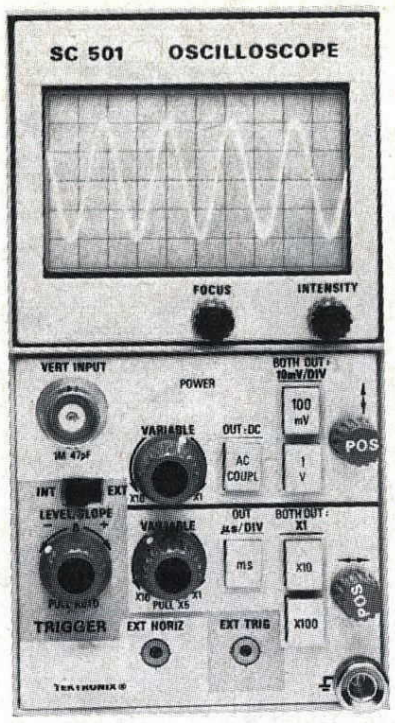
Graticule — Scale, 8 x 10 div with 0.25 in/div internal graticule lines.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating, 0°C to +50°C. Nonoperating −40°C to +75°C.

Altitude — Operating, to 15,000 ft. Nonoperating to 50,000 ft.

SC 502 Oscilloscope **$1500**



SC 501
OSCILLOSCOPE

5 MHz Bandwidth

Single Compartment Size

6.4 cm, (2½ in Crt)

Versatile Operating Features

The SC 501 is a single-channel 5 MHz plug-in unit oscilloscope with a 2.5 inch crt display which occupies a single TM 500-Series Plug-in compartment. Oscilloscope capability significantly enhances the application range of the multifunctional TM 500-Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500-Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 Mainframe, it can be used on the bench, in a rack, or on the road.

The single-channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by pushbutton logic in decade steps from 1 μs/div to 100 μs/div (microsecond), and from 1 ms/div to 100 ms/div (millisecond range). A variable control extends the slowest sweep rate to at least 1 s/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A 0 to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions such as sweeping a voltage controlled frequency oscillator or obtaining variably delayed pulses from the PG 505 Pulse Generator.

The triggering circuits allow stable triggering from either internal or external sources. An AUTO triggering mode and manual LEVEL/SLOPE selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

An internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

VERTICAL DEFLECTION

Bandwidth — Dc to >5 MHz.

Deflection Factors — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

Input Coupling — Ac or dc.

Input Impedance — 1 MΩ paralleled by 47 pF.

Max Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated sweep rates: 1 μs/div to 100 ms/div in decade steps. Uncalibrated (variable) range: extends slowest calibrated rate to ≥1 s/div. X5 magnifier (fixed): extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center 8 div): ≥5% for all sweep rates. Linearity (any two div portion within center eight div): ≥5%.

External Horizontal Amplifier — Bandwidth: dc to 100 kHz. Input impedance: ≥100 kΩ paralleled by 25 pF. Max input voltage: ±3 V.

TRIGGER

Normal Trigger Sensitivity (Trigger Level/Slope In) — Internal: dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V max from dc to 5 MHz. External trigger input impedance: 22 kΩ paralleled by approx 150 pF.

Auto (Trigger Level/Slope Out) — Sweep free-runs in absence of trigger signal, or for trigger repetition rates below 10 Hz.

CRT

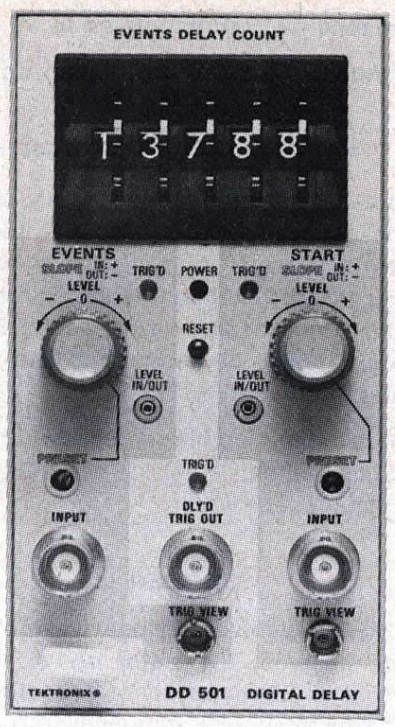
Phosphor — P31.

Graticule — 6 X 10 div (0.203 in per div).

SC 501 Oscilloscope **$820**

OSCILLOSCOPES COMPARISON CHART

	SC 504	SC 503	SC 502	SC 501
Crt	8 x 10 div, 0.25 in/div P31 phosphor	8 x 10 div, 0.25 in/div Storage, P44 phosphor	8 x 10 div, 0.25 in/div P31 phosphor	6 x 10 div, 0.203 in/div P31 phosphor
Vertical (Y) axis	Dual-trace. 80 MHz, 5 mV/div to 10 V/div, Alt, Chop, Ch 1 minus Ch 2, Ch 1 plus Ch 2, X-Y modes	Dual-trace, 10 MHz, per div to 20 V/div, Alt, Chop, CH 1 minus Ch 2 Ch 1 + Ch 2, X-Y modes	Dual-trace, 15 MHz, 1 mV/ per div to 20 V/div (5 and 10 MHz bandwidth at 1 and 2 mV) Alt, Chop, and Ch 1 minus Ch 2 modes	5 MHz bandwidth, 10 mV/ div to 10 V/div
Horizontal (X) axis	Triggered sweep 50 ns/div to 0.2 s/div with X10 magnifier. Enhanced auto trig, line ext/int trig, single sweep, external horizontal input, variable trigger hold off	Triggered sweep 15 ns/div to 2 sec/div with X10 magnifier. Enhanced auto trig, line, ext/int trig, single sweep, external horizontal input, variable trigger holdoff	Triggered sweep 200 ns/div to 0.5 s/div with X10 magnifier, X2.5 variable normal, enhanced auto, ext/int trig, single sweep, external horizontal input, variable trigger hold off	Triggered sweep 1 μs/div to 1 s/div with X5 magnifier to 200 ns/div, normal/auto trigger, internal/external-trigger, external horizontal input
Other features	Trigger view, switchable rear interface capability	Bistable storage, auto erase, variable enhancement and integration, rear interface capability	Trigger view, 12 kV accelerating potential	Compact display
Price	**$1900**	**$2200**	**$1500**	**$820**



DD 501 DIGITAL DELAY

Digital Events Delay for Scope Trigger
Delay to 99,999 Events
Divide by N up to 20 MHz
Pulse Counting to 65 MHz
Time Delay with Ext Clock
Compatible with Most Attenuator Probes

The DD 501 is an events count plug-in unit. Separate external trigger signals connected to the EVENTS and START INPUT connectors allow up to 99,999 events to be counted. That is, the unit counts a predetermined number of events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The last event counted generates a trigger pulse to the DLY'D TRIG OUT connector on the front panel. Delay by event is particularly useful in troubleshooting asynchronous logic systems. The DD 501 can also function as a frequency divider when the same signal is applied to both inputs.

The DD 501 can be used in a "counted burst" mode with pulse or function generators that can be synchronously gated. This provides the ability to dial up the number of pulses you want in a burst for applications with shift registers, memories, data communications, process control, or any system requiring an exact number of pulses or waveforms. A jumper inside the DD 501 converts the DLY'D TRIG OUTPUT to a delay interval (gate) waveform for this application. TEKTRONIX generators capable of being gated by the DD 501 are the FG 501, FG 502, FG 504, and the PG 508.

Other DD 501 applications include ranging for radar, sonar, ultrasonics, or laser. By using the proper frequency clock, the numbers dialed up can represent miles, yards, kilometers, etc. In systems requiring precision timing, several DD 501s and a reference clock can provide precise thumbwheel-selectable repetition rates, delays, pulse width, or timing intervals.

EVENTS DELAY

Count — 1 to 99,999 events.

Max Count Rate — 65 MHz.

Insertion Delay — 30 ns or less from final event to trigger output pulse.

Recycle Time — 50 ns or less.

Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

(All characteristics apply to both events and start inputs).

Input Impedance — 1 MΩ, 20 pF.

Slope — Either + or −, selectable.

Sensitivity — 85 mV p-p @ 30 MHz.

Frequency Response — Up to 65 MHz at 120 mV sensitivity.

Minimum Detectable Pulse Width — 5 ns.

Threshold Level Range — From −1.5 V to +1.5 V (−15 V to +15 V with 10X probe). Can be externally programmed or monitored at front panel jacks.

Trigger View Out — Threshold detector output, at least 0.5 V (200 Ω or less source impedance).

Events Triggered Light — Visual indication that events are being detected.

Start Triggered Light — Visual indication that delay is in progress.

TRIGGER OUTPUT

Pulse Width — Width of events pulse plus 6 ns or less.

Voltage Swing — + 0.8 V or less to at least + 2.0 V with 3 TTL loads (≃5 mA).

Light — Indicates output trigger.

GENERAL

Temperature — Operating: 0°C to +50°C. Non-operating: −40°C to +75°C.

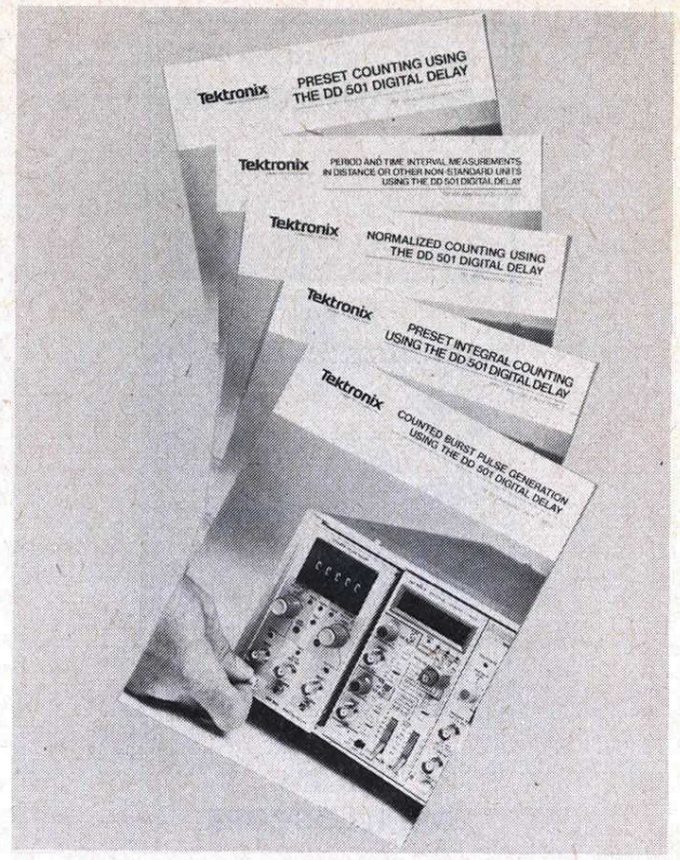
Altitude — Operating: to 15,000 ft; Nonoperating: to 50,000 ft.

Shipping Weight — 3 lb.

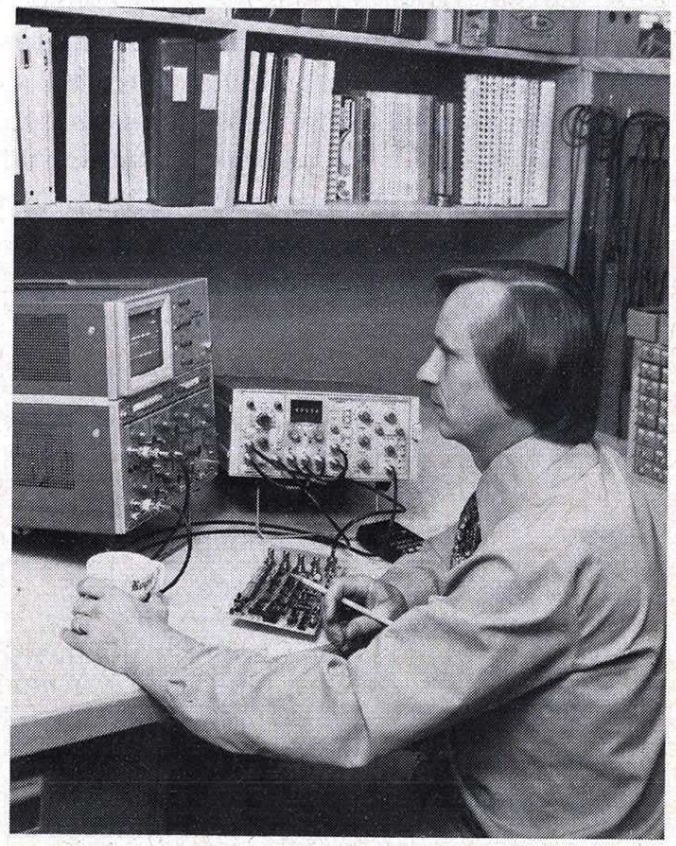
Dimensions — 2.6 in wide, 5 in high, 12.2 in deep (6.6 x 12.7 x 31 cm).

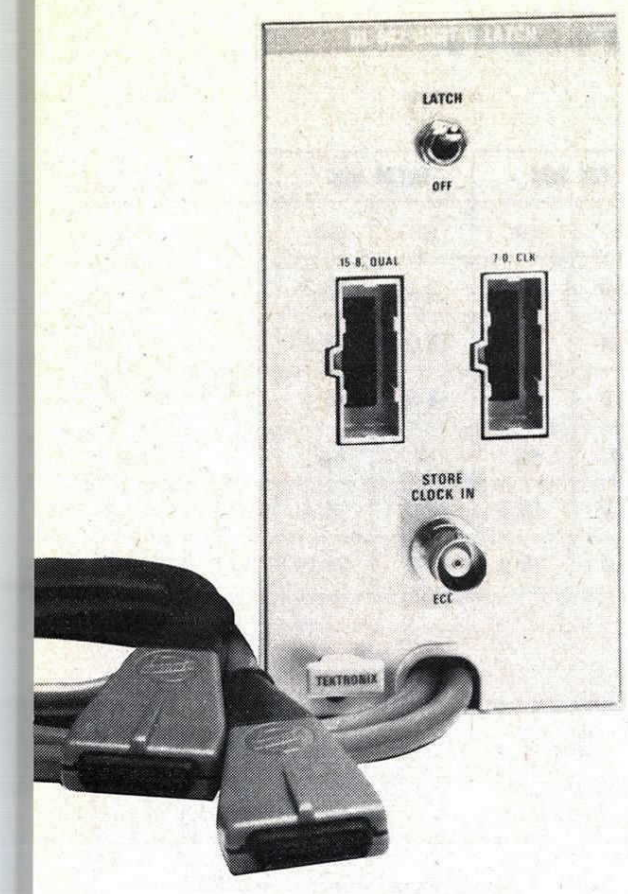
ORDERING INFORMATION

DD 501 Digital Delay **$800**



The digital delay, when combined with other TM 500 Instruments, adds significant power to many measurement or signal generation situations. A series of five TM 500 Application Notes explain various measurement techniques based on the versatile DD 501. These notes include application information, schematic and technical information for measurements such as preset counting, preset integral counting, normalized counting, period and time interval measurements in distance or other non-standard units, and counted burst pulse generation, all using the DD 501. Ask your field engineer for copies of these and other notes in the TM 500 Series.





DL 502
DIGITAL LATCH

16 Channel Latching Capability

Captures Glitches as Narrow as 5 ns at Probe Tips

Allows Expansion of Information Time Frame

TM 500 Compatibility

The TEKTRONIX DL 502 Digital Latch extends the logic analyzer's measurement capabilities. The Digital Latch aids in detecting narrow pulses in a data stream that cannot be captured by a logic analyzer alone. The 16 channel latch captures asynchronous glitches of less than one sample interval or as narrow as 5 ns.

In asynchronous measurements without latching capability, high speed data anomalies go undetected if they do not appear on a clock edge. The DL 502 Digital Latch captures the glitch and holds it until the next clock edge, then expands and displays it for one sample interval.

SPECIFICATIONS

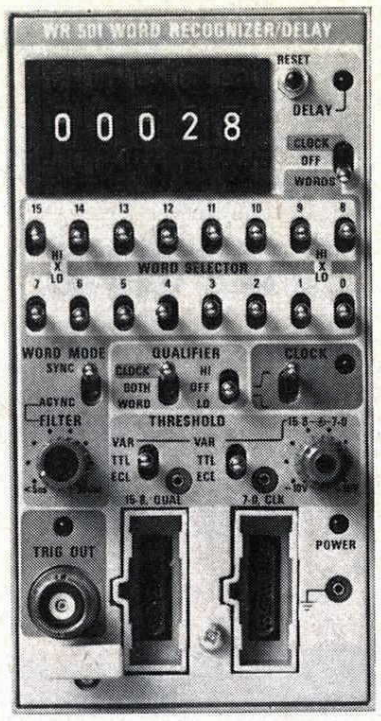
Minimum pulse width to initiate latch — 5 ns.

Minimum amplitude to initiate latch — 500 mV centered at threshold.

Minimum sample interval asynchronous clock — 20 ns.

DL 502 Digital Latch **$1480**

Standard accessories include instruction manual, 6 inch BNC cable.



WR 501 Word Recognizer with Digital Delay

The WR 501 is a 16-bit parallel Word Recognizer with digital delay that produces trigger pulses when a preselected word occurs. It occupies one plug-in position in any TM 500 Series Power Module Mainframe.

The WR 501 may also be used separately as a word recognizer to generate triggers for oscilloscopes or other measurement instruments. It gives you fast access to any unique word in the data stream.

WORD RECOGNIZER (WR 501)

Inputs — 16 data inputs plus a clock and qualifier.

World Selection — Made using sixteen three-position toggle switches. Positions are HI, (don't care), and LO.

Qualifier — Can expand the word recognizer to 17 bits, act as a gate for the external clock or do both.

Clock — Selects positive- or negative-going edge of clock input signal. Used for synchronous operation.

Modes — Front panel selection of snychronous word recognition (a trigger is produced only when the operator selected word occurs at a clock edge; either position, positive or negative edge, may be selected), or asynchronous word recognition (a trigger is produced anytime the recognized word occurs).

Synchronous Mode —

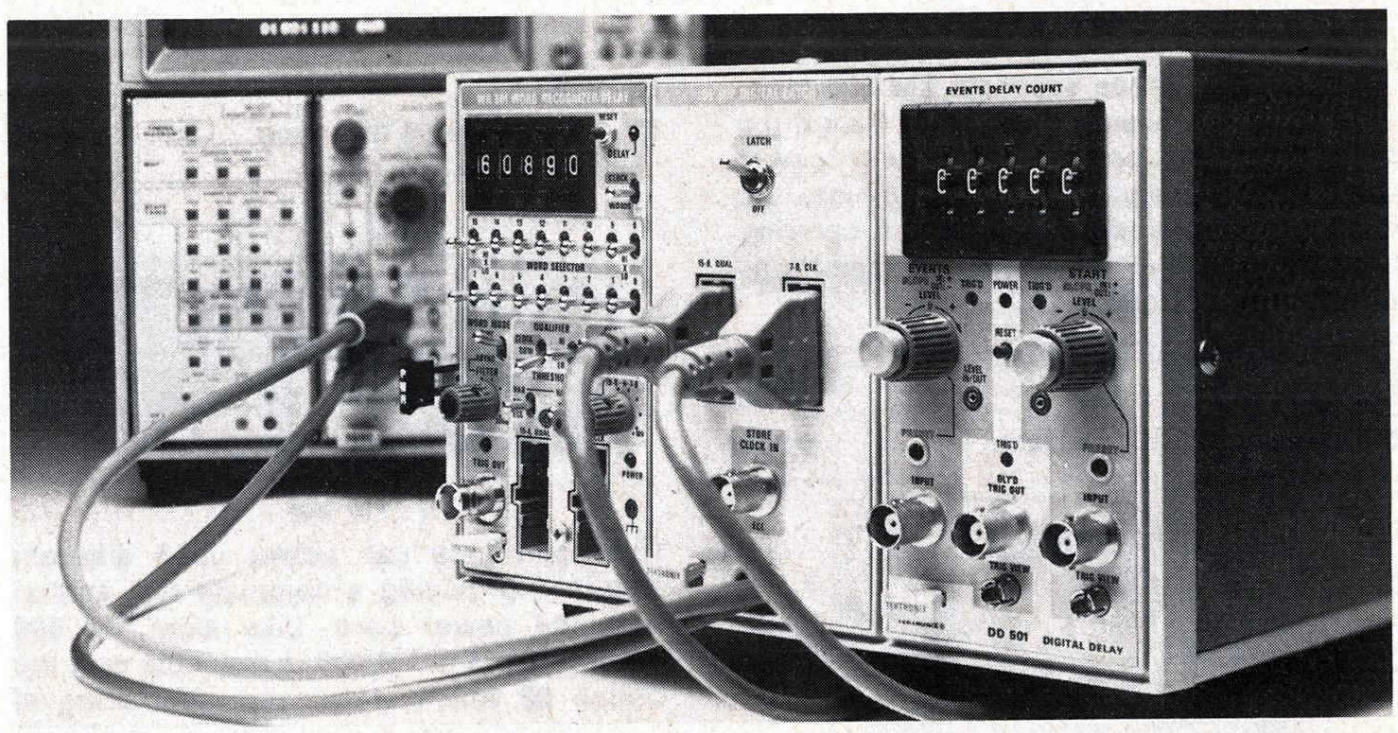
Minimum Set-up time	18 ns
Minimum Hold time	0 ns

(Filter is automatically disabled)

Asynchronous Mode and Filter —
Minimum coincidence time is variable from 15 ns or less to 200 ns or more.

ORDERING INFORMATION

WR 501 Word Recognizer **$1650**

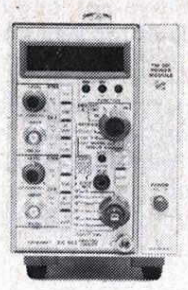


The DL 502 Digital Latch and WR 501 Word Recognizer are TM 500 Plug-ins compatible with all Tektronix Logic Analyzers.

TM 500 | Test and Measurement System

TM 500 Mainframe Information

TM 500 Instruments slide into any one of several power-module mainframes, available in six versions accepting one instrument or combinations up to six. Below are described each of the six mainframes built by Tektronix for TM 500 Instrumentation.



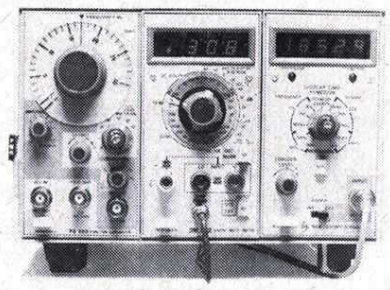
TM 501

Built for use with one single wide plug-in module. Available with Option 02 Rear Interface for interconnection with other instrumentation through back panel of the mainframe.

ORDERING INFORMATION

TM 501 ..... **$190**

TM 501 Option 02 Interface ..... **+$55**



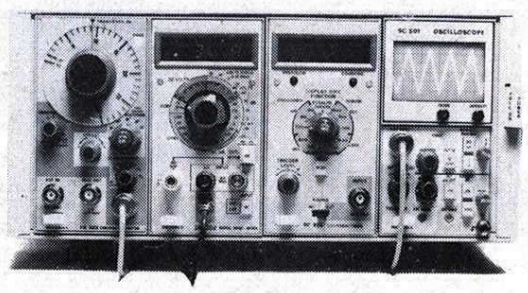
TM 503

Accepts up to three separate TM 500 Modules. This lightweight, portable, bench-top mainframe includes a front panel power switch and tilt bail. Also fits easily into the shelf of a TEK Model 3 Lab Cart. A carrying case is available to protect the mainframe during transportation.

ORDERING INFORMATION

TM 503 ..... **$190**

TM 503 Option 02 Interface ..... **+$75**



TM 504

The TM 504 can be fitted with up to four different TM 500 Modules. This mainframe is designed to fit into the shelves of the TEK Model 3 Lab Cart for complete test station mobility. Each TM 504 Mainframe also comes equipped with front panel switch, tilt bail and a handle. An optional carrying case is available for transportation to and from the worksite.

ORDERING INFORMATION

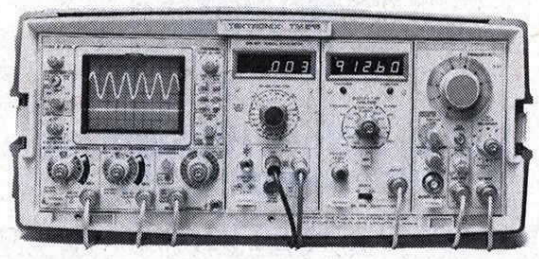
TM 504 ..... **$210**

TM 504 Option 02 Interface ..... **+$100**

POWER MODULE DIMENSIONS & WEIGHTS (without Plug-ins)

CABINET

	TM 501		TM 503		TM 504		TM 506		RTM 506		TM 515	
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
Height	6.0	15.2	6.0	15.2	6.0	15.2	6.0	15.2	5.25	13.3	6.8	17.3
Width	3.9	9.9	8.7	22.1	11.0	27.9	17.4	44.2	19.0	48.3	15.0	38.1
Length	15.3	38.9	15.3	38.9	20.0	50.8	20.0	50.8	18.9	48.0	20.0	50.8
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	5.4	2.4	9.5	4.3	20.5	9.3	29.0	13.2	32.0	14.4	22.5	10.2
Domestic Ship	13	5.9	17	7.7	26.0	11.8	41.0	18.6	46.0	21.0	30.0	13.6



TM 515

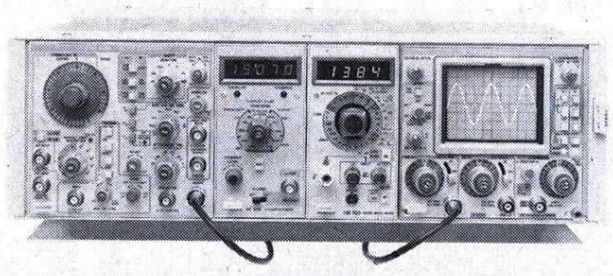
The TM 515 Traveler Mainframe is designed to protect up to 5 separate instruments during transportation to and from the worksite. Included with this rugged mainframe are pop-off front and back covers which protect the instruments and also store accessories. The Traveler Mainframe will slide easily under an airline seat when traveling and comes equipped with a heavy duty handle and tilt bail.

ORDERING INFORMATION

TM 515 ..... **$360**

TM 515 Option 05 Interface ..... **+$75**

with Option 06 48-440 Hz fan ..... **add $150**



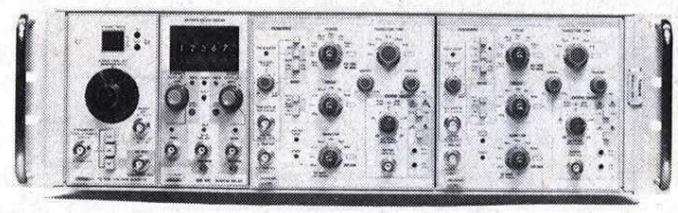
TM 506

This mainframe can power up 6 different plug-in's, providing a complete test station with one power cord. Like most TM 500 Mainframes, the TM 506 is available with the Option 02 which allows rear-interfacing of different modules, reducing front panel clutter.

ORDERING INFORMATION

TM 506 ..... **$280**

TM 506 Option 02 Interface ..... **+$150**



RTM 506

The RTM 506 is a rackmount version of the TM 506. It contains all the same features with the added front panel handle and rackmount rails for built-in configurable test stations. This mainframe saves you space and money in tight situations.

ORDERING INFORMATION

RTM 506 ..... **$370**

RTM 506 Option 02 Interface ..... **+$150**

Option 07 — For operating TR 502 and DC 508 Option 07 in a TM 503, TM 504, TM 506, or TM 515 .. **add $25**

POWER REQUIREMENTS

Line Voltage Ranges — International Transformer: 100, 110, 120, 200, 220, 240 V ac, all within 10%; but not to exceed 250 V ac. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges — International Transformer: 48 Hz to 440 Hz.

NOTE: The ventilating fans on the TM 506 and TM 515 operate on 48-60 Hz only.

Power Consumption — Max primary power approx: 35 W for TM 501, 120 W for TM 503, 200 W for TM 504, 320 W for TM 506, and 240 W for TM 515. Actual power consumption depends on plug-in selection and operating modes.

SUPPLIES (UNREGULATED)

Shared by All Compartments — +33.5 V dc and −33.5 V dc. TM 501 −500 mA max. TM 503 −1 A max. TM 504 −1.4 A max. TM 506 −2.1 A max. TM 515 −1.8 A max.

Low Power Compartments — Two 25 V ac windings, 500 mA each, supplied to each compartment, independently. 17.5 V ac and +11.5 V dc shared in any combination between these two supplies and among all low-power compartments. TM 501 −1 A max. TM 503 and TM 504 −3.6 A max. TM 506 −6.5 A max. TM 515 −6.5 A max.

High Power Compartments — (nearest to switch in TM 504 and TM 506): Two 25 V ac windings, 1 A each. 17.5 V ac and + 11.5 V dc, 4 A max, shared in any combination between these two supplies.

TEMPERATURE RANGE

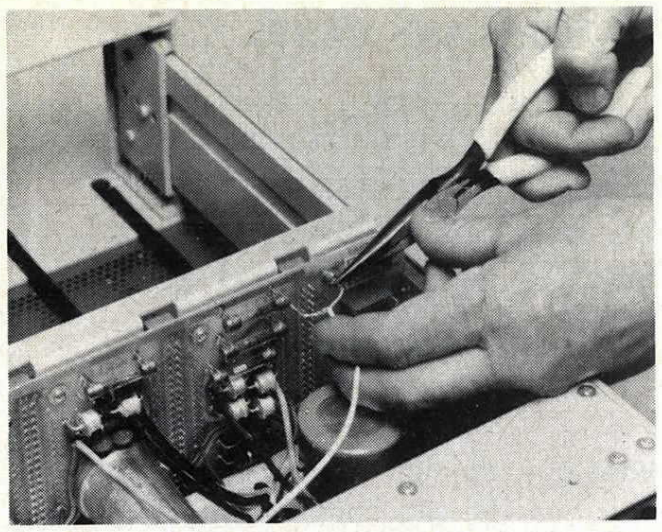
Operating — 0°C to +50°C.

Nonoperating — −40°C to +75°C.

ALTITUDE RANGE

Operating — To 15,000 ft.

Nonoperating — To 50,000 ft.



REAR INTERFACE CAPABILITY WITH TM 500

TM 500 Mainframes offer the unique ability to have separate modular instruments interconnected through the rear interface board of each mainframe. For example, the rear trigger output of a signal source can be interconnected to the rear input of a counter for instant frequency checks at the touch of a front-panel switch. Or, a digital multimeter and power supply may be interconnected to speed precise voltage set-ups without any need to move test leads. Any module can be internally connected thru the mainframe and can also be externally interfaced out the back panel.

Most TM 500 Plug-in modules contain a duplication of the front panel input and output connections in the back. These interface lines are built into the rear-edge circuit card connector of each plug-in. Some modules also have additional signal or control lines which are present only at the back of the instrument. In either case, different modules may be interconnected by the user to reduce front panel clutter or to perform functions not otherwise available.

Mainframes can be interfaced a variety of ways. A user can solder together the appropriate connector pins on a standard mainframe, or can order the mainframe with the Option 02. The Option 02 version of the mainframe comes equipped with square pin connectors on the rear interface circuit board and a special wire kit consisting of standard wires and coaxial cables with mating square pin receptacles. Option 02 also provides a rear-panel 50-pin male connector, mating cable connectors, and one BNC connector per plug-in compartment.

The square pin connectors eliminate the need to hand-solder connections to the interface circuit board, extending the life of the mainframes. The remaining Option 02 components offer a variety of interfacing alternatives limited only by the user's ingenuity and imagination.

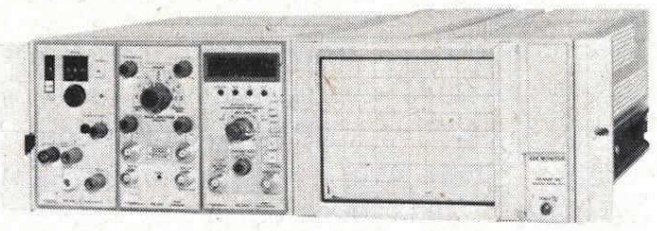
The TM 515 Mainframe is available with an Option 05 interface which includes everything in the Option 02 except for the rear panel 50-pin male connector, mating cable connector and the BNC connectors.

Tektronix also makes a low-cost "do-it-yourself" Rear Interface Modification Kit. It enables those who don't need the full flexibility of factory installed interface pins at every connector to install a limited rear interface on any TM 500 Mainframe except the TM 501. The kit includes twenty-eight square pins, 10 standard wires and 7 coaxial cables, all with female pin receptacles. Installation instructions also included.

For "do-it-yourself" modification kit
Order 040-0846-00 ..... **$21**

Tektronix has published a Rear Interface Data Book that contains information on the interfacing capability of each instrument "family." This book is available through Tektronix by filling out a card included in each mainframe package.

CABINET-TO-RACKMOUNT CONVERSION KITS AND MONITORS



Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two TM 503's side-by-side in a standard rack width.
Order 040-0616-02 ..... **$80**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0617-02 ..... **$120**

Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.
Order 040-0618-01 ..... **$50**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 603A, 604, 604A, 605, 606, 606A, 607, 607A, 608 or 624 in a standard rack width.
Order 040-0624-01 ..... **$75**

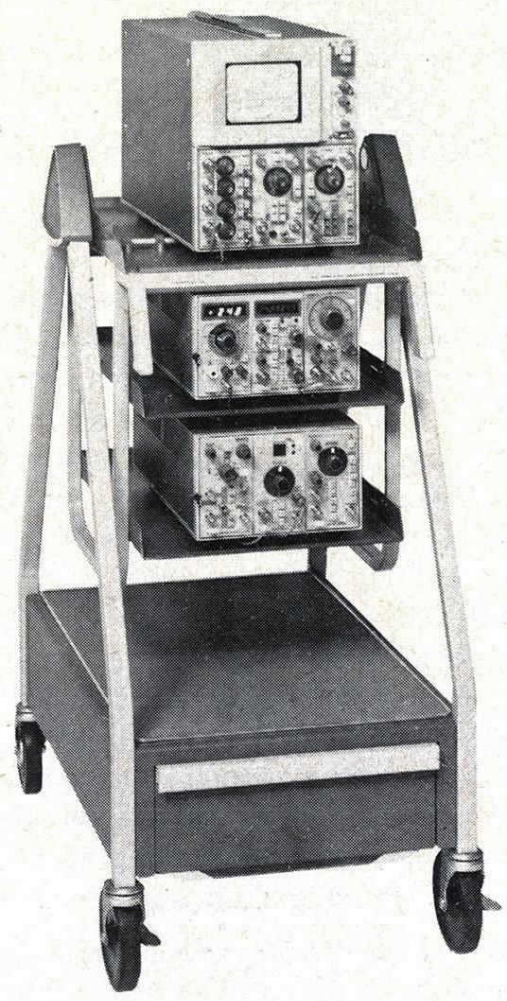
Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to convert a TM 506 (cabinet style) to an RTM 506.
Order 040-0761-03 ..... **$85**

Rackmount-to-cabinet conversion kit equipped to convert an RTM 506 to cabinet style TM 506.
Order 040-0762-00 ..... **$60**

MONITOR ORDERING INFORMATION

A broad range of display monitors may be rackmounted. These include two storage monitors, the 603A Bistable Monitor, and the 607A Variable Persistence Monitor. Non-storage monitors include the 604A (low cost), 606A (high resolution), the 608 (high brightness) and the 624 (good performance —low cost). See page 201 for more information.

TEK LAB CART MODEL 3



This Lab Cart is especially designed for roll-about configurations combining TM 500 instrumentation with the TEKTRONIX Oscilloscope of your choice. It features pistol-grip tilt control and a large accessory drawer in the base. The top tray accepts any TEKTRONIX 7000-Series, 5000-Series, or Portable Oscilloscope. The MODEL 3 comes standard with one lower shelf that will support either a TM 503 or TM 504 with plug-ins. Additional shelves are available as optional accessories. Max capacity of the lower shelf area is two TM 503's or TM 504's, stacked, or up to a TEKTRONIX 7000-Series Oscilloscope in size—with TM 500 packages placed on the tray at your option. The power distribution module at rear underside of the top tray provides four power outlets and a 15-foot line cord.

International modification (Option 01) deletes power distribution module.

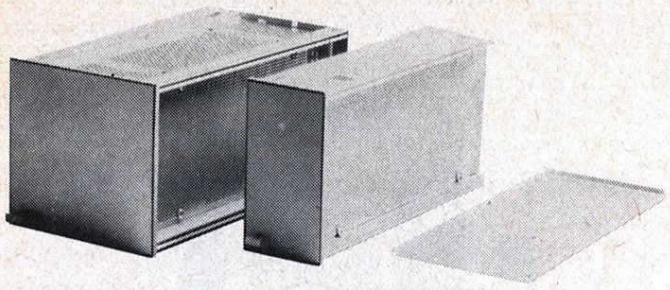
TEK Lab Cart Model 3 ..... **$375**

with Option 01 (International Modification) ..... **No Charge**

Additional Lower Shelf, Order 436-0132-01 ..... **$30**

Safety Belt to secure oscilloscopes or TM 500 to top tray or lower shelves (not needed for 5000 or 7000-Series on top tray)
Order 346-0136-01 ..... **$20**

TM 500 CUSTOM PLUG-IN KITS



Single and double compartment sizes

A complete test and measurement set-up for many typical jobs requires at least one non-standard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceed the cost of the functional elements.

This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards which allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator IC's can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with the other TM 500 Instrumentation.

Single Compartment with Power Supply

Now a blank plug-in kit complete with power supply parts and circuit board layout is available. A single-wide compartment, this plug-in kit saves set up time and build time as the power supply circuitry is designed and kitted for you.

A series of TM 500 Construction Notes provide direction for building custom circuits using the TM 500 Blank Plug-in Kits and standard components. Among the construction notes available are: Suggested Power Supply Circuits, Thermal True Rms Converter and 60 Hz Notch Filter.

Custom Plug-in Kit with Power Supply (single compartment)
040-0803-02 ..... $65

Custom Plug-in Kit (single compartment)
Order 040-0652-05 ..... $35

Custom Plug-in Kit (double compartment)
Order 040-0754-05 ..... $90

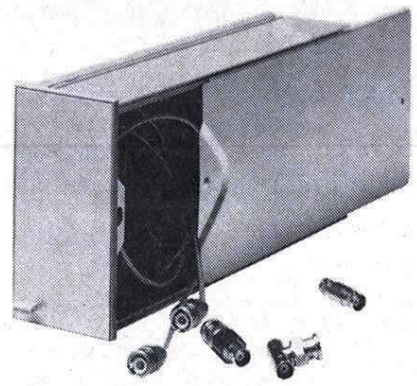
TM 500 Application and Construction Notes

The TM 500 product line is supported by an on-going program to keep you informed of how to achieve optimal performance and versatility from your TM 500 Instruments. Tektronix' goal of providing you with solutions to difficult measurement problems does not end with your purchase of TM 500 Instruments.

Application Notes take you through the steps necessary to solve complex problems, or to make more useful measurements with your TM 500 Instruments. Subjects include: Integration Through V to F Conversion, Generating Delayed Pulses, and Current Sinking with Power Supply Modules.

Construction Notes provide information necessary to build custom circuits using a TM 500 Blank Plug-in Kit and standard components. These notes are developed from the actual construction of more common special circuits; they include parts lists, schematics and other construction details. Some of the available notes include: Power Supply Circuits, Thermal True RMS Converter, and Analog Multipliers.

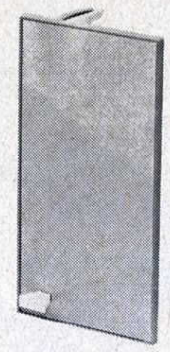
PLUG-IN STORAGE COMPARTMENT



An electronic engineer or technician away from his bench seldom has enough storage space for probes, cables, "tees", accessories, and small tools. The Plug-in Storage Compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, add a plug-in storage compartment for extra convenience. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 Mainframes, 5000-Series Oscilloscope Mainframes, and 203 and 204 SCOPE-MOBILE® Cart plug-in storage bins; inside dimensions 25 cm L x 5.1 cm W x 10.6 cm H, (9⅞ in L x 2 in W x 4¼ in H).

Order Number 016-0362-01 ..... $40

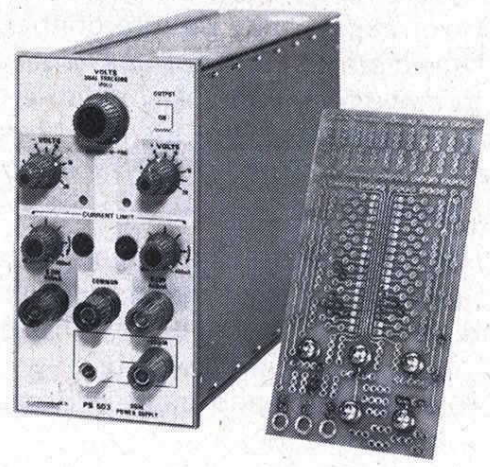
TM 500 BLANK PANEL



When operating the TM 500 Instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Blank Plug-in Panel,
Order 016-0195-03 ..... $11

FRONT-PANEL CIRCUIT BOARD ADAPTER KIT PS 501-1 or PS 503A



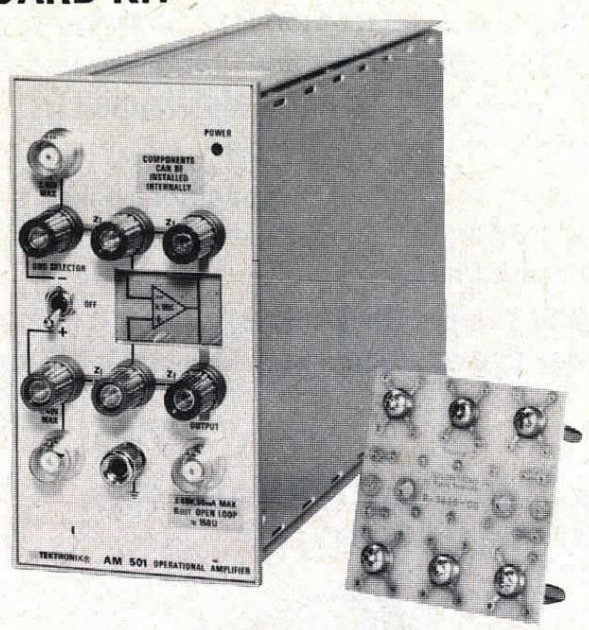
The front-panel circuit-board kit is a convenient way to mount small experimental circuits or fixtures right on the front of a TM 500 Power Supply.

Typical applications for the adapter are as a device tester (test fixture), educational demonstrator (especially IC's), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adapter will supplement the blank plug-in kit for simple or temporary applications.

The adapter kit provides a convenient platform for building up circuits; its pin holes are pre-solder-flowed and some are interconnected. Discrete devices can be readily attached to the adapter kit board, stored, and easily reattached to the "banana jack" plugs on the face of the power supply. Circuit clips for interconnected pin holes are available from Tektronix. The adapter kit is 2½ inches wide.

Order Number 013-0152-00 ..... $15

AM 501 AUXILIARY CIRCUIT BOARD KIT



The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is approximately 2½ inches square. The kit is a pc board which has six terminal studs for attachment to the amplifier's banana jacks. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501's input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier.

An additional advantage of the kit is that it does not interfere with the other connectors on the face of the AM 501.

Order Number 013-0146-00 . . . . . $15

Type 1105 Battery Power Supply

TM 500 Instruments may be operated with the Type 1105 when suitable ac line power is not available. The 1105 is rugged and portable, operating on internal batteries or an external dc source. Operating time is dependent on the number and type of plug-ins being powered, and their operating mode. The following table shows estimated operating time for a full power module in a *typical* situation.

TM 501	7.0 hours
TM 503	2.3 hours
TM 504	1.8 hours
TM 506	1.2 hours
TM 515	1.4 hours

1105 Battery Pack $915
Option 01, 230 V operation . . . . . No charge

MANUAL (ONE SHOT) TRIGGER GENERATOR RG 501, PG 501, AND PG 505

The Manual (one shot) Trigger Generator is a self-contained, battery-operated, hand-held device for manually generating a single pulse. This adapter is used to start a pulse, ramp, sweep, or complete sequence of events on instruments which do not have a manual trigger button or where a remote operation capability is desired, such as some oscilloscopes and the PG 501, PG 505, and RG 501.

The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally two milliseconds in width and three volts in amplitude with a rapid rise and fall. Output impedance is low (50 Ω); the pulse amplitude drops from about 3.6 to 1.8 volts when changed from a high impedance to a 50 Ω termination. Both voltages decrease with battery aging. The battery is a 5.4 V dry cell.

Applications for the trigger generator also include stepping or sequencing of digital systems, analog control systems, mechanical devices, as well as obtaining "single shot" operation from many types and brands of instruments. Biological and physical experiments, where manual triggering is required as a part of the stimuli, are also common applications.

Order Number 016-0597-00 . . . . . $55

RAIN COVERS

These soft, weather-proof, vinyl-coated Rain Covers come in sizes for TM 503 and TM 504 packages of instrumentation, and include adequate space for protective front covers, as well. They feature heavy-duty zippers that open from either end, and include their own carrying handles, offset to compensate for the off-center balancing point of TM 500 Instrumentation packages. The color is TEK blue.

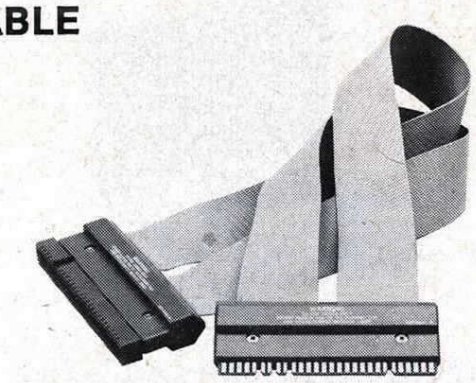
TM 504 Rain Cover
Order 016-0621-00 . . . . . $35
TM 503 Rain Cover
Order 016-0620-00 . . . . . $30

PROTECTIVE FRONT COVER

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 Mainframes. While particularly valuable when the TM 503 or TM 504 (full of instruments) is carried into the field or in a vehicle, the cover is also good insurance against damage to instrument knobs and jacks during normal handling in the lab, or when a mainframe full of instruments is stored. The cover adds 4.5 cm (1¾ inches) to the length of the TM 503, TM 504, and TM 506 Mainframes, and clears the longest knob projections on any of the instruments.

TM 503 Front Panel Cover,
Order 200-1566-00 . . . . . $14
TM 504 Front Panel Cover,
Order 200-1727-00 . . . . . $15
TM 506 Front Panel Cover,
Order 200-1728-00 . . . . . $18

TM 500 FLEXIBLE EXTENDER CABLE



Designed to couple a TM 500 Plug-in with the mainframe rear interface board connection. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-02 . . . . $75

RISE TIME LIMITER

For use with the PG 502 Pulse Generator which has a pulse rise and fall time of less than one nanosecond. In some applications, such as TTL logic where slower rise time is needed, this fast pulse can be limited to six nanoseconds by using the rise time limiter.

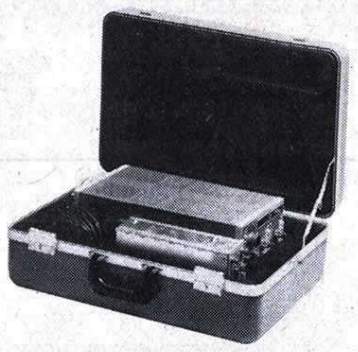
Rise Time Limiter, Order 015-0249-00 . . $50

ACCESSORY POUCH

While the TM 501, TM 503, TM 504, and TM 506 Mainframes were optimized for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500 Mainframe or TEKTRONIX Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions approx 9¼ in long x 5¾ in wide x 2 in high.

Order Number 016-0351-00 .....$18

TM 500 CARRYING CASE



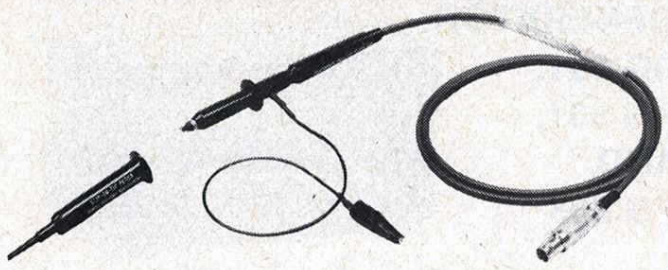
These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ inches long by 8½ inches thick by 15½ inches high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam insert is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200-Series Miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert which will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 61.0 cm long x 21.6 cm thick x 44.5 cm high, (24 in. long by 8½ in. thick by 17½ in. high) and weighs approximately 14 pounds empty.

Carrying Case for TM 503
Order 016-0565-00 .....$160

Carrying Case for TM 504
Order 016-0608-00 .....$170

P6058 TEMPERATURE PROBE



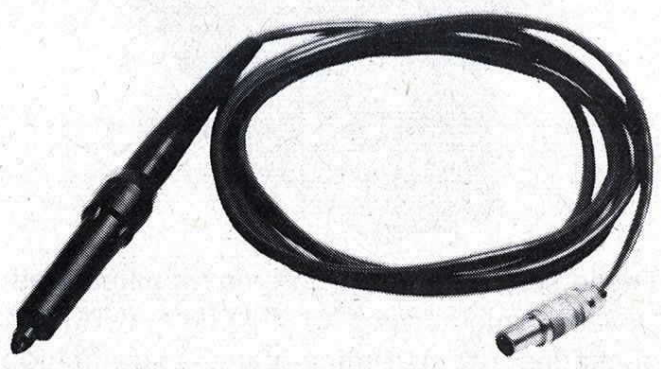
The P6058 Temperature Probe is used with the DM 501 for sensing temperature from −55°C to +150°C. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. P6058 probes are interchangeable among all DM 501's without requiring recalibration since probes and DM 501's are held to tight tolerances. Besides measuring temperature, the P6058 can function as an electrical probe for resistance, current, and voltage measurements to 500 V. To obtain the full probe kit with ground lead and push-on electrical contact tip, order 010-0260-00 below. A simple modification of the DM 501 is also required. For temperature-only measurements, order 010-0259-00.

The temperature probe consists of the temperature sensor, a four-foot, 4-wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 501. The unit weighs approximately five ounces.

P6058 Temperature Probe,
Order 010-0259-00 .....$130

P6058 Temperature Voltage Probe,
Order 010-0260-00 .....$135

P6430 TEMPERATURE PROBE



The P6430 Temperature Probe is used with the DM 502 for sensing temperature from −55°C to +150°C. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. The probe can be immersed vertically, approximately two inches in a liquid, for temperature sensing and still retain water tightness.

The temperature probe consists of the temperature sensor, a six-foot, 2-wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 502. The unit weighs approximately five ounces.

To meet full accuracy specifications a specific P6430 and DM 502 Multimeter must be calibrated as a pair.

P6430 Temperature Probe,
Order 010-6430-00 .....$135

HIGH VOLTAGE PROBE FOR USE WITH DMMs

The High Voltage Probe will measure dc voltages from 1 kV to 40,000 volts with an accuracy of 1% at 25,000 volts. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes.

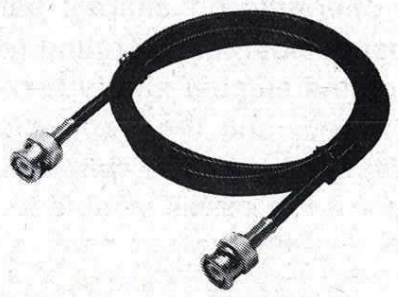
This probe plugs directly into the front end of either multimeter.

CHARACTERISTICS

Voltage range	1 kV to 40 kV dc
Input resistance	1000 MΩ
Division ratio	1000:1
Overall accuracy	20 kV to 30 kV 2%
Upper limit accuracy	Changes linear from 2% at 30 kV to 4% at 40 kV
Lower limit accuracy	Changes linear from 2% at 20 kV to 4% at 1 kV
Input Z at meter	10 MΩ required

Order 010-0277-00 .....$95

50 Ω PRECISION COAXIAL CABLE



For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

50 Ω Cable, Order 012-0482-00 .....$25

Signal Processing Systems

The Digital Alternative for your Measurement needs!

GPIB Products

Signal Processing Systems, SPS, presents a line of **waveform digitizing instruments and systems** which provide practical solutions to measurement problems and analysis through the use of specially designed digitizers, synergistic systems and software.

Almost any phenomenon, which can be detected by a sensor, can reveal a bank of information when processed. However, the method of processing, the cost and the value of that data is solely dependent upon the resources and interpretation of a highly skilled technician.

That's where SPS offers a practical solution. For instance, a selected SPS System

Provides . . .

- Wide ranging **acquisition** capabilities
- Fast, convenient **digitizing** performance
- Easy, complete **storage** control, and
- A call back, **display** feature.

Plus . . .

- Programmability
- IEEE 488 (GPIB) **interface** capability
- TEK SPS BASIC software, and
- Eight **standard** Waveform Processing Systems (WP Systems)

Which means . . .

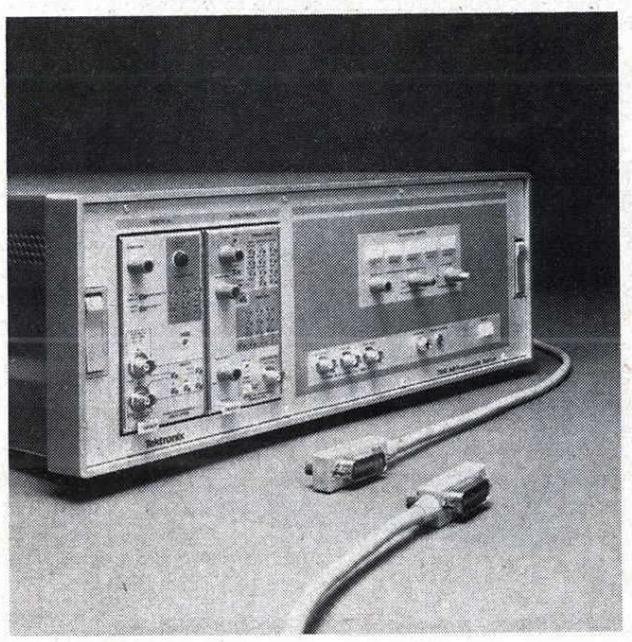
- Meaningful data analysis **fast**
- Complete **control** of measurement parameters
- **Automation** of laborious calculations
- Repeatable measurement without loss of **accuracy**
- **Less dependence** upon highly skilled technicians
- Source **documentation** and
- Effective operational **cost control.**

The Digital Connection

Depending upon which standard WP System selected, one of these digitizers will be used to form the system's nucleus:

- 7912AD Programmable Digitizer
- Digitizing Oscilloscope
- R7912 Transient Digitizer

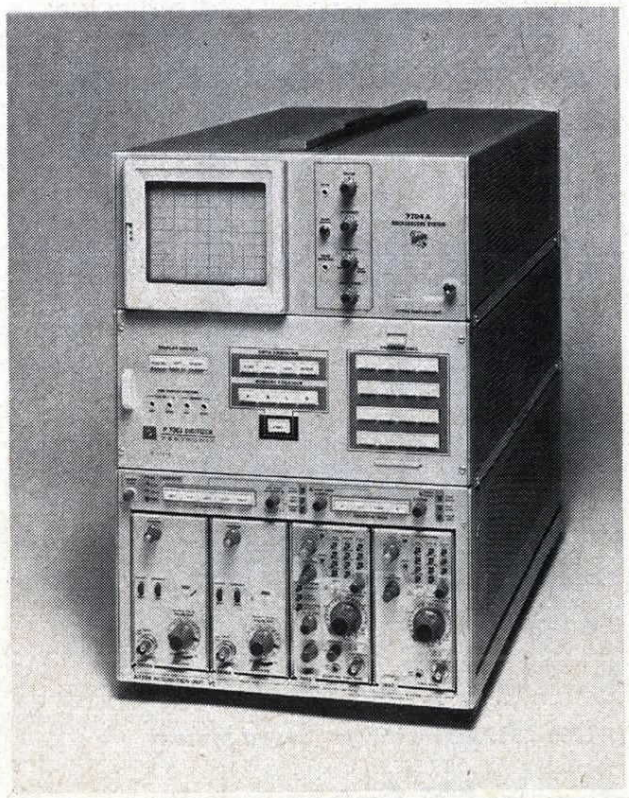
The 7912AD Programmable Digitizer



A fully programmable waveform acquisition and digitizing instrument based on a proven scan conversion technique. This model is useful for recording fast transients (up to 350 ps rise time with direct access plug-in), providing automatic or remote signal acquisition capability (fully programmable to 200 MHz) and for various other high speed waveform digitizing tasks. The instrument uses the ubiquitous GPIB (IEEE 488) for control and signal interfacing with a variety of instrumentation controllers.

In addition, SPS introduces two new programmable plug-ins, 7A16P Programmable Amplifier Plug-in and 7B90P Programmable Time Base Plug-in which at present can only be used in the 7912AD Programmable Digitizer.

The Digitizing Oscilloscope



The Digitizing Oscilloscope is the combination of a 7704A Oscilloscope and a P7001 Digitizer with a local memory (4 channels) making it the most versatile digitizing oscilloscope available. It is compatible with most 7000-Series Plug-ins including amplifiers to 175 MHz, samplers to 14 GHz, and a wide range of time base and spectrum analyzer plug-ins.

It offers a variety of controller interfaces including the GPIB (IEEE 488). Program control of the A/D section offers significant capabilities for automatic test equipment.

These waveform digitizers each use Tektronix' unique **7000-Series packaging** system and are compatible with most **7000-Series Plug-ins,** including amplifiers, time bases and spectrum analyzers.

Control Choices
In addition to this line of waveform digitizers, Tektronix SPS offers a variety of instrumentation controllers and a powerful waveform processing software, TEK SPS BASIC, a powerful, high-level instrument control and signal processing software.

Controllers
CP4165—A test and measurement controller designed for use with waveform processing systems and compatible with TEK SPS BASIC. It can be interfaced with either Q bus or GPIB (IEEE 488).

4051—A powerful, desktop, programmable graphic display, instrument controller, using the GPIB (IEEE 488) and TEK SPS BASIC software.

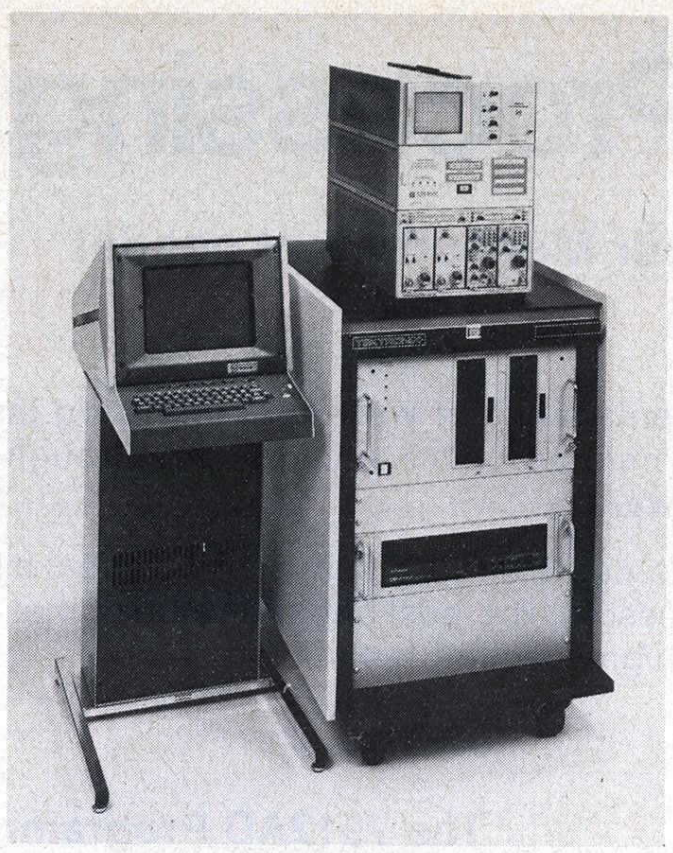
The line of waveform digitizers is also compatible with various other instrumentation controllers using the GPIB (IEEE 488) or other interfaces, including the *DEC PDP 11 series of mini-computers.

*DEC and PDP 11 are registered trademarks of the Digital Equipment Corporation.

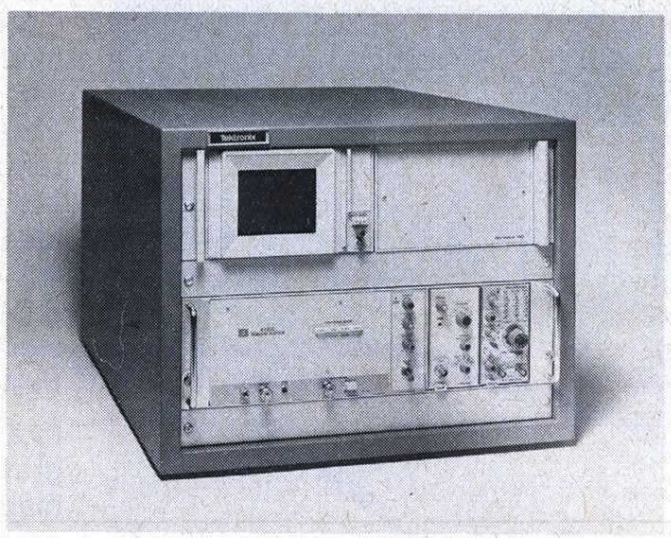
TEK SPS BASIC Software Selection
A new generation of software for signal processing and instrument control systems. Primary features include array and waveform operations, character string processing, program text editing, and file manipulations. The software is interactive, allowing minimally experienced users to quickly develop programs, and is modular, allowing the user to select only those features necessary for a particular application, thus preserving the maximum amount of controller memory for program data.

Functions of TEK SPS BASIC provide for determination of mean, minimum, maximum, and rms values, and also contain single word commands for integrate, differentiate, and cross (the point at which array values cross a level). Fast Fourier Transform and its inverse are included as single word commands. The system also allows the user to write transfer function algorithms for describing the response characteristics of a system, and includes capabilities for averaging and correlation as well as auto correlation.

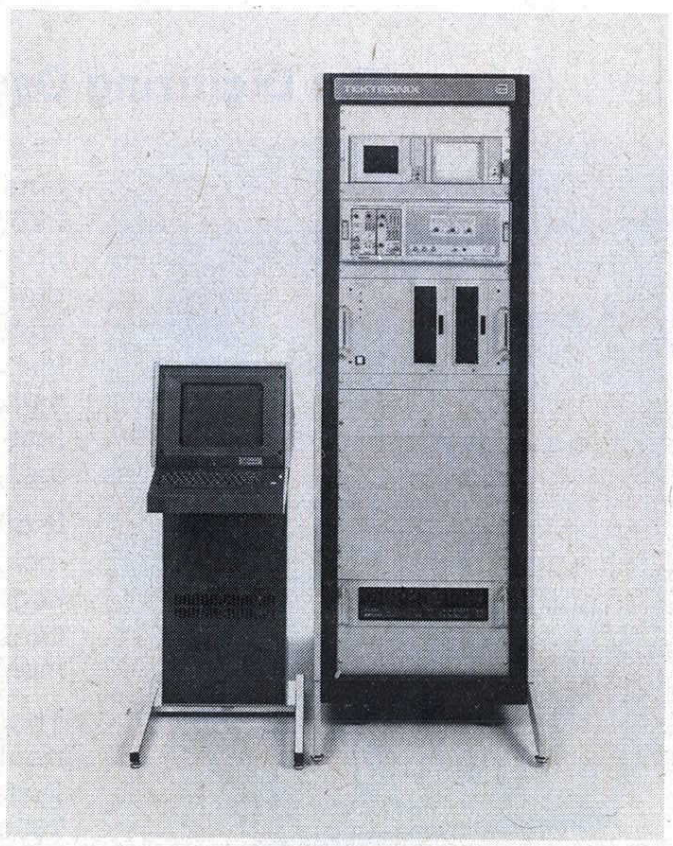
Standard WP Systems
A WP System is a waveform processing system using either a Digitizing Oscilloscope, 7912AD Programmable Digitizer, or an R7912 Transient Digitizer. Various interfaces, controllers and software options are available. The following is a list of standard WP Systems available.
WP1020—Digitizing Oscilloscope controller compatible system.
WP1110—Digitizing Oscilloscope calculator based system.
WP1200—Digitizing Oscilloscope controller based system.
WP2010—R7912 viewing system.
WP2020—R7912 controller compatible system.
WP2200—R7912 controller based system.
WP2050—7912AD controller compatible system.
WP2250—7912AD controller based system.



WP1200—Digitizing Oscilloscope controller based system.



WP2020—R7912 controller compatible system.



WP2250-7912AD controller based system.

Applications for SPS Systems Include;
Fiber Optic Characterization
The Digitizing Oscilloscope system meets the sophisticated waveform processing requirements of fiber optic evaluation, both in research and development and production quality control.

Fusion Research
The 7912 Series of transient digitizers have been used extensively to characterize events in pulsed laser fusion energy research.

Avionics ATE
The Digitizing Oscilloscope is a key component in avionics test systems where simplicity and repeatability of a test are at a premium.

Laboratory Research
SPS intruments have found applications in the laboratory for time of flight mass spectrometry, nuclear magnetic resonance, fluorescence decay, power supply design and transfer function analysis.

List of Application Notes
"DPO Program Library Techniques" (DPO Note 45F1.0)
"Mechanical Measurements Using the DPO" (DPO Note 45A1.1)
"R7912 Transient Digitizer . . . a Solution of Pulsed Laser Measurement Problems" (WDI Note 47N1.0)
"Pulsed Laser Measurements Using the R7912 Transient Digitizer" (WDI Note 47N1.1)
"Real-Time Metals Analysis Using the DPO" (DPO Note 45N1.1)
"Windowing to Control FFT Leakage" (SPS Note 47L1.0)
"Measuring Transistor Switching Times with DPO" (DPO App Note 45K1.1)
"TDR Difference Testing with TEK Signal Processing Systems" (App Note 4711.1)
"Automatic Swept RF Measurements" (DPO App Note 45K2.5)
"Spectrum Analysis Systems" (DPO Concept Note)
"Keeping Pace with Changing Needs in Optical Fiber Evaluation" (DPO Concept Note 4551.0)

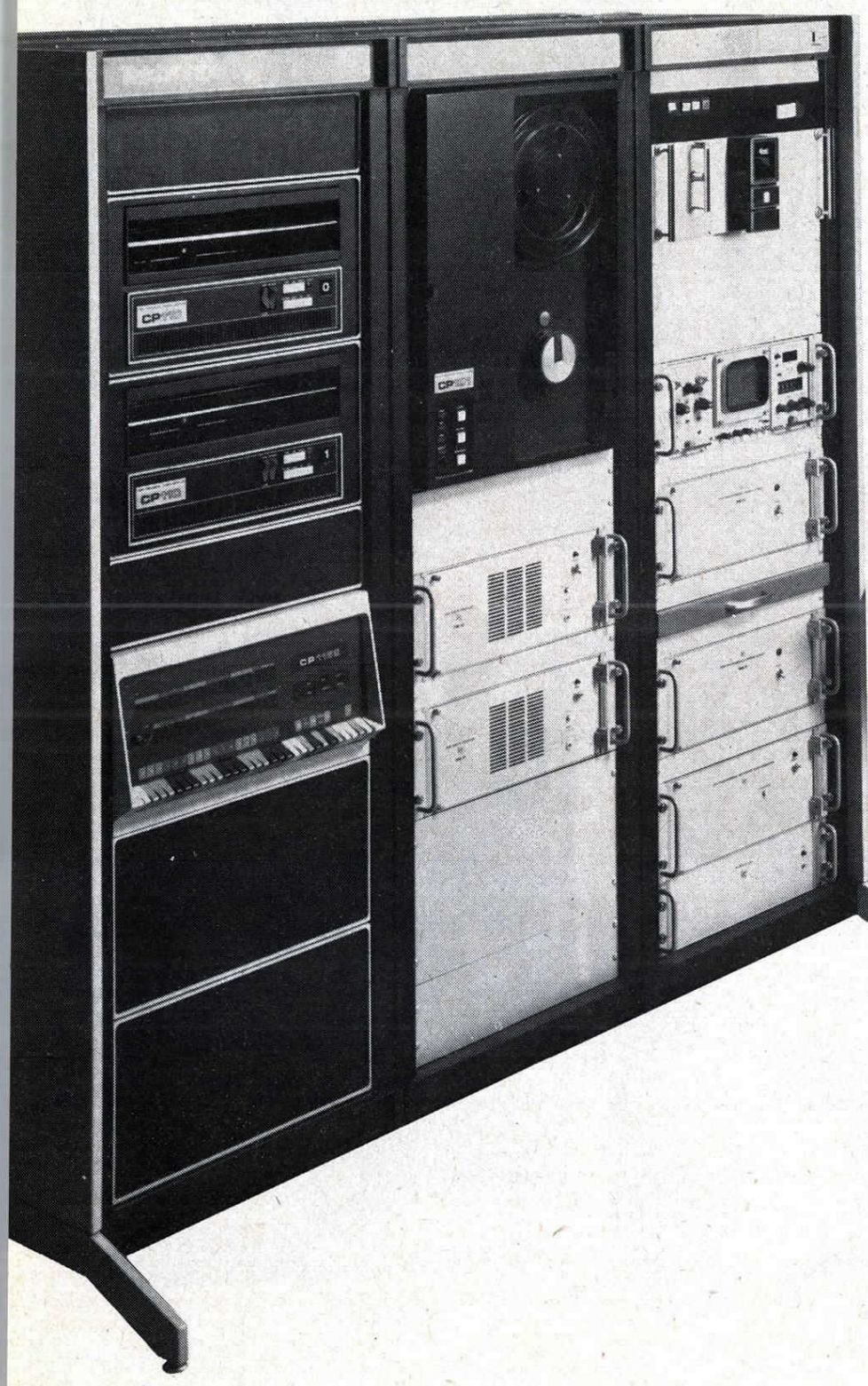
SPS Specialist
If you wish further information concerning WP Systems contact the SPS Specialist in these Tektronix Field Offices:

In the U.S.
Woodland Hills, CA
(213) 999-1171
Santa Clara, CA
(408) 243-9620
Norcross, GA
(404) 449-4770
Albuquerque, NM
(505) 265-5541
Dayton, Ohio
(513) 859-3681
Rockville, MD
(301) 948-7151
Springfield, NJ
(201) 379-1670
Chicago, IL
(312) 259-7580
Boston, MA
(617) 861-6800
or Beaverton, OR
SPS Marketing
(503) 645-6464
Ext. 1163

International
Tektronix Ltd.
P.O. Box 36
St. Peter Port, Guernsey
Channel Islands
Phone 35781

Sony/Tektronix Corporation
TAISOEBISU-Bldg. 6-11 EBISUMINAMI-1
Shibuya-Ku Tokyo, 150 Japan
Phone (03) 710-8191

Semiconductor Test Systems



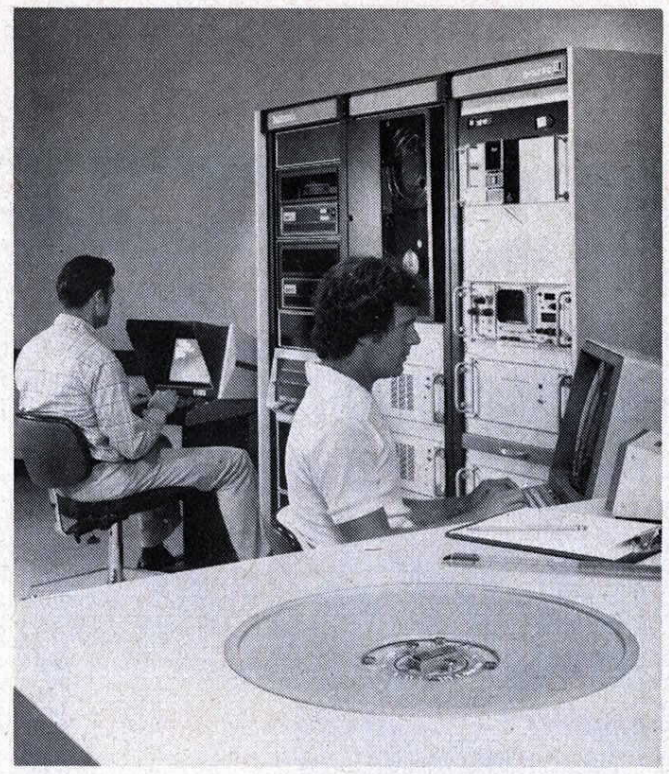
Anticipating Future Technologies

At Tektronix, we've looked to the future to see what test problems the new device technology will create. We've created a complete line of Automated Test Systems to be ready to solve the problems of today . . . and tomorrow.

The S-3200 Series of highly advanced test systems is ready now to help solve the device testing problems you'll soon be facing . . . problems like increased complexity, more bits, faster clock rates and more. When new device technology delivers tough test problems, you'll be ready with the S-3200 Automated Test Systems.

The S-3260, our first test system, was designed in 1970. Since then, it's been recognized as the most advanced LSI/IC test system in the business. Around the world, the S-3260 has been delivering test results for millions of devices, proving itself to be a viable solution to the most advanced characterization problems.

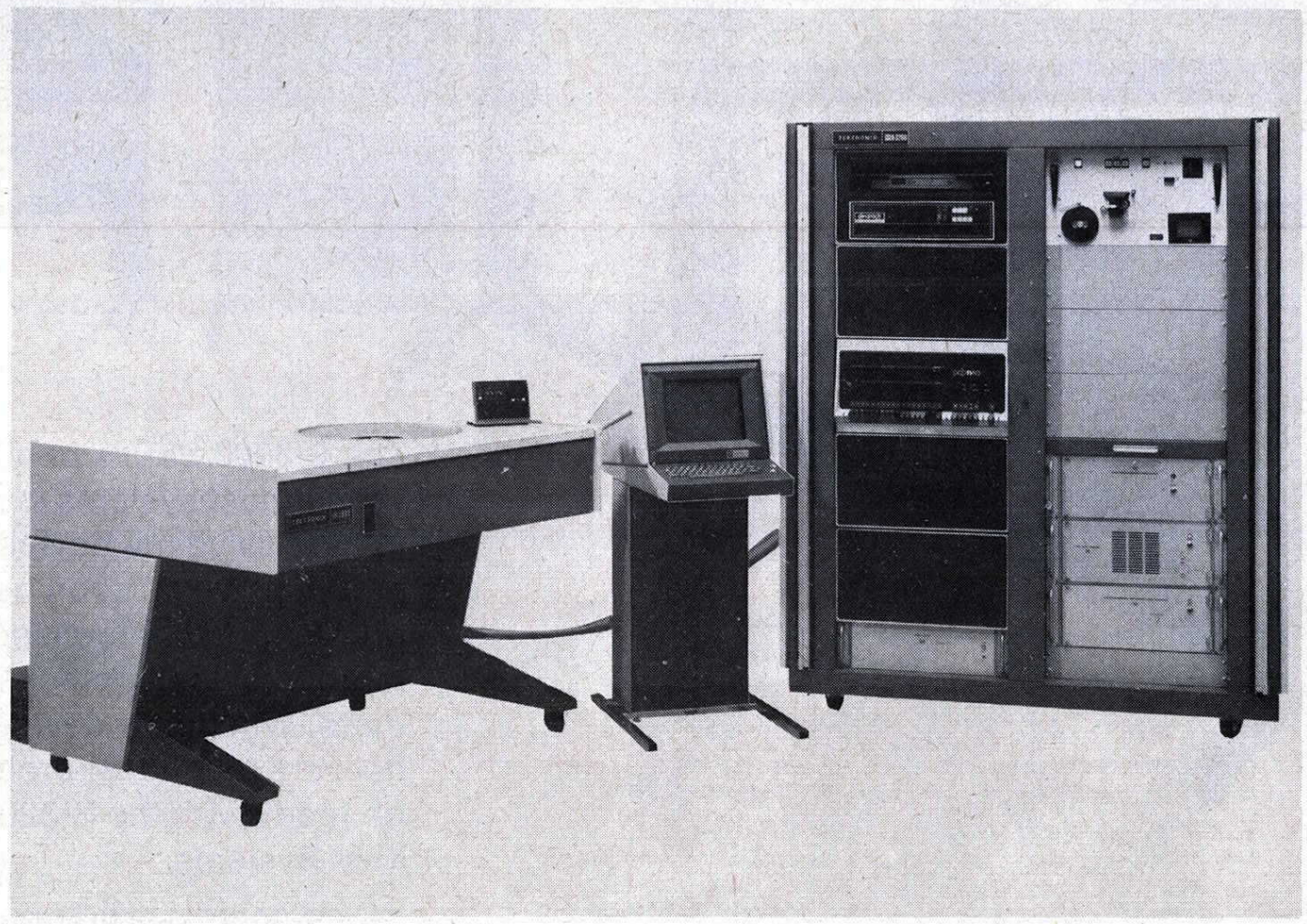
S-3200 Automated Test Systems



Now, we've developed three other test systems, based on the proven architecture of the S-3260, continuing our commitment to the device testing business. The S-3270 added even more advanced hardware to the time-tested S-3260, making the S-3270 the ultimate device characterization system. The S-3250, our production test system, was designed for fast, efficient, accurate testing in a production environment. The S-3280 was created especially to test high-speed logic devices such as ECL and CML devices, and features sub-nanosecond measurement capability with superb accuracy.

Each system features a 20 MHz clock rate, including uninterrupted error storage at that high speed. Each system uses the same highly advanced software which we developed for the S-3260. Using the device-oriented, English-like language of the S-3200's—called TEKTEST III—the programmer can easily and quickly generate, edit and debug programs for device testing, and then can transfer these programs from one system to the other. It's a simple process to generate characterization programs on the S-3270, and then edit these programs for production testing on the S-3250. And all the systems feature highly advanced data reduction and graphics, making the test results manageable and easily understood.

At Tektronix, we've built on our past experience and knowledge about device testing to create a total, compatible line of LSI/IC test systems which can help solve your test problems—now and in the future.

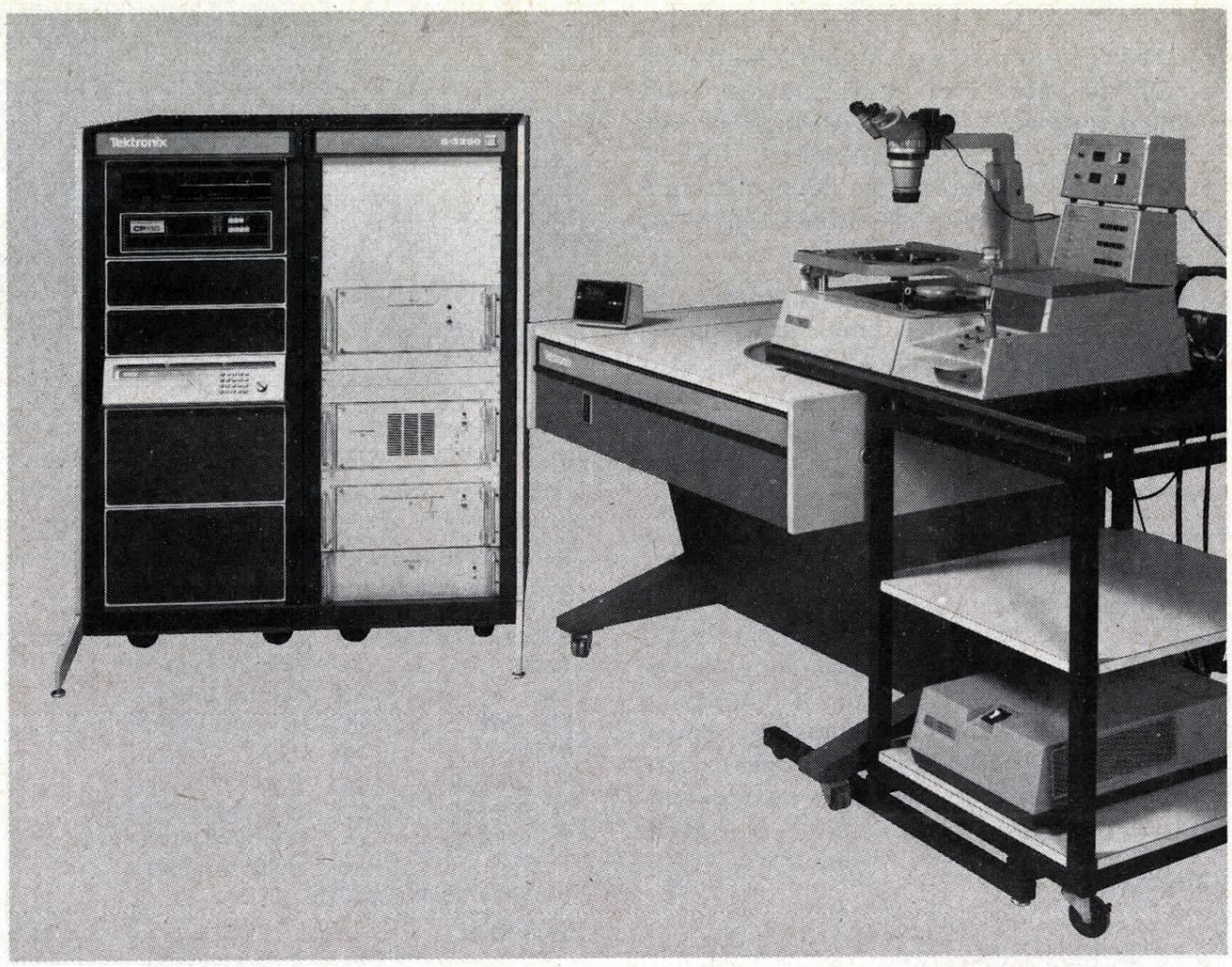


S-3270

- Uninterrupted Error Storage at 20 MHz
- Multiple pattern sources
- Versatile driver formats
- 14 programmable channels of timing information
- Tests devices with up to 128 pins
- Single-shot timing
- Advanced graphics and data reduction
- Uses TEKTEST III, a device-oriented test language
- Easy to program and edit
- True foreground/background timesharing

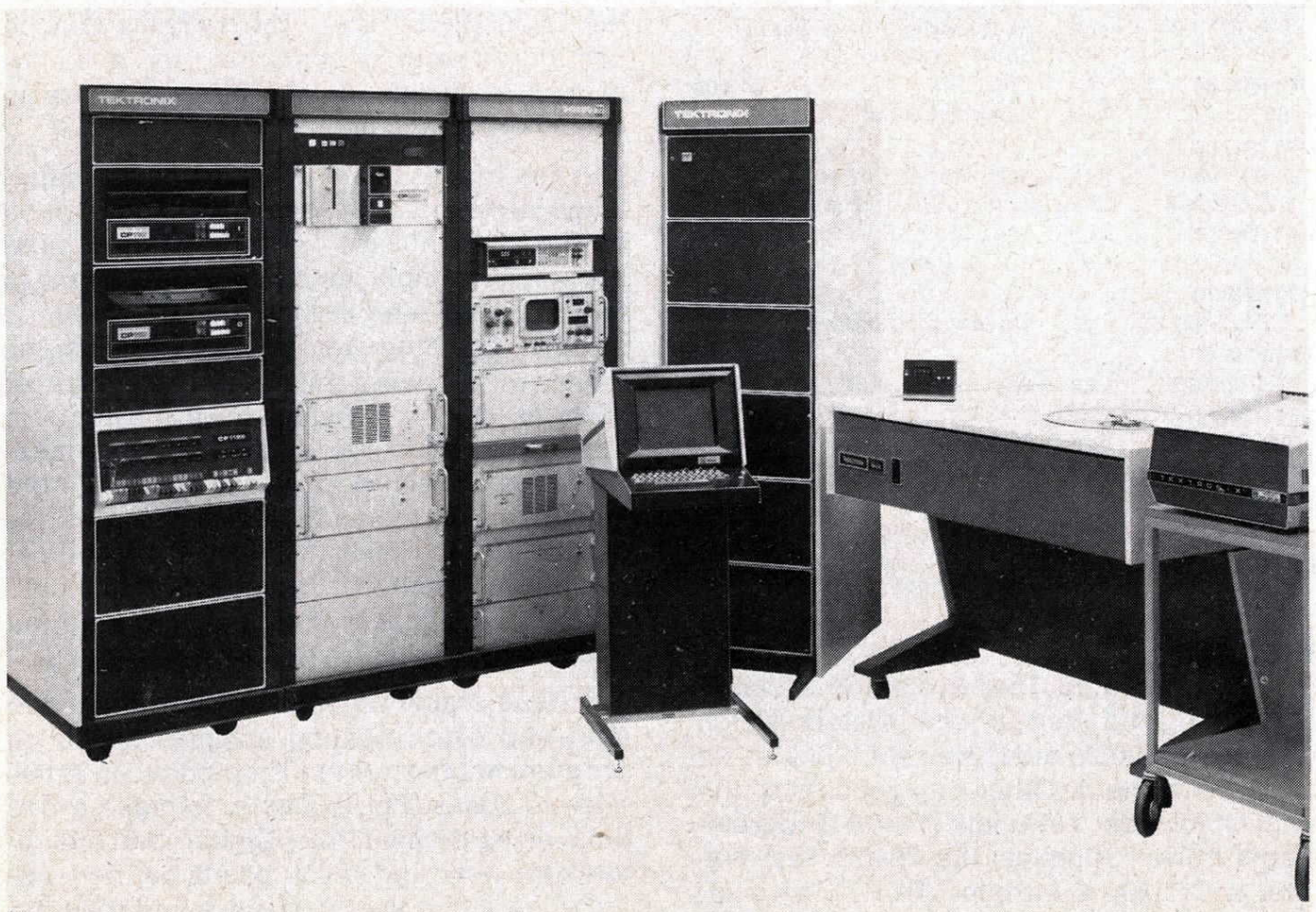
S-3250

- Interfaces with popular handlers and probers
- 20 MHz clock rate
- High through-put
- Minimum operator interface
- Fast change-over
- Uses TEKTEST III
- Easy to program and edit
- Maximum system run-time, since programming can occur during testing.



S-3280

- 100K ECL testing
- 50 Ω environment
- Sub-nanosecond measurements
- Full graphics and data reduction package
- Uses TEKTEST III
- Simple to program and edit
- Tests high speed logic
- CML capability



For more information about the S-3200 Automated Test Systems, contact the Test Systems specialists located in the following Tektronix Field Offices:

Los Angeles, CA
Santa Clara, CA
Boston, MA
Philadelphia, PA
Dallas, TX
Orlando, FL
St. Paul, MN
Woodbridge, NJ

Tektronix, Ltd.
Herts, England

Tektronix France
Orsay, France

Tektronix Sweden
S-171 04 Solna, Sweden

Tektronix Holland
Badhoevedorp, Holland

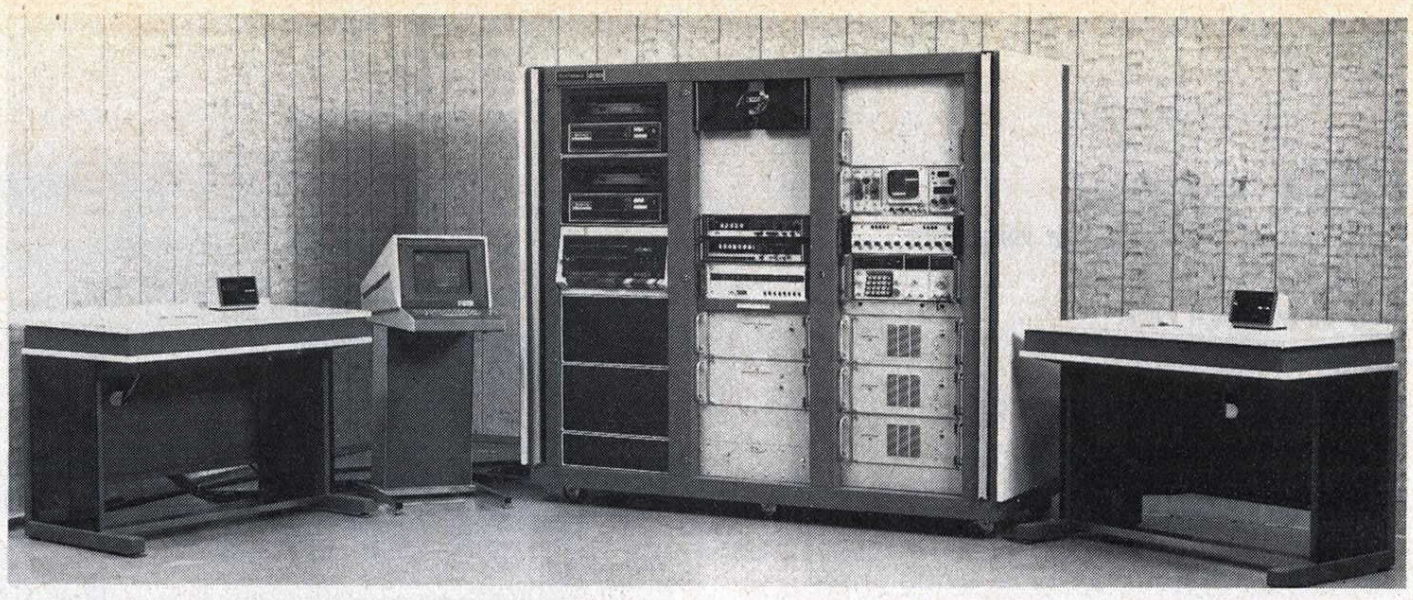
Rohde & Schwartz Vertriebs GmbH,
Koln, Germany

Silverstar Italy (Spa Ltd.)
20146 Milano, Italy

Tektronix International Switz.
CH 6301 Zug, Switzerland

Sony/Tektronix
Tokyo, Japan

S-3000 Series Test System

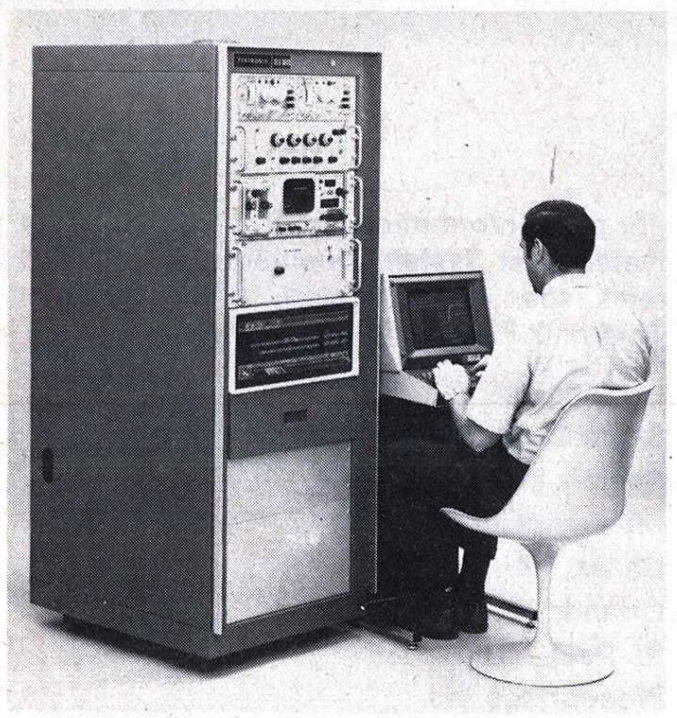


With today's emphasis on high-speed device technology, more and more engineers are specifying devices such as ECL, CML and Shottkey TTL. These high-speed devices feature rise times as fast as 800ps. To capture these fast events, Tektronix offers the S-3000 Series of test systems.

With the S-3000's, you can automatically measure rise time, fall time, propagation delay, storage time, delay time and many other dynamic measurements. The S-3000's also perform signal amplitude measurements such as peak amplitude and average amplitude.

The basis of these systems is the R568 Readout Oscilloscope. The R568 can capture rise times as fast as 75 ps with a 1 ps resolution. Depending on your particular testing requirements, other components can be added to the system, such as Counters, Pulse Generators, Programmable Power Supplies. These systems can be easily configured to meet most dynamic device testing requirements.

S-3003



The S-3003 is a computer-controlled waveform digitizer, which can be a stand-alone test system by using either a Tektronix controller or your computer, or can be interfaced to your test system as an ac measurement sub-system. The S-3003 includes the R568 Readout Oscilloscope, the 3S6 and 3T6 Plug-in Units, and the 1340 Data Coupler, which is comprised of interface circuit cards for the R568 scope, the Waveform Digitizer and optional interfaces to your computer.

The waveforms to be digitized are displayed on the R568 Oscilloscope. The Waveform Digitizer then processes the 10-division displayed waveform into a series of 1000 10-bit words. One word is generated for each displayed dot on the R568. These words are sent to the computer, where the binary image of the waveform can then be processed and measurements made through WAFORM™ software. WAFORM is FORTRAN-based and runs on both DEC PDP-11 and H-P 2100 Series Minicomputers.

When used with a Tektronix graphics terminal, the S-3003 provides full graphics capability, including software waveform analysis, such as FFT and THD, data logging, data reduction, displayed waveforms and such graphic displays as histograms.

S-3003 STANDARD			**$21,350**
R568	1 ea.	Oscilloscope	
3S6	1 ea.	Vertical Unit	
3T6/651C*	1 ea.	Horizontal Sweep Unit	
R1340	1 ea.	Data Coupler	
021-0029-00	1 ea.	Waveform Digitizer	
021-0084-00	1 ea.	3S6 Program Control	
021-0085-00	1 ea.	3T6 Program Control	
1 ea.	1 ea.	Waform Software	

*modified version of 3T6

OPTION 01			**$1,300**
S1	2 ea.	Sampling Head	
OPTION 02			**$1,560**
S2	2 ea.	Sampling Head	
OPTION 03			**$1,930**
S3-A	2 ea.	Sampling Head	
OPTION 04			**$530**
015-0073-00	1 ea.	Accessories Power Supply	
015-0128-01	1 ea.	Signal Chopper S3-A	
OPTION 05			**$1,300**
S5	2 ea.	Sampling Head	
OPTION 06			**$600**
015-0128-01	1 ea.	Accessories Power Supply	
015-0184-00	1 ea.	50 ohm Dual Signal Chopper	
OPTION 07			**$980**
015-0139-01	1 ea.	In/Out Panel	
OPTION 10			**$2,400**
PN 437-0216-00	1 ea.	Cabinet Single Bay	
OPTION 11			**$2,400**
021-0063-00	1 ea.	DP-11 DMA Interface	
OPTION 12			**$3,050**
021-0061-00	1 ea.	ASCII Interface	
021-0089-00	1 ea.	HP 2100 DMA	
OPTION 13			**$1,600**
021-0142-00	1 ea.	Reference Signal	
OPTION 48			**NC**
		Voltage Change 220 V, 50 Hz	

S-3030

S-3030 Automated Test System is a stand-alone dynamic device test system which uses the S-3003's measurement block as its basis component. Other components of the system include Tektronix 1140A Programmable Power Supplies, the 1840D Test Fixture, a CP3200 Controller (PDP11/34 minicomputer), a selection of programmable DVM's, Pulse Generators, Counters and Function Generators, a CP110 (RK05 DEC Pack Disc) and Tektronix Graphic Computer Display Terminals.

The S-3030 is a complete automated test system for linear devices, hybrids, modules and other types of devices which require waveform analysis. Using our advanced, English-like, device oriented test language called TEKTEST II™, the engineer can program, edit and debug the device or the program simply and quickly. TEKTEST II is a modified version of our highly advanced S-3200 Series test systems language, and was developed to make testing and programming a simple process. The advanced software allows easy data logging, data reduction and graphic analysis.

Other features of the system include Fast Fourier Transforms and calculating Total Harmonic Distortion.

S-3100 Series

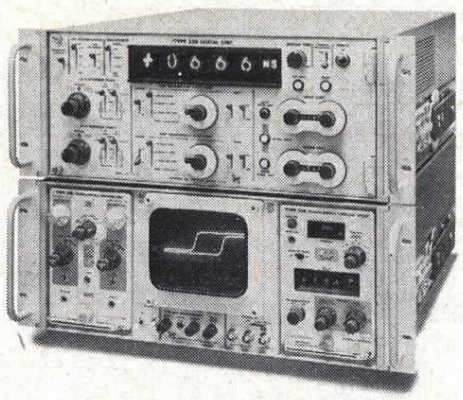
Like the S-3003 Test System, the S-3100's perform automatic, high-speed time measurements such as rise time, fall time, propagation delay and many other measurements. The S-3100's have the capability to capture and measure rise times as fast as 75 ps with 1 ps resolution.

The S-3100 Series Test Systems are based around the R568 Readout Oscilloscope, and the R230 Digital Unit. The systems can be configured with a controller, for a stand-alone test system, or can be used alone as a semi-automatic benchtop test system.

The key to the S-3100's measurement capability is sampling. A repetitive signal, such as the input pulse to a logic gate, is sampled—one sample per pulse. Each sample is taken slightly later in time than the previous sample. The time interval between samples is set by the sweep rate and the number of samples per crt division. As the sample is taken, the amplitude of the signal is measured and recorded in sample-and-hold memory. The resulting display is a series of dots on the R568's crt, where the vertical position of each dot represents the amplitude of the signal at that instant in time (an equivalent time display).

The R230 Digital Unit can be programmed to start and stop counting samples based on programmable start and stop points in reference to zones. For example, to make a rise time measurement, the Digital Unit calculates the zero and 100% points on the leading edge of the acquired pulse and then begins counting samples at the start point (for example, 10%) and stops counting at the stop point (for example, 90%). The R230 then multiplies the number of samples counted by the time interval between samples. The result is displayed on the Digital Unit's front panel. This measurement value is also available to the rear panel for data logging. The R230 may be set up from the front panel or remotely programmed through parallel lines available at the rear panel.

S-3101



The S-3101 is a stand-alone automatic measurement instrument that automatically calculates and displays time measurements. Easy to read digital readout frees the operator from potentially difficult analog display interpretation. This package is the building block for all S-3100 systems and consists of an R568 Readout Oscilloscope, 3S6 and 3T6 Plug-in Units and the R230 Digital Unit. Selection of Optional sampling heads is required to complete the package.

The following is a list of standard equipment and options for the S-3101.

S-3101 STANDARD **$19,380**

R568	1 ea.	Oscilloscope
R230	1 ea.	Digital Unit
3S6	1 ea.	Vertical Unit
3T6	1 ea.	Horizontal Sweep Unit

OPTION 01 ..... **$1,300**
S1 — 2 ea. Sampling Head 50 ohm

OPTION 02 ..... **$1,560**
S2 — 2 ea. Sampling Head 50 ohm

OPTION 03 ..... **$1,930**
S3-A — 2 ea. Sampling Head

OPTION 04 ..... **$320**
015-0128-01 — Dual Chopper for S3-A

OPTION 05 ..... **$1,300**
S5 — 2 ea. Sampling Head

OPTION 06 ..... **$390**
015-0184-00 — Dual Chopper 50 ohm

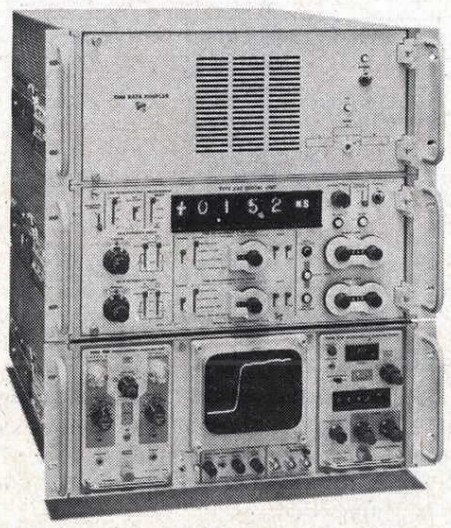
OPTION 10 ..... **$2,100**
437-0215-00 — 1 ea. Cabinet, 63″ Rack Space

OPTION 40 ..... **NC**
Replace 3S6/3T6 with 355/3T

OPTION 41 ..... **−$200**
Non-rackmount equipment
use 568, 230

OPTION 48 ..... **NC**
Voltage change 22 V, 50 Hz

S-3105



The S-3105 is a measurement sub-system designed to perform as the measurement block in a custom built automated test system. The S-3105 includes the components found in the S-3101 plus the 1340 Data Coupler and ASCII (RS232) Interface.

S-3105 STANDARD **$27,900**

R568	1 ea.	Oscilloscope
3S6	1 ea.	Vertical Unit
3T6	1 ea.	Horizontal Sweep Unit
R230	1 ea.	Digital Unit
R1340	1 ea.	Data Coupler
021-0061-00	1 ea.	ASCII RS 232 Interface
021-0084-00	1 ea.	3S6 Program Control
021-0085-00	1 ea.	3T6 Program Control
021-0087-00	1 ea.	R230 Interface

OPTION 01 ..... **$1,300**
S1 — 2 ea. Sampling Head 50 ohm

OPTION 02 ..... **$1,500**
S2 — 2 ea. Sampling Head 50 ohm

OPTION 03 ..... **$1,930**
S3-A — 2 ea. Sampling Head

OPTION 04 ..... **$320**
015-0128-01 — S3-A Dual Signal Chopper

OPTION 05 ..... **$1,300**
S5 — 2 ea. Sampling Head

OPTION 06 ..... **$390**
015-0184-00 — 1 ea. 50 ohm Dual Signal Chopper

OPTION 07 ..... **$600**
021-0120-00 — 1 ea. Program, R230 Limits

OPTION 10 ..... **$2,400**
437-0216-00 — 1 ea. Cabinet Single Bay

OPTION 48 ..... **NC**
Voltage Change 220 V, 50 Hz

S-3000/S-3100 Components

Both S-3100 and S-300 Systems are assembled with "building block" components. The following is a brief description of each component and the interfaces between components. For complete descriptions and specifications contact the Tektronix Sales Engineer specializing automatic IC test systems.

1. The R568 Readout Oscilloscope performs the signal acquisition function in S-3200 and S-300 Series Systems in conjunction with plug-in sampling instruments. In S-3100 Systems the R568 is interfaced to the R230 Digital Unit. In an S-3000 Series System the R568 is interfaced to a R1340 Data Coupler.

2. The R230 Digital Unit performs time and voltage measurements on signals acquired by the R568 in S-3100 Series Systems. The R230 may be programmed by the R240 Program Control Unit, a R241 Programmer or (with a R1340 Data Coupler) the unit may be programmed by a computer or programmable calculator. The R230 also has manual front panel controls. Measurement data displayed on the R230 front panel is transmitted to the controller or data coupler via data output connectors.

3. The R1340 Data Coupler is a multipurpose interface unit for S-3100 and S-3000 Series Systems. The R1340 can accommodate up to 12 interface cards and 18 interconnecting cables. A common TTL bus within the R1340 allows data and control information to flow between the interfaced controller and test system instruments. A wide variety of controller and instrument interfaces are available.

4. The 1140A Programmable Power Supply provides stimulus voltage and current in S-3000 Series Systems. The supply provides one current and four voltage outputs, each independently programmable. The 1140A is programmed via an interface card in the R1340 Data Coupler.

5. Sampling Head Multiplexers allow signals from as many as 64 test points to be measured by the two-input 3S5 or 3S6 Plug-in. Signals sensed by each sampling head are electronically switched (multiplexed) into the sampling plug-in, two signals at a time. The 286 is the basic unit of a sampling head multiplexer system and can operate four sampling heads. The R287 controls up to four 286's, allowing 16 heads to be multiplexed. The R288 controls up to four R287's multiplexing up to 64 sampling heads.

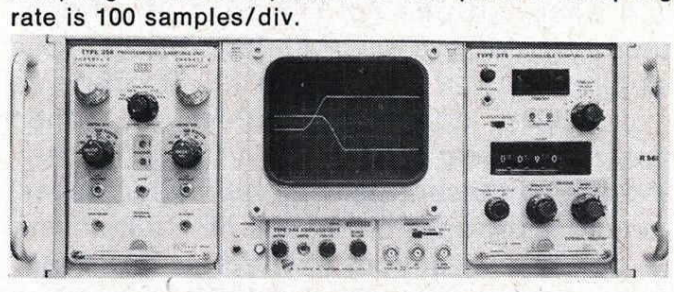
6. The 3S5 and 3S6 are plug-in, dual trace, sampling units for the R568 Readout Oscilloscope. These units allow the R568 to be programmed for deflection factor (2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence), dc offset (range + 1 V to −1 V programmable between +995 mV and −995 mV in 5 mV steps), and smoothing. A variety of sampling heads are aavilable for the 3S5 and 3S6 to meet various measurement requirements.

Sampling Head	Rise Time	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	100 ps	100 Ω, 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 M Ω, 15 pF	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

See descriptions on pages 84 and 85.

External programming of 3S5 is accomplished by either a front or rear panel connector. Signal inputs are on the front. The 3S6 has both its program and signal inputs on the rear.

7. The 3T5 and 3T6 are programmable time base units for the R568. These units may be controlled manually using front panel controls. Real-time sampling is from 1 ms/div to 500 ms/div. Equivalent-time sampling is from 1 μs/div to 100 ps/div. Sampling rate is 100 samples/div.

1


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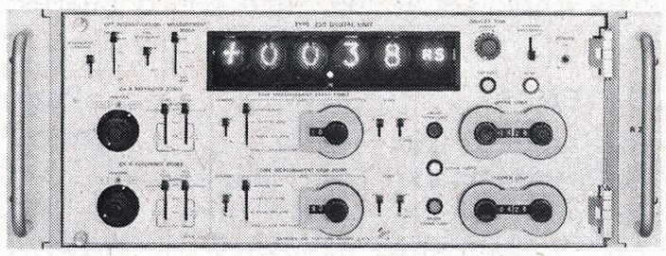

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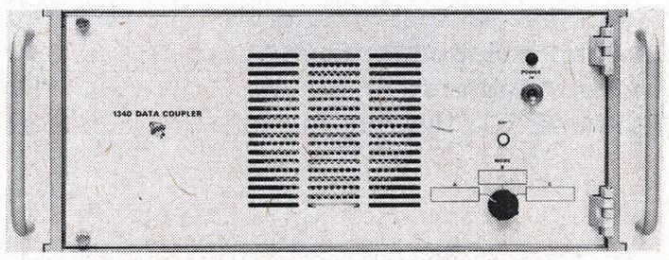

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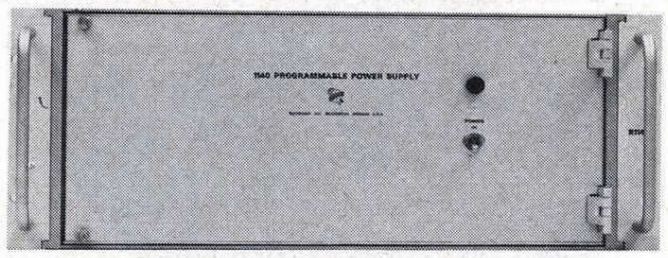

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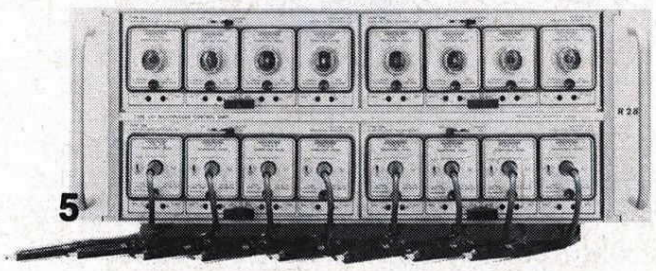

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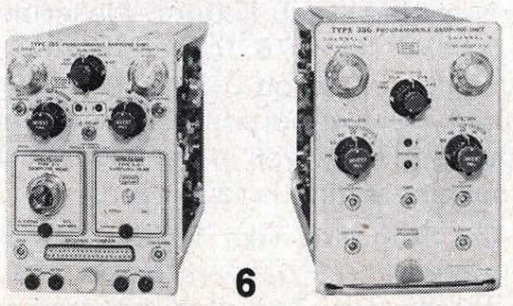

7

CURVE TRACERS

Curve tracers can deliver comprehensive information about a multitude of semiconductor devices and integrated circuits . . . from two- and three-terminal devices through the full range of linear integrated circuits . . . from transistors and diodes to optoisolators, thyristors, and operational amplifiers.

These versatile measurement tools give you more than pinpointed parameters. A curve tracer can show you what happens between specified points in a quickly graphed curve, thus providing the valuable performance data necessary for accurate design, analysis, and evaluation.

If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions (p 176-182) helpful in choosing the system that best meets your requirements. If you would like to receive a brochure, application notes, and other materials to learn more about Curve Tracers and their measurement capabilities, please use the reply card on the inside back cover; or, for faster action, contact a Tektronix Sales Engineer at the Field Office nearest you.

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Op Amp & Regulator Cards 180
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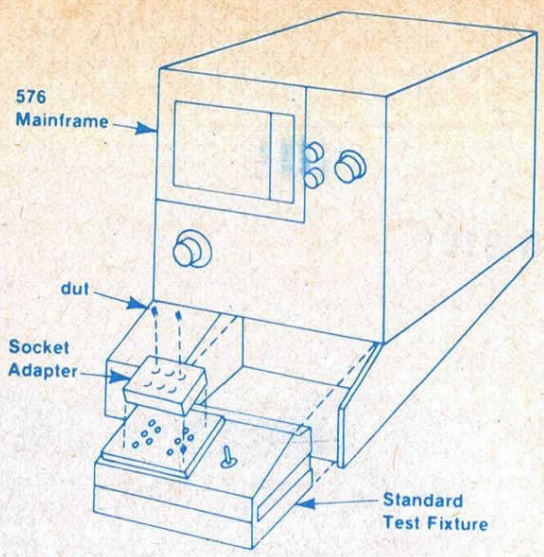
The TEKTRONIX 576 Curve Tracer System continues to hold the title "standard of the industry." The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (described on p 177), and the 176 Pulsed High-Current Fixture (described on p 178). The 576 is an excellent general-purpose curve tracer system that performs well in applications where high current testing is required.

With the Standard Test Fixture, the collector supply of 576 delivers up to 220 watts peak to the dut. The step generators can deliver up to 2 A in both its current and voltage modes of operation. Of course, with the 176, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the 577 is the display area READ-OUT. Adjacent to 576's crt are alphanumeric indicators of vertical and horizontal deflection



576 Curve Tracer

factors, step amplitude, and Beta/div or gm/div. The Beta or gm readout saves the operator from the arithmetic usually necessary to arrive at these parameters. The READ-OUT also provides a permanent record of major knob settings in 576 crt photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer are: adjustable current limiting in the step generator, either 300 μs or 80 μs pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and illuminated graticule.

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 — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

STEP GENERATOR

Current Mode — Step/offset amplitude range is 5 nA/step (with X0.1 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 X0.1 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; with 5% between steps, within 10% with X0.1 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 — X0.5, X1 (NORM), and X2 the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps — Approx 80 μs or 300 μs width, at NORM or X0.5 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 pushbutton.

Step Family — REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps — Digitally selectable between 1 and 10.

DEFLECTION CONTROLS

Display Accuracies — As percentage of highest on-screen value.

		OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
NORM and DC MODES	**NORMAL**	**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 (5 mV/div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step generator; 1 step/div.

Curve Tracer Programmable Test Fixture

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. Continuous fine control over 5 div or less.

Display Offset — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

CRT and READOUT

Crt — 6½ in 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.

Readout — The readouts, adjacent to crt, are digital indicators of the following 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 mA/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.

STANDARD TEST FIXTURE

Description — 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.

OTHER CHARACTERISTICS

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 V ac to 136 V ac or 180 V ac to 272 V ac (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10° C to +40°C.

Dimensions and Weights

	in	cm
Height	15.0	38.1
Width	11.5	29.2
Depth	23.0	58.4
	lb	**kg**
Net Weight	70.5	32.0
Shipping Weight	≈107	≈48.5

INCLUDED ACCESSORIES

Transistor adapter (013-0098-02), FET adapter (013-0099-02). TO3 adapter (013-0100-01), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), Kelvin sensors for large and small plastic transistors (013-0138-01), and protective cover (337-1194-00).

ORDERING INFORMATION

576 Curve Tracer with Standard Test Fixture $5975

The 576 Option 01 deletes the parameter readout module but maintains provisions for insertion of the module # (020-0031-00) at any time.

Order Option 01 ..... Sub $500

Auto Scale-Factor Readout Module
Order 020-0031-00 ..... $765

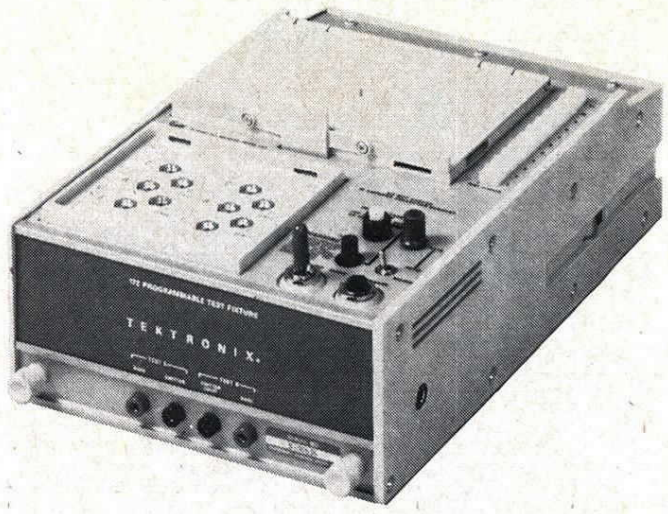
OPTIONAL ACCESSORIES

Camera — See Oscilloscope/Camera Adapters chart in camera section of this catalog.

SCOPE-MOBILE® Cart — TEK Lab Cart Model 3.
Order Model 3 ..... $375

Test Set-up Chart — Package of 250.
Order 070-0970-01 ..... $7

172 Test Fixture ..... See page 177
176 Test Fixture ..... See page 178
Socket Adapters ..... See page 181



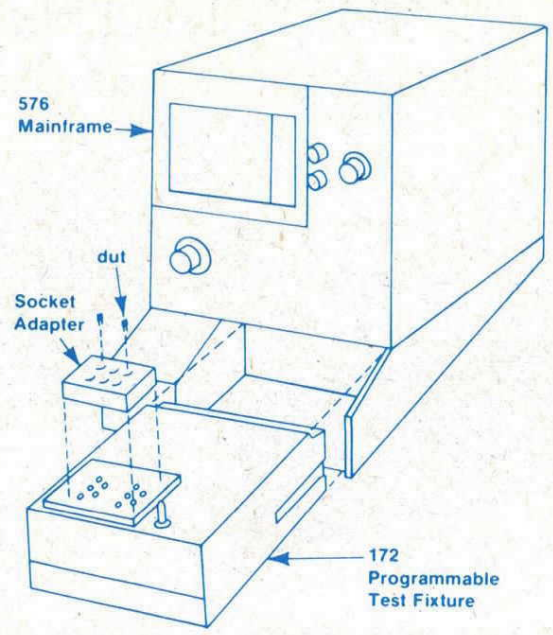
The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program a sequence of tests of J FET's, transistors, and diodes.

The 172 can greatly reduce total test time in applications when more than one measurement is made on a batch of many devices. Without the 172 all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 Programmable Test Fixture performs as many as eleven different tests on each device.

The 172 sequences through the various tests either automatically or manually. A variable RATE control is provided for the operator to set the test sequence at a rate which is best for him. A new operator requires more time per test, but with experience he will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE CAPABILITIES
Test	Xstr	J FETs	Diodes	
1*	H_{FE}, $V_{CE(sat)}$	V_P	V_F	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V.
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA. When testing J FET's the base terminal is shorted to the emitter terminal. Collector Sweep: three fixed ranges; 2 V, 5 V, and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A, and 150 mA, respectively.
4	Same as #3.			
5	I_{CEO} or I_{CES}, I_{CER} with external short or resistor			Voltage Supply: 1 V to 500 V dc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is nA/div.
6	I_{CBO}	I_{GSS}		Same as #5.
7	I_{EBO}		I_R	Same as #5.
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 100 mA dc for breakdown voltage measurements to 50 V.
9	$V_{(BR)CES}$			Same as #8.
10	$V_{(BR)CBO}$	BV_{GSS}		Same as #8.
11	$V_{(BR)EBO}$		V_R	Same as #8.

*All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same



conditions as for Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.

For the remaining tests the only 576 controls that are functional are the Polarity and crt controls such as INTENSITY, FOCUS, DISPLAY OFFSET.

CHARACTERISTICS

VERTICAL AND HORIZONAL AMPLIFIERS

Display Accuracies — The same as the 576 Curve Tracer with its included Standard Test Fixture.

Vertical Deflection Factor — Test 1 and 2 (Collector or Emitter Current): 1_c 1 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1μA to 0.5 A/div in 18 steps. Test 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1, 2, 5 sequence.

Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for test 2, at least 100 MHz at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Test 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1, 2, 5 sequence.

Collector Sweep Voltage — At least 2 V open circut, or 1.5 A short circuit, at 100 mV/div and 200 mV/div. At least 5 V open circuit, or 2 A short circuit, at 500 mV/div. At least 20 V open circuit, or 150 mA short circuit, at 1 V/div and 2 V/div.

Current Supply Accuracy — 0.1 μA to 11 mA, accurate within 2% ±30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% ±30 nA with up to 50 V compliance. Increments of current are: 0.1 μA (from 0.1 μA to 11 μA), 1 μA (from 10 μA to 110 μA), 10 μA (from 100 μA to 1.1 mA), 100 μA (from 1 mA to 11 mA), and 1 mA (from 10 mA to 110 mA).

Voltage Supply Accuracy — 1 V to 500 V, accurate within 3% ±300 mV with at least 0.5 mA compliance.

Test Display Time Range (Automatic) — 300 ms or less to at least 2 s continuously variable. Manual operation from a front-panel switch or optional foot switch.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights	in	cm
Height w/cover	6.5	16.5
Width	7.8	19.8
Depth	12.4	31.5
	lb	**kg**
Net weight	11.5	5.2
Shipping weight	≈18.0	≈8.2

Included Accessories — One protective cover, five programming cards, 250 programming card pins, five crt overlay limit cards.

ORDERING INFORMATION

172 Programmable Test Fixture $2625

OPTIONAL ACCESSORIES

See page 181

Pulsed High Current Fixture

The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with 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 considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over dissipation. The 176 Test Fixture fits in place of the 576 Standard Test Fixture. 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 pushbutton 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 pushbutton 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 pushbutton 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 pushbuttons provide inputs to the fiberoptic readout to display actual values.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

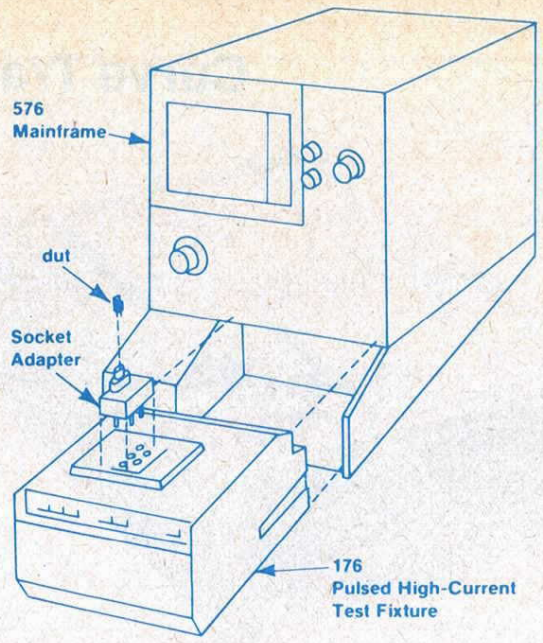
Width — 300 μs or 80 μs determined by 576.

Repetition Rate — Power-line frequency.

Polarity — + or − determined by 576 polarity control.

Amplitude — Ranges are 15, 75, 350 V 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.

Max Peak Watts — Three illuminated pushbuttons select 10, 100, 1000 W max 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 pushbutton.

Accuracy (Current steps including offset) — Incremental is within 5% between any two steps; within 10% with X0.1 STEP MULT. Absolute is within 3% of total output ±1% of one step or within 3% of one step, whichever is greater.

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

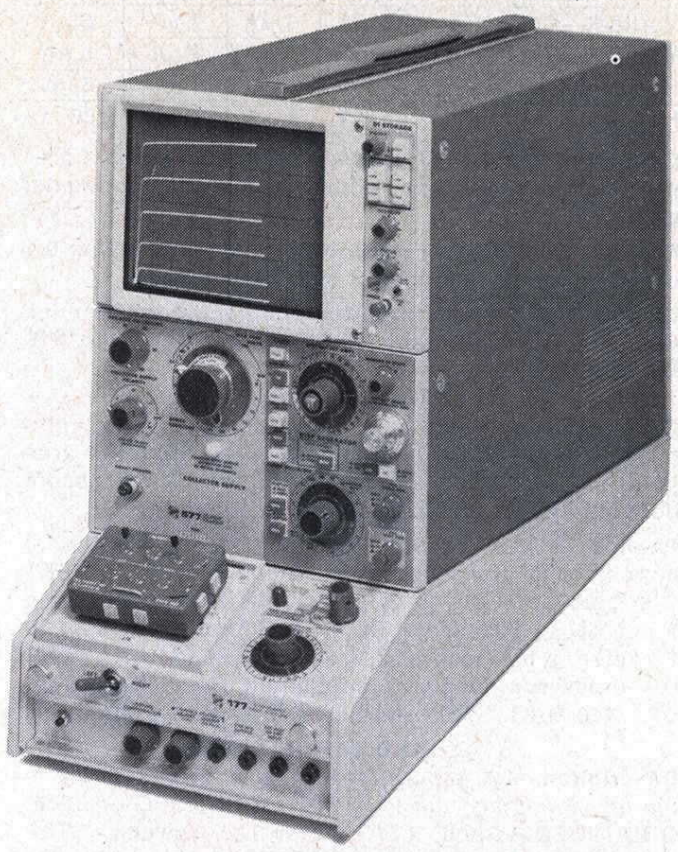
	in	cm
Height	4.6	11.7
Width	7.9	20.1
Depth	11.4	29.0
	lb	**kg**
Net weight	12.8	5.8
Shipping weight	18.0	8.2

Included Accessories — TO36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective shield (337-1194-00).

ORDERING INFORMATION

Order 176 Pulsed High-Current Fixture $2875

577 Curve Tracer

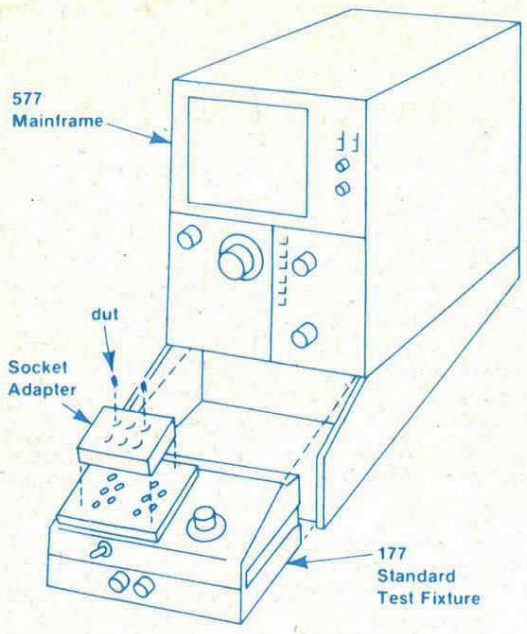


The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are storage and the emphasis on low current measurements.

The 577's storage crt may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the crt while in the storage mode. A good example of a dot display occurs in op amp testing because the open-loop 3-db bandwidth of many op amps is so low that the curves must be plotted slowly. Linear IC's such as op amps may be tested with the 577 by using the 178 Linear IC Test Fixture (see page 179-180).

In the 577/177 Curve Tracer System several features facilitate low current measurements; they include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the collector supply lead (which permits measurements on three terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available, 10 A continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.



Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the step generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both crt axes, and a beam finder.

CHARACTERISTICS

All characteristics are for the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes — Five modes of collector supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

Voltage — The voltage is variable to the max peak volts selected.

Max Peak Volts Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

Series Resistance — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains max peak power to the device-under-test when changing voltage ranges.

Safety Interlock — Protects operator from 100-, 400-, and 1600-volt ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Current Mode — Step amplitude range is 5 nA/step (with STEP X0.1) to 200 mA/step, in a 1-2-5 sequence. Available current is at least 2 A on the highest amplitude setting with 5 V or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

Voltage Mode — Step amplitude range is 5 mV/step (with STEP X0.1) to 2 V/step, in a 1-2-5 sequence. Current is limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 V) derating to 0 mA at 20 V.

Accuracy — Incremental; within 2% between steps. Absolute; within 3% of total output or AMPLITUDE setting, whichever is greater. When STEP X0.1 is actuated the absolute step accuracy is 4%.

Step Rate — Selectable at 1X (SLOW), 2X (NORM), or 4X (FAST) line frequency.

Pulsed Steps — Steps can be gated for a duration of approx 300 μs for testing at low duty cycle.

Step/Offset Polarity — With NORM POLARITY selected, the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with STEP/OFFSET POLARITY control or from the test fixture.

Offset — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either AID or OPPOSE steps. Max range of offset is 10 full-amplitude steps.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10 full-amplitude steps. Selectable up to approx 95 steps when using STEP X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies — As a percentage of highest on-screen value.

Display Mode	Normal	Magnified
Vert Collector Current	3% ±1 nA	4% ±1 nA
Horiz Collector Volts	3%	4%
Horiz Base Volts	3%	4%
Horiz Step Gen	4%	5%

Vertical Deflection Factor — Collector current is 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2 A/div with X10 magnification).

Horizonal Deflection Factor — Collector volts; 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 V div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 V/div with X10 magnification). Step generator; 1 step/div (0.1 step/div with X10 magnification).

Automatic Scale Factor Readout — Change in deflection factor is indicated by lights behind the knob skirt when using X10 MAG.

Automatic Positioning — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert — Single control inverts display and repositions trace.

Display Filter — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

Crt — Rectangular 6½ in with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage crt with phosphor similar to P1. The D2 display unit has a nonstorage crt with P31 phosphor. Accelerating potential is 3.5 kV.

Beam Finder — Compresses off-screen trace to within graticule area.

Standard Test Fixture

177 TEST FIXTURE

Device Lead Selection — Switch provides six different lead configurations. Three positions for EMITTER GROUNDED measurements provide STEP GEN, OPEN (OR EXT), and SHORT base terminal connections. Two positions for BASE GROUNDED measurements provide STEP GEN and OPEN (OR EXT) emitter terminal connections. One position provides for EMITTER BASE BREAKDOWN or leakage measurements up to 25 volts.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all TEKTRONIX Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adapter capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements — 100, 110, 120 V ac or 200, 220, 240 V ac all within ±10%. 50 to 60 Hz, 155 W max at 110 V ac and 60 Hz.

Ambient Temperature — Performance characteristics are valid over an ambient temperature of +10°C to +40°C.

Dimensions and Weights

	577/D1 or 577/D2		177	
	in	cm	in	cm
Height	19.8	50.3	4.0	10.2
Width	8.8	22.4	7.9	20.1
Depth	23.0	58.4	6.0	15.2
	lb	kg	lb	kg
Net Weight	40	18.1	2.5	1.1
Shipping Weight	50	22.7	6	2.7

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≃53 lb or ≃24 kg.

INCLUDED ACCESSORIES

Transistor adapter for most bipolar-transistors and some MOS FET's (013-0098-02), axial lead diode adapter with Kelvin sensing terminals (013-0111-00), protective shield for test connection area (337-1194-00).

ORDERING INFORMATION

577/D1 Storage Curve Tracer Mainframe **$3495**

577/D2 Nonstorage Curve Tracer Mainframe **$3025**

Option 10, 10 x 10 cm Graticule; available with either storage or nonstorage mainframe ..... **Add $45**

177 Standard Test Fixture **$695**

OPTIONAL ACCESSORIES

178 Linear Test Fixture; see following page for complete description **$1775**

Camera — C-5B, see 216 for complete description **$395**

Cart — Tek Lab Cart, Model 3
Order Model 3 ..... **$375**

Test Set-up Chart — package of 250
Order 070-1639-00 ..... **$7.50**

Device Adapter Sockets: see page 181 for complete description.

Linear IC Test Fixture

Tests Single, Dual, or Quad:
Operational Amplifiers, Comparators
Differential Amplifiers, Regulators
and More

Since linear IC's are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 Linear IC Test Fixture provides the necessary accurate low current measurement capability, test cards set up the measurement function, and the 577's storage crt allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the crt while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 Mainframe, 178 Linear IC Test Fixture, appropriate test cards (choose from three op amp cards and two regulator cards), and the proper socket adapter (see pages 180 & 181) that interfaces the system to the device-under-test.

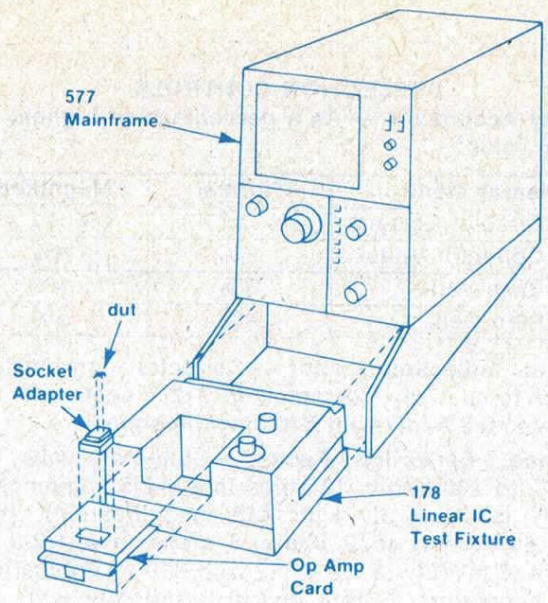
Test cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of test cards are available: op amp cards and regulator cards. Op amp cards are used for testing standard and special op amps, comparators, differential amplifiers, video amplifiers, etc. Regulator cards are used for testing positive and negative three-terminal voltage regulators.

OP AMP CARDS

The **Standard Op Amp Card** is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, cmrr, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The **Hardwire Card** is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device-under-test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The **Multiple Op Amp Card** allows the operator to test up to four devices in a single package by simply operating a four-position switch. The four-position switch selects the op amp (in a multiple op amp package) or the selection of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.



Socket Adapters for Op Amp Cards — The device-under-test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adapters using the Amphenol-Barnes adapter system. This system accepts most of the standard package configurations (TO5, DIP, flat pack, etc). Sockets for these cards are shown on page 181.

REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

Socket Adapters for Regulator Cards — Socket adapters for both positive and negative three-terminal regulators are the same as the Kelvin Sensing Adapters used on the standard curve tracer (see next page).

CHARACTERISTICS

VERTICAL DEFLECTION (1-2-5 Sequence)	NORMAL	MAGNIFIED
Input Voltage or Δ Input Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy	3% ±50 pA	4% ±50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy	3% ±0.1 μA	4% ±0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy	3% ±1 nA	4% ±1 nA

Accuracies are a percentage of highest on-screen values.

Power Supplies — Positive and negative supplies are adjustable from 0 to 30 V, available current is at least 150 mA with adjustable current limiting. The voltage of both supplies can be adjusted from a single calibrated control; accuracy is 2% ±100 mV. Negative supply can be independently adjusted by an uncalibrated control.

Sweep Generator — A sinusoidal signal controls the output, common-mode input, or the power supply voltages of the device-under-test. The frequency is adjustable from 0.01 Hz to 1 kHz; amplitude is adjustable up to 30 V peak.

Source Resistance — For input resistor pairs selectable, 50 Ω, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 550 Ω greater.

Load Resistance — Six selectable load resistors, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ, and 50 kΩ, or external resistors may be used.

Collector Supply — The 25 V and 100 V ranges of the Collector Supply (located on 577 Mainframe) are available to the 178 Test Fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 Test Fixture. (See 577/177 characteristics for Collector Supply performance.)

Step Generator — All the capabilities of the Step Generator (located on 577 Mainframe) are available to the 178 Test Fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for Step Generator performance.)

DUT Supplies Disconnect — A single switch disconnects all power to the device-under-test: both plus and minus power supplies, Collector Supply, and Step Generator.

Function Switch — Selects vertical and horizontal deflection signals and connection of the test signal to the device under test.

Zero — Single pushbutton provides a zero reference to the crt display and, in certain functions, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

THREE-TERMINAL REGULATOR TEST CARD CHARACTERISTICS

Device Under Test Input Supply

INPUT VOLTAGE — Two ranges, 0-30 V and 0-60 V. 0-30 V is within ±2% ±200 mV of dial setting, and 0-60 is within ±2.5% ±300 mV of dial setting.

REGULATION — Within 200 mV.

INPUT SWEEP FREQUENCY — Dc to 1 kHz.

300 μs PULSED CURRENT — 5 mA to 2 A.

SHORT DURATION DC CURRENT (One minute)

Supply Voltage	Current
0 - 10	700 mA
10 - 20	350 mA
20 - 40	300 mA
40 - 60	120 mA

Device Under Test Current Load — 5 mA to 2 A within ±3% of 0 to 1.25 mA.

Device Under Test Comparison Output Dc Voltage Accuracy — 0-10 V range within ±1% ±20 mV; 0-100 V range within ±1% ±150 mV.

OTHER CHARACTERISTICS

Dimensions and Weights

	in	cm
Height	4.5	11.4
Width	7.9	20.1
Depth	7.8	19.8
	lb	**kg**
Net Weight	3.3	1.5
Shipping Weight	8	3.6

Included Accessories — Dual-in-line 16 pin IC socket (136-0442-00). Standard Op Amp Card with cover and ten patch cords (013-0149-01), interchangeable nomenclature panel for function switch (333-1770-00).

ORDERING INFORMATION

178 Linear IC Test Fixture $1775

Standard Op Amp Card — (One included with 178)
Order 013-0149-01 ..... $170

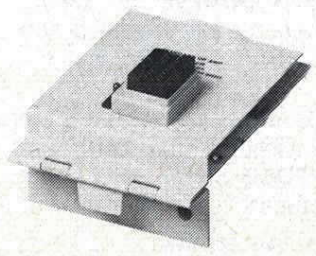
Hardwire Card
Order 013-0150-01 ..... $100

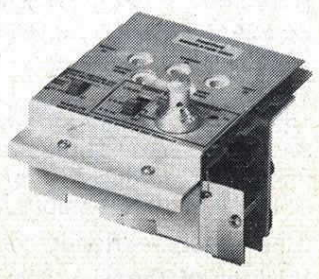
Multiple Op-Amp Card (013-0155-00) $300

Positive Regulator Card
Order 013-0147-00 ..... $375

Negative Regulator Card
Order 013-0148-00 ..... $375

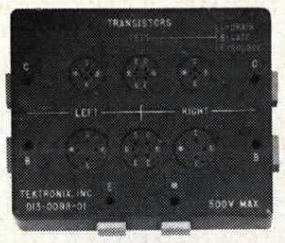
Standard Op Amp Card





Positive Regulator Card

Socket Adapters



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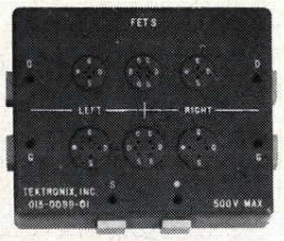

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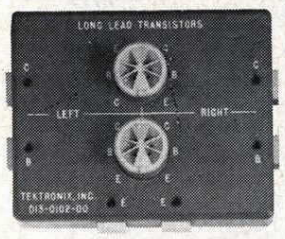

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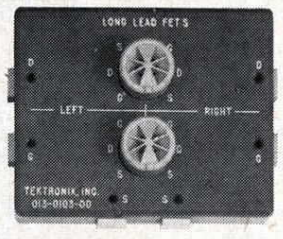

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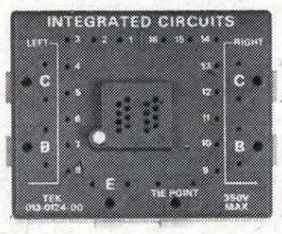


E

DUAL WIDTH ADAPTERS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

A. Transistor Adapter — Useful for most single and dual bipolar transistors and some MOS FET's.
Order (013-0098-02) **$90**

B. FET Adapter — Useful for most single and dual FET's.
Order (013-0099-02) **$90**

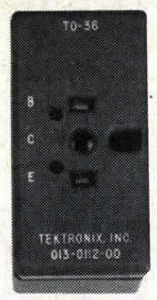
C. Long Lead Transistor Adapter — Accepts dual or single transistors with untrimmed leads.
Order (013-0102-00) **$70**

D. Long Lead FET Adapter — Accepts dual or single FET's with untrimmed leads.
Order (013-0103-00) **$80**

E. Integrated Circuit Adapter — Allows connection to multipin device packages. The appropriate multilead 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 cord. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. Order the appropriate multilead socket listed separately.
Order (013-0124-01) Includes 8 each 4-in test leads **$140**

A

B



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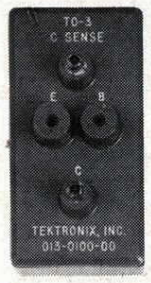

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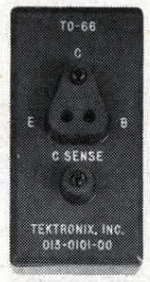

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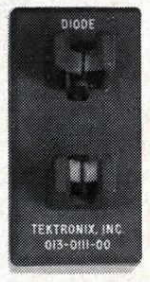

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KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

A. Transistor Adapter — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order (013-0127-01) **$40**

B. In-Line Adapter — Accepts large and small transistors with in-line leads. The adapter will accept devices with approx spacing between terminals of 0.06 in up to 0.18 in. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order (013-0138-01) **$42**

C. TO36 Adapter — Order (013-0112-00) **$40**

D. TO3 Adapter — Can be rewired to accommodate nonstandard configurations.
Order (0130-100-01) **$40**

E. TO66 Adapter —
Order (013-0101-00) **$40**

F. Axial Lead Diode Adapter —
Order (013-0111-00) **$40**

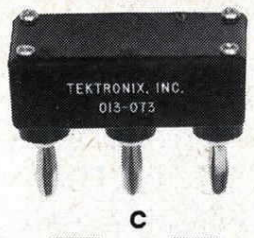
G. Stud Diode Adapter —
Order (013-0110-00) **$40**

H. Blank Adapter — For mounting special sockets.
Order (013-0104-00) **$20**

I. Power Transistor Adapter —
Order (013-0163-00) **$40**

A

B



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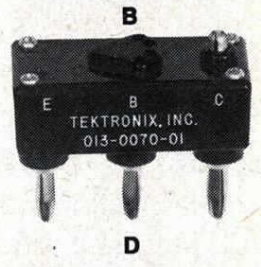

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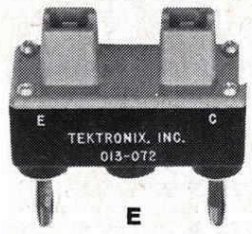

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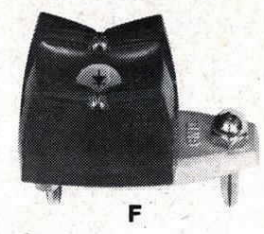

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3 PIN ADAPTERS

The following accessories may be used with any of the TEKTRONIX Curve Tracer products. They do not have Kelvin sensing contacts.

A. Long Lead Transistor Adapter —
Order (013-0069-00) **$15**

B. TO5 or TO18 Transistor Adapter —
Order (013-0128-00) **$17.50**

C. Blank Adapter — For mounting special sockets.
Order (013-0073-00) **$9**

D. TO3 or TO66 Transistor Adapter —
Order (013-0070-01) **$18**

E. Diode Test Adapter — Holds axial-lead diodes.
Order (013-0072-00) **$13**

F. Diode Test Adapter — Magnetically holds steel axial-lead diodes.
Order (013-0079-00) **$90**

MULTILEAD SOCKETS

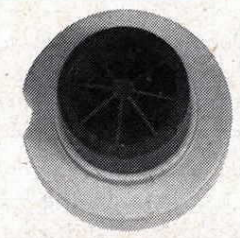
These sockets are used with the Integrated Circuits Adapter (013-0124-01) listed under Dual Width Adapters, and with the 178 Test Fixture.

A. 8 Lead TO package —
Order (136-0444-00) **$27**

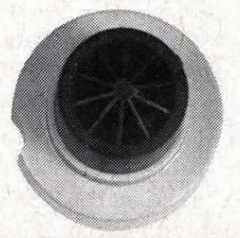
B. 10 Lead TO package —
Order (136-0441-00) **$27**

C. 14 Lead Dual-in-line package —
Order (136-0443-00) **$21**

D. 16 Lead Dual-in-line package —
Order (136-0442-00) **$21**



A



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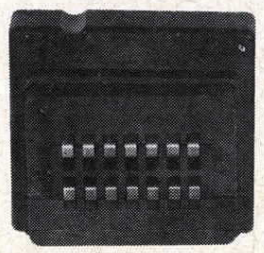

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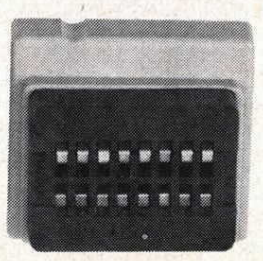


D

(These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Amphenol Sales Division, 2875 South 25th Avenue, Broadview, Illinois 60153, OR from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 75061.)

Curve Tracer
Plug-ins for the 5000- and 7000-Series Oscilloscopes

Tests Semiconductor Devices to 0.5 W

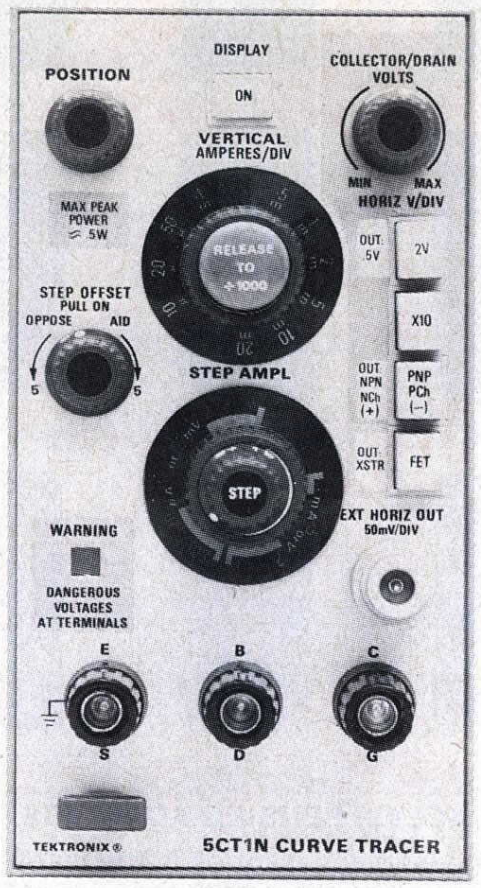
10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

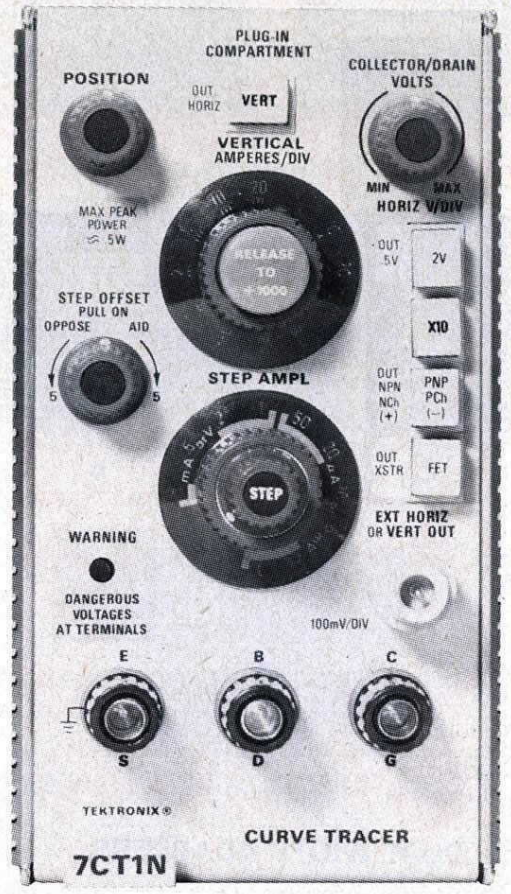
Easy to Operate

The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 5000-Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000-Series Oscilloscope Systems.

5CT1N



7CT1N



CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short circuit current, within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least X5 amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental; within 3% between steps. Absolute; within ± (3% + X0.3 amplitude setting).

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in one-step increments between 0 and 10.

Offset — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal V when in the ÷ 1000 mode.

Horizontal Deflection Factors — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

5CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 5000-Series Plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 5000-Series Oscilloscope Mainframe.

7CT1N Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 7000-Series Plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 7000-Series Oscilloscope Mainframe.

OTHER CHARACTERISTICS

Ambient Temperature — Performance characteristics are valid from 0°C to +50°C.

	5CT1N		7CT1N	
Dimensions	**in**	**cm**	**in**	**cm**
Length	12.0	30.5	14.5	36.8
Width	2.6	6.6	2.8	7.1
Height	5.0	12.7	5.0	12.7
Weight	**lb**	**kg**	**lb**	**kg**
Net	1.8	0.8	2.5	1.1
Shipping	4	1.8	6	2.7

Included Accessories — Test Adapter (013-0128-00) with two sets of test terminals, one with TO5 basing and the other with TO18 basing.

Order 5CT1N Curve Tracer $535

Order 7CT1N Curve Tracer $895

For optional accessories see 3 pin adapters on page 181.

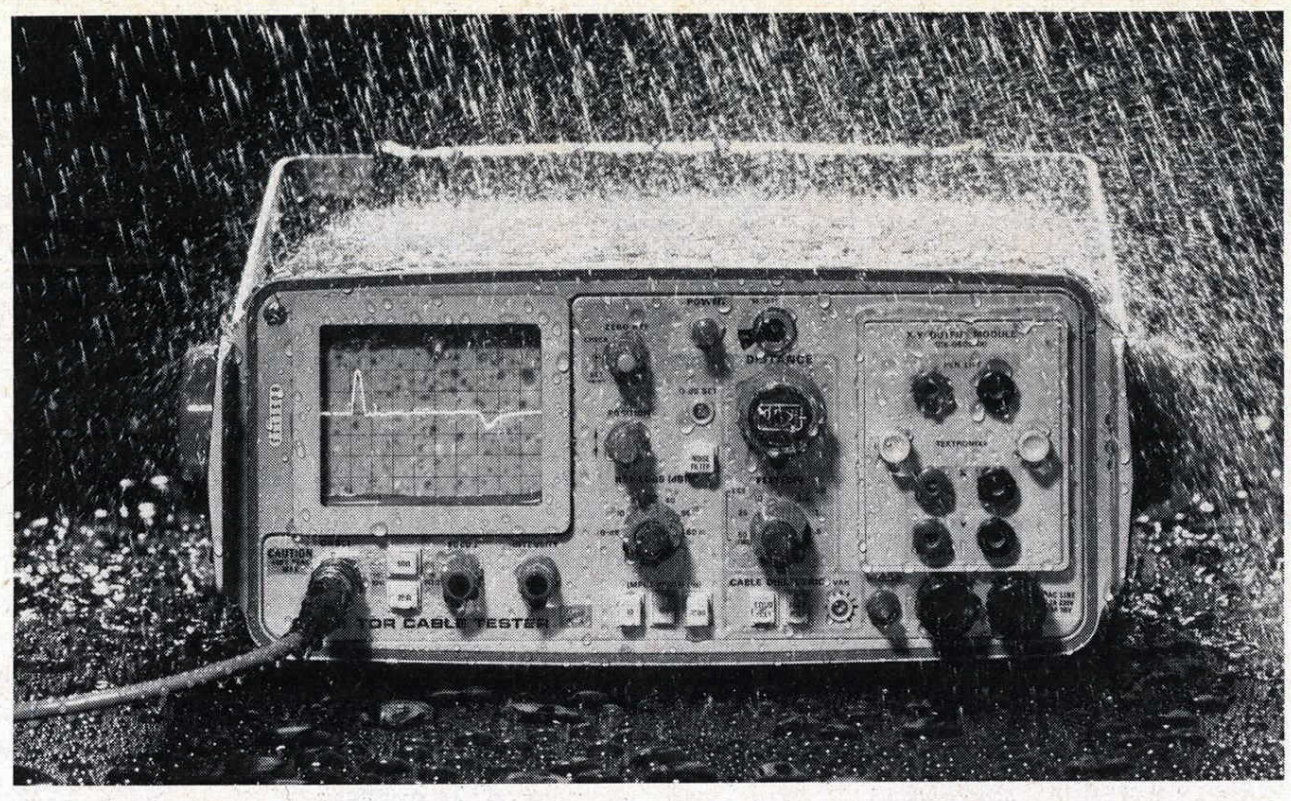
Cable Testers

Portable—Battery Powered, Self-Contained, Light (18 pounds), Small (5 x 12½ x 18½ in)

Rugged—Designed to MIL-T-28800, Type II, Class 2, Style A

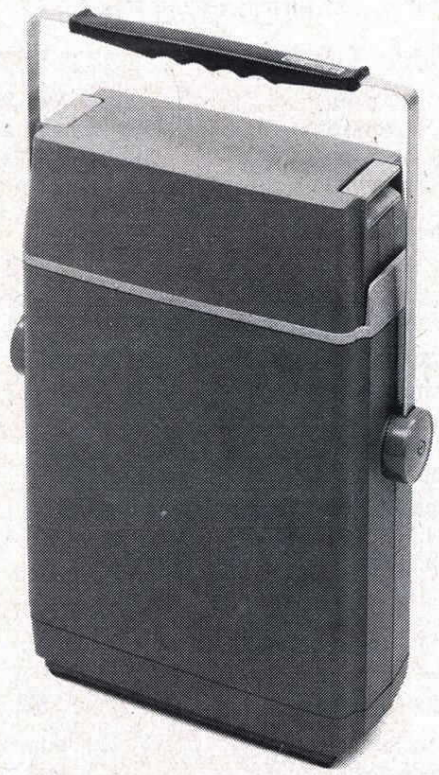
Versatile—Test Any Type Cable

Easy to Use—Produces Results with Minimum Operator Training



The portable, rugged 1502 and 1503 TDR Cable Testers are field maintenance tools that are simple to operate and will test any transmission cable under virtually any conditions. The 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The 1503 tests long runs of coax or twisted pair cables in telephone and other communications applications.

These units use a technique called Time Domain Reflectometry (TDR) to identify and locate cable faults. When connected to a line in the cable, the unit sends out an electrical pulse that is reflected back to the unit by a fault in the cable. Fault type is identified by the shape of the display, and fault distance is determined by the displayed interval from the test pulse to the fault pulse.



For easy carrying and operation in tight spaces, these units are lightweight and small and will operate at least five hours on the internal, rechargeable batteries.

Since permanent records are useful in cable maintenance, an optional, plug-in chart recorder is available for paper recording of the test. The standard plug-in X-Y Output module can drive an external X-Y Recorder.

1502

This unit is directly calibrated in reflection coefficient (rho) and distance. The 1502 uses a step-pulse and provides fault resolution to 0.6 inch on short cables. The 1502 performs to a maximum of 2000 feet, but with decreasing resolution as the fault distance increases. The unit is matched to 50-ohm cables, but may be used on others by adjusting the front panel GAIN control or using optional impedance adapters.

1503

For long cables, the 1503 provides high-energy, ½-sine-shaped pulses. Range of the 1503, dependent upon cable type, is up to 50,000 feet. Resolution capability provides for resolving faults as close together as three feet on short cables. Impedance levels of 50, 75, 93 and 125 ohms are selectable.

1503 Option 01

1503 Option 01 has DISTANCE CAL switches that make it more convenient for fault location in a variety of cables including coax. When the 1503 Option 01 has been calibrated for each cable before trouble occurs, and the records are kept, the DISTANCE CAL switches can be set exactly and damage location can begin immediately.

PA1 Cable Comparator

The PA1 Cable Comparator is used with the 1503 to amplify the test pulse and test two lines at the same time. This means instant comparison of a bad line with a good one, the ability to see crosstalk and a clear picture of faults on noisy or lossy lines.

The PA1 is connected between the 1503 and the cable to be tested, with the results displayed on the 1503 for measurement.

1502, 1503 Option 05

The 1502, 1503 Option 05 provides metric specifications for both units, where in many cases the metric specification is not a direct conversion from English measure. Metric specifications are listed with the 1502 and 1503 specifications, bracketed and italicized where conversion to metric is appropriate.

1502, 1503 Portable TDR Cable Testers

NOTE: When specifications are different for the metric version, Option 05 (in many cases, the metric specification is not a direct conversion from English measure), or where conversion to metric is appropriate, the metric specifications are shown in italics and are set in brackets.

1502 Characteristics

TEST SIGNAL

System Reflected Rise — ≤0.07 ft *[≤2.1 cm]* (≤140 ps).

Aberrations—±5% during 1st 10 ft *[300 cm]* after rise. ±0.5% peak beyond 10 ft *[300 cm]* NOISE FILTER "out." ±0.2% peak beyond 10 ft *[300 cm]* NOISE FILTER "in."

Jitter—≤0.02 ft *[0.6 cm]* (≤40 ps) for X.1. ≤0.1 ft *[≤3 cm]* (≤200 ps) for X1.

Termination — 50 Ω, within 2%.

Pulse Amplitude — 225 mV nominal (into 50-Ω load).

Test Connector —
Type: BNC.
Coupling: dc.
Max Input: DO NOT APPLY EXTERNAL VOLTAGE.

VERTICAL SYSTEM

Deflection Factor — 5 mρ/div to 500 mρ/div.

Accuracy: ±3%.
Gain: ≥3.5:1 from calibrated point.

Displayed Noise — ±5 mρ or less, NOISE FILTER switch "out."

Low Noise Operation — ±2 mρ or less, NOISE FILTER switch "in."

HORIZONTAL SYSTEM

Distance Controls —

Distance Dial:

Range — 0 to 100 ft *[0 to 25 m]* for X.1. 0 to 1000 ft *[0 to 250 m]* for X1.
Accuracy—within ±2% of reading ±0.05 ft *[±2% ±0.05 m]* for X.1. Within ±2% of reading ±0.5 ft *[±2% ±0.5 m]* for X1.

FEET/DIV Control:

Range — 0.1 to 20 ft/div *[0.025 to 5 m/div]* for X.1. 1 to 200 ft/div *[0.25 to 50 m/div]* for X1.
Accuracy — with 2% of full crt screen.

CABLE DIELECTRIC Scales (V_p/V_{air}) — SOLID POLY, 0.66; SOLID PTFE, 0.70; OTHER VAR, 0.55 to 1.0. VAR is calibrated for air when turned fully cw.

Sweep Repetition — 35 ±5 Hz with NOISE FILTER switch "out." 4 Hz within ±20% with NOISE FILTER switch "in."

1502 Included Accessories — Watertight front cover, TDR Slide Rule (003-0700-00); 50-Ω BNC Terminator (011-0123-00); Precision 50-Ω Cable (012-0482-00); Viewing Hood (016-0297-00); X-Y Output Module (016-0606-00); Replacement Fuses (for front panel) 117 V ac (159-0032-00) or 234 V ac (159-0029-01); Power Cord (161-0066-00); Mesh Filter (CRT) (378-0055-00); BNC Female-to-Female Adapter (103-0028-00).

1503 Characteristics

TEST SIGNAL

Duration — 10 ns, 100 ns, 1000 ns ±20% at half amplitude.

Amplitude — 10 V ±20% unterminated. 5 V ±20% terminated.

Shape — ½ sine ±20%.

Termination — 50 Ω, 75 Ω, and 93 Ω, with 1%; 125 Ω within 3%.

Jitter — 0.2 div max.

Test Connector —
Type: BNC.
Coupling: ac.
Max Input: ±400 V (dc + peak ac at max frequency of 440 Hz).

VERTICAL SYSTEM

Display —
Range: +6 to −18 dB from reference.
Accuracy: ±3%.

Display Reference —
Range: 0 to 60 dB, 7 steps, 10 dB per step.
Accuracy: ±0.1 dB.
Variable: 0 to 18 dB additive to steps.

Displayed Noise —
Aberrations: −30 dB p-p.
Random: −80 dB rms.

Low-Noise Operation — 86 dB rms, random.

HORIZONTAL SYSTEM

Distance Controls —

Distance Dial:

Range — 0 to 2,500 ft at X10 *[0 to 500 m at X1]*. 0 to 25,000 ft at X100 *[0 to 15,000 m at X10]*.
Accuracy — 2% of reading + 1 digit on dial.

FEET/DIV Control:

Range — 5 to 500 ft/div at X10 *[1 to 100 m/div at X1]*. 50 to 5000 ft/div at X100 *[10 to 1000 m/div at X10]*.
Accuracy — 2% of reading + 1 digit on dial.

CABLE DIELECTRIC Scales (V_p/V_{air}) — SOLID POLY, 0.66; FOAM POLY, 0.81; VAR, 0.31-1.0. VAR is calibrated for air when turned fully cw.

DISTANCE CAL Scales, Option 01 only (V_p/V_{air}) — Selectable from 0.2 to 1.0 in .01 increments.

Sweep Repetition — 35 ±5 Hz with NOISE FILTER switch "out." 20 s/sweep nominal in chart recorder mode (dependent upon chart recorder).

1503 Included Accessories — Watertight front cover, Replacement Fuses (for front panel) 117 V ac (159-0032-00) or 234 V ac (159-0029-01); Power Cord (161-0066-00); Viewing Hood (016-0297-00); 50-Ω BNC Terminator (011-0123-00); X-Y Output Module (016-0606-00); Mesh Filter (CRT) (378-0055-00); 9-ft BNC-to-Clip-Lead Cable (012-0671-00).

PA-1 Characteristics

Test Pulse Amplitude —
15 V for 10 ns pulse width
25 V for 100 ns and 1000 ns pulse widths
Voltages ±20%

60 Hz Rejection — 40 dB.

POWER SYSTEM

Battery Powered — Requires four (4) ASA "D" size alkaline cells (not provided).

Service Life — 100 hours minimum.

PHYSICAL CHARACTERISTICS

Weight — 3.75 lbs. (8.25 kg)

Domestic Shipping Weight — 6.75 lbs. (14.85 kg)

Width — 7.25 in. (18.4 cm)

Depth — 6.0 in. (15.3 cm)

Length — 11.5 in. (29.2 cm)

ENVIRONMENTAL CHARACTERISTICS

Military Specification MIL-T-28800, Type II, Class 2, Style B was used as a guideline for the environmental specifications.

Operating Temperature — −15°C to +55°C.

Water Resistance — Splash and drip proof. Cover removed.

Vibration — 3.0 g; 5 to 55 Hz.

Shock, Mechanical Pulse — 30 g. ½ sine shock.

PA-1 Cable Comparator $375

Common Characteristics

POWER SYSTEM

Line Voltage — 117 V ac ±20%, 48 to 410 Hz, 234 V ac ±20%, 48 to 410 Hz.

Battery Pack —

Operation: At least 5 hr (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.

Full Charge Time: 16 hr.

Typical Charge Capacity:

Charge Temperature	Discharge Temperature		
	−15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

EXTERNAL RECORDER INTERFACE (STANDARD X-Y MODULE)

Horizontal — 0.1 V/div, source impedance is 10 kΩ.

Vertical — 0.09 to 0.13 V/div (adjustable), source impedance is 10 kΩ.

PHYSICAL CHARACTERISTICS

Weight — 18 lb *[8.2 kg]* with front cover and standard accessories. 16 lb *[7.3 kg]* without front cover and accessories.

Domestic Shipping Weight — 24.4 lb *[11.1 kg]*.

Export Shipping Weight — Approx 36 lb *[16.3 kg]*.

Height — 5.0 in *[12.7 cm]*.

Width — 12.4 in *[31.5 cm]* with handle. 11.8 in *[30 cm]* without handle.

Depth — 16.5 in *[41.9 cm]* including front cover, handle not extended. 18.7 in *[47.5 cm]* handle extended.

ORDERING INFORMATION

1502 TDR Cable Tester $3750

Option 04 (with recorder) . . . . . add **$650**
Option 05 (metric version) . . . . . no extra charge
Option 06 (234-V version) . . . . . no extra charge
Option 76 (P7 phosphor) . . . . . **+$35**

1502 Optional Accessories

Chart Recorder — 016-0506-03 . . . . . **$700**
Chart Paper (roll) 006-1658-01 . . . . . **$5.75**
Chart Paper (100-roll case) 006-1658-02 . . . . . **$425**
Accessory Pouch — 016-0351-00 . . . . . **$18**
Impedance Adapter —
50/75 Ω — 017-0091-00* **$60**
50/93 Ω — 017-0092-00* **$60**
50/125 Ω — 017-0090-00* **$60**
*Should be purchased with following two parts:
Connector, BNC Female-to-GR — 017-0063-00 . . **$25**
Connector, BNC Male-to-GR — 017-0064-00 . . . . **$35**
Direct Current Adapter with Filter (for use with standard 12 V automobile lighter plug with negative ground) 25 foot — 015-0327-00 . . . . . **$95**

1503 TDR Cable Tester $3250

Option 01 (Distance Cal) . . . . . add **$100**
Option 04 (with recorder) . . . . . add **$650**
Option 05 (metric version) . . . . . no extra charge
Option 06 (234-V version) . . . . . no extra charge
Option 76 (P7 phosphor) . . . . . **+$35**

Also available is a modified **1503 TDR Cable Tester** with calibrated pushbutton selection for telephone L-carrier cables . . . . . **request quote**

1503 Optional Accessories

Chart Recorder — 016-0506-03 . . . . . **$700**
Chart Paper (roll) 006-1658-01 . . . . . **$5.75**
Chart Paper (100-roll case) 006-1658-02 . . . . . **$425**
Isolation Network (for balanced lines) —
013-0169-00 . . . . . **$140**
Adapter Cables (BNC-to-Clips) —
9-foot — 012-0671-00 . . . . . **$40**
30-foot — 012-0671-01 . . . . . **$55**
Accessory Pouch — 016-0351-00 . . . . . **$18**
Direct Current Adapter with Filter (for use with standard 12 V automobile lighter plug with negative ground) 25 foot — 015-0327-00 . . . . . **$95**

LOGISTICS INFORMATION

For logistics data, see Tektronix Logistics Data Book.

Digital Photometer/Radiometer

J16 Photometer/Radiometer (Fig 1)

3½-Digit Light-Emitting Diode Readout

Portability and Versatility

Complete Probe Interchangeability without Recalibration

Available with Metric Readout

The J16 is a portable photometer/radiometer that is equally at home in the lab or in the field. It weighs 3.3 lbs., measures 2.4 x 4.6 x 8″ and comes with a shoulder strap and rechargeable nickel-cadmium batteries or optional ac power supply. The J16 is used with one of the eight interchangeable pre-calibrated silicon detector probes. (Listed on this page.)

The Digital Photometer/Radiometer has excellent long-term calibration stability and is environmentalized to operate −15°C to +40°C and meet MIL spec for humidity.

Also available for the J16 are probe cable (for separate operation of the probe), and analog and bcd outputs.

All J16 Probes

Rugged, Stable Silicon Sensor and Glass Spectral-Correction Filter

Hold Switch to Store Reading

Calibration Accuracy of Reading 5% ± One Digit

No Fatigue or Saturation Effects

Excellent Calibration Stability

J6511 Illuminance Probe (Fig 2)

Accurate Photopic (Color) Correction

Accurate Cosine Correction (180° Field of View)

Measures 0.001 to 1999 Footcandles (0.01 to 19,999 Lux*)

Resolution 0.0001 Footcandles (0.001 Lux*)

5% Accuracy Even with Low-Pressure Sodium Lighting

25-Ft Cable Attached

Built-in Bubble Level

Use for OSHA Standards, Office Lighting, Highway Lighting, Automotive Lighting, Medical Lighting

J6523 1° Luminance Probe (Fig 3)

1° Acceptance Angle

Optical Sighting and Viewing System

Accurate Photopic (Color) Correction

Measures 0.1 to 19,990 Footlamberts (1 to 199,900 Nits*)

Resolution 0.01 Footlamberts (0.1 Nits*)

Measures a Spot as Small as 0.23 Inches at 18-In Distance (0.035″ with Commercially Available Standard Photographic Close-up Lenses)

Focus Range of 18 Inches to Infinity

5% Accuracy Even with Low-Pressure Sodium Lighting

Use for Highway Lighting, Television, Photographic Equipment, Cathode-Ray Tubes

**Metric version.*

Fig 1 Fig 2 Fig 3 Fig 4 Fig 5

J6502 Irradiance Probe (Fig 4)

Flat Spectral Response within ±7% from 450 to 950 nm

Measures 1 nW/cm² to 1.999 mW/cm² (0.01 to 19,900 mW/M²*)

Resolution 0.1 nW/cm² (0.001 mW/M²*)

1-cm² Sensor Allows Direct Reading of Laser Power in μW with Detector Underfilled by Beam

Acceptance Angle Approximately 120°

Use for Lasers, Environmental Research, Tv Monitor Color Temperature Adjustment, Ir LED's

J6503 8° Luminance Probe (Fig 4)

Accurate Photopic (Color) Correction

Measures 0.1 to 199,900 Footlamberts (1 to 1,999,000 Nits*)

Resolution 0.01 Footlamberts (0.1 Nits*)

Use for Television, Illumination, Photographic Equipment, Cathode-Ray Tubes

J6501 Illuminance Probe (Fig 4)

Same Characteristics as J6511 Except No Cosine Correction; Construction Similar to J6502. (When Using 014-0047-00 LED Adapter, the Ranges are the Same as Those for the J6505.)

Use for Green and Yellow LED's, Lamp Testing, and Other Point Light Sources

J6505 Red LED Probe (Fig 4 and 5)

Accurately Matches Photopic Curve from 600 to 710 nm

Measures 0.01 Millicandela to 199.9 Candelas at 3.8 Inches (Higher at Greater Distances)

Resolution 0.01 Millicandela

Includes Snap-on LED Adapter to Position LED and Exclude Room Light

Use for Red LED's, Red Automotive, and Aircraft Lights

J6512 Irradiance Probe (Similar to Fig 2)

Same Characteristics as J6502; Construction Similar to J6511

Use for Lasers, Medical, Environmental Research

J6504 Uncorrected Probe (Fig 4)

Spectral Response: Uv-Enhanced Silicon Curve (250 to 1200 nm)

Highest Sensitivity (No Filters Are Used to Modify Spectral Response)

Relative Reading Only

Use for Periodic Tests of Photoresist Exposure Equipment, Uv Light Sources

ORDERING INFORMATION

J16 Battery power, 90-136 V, 50-60 Hz, includes battery charger $830

J16 Opt. 01 Battery power, 180-272 V, 50-60 Hz, includes battery charger ..... No Charge

J16 Opt. 02 Provides metric readout in lieu of U.S. unit readout ..... No Charge

J16 Opt. 03 Ac power 90-136 V, 50-400 Hz ..... No Charge

J16 Opt. 04 Ac power 180-272 V, 50-400 Hz ..... No Charge

J16-TV

Also available is the J16-TV Photometer/Radiometer package for making a variety of light measurements in the television studio. The J16-TV package includes the portable J16 Photometer/Radiometer, a J6502 Irradiance Probe, a light occluder, a probe extension cable and battery charger.

ORDERING INFORMATION

J16-TV Battery power, 90-136 V, 50-60 Hz, includes battery charger . $1300

The J16-TV is also available with Option 01, 02, 03, 04—no additional charge.

Analog and digital outputs available for J16 and J16 TV on special order.

PROBES

J6511 Illuminance Probe $420
J6523 1° Luminance Probe $1150
J6502 Irradiance Probe $400
J6503 8° Luminance Probe $400
J6501 Illuminance Probe $400
J605 Red LED Probe $475
J6512 Irradiance Probe $450
J6504 Uncorrected Probe $400

An actual spectral curve of all the above probes is available as an option. Specify Option 05 when ordering. ..... **Add $75**

Any Option 02 J16 must be used with an Option 02 probe. Specifiy Option 02 when ordering probe, no additional charge.

ACCESSORIES

42-in Probe Extension Cable for J6501, J6502, J6503, J6504, and J6505.
Order 012-0414-02 (Longer on Special Order) **$70**

Light Occluder (for Color Tv Monitor Setup).
Order 016-0305-00 ..... **$18**

Filter Holder — Mounts 1-in Diameter Filters to J6501, J6502, J6503, J6504, and J6505.
Order 016-0527-00 ..... **$18**

Filter Holder — Mounts 2-in Diameter Filters to J6512.
Order 352-0380-00 ..... **$3**

Tripod, Order 016-0253-00 ..... **$55**

Ac Power Supply, 115 V, 50-400 Hz.
Order 119-0404-00 ..... **$160**

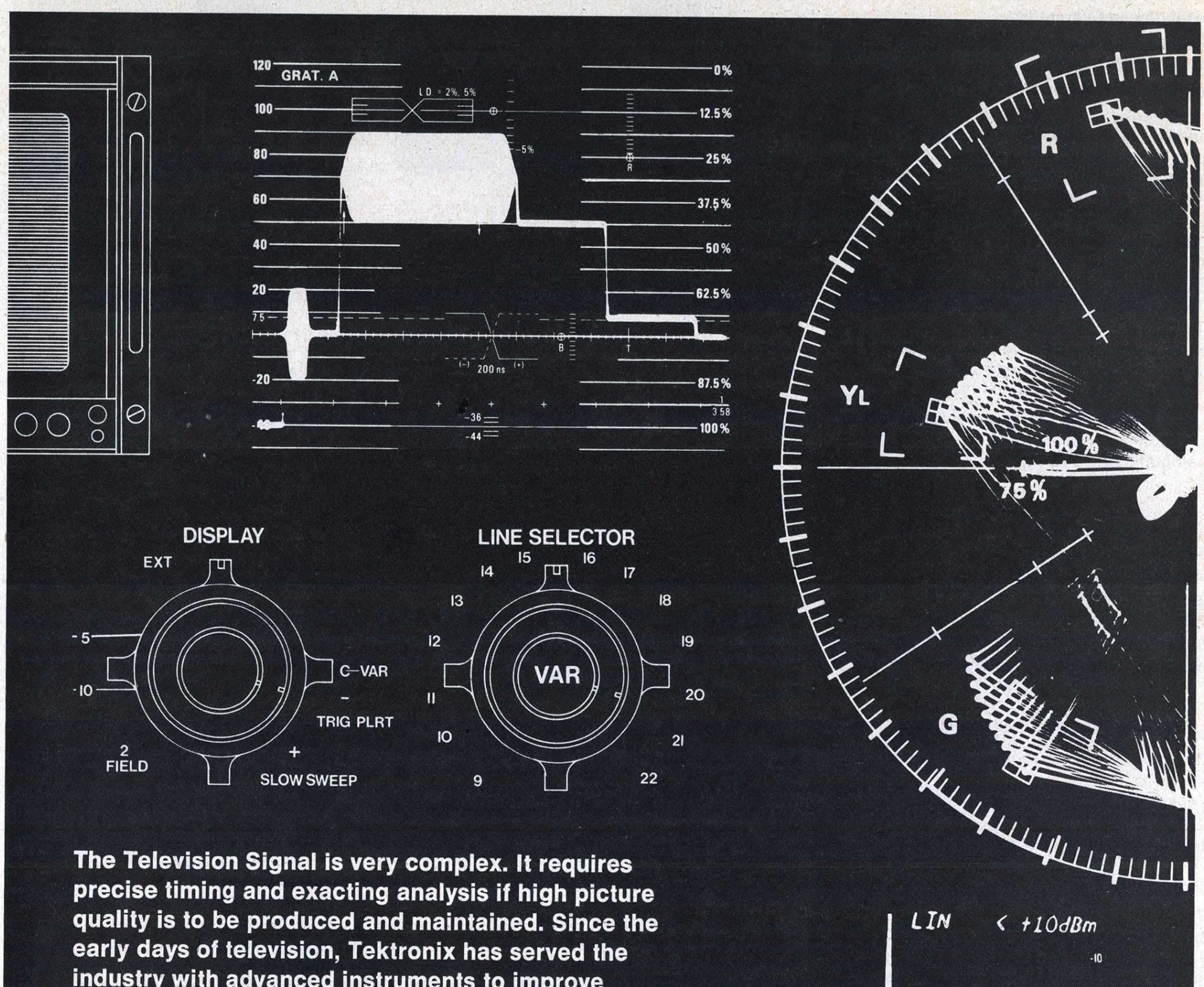
Ac Power Supply, 230 V, 50-400 Hz.
Order 119-0404-01 ..... **$170**

LED Adapter (included with J6505).
Order 014-0047-00 ..... **$62**

Extra battery pack for J16 and J16-TV
Order 016-0539-01 ..... **$110**

13

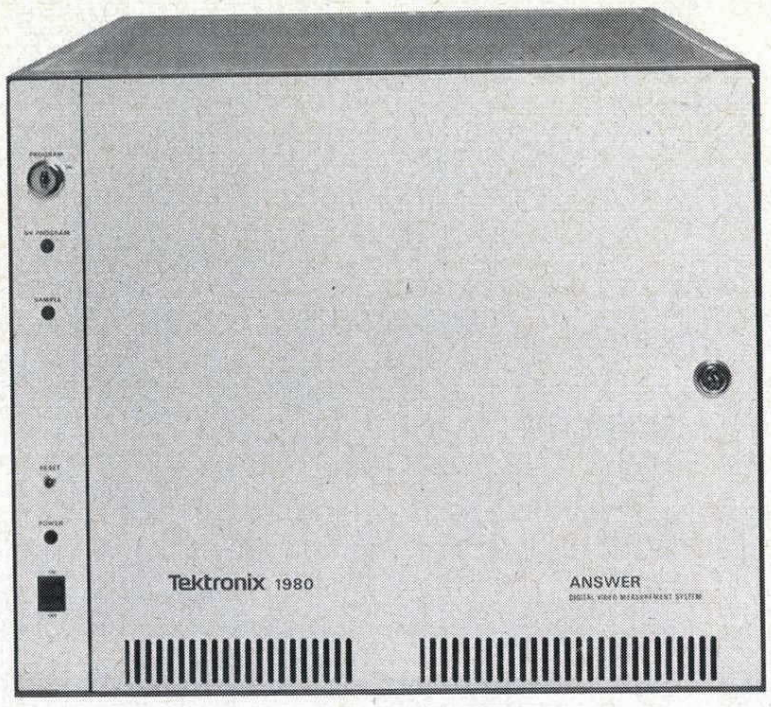
Television Products



The Television Signal is very complex. It requires precise timing and exacting analysis if high picture quality is to be produced and maintained. Since the early days of television, Tektronix has served the industry with advanced instruments to improve picture quality. Today our people and products are industry leaders in timing, testing, measuring, correcting and displaying the televison signal.

An overview of the Tektronix Products that can help you achieve and maintain picture quality appears on the next page. Complete product specifications are given in the TEKTRONIX TELEVISION CATALOG. To get your copy, please use the response card in this catalog or call toll free, within Continental U.S., 1-800-547-1512.

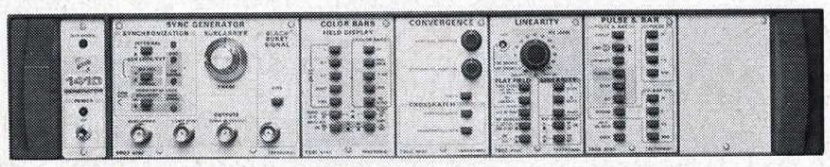
Whatever your color standard — PAL, SECAM, or NTSC — Tektronix Television Products will help you deliver the picture quality you want.



ANSWER™ is a new, all digital, software-programmable, automated video signal measurement set. It is factory programmed to make over 30 amplitude, phase, and timing measurements using NTC 7 and FCC VIT signals. Special measurement requirements may be user programmed in BASIC. Measurement results are output in ASCII code. ANSWER is RS-232C and GPIB compatible. Its uses include monitoring the video signal in common carrier satellite and terrestrial systems, broadcast plants, unattended tv transmitter systems and video equipment manufacturing quality control.

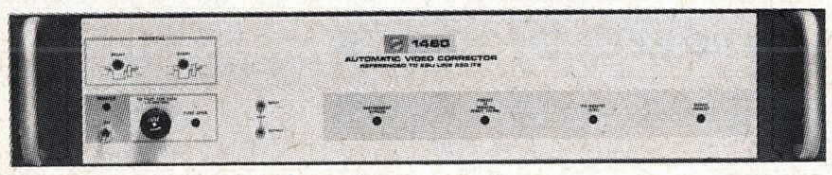
Demodulators—Systems M, B and G

The Tektronix 1450 Demodulator aids measurement of the quality of the transmitted signal and performance of the television transmitter. It does not introduce any distortion into measurements via the demodulation process. Selectable envelope or synchronous detection is provided. Technological advances in the 1450, such as Tektronix-developed surface acoustic wave filters, make it one of the most advanced demodulators available.



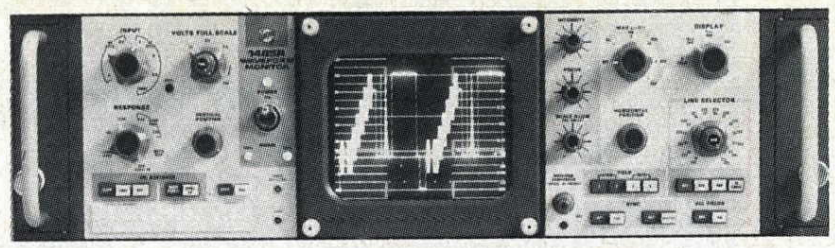
Generators—Sync and test signal for NTSC, PAL, PAL-M and SECAM

All of the many signals needed to accurately time and test broadcast and closed circuit color video equipment are provided by TEKTRONIX Television Signal Generators. Most TEKTRONIX Generators provide many signals, rather than just one or two, with an arrangement of fully or partially independent controls. Genlock and signal processing functions are included.



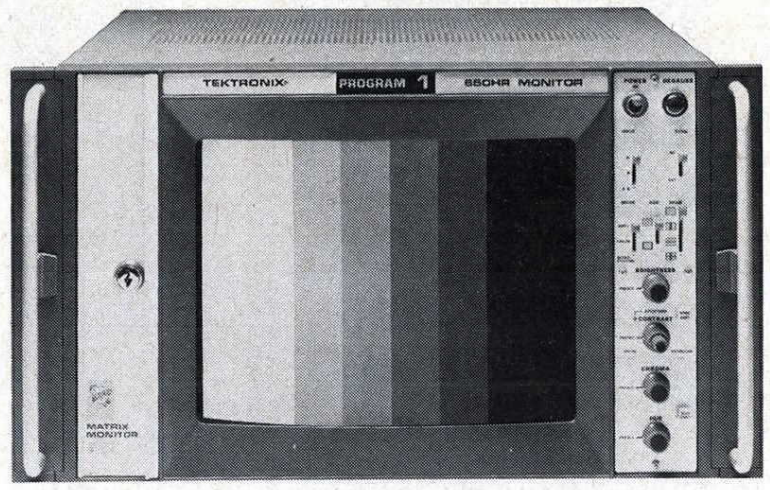
Correctors—NTSC and PAL

TEKTRONIX Automatic Video Correctors sample and correct a reference signal located in the vertical-blanking interval to correct the video signal. The full field signal is simultaneously corrected by the same automatic changes that correct the reference signal.



Waveform Monitors—NTSC, PAL, PAL-M, and SECAM

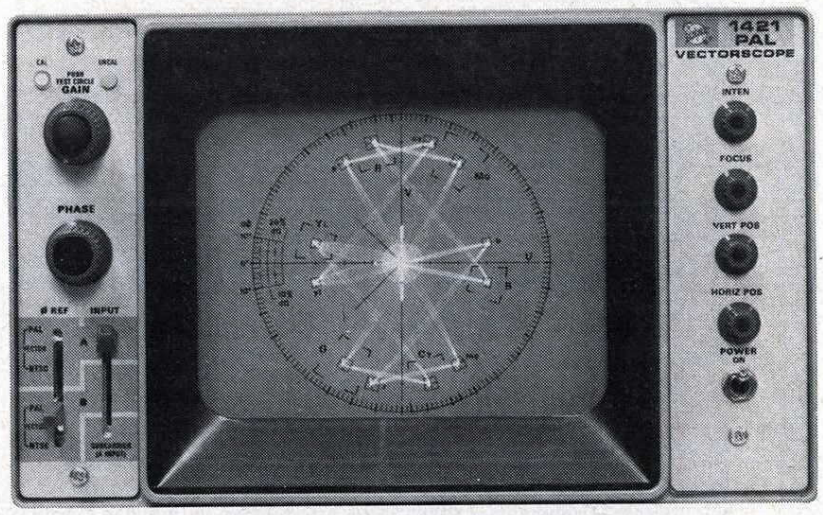
With sync-selective triggering and precise vertical characteristics, TEKTRONIX Waveform Monitors are designed for quick and accurate measurement of the components of the composite-video signal. There is a selection of TEKTRONIX Waveform Monitors for 525/60 and 625/50 scanning standards and for full or half-width rack installation. Cabinet-style units are also available.



Picture Monitors—NTSC, PAL, PAL-M and SECAM

In addition to having stable, consistent color characteristics, TEKTRONIX Color Picture Monitors provide underscan and vertical and horizontal delay for detailed examination of the entire picture. And for those who need it, 50% higher resolution is available in the new 650 HR Series.

TEKTRONIX Monitors are sized to fit the critical space requirements of your installations. The Trinitron kinescope makes both the 650 Series and the 670 Series simple to converge and contributes to the color stability of both series.



Vectorscopes—NTSC, PAL and PAL-M

Vectorscopes are used to display and examine the chrominance signal. Some Vectorscopes offer linear time-base displays in addition to vector displays. Luminance amplitude, chrominance amplitude, chrominance phase, differential phase, and differential gain are included in the wide variety of specialized measurements for which Vectorscopes are used.

The complete reference for data on TEKTRONIX Television Products is the TEKTRONIX Television Catalog. To get it, see the response card in this catalog or call toll free 1-800-547-1512.
Check this catalog for other products used in the video communications industry: sideband analyzers, spectrum analyzers, scopes with sync separation features, and the TM 500 Modular Instruments.

TRINITRON is a registered tradename of Sony Corporation.

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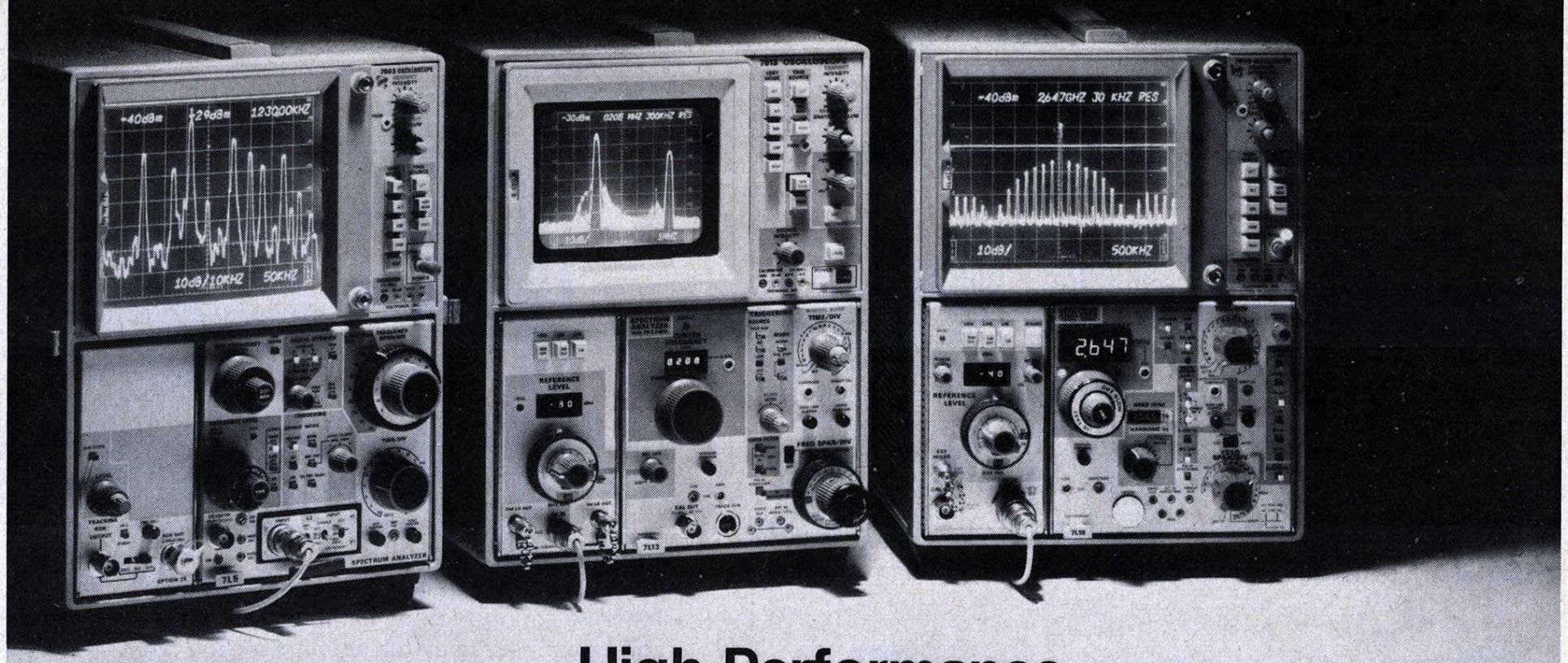
Spectrum Analyzers and Tracking Generators



High-Performance plug-in SPECTRUM ANALYZERS 20 Hz to 60 GHz

The 7000 Series family of high performance plug-in spectrum analyzers includes the 7L18, 7L13, and 7L5. Read about these and other spectrum analyzer products in the next 10 pages.

30 Hz Resolution to 12 GHz

Microprocessor-aided Front Panel Controls

Digital Display and Signal Processing (Max Hold, Save A, Split and Comparison Features, and Algebraic Addition)

Calibrated Reference Level Includes Internal Preselector

60 GHz with Optional Waveguide Mixers

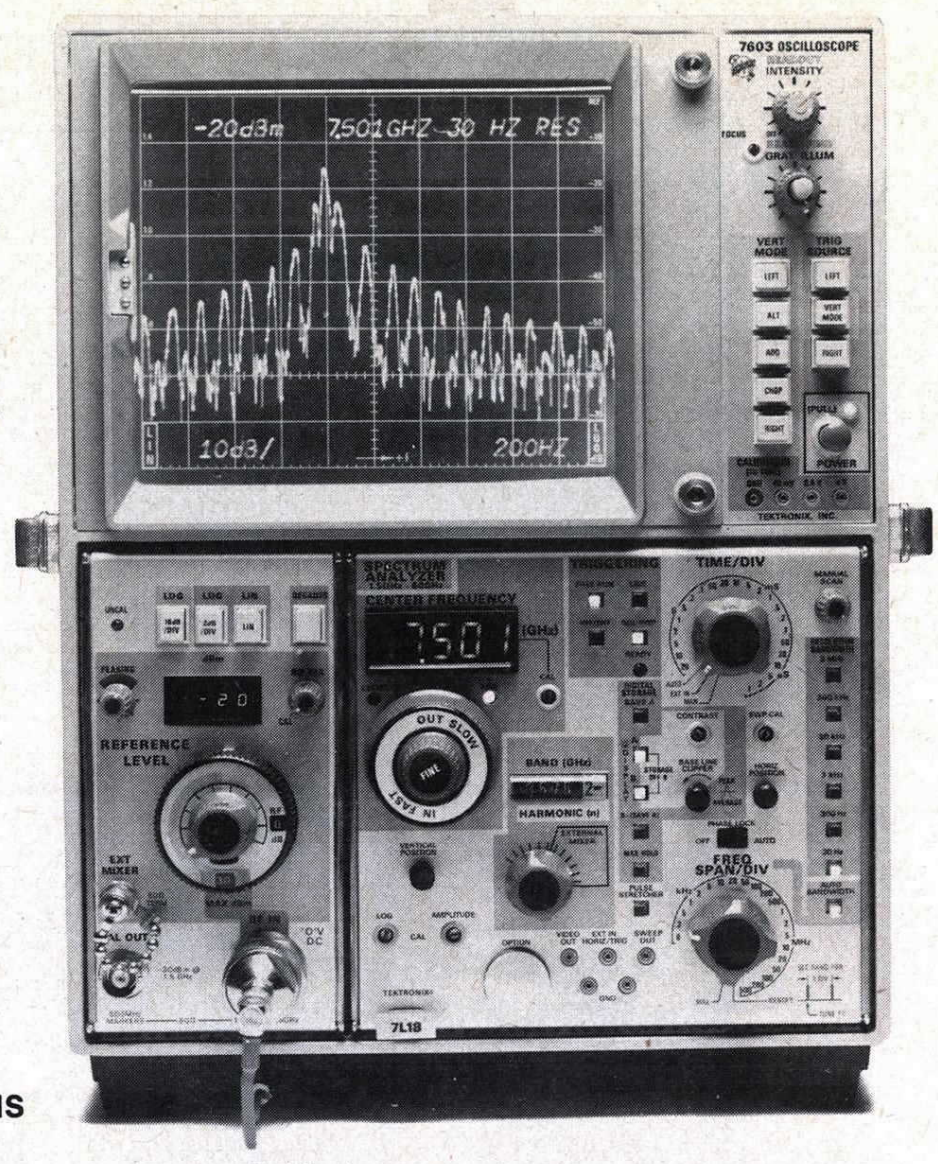
Transportable—Just 48 Pounds Including 7603 Mainframe

Preselected for Freedom from Spurious Responses

80 dB Display Dynamic Range

≤ 10 Hz Residual FM (Fundamental Mixing)

Fits all 7000-Series Mainframes including USM-281C



7L18 SPECIFICATIONS

FREQUENCY RELATED

Frequency Range—1.5 GHz to 60.5 GHz

Tuning Range—

With internal mixer: 1.5 GHz to 18 GHz.

With external mixer: 12.5 GHz to 60.5 GHz.

Frequency Span—Per Division: 20 calibrated span width from 200 Hz/div to 500 MHz/div in a 1-2-5 sequence. Max span: Depends on mixing mode. Span width =N x 2 GHz where N is the mixing mode. Maximum span full screen is 8.5 GHz with internal mixer (9.5 to 18 GHz band). Zero Span: Non-sweeping tunable receiver mode.

Tracking Preselector—Internal and automatic 1.5 to 18 GHz. Rejection of harmonic mixing, image and multiple responses > 70 dB.

Frequency Bands—

With internal mixer	(N = mixing mode)
1.5 GHz to 3.5 GHz	N = 1−
2.5 GHz to 4.5 GHz	N = 1+
3.5 GHz to 7.5 GHz	N = 2−
6.5 GHz to 12.5 GHz	N = 3+
9.5 GHz to 18.0 GHz	N = 5−
With external mixer	(N = mixing mode)
12.5 GHz to 24.5 GHz	N = 6+
14.5 GHz to 28.5 GHz	N = 7+
16.5 GHz to 32.5 GHz	N − 8+
18.5 GHz to 36.5 GHz	N = 9+
20.5 GHz to 40.5 GHz	N = 10+
30.5 GHz to 60.5 GHz	N = 15+

Frequency Accuracy—

Dial Accuracy: (5 MHz +20% of frequency span/div) x N [typically (1 MHz)x N with degauss activated].

Span accuracy—5% over center 8 horizontal divisions (typically 3%).

Stability—Residual fm, stabilized 10 Hz peak-to-peak x N (typically 2 Hz peak-to-peak x N).

Frequency Drift—

Long term drift: (at fixed center frequency after 2 hr warm up).

Stabilized: 2 kHz/hr x N.

Unstabilized: 50 kHz/hr x N.

Setability—

Within 1 MHz for 1.5 GHz to 18 GHz (after 2 hr warm up).

Within 10 MHz with external mixers (after 2 hr warm up).

Resolution—

Bandwidth range: Selectable 6 dB bandwidths from 30 Hz to 3 MHz in decade steps plus auto.

Shape factor: 4:1, 60 db to 6 dB points, 300 Hz to 3 MHz, 12:1, 60 dB to 6 dB points, 30 Hz.

Bandwidth accuracy: 6 dB points, 20%.

Phase Noise Sidebands—When phase locked, for fundamental (N=1) conversion: −70 dBc min at frequency offsets ≥20X resolution bandwidth settings.

Table 1

Sensitivity and Frequency Response with Internal Mixers—(Average noise level specified for 300 Hz resolution bandwidth. Frequency Response with 10 dB input attenuator setting.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	*Frequency Response Optimum Peaking (dB Max)
1.5—3.5	1−	−119	±1.5
2.5—4.5	1+	−119	±1.5
3.5—7.5	2−	−109	±2.0
6.5—12.5	3+	−107	±2.5
9.5—18.0	5−	−92	±3.0

*Includes mixer frequency response, rf attenator frequency response, internal preselector frequency response, mixing mode gain variation, rf input VSWR.

Table 2

Sensitivity and Frequency Response with External Mixers—Average noise level specified for 3 kHz resolution bandwidth.)

Frequency Range (GHz)	Mixing Mode	Average Noise Level (dBm Max)	Frequency Response (dB Max)
12.5—18.0	6+	−85	—
**18.0—26.5	7+	−90	±3
**26.5—40	10+	−85	±3
**40—60.5	15+	−75	±3

**High Performance Mixer Line.

AMPLITUDE RELATED

MEASUREMENT RANGE

Log Reference Level— −110 dBm to +40 dBm (+30 dBm max safe input level).

Log Display Dynamic Range—80 dB.

Linear—8 divisions with calibrated reference levels.

Rf Attenuation Range—6 steps @ 10 dB/step.

If Gain Range—9 steps @ 10 dB/step −20 dBm to −110 dBm (with zero rf attenuation) (−20 dBm is reduced noise position).

Sensitivity and Frequency Response—See tables 1 and 2, and figure 1.

Amplitude Accuracy—

If gain variation with different resolution bandwidths (at 25°C).

Log: ±0.5 dB.

Reference level variation due to band switching: ±1.0 dB.

Display—

Log 10 dB/div: ±1.0 dB/10dB to a maximum of 2.0 dB. Log 2 dB/div: ±0.4 dB/2 dB to a maximum of 1.0 dB.

Linear: ±10%.

If gain: ±1.0 dB/10 dB, ±2 dB max.

Rf attenuator: ±0.3 dB/10 dB to a maximum of ±0.7 dB.

Calibrator output: Amplitude −30 dBm ±0.5 dB, frequency 2.0 GHz ±0.01%.

Absolute Calibration Accuracy 1.5 to 18 GHz: Overall accuracy is a function of measurement technique and includes the following parameters: Amplitude calibrator + band switching error + if gain switching + rf attenuator switching + logging error + flatness + digital quantizing error (if digital storage is used). With appropriate technique, absolute accuracy of ±2.5 dB is usually achievable (1.5 to 18 GHz).

INPUT CHARACTERISTICS

Input Impedance—50 ohms nominal (1.5 to 18 GHz).

Connector—Type "N" female.

VSWR—≤ 1.35 for attenuator settings of ≥10 dB.

Maximum Input Level—1 watt (+30 dBm).

Optimum Input Level—≤ −30 dBm with zero rf attenuation.

Input Compression Point—≥ −28 dBm from 1.5 to 1.8 GHz. ≥−18 dBm from 1.8 to 18 GHz. (Both with zero rf attenuation.)

L.O. Emission—−80 dBm, 1.5 to 18 GHz (10 dB input attenuator setting).

SPURIOUS RESPONSES

Residual—(No signal present at input) with input attenuation at 0 dB, ≤ −110 dBm.

Intermodulation Distortion—Third order down 70 dB or more from any two full screen signals, when if gain is not set to red zone (reduced noise position).

Mixed—All harmonic mixing, image and multiple responses down 70 dBc to 18 GHz.

DIGITAL STORAGE AND SIGNAL PROCESSING

Multiple memory display storage (A & B memory).

Save "A".

Digital display averaging.

Max hold.

B minus "Save A".

Disable for non-storage viewing.

GENERAL

Sweep Characteristics—1 μs/div to 20 sec/div in a 1, 2, 5 sequence plus auto, manual, and external. Accuracy ±5%.

Triggering Modes—Internal, external, free run, single sweep. Triggering source line, internal, external. Sensitivity: 1 div internal, 0.5 volt external (50 volts max). Frequency Range: 15 Hz to 1 MHz.

Video Output—500 mV ±5%/div of display.

Pulse Stretcher—Enhances pulsed rf measurements.

Degauss—Improves frequency measurement accuracy.

X, Y Output—Front panel pin jacks.

Uncal Light—Provides indication of uncalibrated display amplitude.

Peaking—Optimizes sensitivity and frequency response.

ACCESSORIES

Included—	Part Number
1 Spectrum Analyzer Graticule	337-1439-01
1 Spectrum Analyzer Graticule	337-1159-02
1 50 ohm coaxial cable, 10 in.	012-0208-00
1 Adapter, BNC female to N male	103-0045-00
Plug-in to Mainframe Securing Kit	016-0637-00

Optional—

General Purpose Waveguide Mixers

Set 016-0640-00 ..... $550

Mixer 119-0097-00 130

Mixer 119-0098-00 170

Mixer 119-0099-00 200

Cable 012-0748-00 15

Case 004-1651-00 35

High Performance Waveguide Mixers

Set 016-0641-00 ..... $2705

Mixer 016-0631-00 850

Mixer 016-0632-00 850

Mixer 016-0634-00 950

Cable 012-0649-00 20

Case 004-1651-00 35

Carrying Case: Protective aluminum case with hinged latchable front cover and carrying handle.

016-0626-00 ..... $185

ORDERING INFORMATION

7L18 Spectrum Analyzer $14,600

***7603 Oscilloscope $2260**

R7603 Oscilloscope (Rackmount) $2560

Option 06 Internal S A Graticule ..... +50

Option 08 Protective Front Cover (Cabinet Only) ..... +$100

*Suggested Mainframe: 7603 Opt 08/Opt 06 for maximum transportability. Has protective front cover (Opt 08) and Spectrum Analyzer Graticule (Opt 06). See 7000 Series pages for oscilloscope specifications and options.

7L13 | 1 kHz to 1800 MHz Spectrum Analyzer

1 kHz to 1800 MHz in One Display

Fully Calibrated Displays

30 Hz to 3 MHz Resolution

4:1 Resolution Bandwidth Shape Factor

70 dB On-screen Dynamic Range

IM Distortion 70 dB below Full Screen

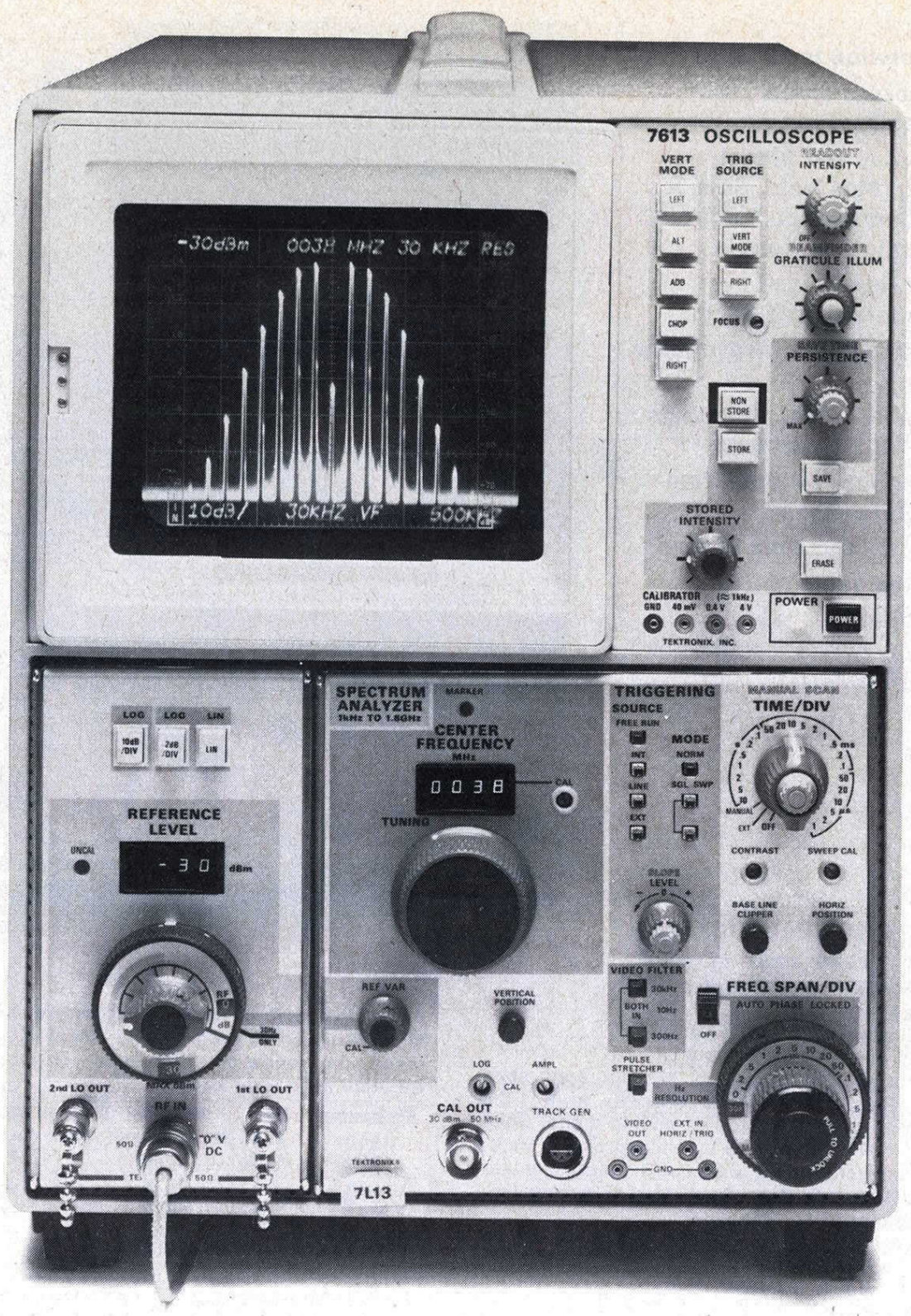
Spurious Free Operation

Automatic Phase Lock

—128 dBm Sensitivity

The 7L13 Spectrum Analyzer represents the highest performance possible today in an instrument of this frequency range and price. The fm stability is 10 Hz, making 30-Hz resolution possible across the entire frequency range.

This analyzer is a high quality laboratory instrument. In addition to incorporating the standard features of the 7L12, it has crt readout of the center frequency, and an UNCAL light to indicate incorrect settings of the sweep rate or resolution controls.



The 2.5 GHz modified 7L13 in a 7613 mainframe featuring variable persistence. Variable persistence is recommended for maximum utilization of the capabilities of the 7L13. Information is available upon request.

7L13 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 1 kHz to 1.8 GHz.

Resolution Bandwidth — Resolution bandwidth selections from 30 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 12:1 or better for 30 Hz resolution and 4:1 or better for 300 Hz to 3 MHz resolution.

Stability — Within 2 kHz, after a 2 hour warm-up, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — —10 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from —110 dBm to +30 dBm, within ±2 dB. An UNCAL indicator shows when excessive sweep speeds are selected.

Log 10 dB/div:
—70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
—14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode) —128 dBm at 30 Hz, —115 dBm at 300 Hz, —108 dBm at 3 kHz, —100 dBm at 30 kHz, —90 dBm at 0.3 MHz, —80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — +1 dB, —2 dB over any frequency span.

Spurious Responses —
Residual — (No signal present at input) with input attenuation at 0 dB, ≤—100 dBm.

Intermodulation Distortion — Third order down 70 dB or more from two —30 dBm signals within any frequency span. Second order down 70 dB or more from two —40 dBm signals.

Mixed — All image, harmonic related, and out-of-band mixing responses are ≥70 dB down from a level of —30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 80 dB when operating with 30 Hz resolution bandwidth. 70 dB with 300 Hz to 3 MHz resolution bandwidth. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — Calibrated steps in 1-2-5 sequence from 200 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — Selection of an external sweep source, manual sweep, or calibrated time base, 10 s/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, —30 dBm at 50 Ω.

Video Out — Approx 2 V full screen.

Horiz In — (and Trig) For use with chart recorder.

Tracking Gen (Logic) — For use with tracking generator (5 V TTL).

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000-Series Oscilloscopes. Amber Light Filter: 378-0684-01; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

7L13 Spectrum Analyzer **$9500**

7603 Mainframe **$2260**

Option 08 Protective Front Cover ..... **+$100**

Option 77 P7 Phosphor and Internal S A Graticule ..... **+$35**

7613 Variable Persistence Mainframe **$3430**

Option 06 Internal S A Graticule ..... **+$50**

Option 08 Protective Front Cover ..... **+$100**

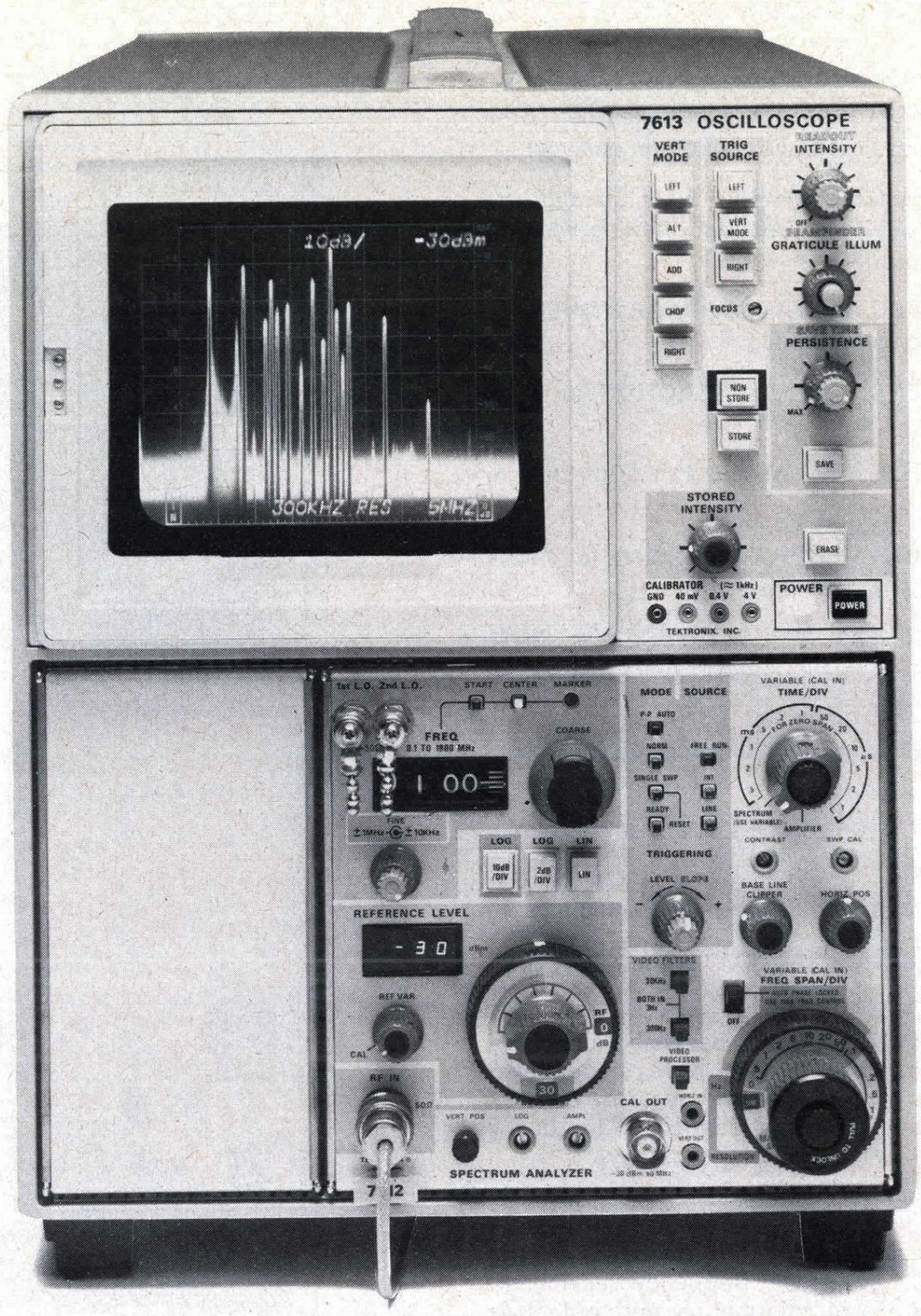
Extended Frequency Range to 2.5 GHz. Ask about the modified 7L13.

100 kHz to 1800 MHz in One Display
Fully Calibrated Displays
300 Hz to 3 MHz Resolution
4:1 Resolution Bandwidth Shape Factor
70 dB On-screen Dynamic Range
IM Distortion 70 dB below Full Screen
Spurious Free Operation
Automatic Phase Lock
—115 dBm Sensitivity

The 7L12 Spectrum Analyzer is a modern, high-performance, swept front-end type of analyzer covering the frequency range up to 1.8 GHz. The unit employs phase lock stability and an ample selection of resolution bandwidths in an economical field or laboratory instrument.

The unit has a 3 MHz resolution mode for accurate measurement of pulse phenomena; the zero-span mode may be used to present a demodulated display of a signal for time domain measurements. A 4:1 resolution bandwidth shape filter introduced by Tektronix permits close-in measurements not possible with conventional filters. Noise measurements are also easily made due to the high sensitivity, video filters, and equivalent resolution and noise power bandwidth of the instrument.

The 7L12 fills two holes in any 3- or 4-hole 7000-Series Mainframe and features a complete time base so that other oscilloscope or time domain plug-ins may be used simultaneously. As with all 7000-Series Plug-ins, CRT READOUT will display the major parameters. For the 7L12, these include: reference level, dB/div, frequency span and resolution.



7L12 with 016-0155-00 Blank Panel in 7613 Option 06 Variable Persistence Mainframe with internal spectrum analyzer graticule.

7L12 CHARACTERISTICS

FREQUENCY CHARACTERISTICS

Range — 100 kHz to 1.8 GHz. (Usable below 100 kHz with degraded performance.)

Resolution Bandwidth — Resolution bandwidth selections from 300 Hz to 3 MHz. Shape factor 60 dB to 6 dB is 4:1 or better.

Stability — Within 50 kHz, after 2 hour warm-up, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz, when not phase locked, over a one hour period, at a fixed temperature.

Incidental Fm — 200 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from −100 dBm to +30 dBm, within ±2 dB.

Log 10 dB/div:
−70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
−14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

Cw Sensitivity — (Signal + noise = twice noise in LIN mode). −115 dBm at 300 Hz, −108 dBm at 3 kHz, −100 dBm at 30 kHz, −90 dBm at 0.3 MHz, −80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — ±1.5 dB over any frequency span.

Spurious Responses —
Residual — (No signal present at input) with input attenuation at 0 dB, ≤−100 dBm.
Intermodulation Distortion — Third order down 70 dB or more from two −30 dBm signals within any frequency span. Second order down 70 dB or more from two −40 dBm signals.
Mixed — All image, harmonic related, and out-of-band mixing responses are ≥70 dB down from a level of −30 dBm to the input mixer (0 dB input attenuation).

Dynamic Range — 70 dB. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — 500 Hz/div to 100 MHz/div. A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — 10 ms/div to 1 μs/div.

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz comb, −30 dBm at 50 Ω.

Vert Out — Approx 2 V full screen.

Horiz In — For use with chart recorder.

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings, 337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000-Series Oscilloscopes. Amber Light Filter: 378-0684-01; Light Filter: 378-0625-07; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

ORDERING INFORMATION

7L12 Spectrum Analyzer $6500
7603 Mainframe $2260
Option 08 Protective Front Cover ..... +$100
Option 77 P7 Phosphor and Internal S A Graticule ..... +$35
7613 Variable Persistence Mainframe $3430
Option 06 Internal S A Graticule ..... +$50
Option 08 Protective Front Cover ..... +$100
7K11 CATV Preamplifier $675

Extended Frequency Range to 2.5 GHz. Ask about the modified 7L12.

7L5 | 20 Hz to 5 MHz Spectrum Analyzer

THREE-KNOB OPERATION makes the 7L5 the world's easiest-to-use spectrum analyzer.

SYNTHESIZER STABILITY for six-digit accuracy of center frequency setting with virtually no drift.

IMPROVED DIGITAL STORAGE & AVERAGING of display signals.

REFERENCE LEVEL SELECTION in 1 dB steps.

ABSOLUTE CALIBRATION in dBm, dBV or volts/div.

TRACKING GENERATOR option for swept component measurements.

CHANGEABLE INPUT IMPEDANCE MODULES to accommodate any impedance requirement.

WIDE DYNAMIC RANGE and nanovolt sensitivity.

PRESET REFERENCE LEVEL for extra input protection.

CRT READOUT of all major parameters.

NEW B MINUS "SAVE A" feature added.

The 7L5 is an audio/baseband spectrum analyzer plug-in that provides exceptional frequency accuracy and operator convenience through a combination of frequency synthesizer and digital technology.

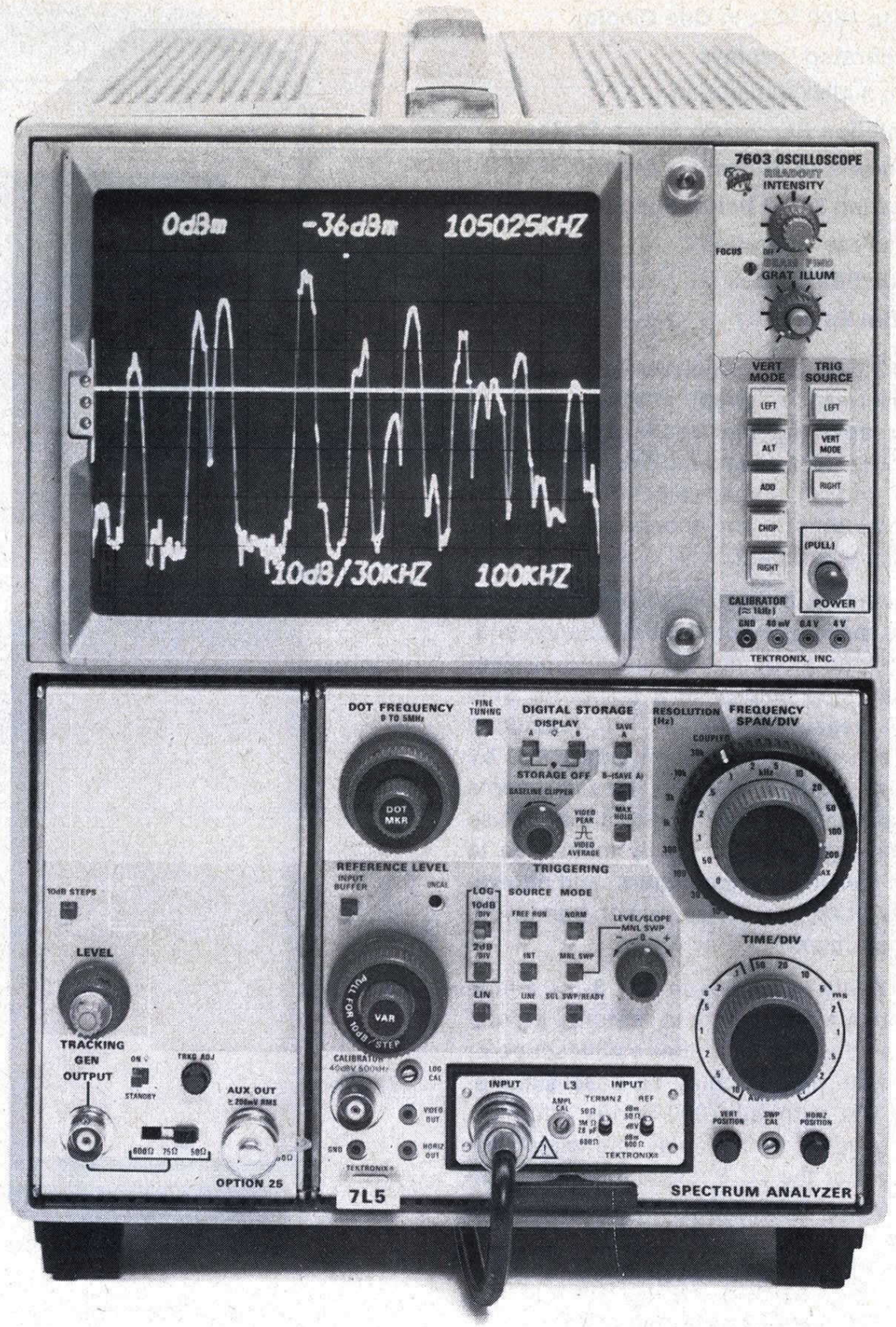
The center frequency can be set with six digit accuracy immediately after turn-on. A built-in micro-computer decodes control settings, processes frequency span and reference level information and optimizes sweep time and resolution for the span chosen.

To accommodate a wide variety of user preferences, the 7L5 uses changeable plug-in input modules providing a variety of input impedances such as 50, 75, 600, or 1 megohm. The built-in computer automatically adjusts the calibrator to provide the correct reference level for the impedance chosen.

Digital storage, in addition to providing clean, easy-to-interpret displays, also makes such special functions as digital averaging and peak detection possible. The display is stored electronically and updated during each sweep. Two complete displays can be held in memory for comparison. A max hold function stores the maximum signal level over long periods of time to measure amplitude and frequency drift.

Crt readout displays the center frequency, reference level, resolution bandwidth, dB per division and frequency span.

The new B minus "Save A" provides algebraic subtraction of two traces, so that changes in multi-signal spectrums can be monitored.



7L5 Option 25 Spectrum Analyzer with L3 Plug-in Module in a 7603 Option 06 Mainframe with internal spectrum analyzer graticule.

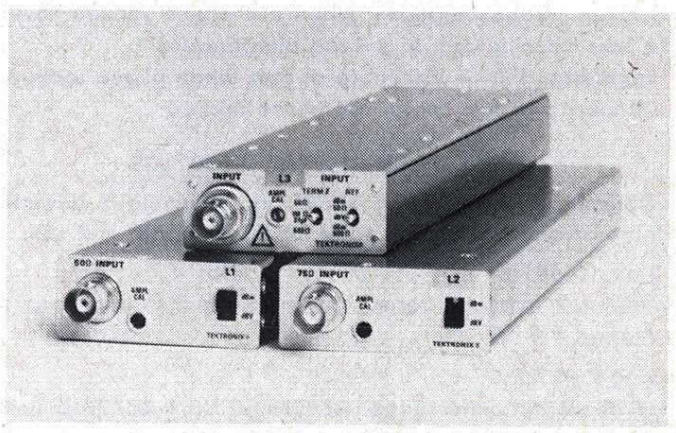
7L5 OPTIONS

Option 25 Tracking Generator
The 7L5 with Option 25 Tracking Generator provides a selectable 50 Ω, 75 Ω, or 600 Ω impedance source that has a calibrated output level for swept frequency tests from 10 Hz to 5.0 MHz.

Option 21 Logarithmic Frequency Display
The 7L5 Option 21 is a three-wide version of the normally two-wide 7L5 7000-Series Plug-in Spectrum Analyzer. The additional compartment houses circuitry that generates a logarithmic frequency display covering all 21 proportional bandwidth IRIG telemetry channels. The nominal frequency range is 200 Hz to 200 kHz.

Option 28 Front Panel Readout
The 7L5 Option 28 provides LED front panel readout of center frequency and reference level. Option 28 is recommended for 7000-Series Mainframes that have no provision for crt readout such as the 7603N11s.

Combined Options
All three Options 21, 25, and 28 can be combined in one instrument. Options 21 and 25 can be combined, as can Options 25 and 28. Option 25 is available separately as a field modification kit to be attached to an existing 7L5. Options 21 and 28 can only be installed at the factory.



Changeable modules permit the 7L5 user to adapt to new measurement requirements. Modules now available are the 50 Ω L1, 75 Ω L2, 1 MΩ L3, and the L1-GC. The probe-compatible L3 offers selectable internal 50 Ω, 1 MΩ, or 600 Ω impedance, while the L3-1 offers 75 Ω, 1 MΩ or 600 Ω. The module you select calibrates displays for the impedance in use. The L1-GC module (not shown) covers if frequencies of 21.4 MHz and 10.7 MHz plus the normal 20 Hz to 5 MHz frequency range.

CHARACTERISTICS WITH PLUG-IN INPUT IMPEDANCE MODULE

	L1	L2	L3	L3-1
INPUT CHARACTERISTICS				
Input Impedance —	50 Ω	75 Ω	1 MΩ/28 pF (also 50Ω and 600Ω)	(also 75Ω and 600Ω)
Input Power — Max input power for reference levels:				
above 0 dBm	+21 dBm		+21 dBm	
below 0 dBm	+10 dBm		+21 dBm	
			100 V (peak ac + dc) @ 1 MΩ input z	
AMPLITUDE CHARACTERISTICS				
Residual Response — Internally generated spurious signals (referred to input).	−130 dBm or less, −125 dBm for calibrator and harmonics		−143 dBV or less −138 dBV for calibrator and harmonics	
Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in VIDEO AVERAGE mode with 10 s/div sweep rate and INPUT BUFFER control off. Equivalent input noise for resolution bandwidth of:	*(equal to or better than)		*(equal to or better than)	
10 Hz	−135 dBm		−148 dBV	
30 Hz	−133 dBm		−146 dBV	
100 Hz	−130 dBm		−143 dBV	
300 Hz	−125 dBm		−138 dBV	
1 kHz	−120 dBm		−133 dBV	
3 kHz	−115 dBm		−128 dBV	
10 kHz	−110 dBm		−123 dBV	
30 kHz	−105 dBm		−118 dBV	
Sensitivity is further degraded 8 dB with INPUT BUFFER on. Noise level increases approx 10 dB operating in VIDEO PEAK mode.				
Intermodulation Distortion — Within any frequency span, intermodulation products for two, on screen, signals				
of any input level: 3rd order products	at least 75 dB down		at least 75 dB down	
2nd order products	at least 72 dB down		at least 72 dB down	
of any input level up to −53 dBv/−40 dBm (50 Ω): 2nd and 3rd order products	at least 80 dB down		at least 80 dB down	
of any input level with INPUT BUFFER on: 2nd and 3rd order products	at least 80 dB down		at least 80 dB down	
Display Flatness — Peak-to-peak display variation over any frequency span.	0.5 dB max (Add 0.5% quantization error in digital storage)		0.5 dB max (25 Hz to 5 MHz) 0.75 dB max (20 Hz to 5 MHz) (Add 0.5% quantization error in digital storage)	
On-screen Dynamic Range —	80 dB (full 8 div)		80 dB (full 8 div)	
Reference Level** — In LOG mode, reference level refers to top horizontal graticule line. Calibrated in dB steps.	1-dB and 10-dB steps		1-dB and 10-dB steps	
Range — LOG 10 dB/div mode	−78 dBm to +21 dBm		−83 dBV to +8 dBV	
LOG 2 dB/div mode	−128 dBm to +21 dBm		−141 dBV to +8 dBV	
LIN mode	20 nV/div to 200 mV/div in 1-2-5 sequence		20 nV/div to 200 mV/div in 1-2-5 sequence	
Accuracy—When calibrated @ −40 dBV in LOG mode.	Within 0.2 dB/dB, to max of 0.25 db/10 dB change in reference level		Within 0.2 dB/dB, to max of 0.25 db/10 dB change in reference level	
Display Dynamic Range Accuracy— LOG 10 dB/div mode	.05 dB per dB to 2 dB max for 80 dB full screen		.05 dB per dB to 2 dB max for 80 dB full screen	
LOG 2 dB/div mode	0.1 dB per dB to 1 dB max for 16 db full screen		0.1 dB per dB to 1 dB max for 16 db full screen	
LIN mode	±5%		±5%	

*Note: dBm = dBV −10 Log Z + 30 where Z = impedance
Example: dBV = [dBm (600 Ω) — 2.22]

**Note: A > sign is displayed by the reference level readout when the reference level is not calibrated and the UNCAL light is on. A < sign is displayed when the reference variable is out of its detent.

7L5 CHARACTERISTICS

The following characteristics and features apply to the 7L5 Spectrum Analyzer and its options. They are applicable over the environmental specification criteria for the 7000-Series Mainframes.

FREQUENCY CHARACTERISTICS

Range — Input frequency range is 20 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz tuned in 250 Hz steps. Dot accuracy: 0°C to 50°C ±(20 Hz + 10^{-5} of dot frequency); 20°C to 30°C ±(5 Hz + 2X 10^{-6} of dot frequency).

Drift — Frequency drift is ≤ 5 Hz/hour.

Residual Incidental Fm — Residual fm is ≤ 1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. Residual fm is ≤ 40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

Resolution Bandwidth — 8 resolution bandwidths range from 30 kHz to 10 Hz. COUPLED switch position electronically couples resolution to span/div selection so that both are controlled by the same knob. Bandwidth accuracy @ 6 dB down is within 20% of selected resolution. Shape factor (60:6 dB ratio) is 10:1 or better for 10 Hz to 1 kHz and 5:1 or better from 3 kHz to 30 kHz. Amplitude change between resolution bandwidths is ≤ 0.5 dB for 30 kHz to 100 Hz and ≤ 2.0 dB for 30 kHz to 10 Hz.

SWEEP CHARACTERISTICS

Frequency Span—Provides calibrated frequency spans from 50 Hz/div to max (500 kHz/div) within 4% in 1-2-5 sequence.

Horizontal linearity is within 4% over the entire 10 div display.

A 0-Hz/div position is provided for time domain operation.

Sweep Rate — Time per div is selectable from 10 s/div to 0.1 ms/div in 1-2-5 sequence. An AUTO position permits automatic selection of optimum time/div depending on resolution and span/div settings.

Sweep rate accuracy is within 5% of the rate selected.

Triggering — Provides two triggering sources, INT (internal) and LINE, in addition to a FREE-RUN position.

When INT is selected, ac coupled signal components from the mainframe trigger source (left or right vertical amplifiers) are used.

When LINE is selected, ac coupled sample of mainframe ac line voltage is used.

Three triggering modes are NORM (normal), SGL SWP/READY (single sweep), and MNL SWEEP (manual sweep).

Trigger level is ≥1.0 div of internal signal for both NORM and SGL SWP modes over the approx frequency range of 30 Hz to 500 kHz.

OUTPUT CONNECTORS

Video Out — Front-panel pin jack connector supplies the video (vertical) output signal at an amplitude of 50 mV/div +5% (about the crt vertical center) with source impedance of 1 kΩ. (Analog signal prior to digitization for storage).

Horiz Out — A front-panel pin jack connector supplies horizontal output signal (negative-going sawtooth that varies from about 0 to about −6 V dc with a source impedance of 5 kΩ).

Calibrator — Front-panel BNC connector supplies a calibrated 500 kHz square wave output signal (derived from the analyzer's time base). Output amplitude is within ±0.15 dB of −40 dBV into the plug-in impedance.

OPTION 25 TRACKING GENERATOR CHARACTERISTICS

Frequency Range — 20 Hz to 5.0 MHz.

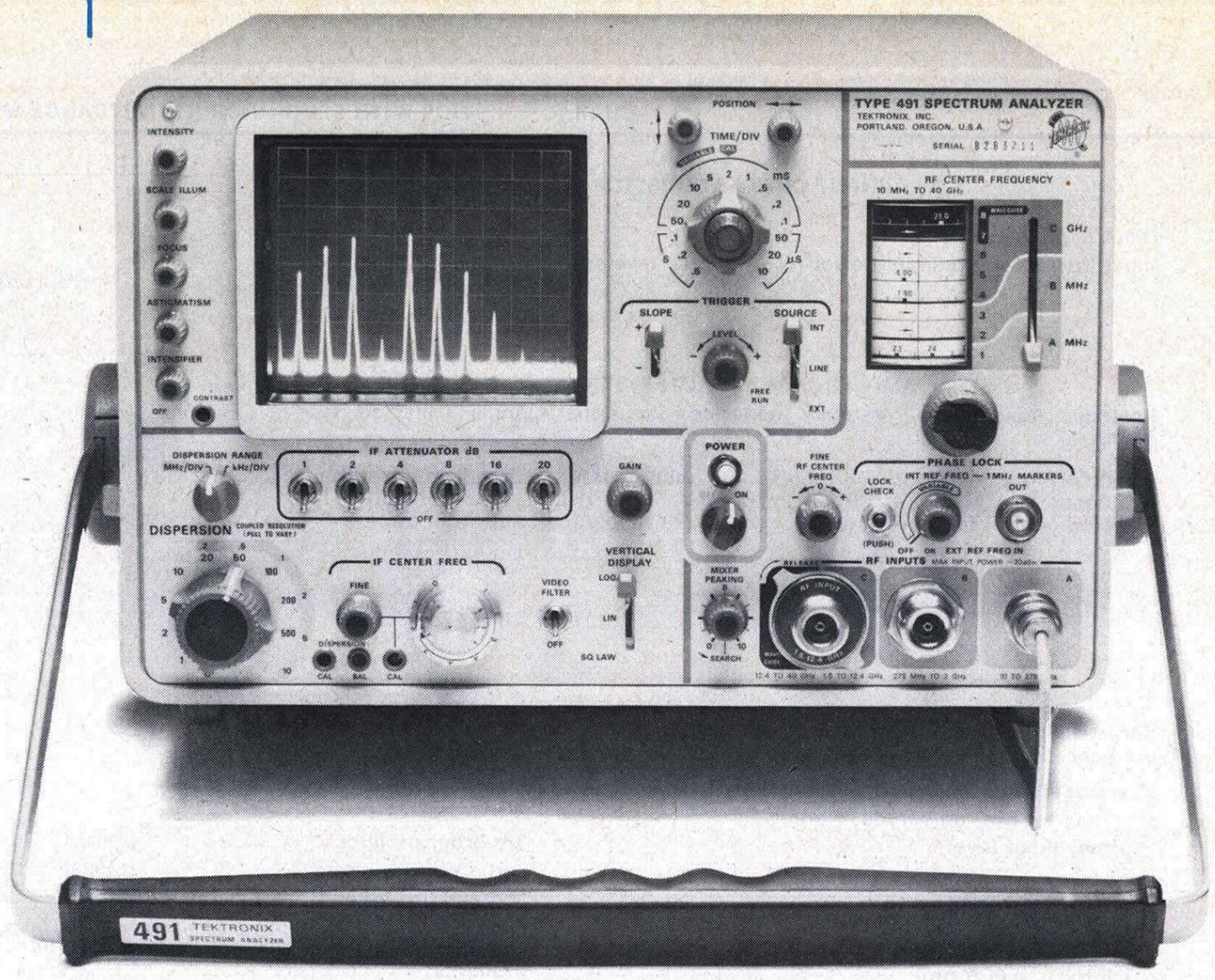
Output Impedance — 50 Ω, 75 Ω, or 600 Ω selected by a front panel switch.

Amplitude — The output level is calibrated in dBm or dBV and selectable in 10 dB or 1 dB steps. A vernier provides continuous variation between calibrated steps.

Range —
50 Ω, 0 dBm to −63 dBm
75 Ω, −6 dBm to −69 dBm
600 Ω, −17 dBm to −80 dBm

Continued on Page 194

491 | 10 MHz to 40 GHz Spectrum Analyzer



10 MHz to 40 GHz with 491
10 MHz to 2 GHz with 491 Option 01
1.5 GHz to 40 GHz with 491 Option 02

The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is easy to carry, weighing less than 40 pounds complete with accessories. The R491 is electrically identical and requires only seven inches of rack height.

FREQUENCY CHARACTERISTICS

Range

10 MHz to 40 GHz

Option 01

10 MHz to 2 GHz

Option 02

1.5 GHz to 40 GHz

Resolution — 1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

Frequency Stability — ±200 kHz after 1 minute.

Incidental Fm — Less than 300 Hz at fundamental, with Phase Lock.

AMPLITUDE CHARACTERISTICS

Display Flatness — Max 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 max amplitude variation (100 MHz dispersion) is 6 dB or less.

Max Input Power — −30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

Vertical Display (8 Div) — Log — ≥ 40 dB dynamic range. Linear. Square Law — ≥ 13 dB dynamic range.

If Attenuator — 51 dB in 1 dB steps, ±0.1 dB/dB.

If Gain Control — > 50 dB range.

Sensitivity — Greater than — 100 dBm to 8.2 GHz
Greater than — 90 dBm to 18 GHz
Greater than — 70 dBm to 40 GHz

INPUT CHARACTERISTICS

50 Ω Input

SWEEP CHARACTERISTICS

Sweep Range — The 491 uses a complete triggered oscilloscope type time base with 15 calibrated steps from 10 μs/div to 0.5 s/div.

Calibrated Dispersion — 1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div and MHz/div).

CRT AND DISPLAY FEATURES

Crt — 8 x 10 div display area (each div = 0.8 cm); P7 phosphor.

ENVIRONMENTAL CAPABILITIES

The 491 meets MIL-I-6181D specs for EMI, operates up to 15,000 ft with temperatures from −15°C to +55°C and can stand a 30 g shock.

Weight —		
Rackmount	41 lb	18.6 kg
Portable	30 lb	13.6 kg

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 cable (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). The R491 includes all above accessories except the front cover and protective cover, also includes slide-out assembly and hardware.

ORDERING INFORMATION

491 Spectrum Analyzer $10,700

R491 Spectrum Analyzer (Rackmount) $10,825

Option 01 (10 MHz to 2 GHz) ..... −$1395

Option 02 (1.5 GHz to 40 GHz) ..... −$1195

1105 Battery Power Supply $915

Additional specifications are available through your local Tektronix Field Office.

7L5 Characteristics—Continued

Accuracy — (Max Output calibrated at 500 kHz.)
50 Ω, 0 dBm ±0.25 dBm
75 Ω, −6 dBm + 0.4, −0.2 dBm
600 Ω, −17 dBm + 0.5, −0.1 dBm

Attenuator —
Range: 0 to 63 dB in 10 dB or 1 dB steps.
Accuracy: Within 0.2 dB/dB to a maximum of 0.25 dB/10 dB absolute.

Flatness —
50 Ω and 75 Ω: Within 0.5 dB peak-to-peak.
600 Ω: Within 1.0 dB peak-to-peak.
Total System Flatness (7L5 with Option 25)
50 Ω and 75 Ω: Within 1.0 dB peak-to-peak.
600 Ω: Within 1.25 dB peak-to-peak.

Dynamic Range (7L5 with Option 25) — ≥110 dB.

Residual FM (peak-to-peak) —
Spans to 2 kHz/div: 2 Hz (7L5 with Option 25).
Spans 5 kHz/div or greater: 40 Hz (7L5 with Option 25).

Stability — 25 Hz/5 minutes after 10 minute warm-up decreasing to 25 Hz/hr maximum after 1 hour.

Spurious Suppression, 10 Hz to 5.0 MHz (Harmonic and non-harmonic) — 40 dB or more with respect to the carrier.

Auxiliary Output — ≥200 mV rms into 50 Ω.

ORDERING INFORMATION

7L5 Spectrum Analyzer $6650
(Spectrum Analyzer Requires L Plug-in Module.)

Option 21 with Logarithmic Frequency Display ..... Add $750

Option 25 with Tracking Generator ..... Add $1000
For a separate tracking generator, (One-wide field modification to be attached to an existing 7L5) order 040-0810-00 ..... $1025

Option 28 with Front-Panel Readout ..... Add $500

Option 30 combines Options 21 and 25 .... Add $1400

Option 32 combines Options 25 and 28 ..... Add $1300

Option 33 combines Options 21, 25 and 28 .. Add $1800

Included Accessories — Graticule, Spectrum Analyzer 337-1159-00 (7000 Series), and 337-1439-01 (7603). Filter, light blue 378-0684-00.

L1 Plug-in Module (50 Ω) $600

L2 Plug-in Module (75 Ω) $600

L3 Plug-in Module (1 MΩ, 50 Ω, 600 Ω) .. $925

L3 Plug-in Module Option 01 (1 MΩ, 75 Ω, 600 Ω) ..... No Charge

L1-GC Module (50 Ω) ..... Request Quote

†7603 Oscilloscope $2260

†R7603 Oscilloscope (Rackmount) $2560

Option 06 Internal S A Graticule ..... +50

Option 08 Protective Front Cover (Cabinet Only) ..... Add $100

†7704A Oscilloscope $3635

†R7704 Oscilloscope $4630

†Suggested Mainframe. See 7000-Series pages for oscilloscope specifications and options.

OPTIONAL ACCESSORIES

Tracking Generator, one wide field modification kit, to be attached to an existing 7L5 040-0810-00 ..... $1025

2701 50 Ω Step Attenuator $350

2703 75 Ω Step Attenuator $375

75 Ω to 50 Ω Min Loss Attenuator (Ac Coupled) 011-0112-00 ..... $50

P6105 10X Probe, (2m) 010-6105-03 ..... $75

BALANCED INPUT TRANSFORMER

Frequency Range — 50 kHz to 3 MHz, usable from 10 kHz to 20 MHz.

Flatness — 0.25 dB peak-to-peak maximum (50 kHz to 3 MHz) including nominal 0.1 dB insertion loss.

Common-Mode Rejection — 25 dB minimum (50 kHz to 3 MHz).

Output Termination — Switchable between 124Ω, 135Ω, and NONE for bridging or external termination.

Connectors — WECO (0.37″ with 0.090 center) on 0.625″ spacing for balanced input. BNC for single-ended output.

Balanced Input Transformer 013-0182-00 ..... $120

TV Sideband Adapter | 1405

1405/7L12 Sideband Analyzer

Response of Transmitter under Test within ±0.2 dB

Frequency Response of Rf and If Circuits for Transmitters with Frequency to 1 GHz

Video Circuits Can Be Swept

For In-service Testing, Use of External Blanking Allows Either Full-field or Single-line Operation

Check Aural Fm Deviation with Built-in Bessel Null Technique

Flexible Marker System Will Accept Standard Crystals

To analyze the sideband response of a television transmitter, the 1405 Sideband Adapter is used with a spectrum analyzer, such as the 7L12 or 7L13. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sinusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. The 1405/Spectrum Analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Complete specifications and prices are available in the Television Products Catalog.

ORDERING INFORMATION

1405 TV Sideband Adapter (525/60 Markers) $3300

Option 01 TV Sideband Adapter (625/50 Markers) ..... +$100

OPTIONAL ACCESSORIES

Rackmount-conversion kit for mounting 1405 or 1405 Option 01 in std. 19 inch rack. 016-0489-00 ..... $150

600 Ω Attenuator, 51 dB in 1 dB steps
011-0093-00 ..... $210

Step Attenuators and Preamplifiers | 2701, 2703 7K11, AM 511

The 2701 and 2703 Step Attenuators are laboratory quality, bench top instruments for attenuation of large value radio frequency signals. The 2701 50 Ω Attenuator is particularly useful in making receiver sensitivity and distortion measurements. The range of attenuation is 0 to 79 dB, selected in 1 dB steps with tens and units cam switches. A front-panel switch selects DC, AC, or DC TERM (a 50 Ω precision termination).

The 2703 75 Ω Step Attenuator is tailored for television, CATV, telephone and radio applications. A front panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity. A dc block has been incorporated for both rear-panel ports to protect the attenuator against accidental burnout from high dc offsets or ac power on center conductors.

The board assemblies and thick-film hybrid attenuation chips used in both instruments are mounted in a sturdy metal housing; solid top and bottom plates provide excellent mechanical and electrical stability. The two cam switches which select individual chips operate through gold-plated switch contacts. Held on a four-layer circuit board with spring clips, the chip substrates can be replaced easily in the field.

The attenuators may be used for frequencies up to 2 GHz, with slight degradation of the attenuation accuracy and vswr characteristics specified at 1 GHz.

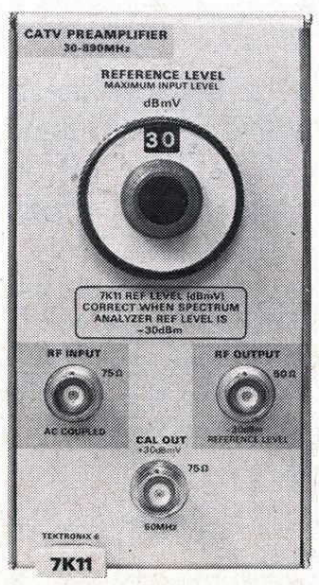
CHARACTERISTICS	2701	2703
Attenuation	0 to 79 dB in 1 dB steps	0 to 109 dB in dB steps (Including extra 30 dB range)
Impedance	50 ohms nominal	75 ohms nominal
Frequency	Dc to 1 GHz	3 kHz to 1 GHz*
Max Average Input Power	1.5 W to 65°C	1.5 W to 65°C
Signal Coupling	Dc, ac, and dc terminated at one port only	Ac only both PORTS*
Size	7½ in lg x 4½ in w x 2½ in h	7½ in lg x 4½ in w x 2½ in h
Connector	Type BNC Female 50 ohm	Type BNC Female 75 ohm

**Blocking capacitors may be removed for specialized applications.*

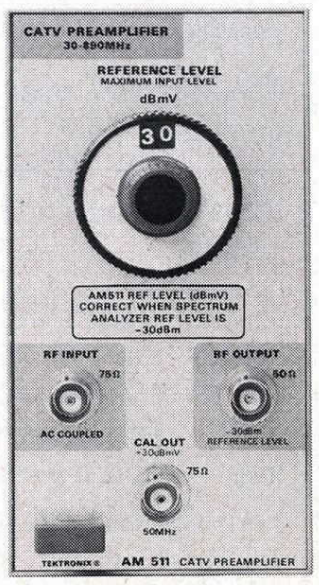
ORDERING INFORMATION

2701 50 Ω Step Attenuator $350

2703 75 Ω Step Attenuator $375



7K11



AM 511

These plug-in preamplifiers are designed for spectrum analyzer applications where extra sensitivity is required. The 7K11 is a 7000-Series Plug-in while the AM 511 fits into the TM 500 Modular Series power supplies.

The amplifiers are tailored to the CATV and field intensity measurement markets, providing a 75 Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifiers well-suited for signal-to-noise and low-level radiation measurements.

CHARACTERISTICS
(with 7L12 and 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is no greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13) — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for: third order intermodulation with two signals at the reference level (full screen).

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

Input Impedance — 75 Ω.

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

Accessories — BNC to BNC 50 Ω Cable, 5½ inch: 012-0057-01; BNC to F Adapter: 013-0126-00; BNC to BNC 75 Ω Cable, 42 inch: 012-0074-00.

ORDERING INFORMATION

7K11 CATV Preamplifier $675

AM 511 CATV Preamplifier $675

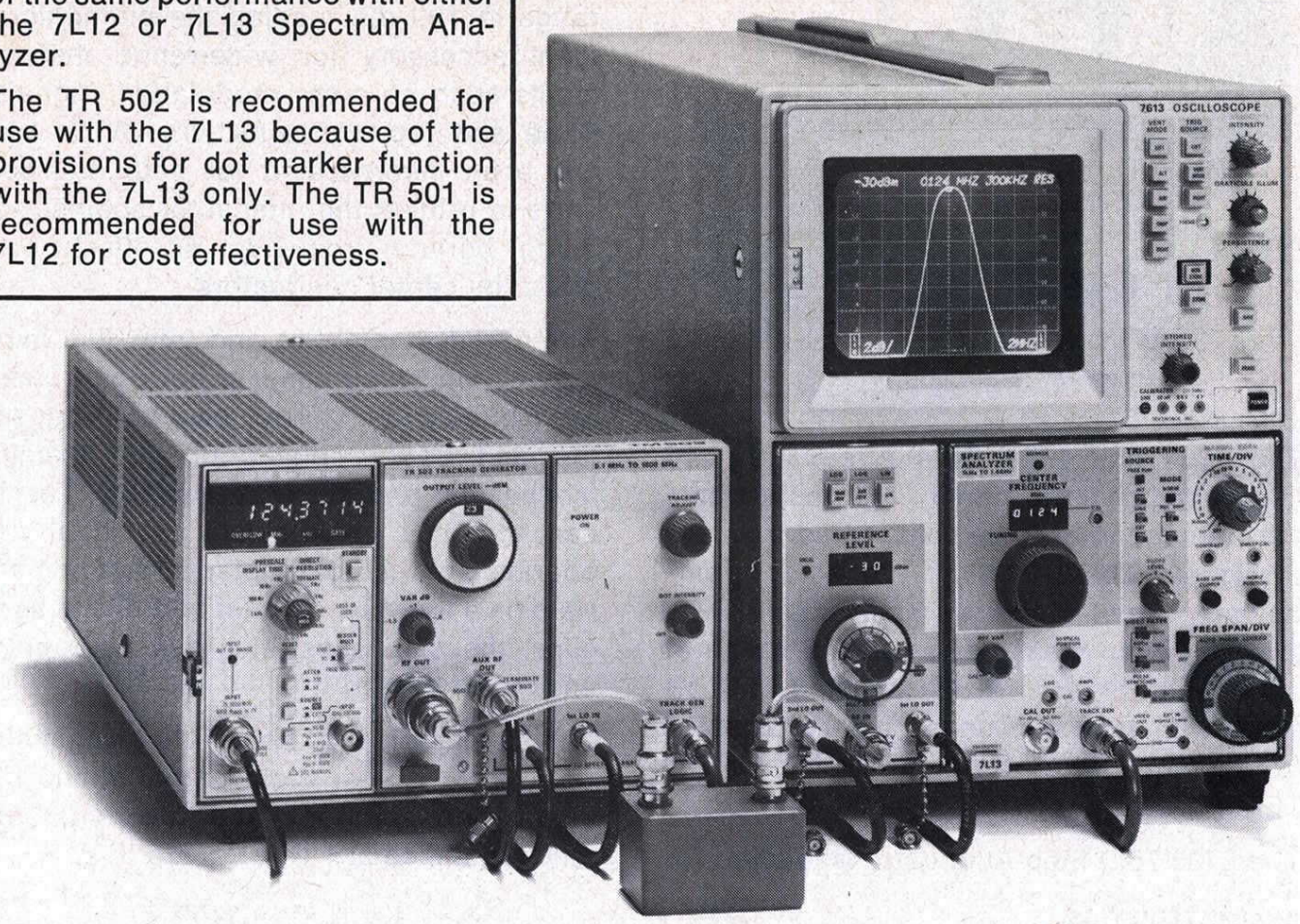
TM 501 Power Module for AM 511 .... $190

TR 501
TR 502

100 kHz to 1800 MHz Tracking Generators

The TR 501 or TR 502 are capable of the same performance with either the 7L12 or 7L13 Spectrum Analyzer.

The TR 502 is recommended for use with the 7L13 because of the provisions for dot marker function with the 7L13 only. The TR 501 is recommended for use with the 7L12 for cost effectiveness.



For swept frequency tests and precise frequency measurements, the TR 502 Tracking Generator may be used with a DC 508 Option 07 Digital Counter, in a TM 503 Option 07 Power Module, with a 7L13 Spectrum Analyzer in 7613 Option 06 Mainframe.

Wide Frequency Range — 100 kHz to 1.8 GHz

System Stability
10 Hz (TR 502 w/7L13)
200 Hz (TR 501 w/7L12)

Flatness — ±0.5 dB
±2.0 dB (TR 502/7L13)
±3.0 dB (TR 501/7L12)

Resolution
30 Hz (TR 502 w/7L13)
300 Hz (TR 501 w/7L12)

Plus — TR 502 Has Automatic Counter Dot Marker When Used with DC 508 Option 07 and 7L13

The TR 502 and TR 501 Tracking Generators work with either the 7L13 or 7L12 Spectrum Analyzers to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz.

When used as a cw source, with the analyzer in a zero span (nonswept) mode, the TR 502/7L13 system has 10 Hz stability. (The TR 501/7L12 system has 200 Hz stability.) This exceptional stability enhances the dynamic range capability of the analyzer/tracking generator combination.

The Tracking Generator AUX RF OUTPUT may be used to drive a frequency counter. Frequencies up to 1800 MHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer. TR 502/7L13 sensitivity is −128 dBm at 30 Hz resolution bandwidth. (TR 501/7L12 sensitivity is −115 dBm at 300 Hz resolution bandwidth.) When the TR 502 is used with the 1 GHz DC 508 Option 07 Frequency Counter the spectrum display center frequency, indicated by a bright dot, is automatically counted.

The tracking generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the tracking generator. The output frequency of the tracking generator is the same as the frequency of the analyzer at any instant of the sweep.

The tracking generator is a two-wide unit compatible with the TM 500 Modular Instrument Series. When powered by a TM 503, there is room for a 1 GHz DC 508 or other counter.

CHARACTERISTICS

Apply to both TR 502/7L13 and TR 501/7L12 except where noted.

FREQUENCY CHARACTERISTICS

Range — 0.1 MHz to 1800 MHz.

Resolution Bandwidth — 30 Hz to 3 MHz (TR 502/7L13). 300 Hz to 3 MHz (TR 501/7L12).

Stability — 10 Hz p-p (TR 502/7L13). 200 Hz p-p (TR 501/7L12).

AMPLITUDE CHARACTERISTICS

Rf Output Amplitude — 0 dBm to −59 dBm in 10 and 1 dB steps plus 2 dB vernier (TR 502). 0 dBm to −11 dBm in 1 dB steps plus 2 dB vernier (TR 501).

Auxiliary Output Level — 0.1 rms in 50 Ω.

Flatness — ±0.5 dB (Tracking Generator only). ±2.0 dB (TR 502/7L13). ±3.0 dB (TR 501/7L12).

Spurious Output —
Harmonic: >20 dB below carrier.
Nonharmonic: >40 dB below carrier.

Dynamic Range — >110 dB (TR 502/7L13). >100 dB (TR 501/7L12).

SWEEP CHARACTERISTICS

Frequency Span — 200 Hz/div to 180 MHz/div (TR 502/7L13). 500 Hz/div to 180 MHz/div (TR 501/7L12).

OUTPUT CONNECTORS

Rf Out — 50 Ω nominal impedance, vswr 2:1 or less.

Aux Rf Out — For use with frequency counter.

Included Accessories — Two 50 Ω coaxial cables 012-0649-00, logic interface cable (TR 502 only) 012-0648-00, adapter N male to BNC female 103-0045-00, retainer plug-in 343-0604-00 fixed 10 dB attenuator with 3 mm fittings 307-0553-00 (TR 501 only).

ORDERING INFORMATION

TR 502 Tracking Generator $4900

Suggested Complementary Items

TM 503 Option 07 Power Module $215

DC 508 Option 07 Digital Counter $1350

TR 501 Tracking Generator $4000

Suggested Complementary Items

TM 503 Power Module $190

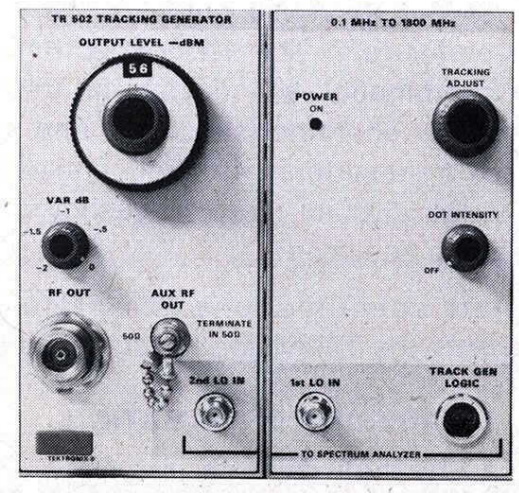
DC 508 Digital Counter $1150

or

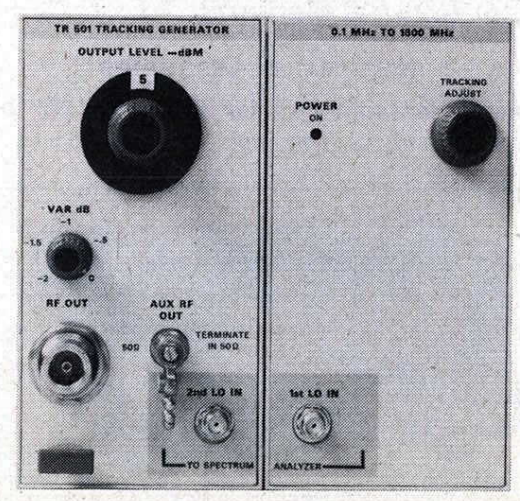
Blank Panel 016-0195-03 ..... $11

14 dB, 3 mm attenuator 015-1002-00
(used in the 2nd L.O. input line to improve TR 501/7L12 isolation) **$120**

Note: Existing 7L12 Spectrum Analyzers, if not already factory equipped for use with the TR 501, may be modified. Further information may be obtained from your local Tektronix office or representative.

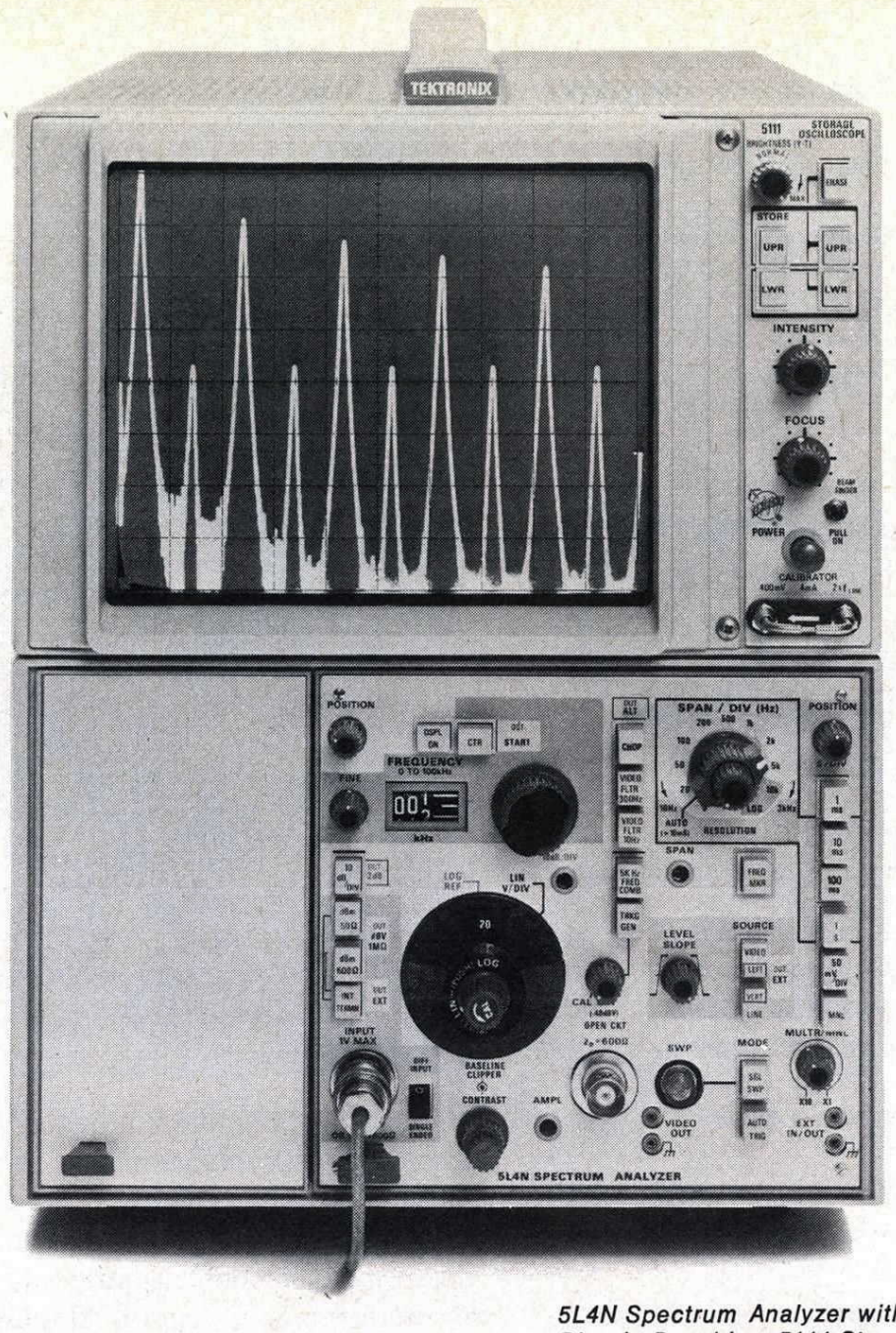


TR 502 Tracking Generator.



TR 501 Tracking Generator.

20 Hz to 100 kHz Spectrum Analyzer | 5L4N



5L4N Spectrum Analyzer with 016-0195-00 Blank Plug-in Panel in a 5111 Storage Oscilloscope.

20 Hz to 100 kHz
Selectable Impedance
Calibrated Appropriate to Impedance Selected
Single-Ended Input
Differential (Balanced) Input
On Screen Dynamic Range 80 dB (Full 8 div)
Intermod >70 dB Down
Resolution Bandwidth 10 Hz to 3 kHz
Auto Resolution
Built-in Tracking Generator
20 Hz to 20 kHz Log Sweep*

The 5L4N is a 20 Hz to 100 kHz spectrum analyzer that offers both high performance and economy. The analyzer features selectable input impedances, 80 dB of dynamic range and a built-in tracking generator.

This spectrum analyzer is especially suited for noise and distortion studies in the audio range and comes equipped for 20 Hz to 20 kHz log sweeps.

Many educators prefer this economical analyzer to teach frequency-related theory and demonstrate practical application in the areas of speech, sound, music, vibration, audio, broadcasting and many others.

The 5L4N can be used with any 5000-Series Oscilloscope Mainframe. Only two compartments are occupied by the analyzer so that, with the addition of a vertical plug-in, basic oscilloscope functions may be obtained. We recommend the use of a 5111 Storage Oscilloscope for maximum utilization of the analyzer.

**100 Hz to 100 kHz also available.*

FREQUENCY CHARACTERISTICS

Range — 20 Hz to 100 kHz. Accuracy ±3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Resolution Bandwidth — The resolution bandwidth is continuously variable from 3 kHz to 10 Hz. An AUTO mode provides the best resolution for the frequency scan and sweep rate selected. Signal level change over the resolution bandwidth range is 2 dB or less. Line frequency modulation of 50 Hz or more can be resolved up to 70 dB below the signal level. In the log sweep mode the resolution bandwidth changes with frequency giving an effect similar to octave bandwidth sweeps.

Stability — Within 30 Hz over a 10 min period, at a fixed ambient temperature.

Incidental Fm — 2 Hz (p-p) or less.

AMPLITUDE CHARACTERISTICS

Reference Level Range —
Log 10 dB/div:
from −10 dBm/dBV to −70 dBm/dBV, within 0.4 dB/10 dB to max of 1 dB at −70 dBm/dBV.
Log 2 dB/div:
from −10 dBm/dBV to −130 dBm/dBV within 0.4 dB/10 dB to max of 1 dB at −70 dBm/dBV and 2 dB at −130 dBm/dBV.
Linear:
from 50 mV/div to 20 nV/div within 5% decade.

Cw Sensitivity (Signal Level + Noise = 2X Noise) — The following characteristics are applicable with the input internally terminated, or with a 600 Ω or less source impedance.

Display Mode	Resolution Bandwidth 3 kHz	Resolution Bandwidth 10 Hz
dBV	−123 dBV	−147 dBV
dBm 50 Ω	−110 dBm	−134 dBm
dBm 600 Ω	−121 dBm	−145 dBm
LINEAR	680 nV	45 nV

Flatness (20 Hz-100 kHz) — Flatness remains within ±0.2 dB, over any selected frequency span, with respect to the level of −40 dBV signal at 5 kHz. Intermodulation Distortion — with two signals, within any frequency span, that are less than or equal to the reference level:

−10 dBm/dBV	≥70 dB down
≤ −20 dBm/dBV	≥75 dB down

Internal Spurious Signals — Equal to or less than −130 dBm/dBV referred to the input. Line related spurii less than −120dBm/dBV.
Dynamic Range — 80 dB (8 div).

INPUT CHARACTERISTICS

Selectable Impedance — 1 MΩ/47 pF or 600 Ω or 50 Ω (single-ended or differential).
Differential Input Characteristics — Full screen limit is approx 300 mV to 400 mV. Common-mode rejection ratio is 70 dB or more.
Single Ended Input Characteristics — Max single input for linear operation: −10 dBm/dBV or 0.316 V rms.

SWEEP CHARACTERISTICS

Linear Frequency Span — 20 Hz/div to 10 kHz/div, 1-2-5 sequence. 4% accuracy.
Log Frequency Span — 100 Hz to 100 kHz internally reprogrammable from 20 Hz to 20 kHz.
Zero Frequency Span — Analyzer operates as a fixed tuned receiver for time-domain displays.
Internal Sweep Sources — Time base 1 s/div to 1 ms/div (increased up to X10 with multiplier).
Triggering — Internal at least 0.1 div, External at least 250 mV. Slope and level selection are provided. Auto Trigger provides a sweep baseline when a trigger signal is absent. Single sweep provided.
Manual Sweep — Provided.
External Sweep — Requires 0 V to 500 mV ±50 mV; from a 1 kΩ or less source to sweep the full span.

OUTPUT CONNECTIONS

Tracking Generator — 600 Ω source. Calibrated output level is −40 dBV ±0.2 dB (10 mV) open circuit, or −46 dBV when terminated into 600 Ω. Output level can be varied from approximately 0.001 V to 0.1 V open circuit.
5 kHz Freq Comb — 600 Ω source of 5 kHz ±0.005% markers for span calibration.
Video Out — Provides 250 mV ±5% of video signal per display div (0 V to 2 V). Source impedance is about 1.0 kΩ.
Ext In/Out — Provides 500 mV ±25 mV, per div of span, from 0 to 5 V, when using internal or manual sweep.

INCLUDED ACCESSORIES

013-0156-00 Adapter, Floating BNC to Dual BNC. 175-1178-00 BNC to Pin Jack Adapter Cable. 331-0429-00 Log Graticule (20 Hz-20 kHz).

ORDERING INFORMATION

5L4N Spectrum Analyzer $3150
We recommend that the Plug-in 5L4N be ordered with a storage mainframe.
5111 Storage Oscilloscope (Cabinet) $1490
Option 02 Protective Front Cover ..... +$25
R5111 Storage Oscilloscope (Rackmount) $1540

OPTIONAL PLUG-INS FOR TIME DOMAIN USE
5A15N Single Trace Amplifier $200
5B10N Time Base Amplifier $305

OPTIONAL ACCESSORIES
010-0160-00 10X Probe P6006 (6 ft.) $60
016-0195-02 Blank Plug-in Panel $9
2701 Step Attenuator (50 Ω) $350
011-0093-00 Step Attenuator (600 Ω) $210

Spectrum Analyzer Accessories

PADS AND ADAPTERS

75 Ω to 50 Ω Minimum Loss Attenuator with dc block, 5.7 dB loss **011-0112-00** **$50**

75 Ω to 50 Ω Matching Attenuator with 11.25 dB conversion factor from dBm to dBmV with dc block **011-0118-00** **$60**

75 Ω to 50 Ω Minimum Loss Attenuator 5.7 dB loss, dc coupled **011-0057-00** **$25**

Fixed 10 dB attenuator with 3 mm fittings for use with TR 501/TR 502 with 7L12 **307-0553-00** **$30**

Dc Block BNC to BNC max dc potential 50 volts **015-0221-00** **$75**

"F" Female to BNC Male Adapter 013-0126-00 .... **$10**

BNC Female to "F" Male 103-0158-00 ..... **$8.50**

Calibrator Jumper 50 Ω BNC to BNC 5½ in **012-0214-00** **$26**

Jumper Cable BNC to BNC 50 Ω, 42 in **012-0057-01** **$15**

Jumper Cable BNC to BNC 75 Ω, 42 in **012-0074-00** **$15**

"N" Female to BNC Male 103-0058-00 ..... **$7.00**

PROTECTIVE VINYL COVERS

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe or instruments.

7000-Series 3 Hole Mainframe Cover 016-0192-01 ..... **$15**

7000-Series 4 Hole Mainframe Cover 016-0531-00 ..... **$15**

5000-Series Mainframe Cover 016-0544-00 ..... **$15**

491 Analyzer Cover 016-0074-01 ..... **$18**

RIGID FRONT COVERS

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

See appropriate spectrum analyzer and mainframe ordering information regarding the Option 08 Protective Front Cover for 7603 and 7613, or the Option 02 Protective Front Cover for 5100 Series Mainframes.

Protective Front Cover for existing 7603 or 7613 Mainframes:

Blue, 040-0835-00 ..... **$75**

Gray, 040-0628-00 ..... **$75**

491 Spectrum Analyzer — cover supplied, no charge with instrument.

GRATICULES, FILTERS

Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes **378-0625-07** **$4.25**

Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes **337-1439-01** **$4.00**

Plastic Implosion Shield and S A Graticule All other 7000-Series Mainframes **337-1159-02** ... **$4.25**

(Internal graticules are available with most 7000-Series Mainframes)

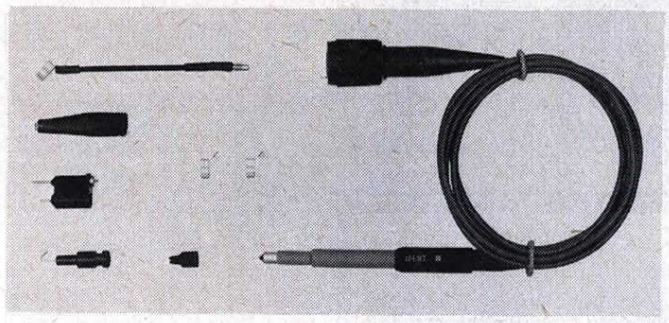
EMI Metal Screen Mesh Filter for 7500-, 7700-Series Instruments **378-0603-00** **$28**

EMI Metal Screen Mesh Filter for 7400-Series Instruments **378-0696-00** **$28**

Audio 20-20 kHz Log Graticule for 5000-Series Instruments — **331-0429-00** **$2.50**

IRIG Log Graticule for 7L5 331-0421-00 ..... **$2.50**

Complete selection of colored filters is available in the accessories section.



PROBES

A variety of probes is available in varying frequency and impedance ranges that can be used with the 7L12, 7L13, and 1401A Spectrum Analyzers:

FET Probe P6201 to 900 MHz 010-6201-01 ..... **$675**

FET Probe P6202 to 500 MHz 010-6202-01 ..... **$475**

Conventional Probe P6056 Dc to 3.5 GHz 6 ft. 010-6056-03 ..... **$115**

Conventional Probe P6057 Dc to 1.4 GHz with Adapter **010-6057-03** **$115**

Current Probe P6022 to 150 MHz 015-0135-00 ... **$250**

Complete specifications are available in the probes and accessories section.

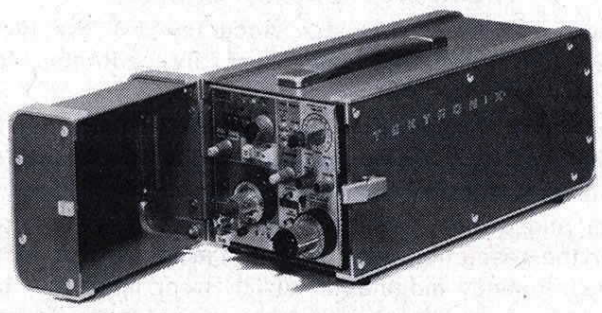
CAMERAS

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available. However, the most popular units for the 5000 and 7000-Series Instruments are:

Polaroid Film Back C-59P **$750**

Polaroid Film Back C-5B **$395**

Complete specifications on all cameras are available in the cameras, probes, and accessories section.



CARRYING CASES AND MOUNTS

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L12 or 7L13 Plug-in units.

Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

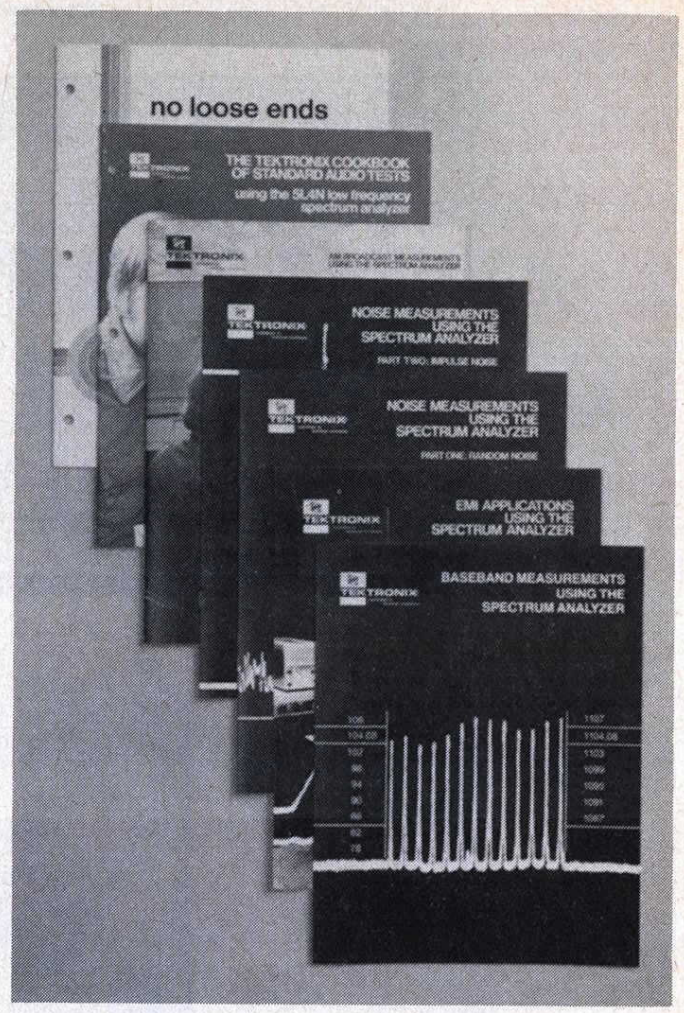
A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired. Securing Kit, fits 7L12 or 7L13, **016-0637-00** **$15**

3-wide Carrying Case for 7L13, 7L5 Option 25, etc. 016-0626-00 ..... **$185**

2-wide Carrying Case for 7L12, 7L5, etc. 016-0625-00 ..... **$185**

Luggage-type Carrying Case for 7603 Opt 08, 7613 Opt 08 (Analyzer must have 016-0637-00 Securing Kit) 016-0628-00 ..... **$250**

Your local field office or representative can quote prices and availability on any of these accessories.



Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on baseband, EMI, am, fm, two-way radio and television measurements, cable television proof of performance, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

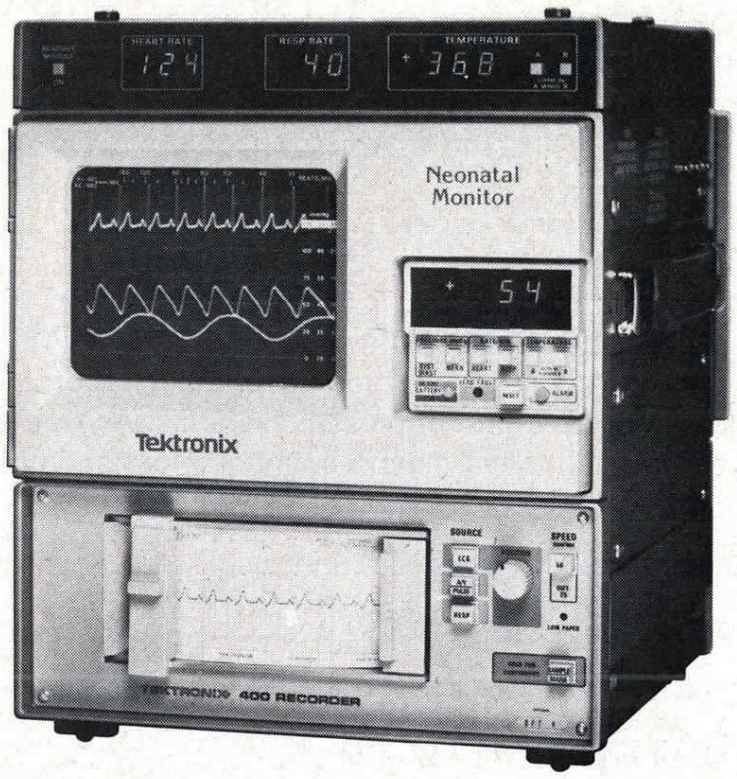
In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local Tektronix Field Office or Representative.

Option 08 protective front cover is shown on 7613 Mainframe.

Patient Monitors

Tektronix physiological monitors provide the medical professional with a full range of vital-signs monitoring in portable, compact packages. One instrument, for example, monitors ECG alone. Yet another monitors everything from ECG to pulse, respiration, temperature (including temperature from two body areas) and pressure, with systolic/diastolic or mean blood pressure readout. (Our 414 Option 21 even displays dual pressure readout.) Our 401 Series Digital Readout Modules provide additional digital readouts, and the 400 Series Recorders deliver hard copies (both waveform and alphanumerics) for a permanent record. Units are ac or battery powered, easy to operate and completely self-contained.

As an additional feature, your Tektronix Patient Monitor can be serviced by trained professionals at Tektronix Service Centers or through our distributors worldwide. Find out how Tektronix can provide a better solution to your monitoring needs. Simply check the appropriate box on the reply card at the back of this catalog now, or call our Hot Line toll free within the continental U.S., 800-547-4804.



413 Neonatal Monitor—
(Shown above with 400 Series Recorder and 401 Series Digital Readout Module). Simultaneously displays ECG, respiration, and blood pressure or pulse waveform. A digital readout shows heart rate, respiration rate, systolic/diastolic pressures, mean blood pressure, two temperatures, or temperature difference. Ac or battery operation.
Standard 413 Monitor **$4100**

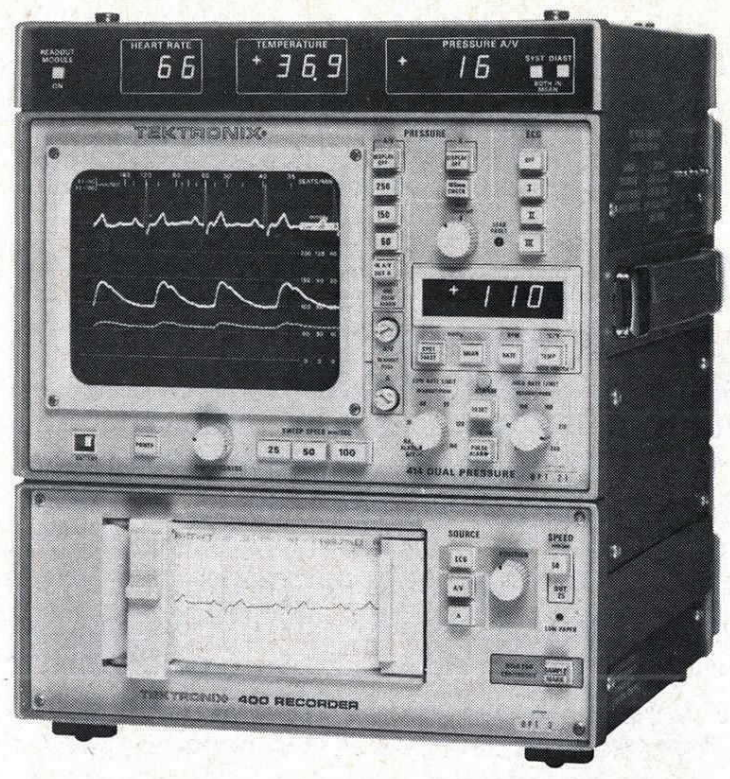
413 Option 20 Neonatal Monitor—
Identical to the standard 413 Neonatal Monitor, except that it provides neither blood pressure waveform, nor pressure related digital readouts. Ac or battery operation.
413 Option 20 Monitor **$4000**

413 Option 22 Patient Monitor—
Provides same features as the standard 413, except designed for adult measurement. Ac or battery operation.
413 Option 22 Monitor **$4100**

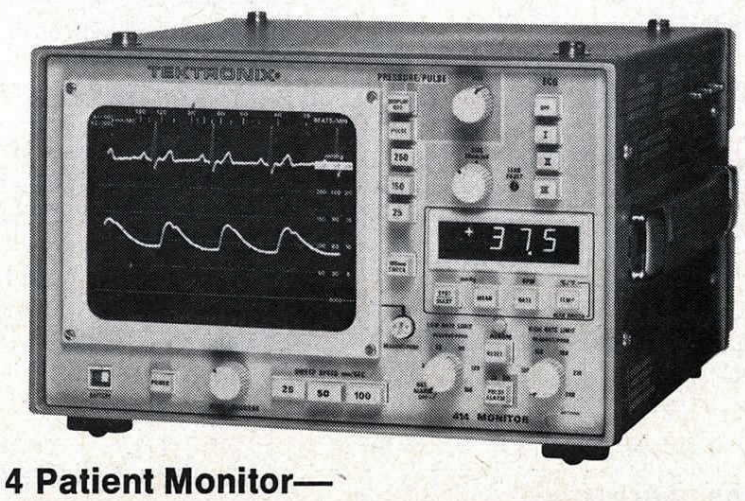
Tektronix Offers Varied Service Agreements and Leasing Plans.

- Service Agreements covering TEKTRONIX Portable Patient Monitors vary in duration and cost according to service and use requirements.
- The basic Tektronix lease agreement covers periods of one to three years in six-month increments and offers low cost renewal for one-year periods. An option to purchase plan is also available.

For complete information, see your local Tektronix representative.

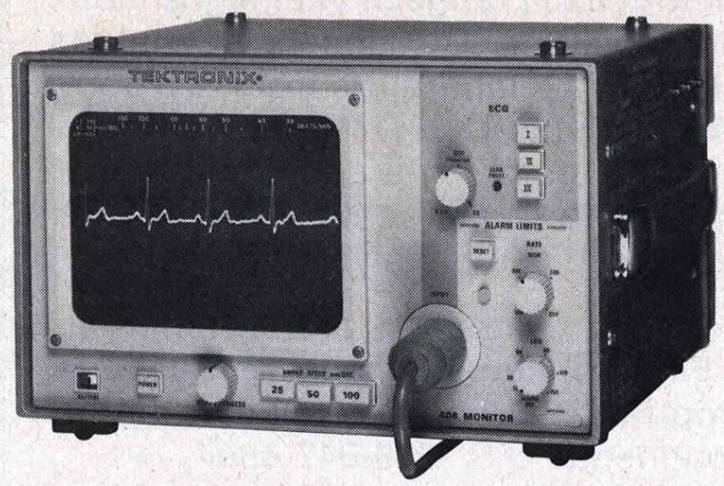


414 Option 21 Patient Monitor—
(Shown above with 400 Series Recorder and 401 Series Digital Readout Module)—This three-trace instrument offers simultaneous crt display of ECG and two blood pressure waveforms. First pressure channel is Arterial/Venous with three pressure ranges; second channel is Arterial dedicated to 250 mm Hg. Digital readout displays systolic/diastolic and mean blood pressures from either pressure channel, heart rate, and temperature. Ac or battery operation. Options include full lead select.
414 Option 21 Monitor **$3900**



414 Patient Monitor—
This dual trace instrument displays ECG and blood pressure or peripheral pulse, and provides a digital readout of heart rate, systolic/diastolic pressures, mean blood pressure, or temperature. The standard monitor features three-lead selection plus pressure and heart rate alarm limits, selectable sweep speeds, and ac or internal battery operation. Options include full-lead selection and dual pressure display.
Standard 414 Monitor **$3100**

Portable Patient Monitors



408 ECG Monitor—

This low cost, single-trace instrument is designed for applications requiring ECG measurements only. It features three-lead selection, variable heart rate alarm limits, three selectable sweep speeds, and ac or internal battery operation. Full lead selection is optional.

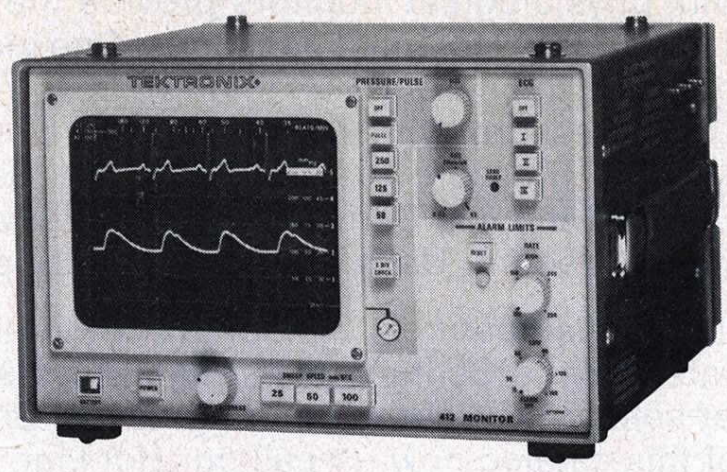
Standard 408 Monitor **$1800**

401 Series Digital Readout Modules For TEKTRONIX 413, 414 and 414 Option 21—

Each module provides three dedicated digital readouts in addition to the monitor readout. On the 413: ECG, respiration rate, and temperature (select between one of two temperature channels or the difference between temperatures). On both the 414 and 414 Option 21: ECG, temperature and blood pressure (select either systolic, diastolic or mean pressure) the module for the 414 Option 21 (dual pressure) is dedicated to the arterial/venous pressure channel. Modules are light weight (2 lbs. 4 oz.—1.02 kg) and only 1⅜ inches (3.5 cm) high. Ac or battery power is supplied by the monitor. No external cables are required.

Standard 401 Digital Readout Module (for 413) **$950**
Model 401, Option 01 (for 414) **$950**
Model 401, Option 02 (for 414, Option 21) **$950**

Modules ordered to retrofit to an already-purchased monitor should be installed at your local Tektronix service center (nominal charge for installation).



412 Portable Monitor—

This model offers dual-trace, three-lead selectable ECG and blood pressure or peripheral pulse display. It also provides variable heart rate alarm limits, three sweep speeds, and ac or internal battery operation.

Standard 412 Monitor **$2400**

400 Series Recorders—

These six-pound hard copy units attach directly to TEKTRONIX Patient Monitors and provide thermal printout records of ECG, blood pressure, or peripheral pulse waveforms. As well as alphanumeric printout in the margin of all digital information processed by the monitor.

Standard 400 Recorder (for 408 Monitor) **$1300**

Model 400, Option 01 (for 412) **$1400**

Model 400, Option 02 (for 414 Series—except Opt. 21) **$2400**

Model 400, Option 03 (for 414, Opt. 21) **$2400**

Model 400, Option 04 (for 413 Series) **$2400**

408, 412, 413, 414 Accessories

PATIENT CABLES

Torso Cable (3 electrodes)—
(012-0445-00) **$35**

Torso Cable for 413 (3 electrodes)—
(012-0739-00) **$35**

Limb Cable (3 electrodes)—With No. 4-40 tapped fittings (012-0459-00) **$60**

Electrode Wires for Patient Cables
18 inch wires with snap fittings for disposable electrodes, set of three.
(012-0502-00) **$9**

18 inch wires with No. 4-40 tapped fittings—
White (RA) (012-0449-00) **$8**
Black (LA) (012-0450-00) **$8**
Red (LL) (012-0451-00) **$8**

ELECTRODE ADAPTERS

All equipped with No. 4-40 thread to mate with limb cable or related electrode wires.

Snap Adapter—(103-0110-00) **$2.50**
Needle Adapter—(103-0108-00) **$2**
Plate Adapter—(103-0079-00) **$1**

ELECTRODES

Electrode—Re-usable, Ag/AgCl, with No. 4-40 thread (119-0197-00) **$10**

Attachment Rings—(006-1099-00) **$9**

Other attachment methods—MICROPORE tape or pads cut from RESTON No. 1360 or No. 1561.

Electrode Paste—(006-1098-00) **$3.50**

Disposable Electrodes—Snap-fit adult monitoring electrodes. Pre-gelled; foam adhesive pad. Box of 30 (in sealed envelopes of three each).
(119-0353-01) **$30**

Disposable Electrodes—Snap-fit infant monitoring electrodes. Pre-gelled; foam adhesive pad. Box of 30 (in sealed envelopes of three each).
(119-0898-00) **$30**

PULSE SENSORS

Finger—(015-0236-01) **$85**

Radial—Best sensor for infants. May also be used for finger, toe, etc.
(015-0237-01) **$85**

TRANSDUCERS

Statham P23 1d—(015-0233-00) **$540**
Trantec 800—(015-0234-00) **$525**
Bell & Howell—4327-I (015-0235-00) **$540**

TEMPERATURE PROBE

YSI 701—For use with 413 or 414.
(118-0256-00) **$40**

MOUNTING FIXTURES

Mounting Kit—Mounts monitor at five foot level. Attached to vertical pipes or surfaces of anesthesia machines or similar devices.
(016-0110-00) **$180**

Support—The upper-most portion of the mounting stand is available separately.
(407-1767-00) **$6**

Mounting Adapter—Attaches to instrument.
(014-0054-00) **$11**

Pole Clamp—Used to mount monitor models 408, 412, 413, 414 on poles ½ inch to 1¼ inch in diameter.
(014-0053-00) **$36**

MISCELLANEOUS

Replacement "D" Cell Battery Set—
(119-0441-01) **$110**

Replacement "F" Cell Battery Set—
(119-0443-01) **$150**

Accessory Pouch—(016-0560-00) **$15**

Servicing Extender Set—408 and 412 only.
(020-0078-00) **$70**

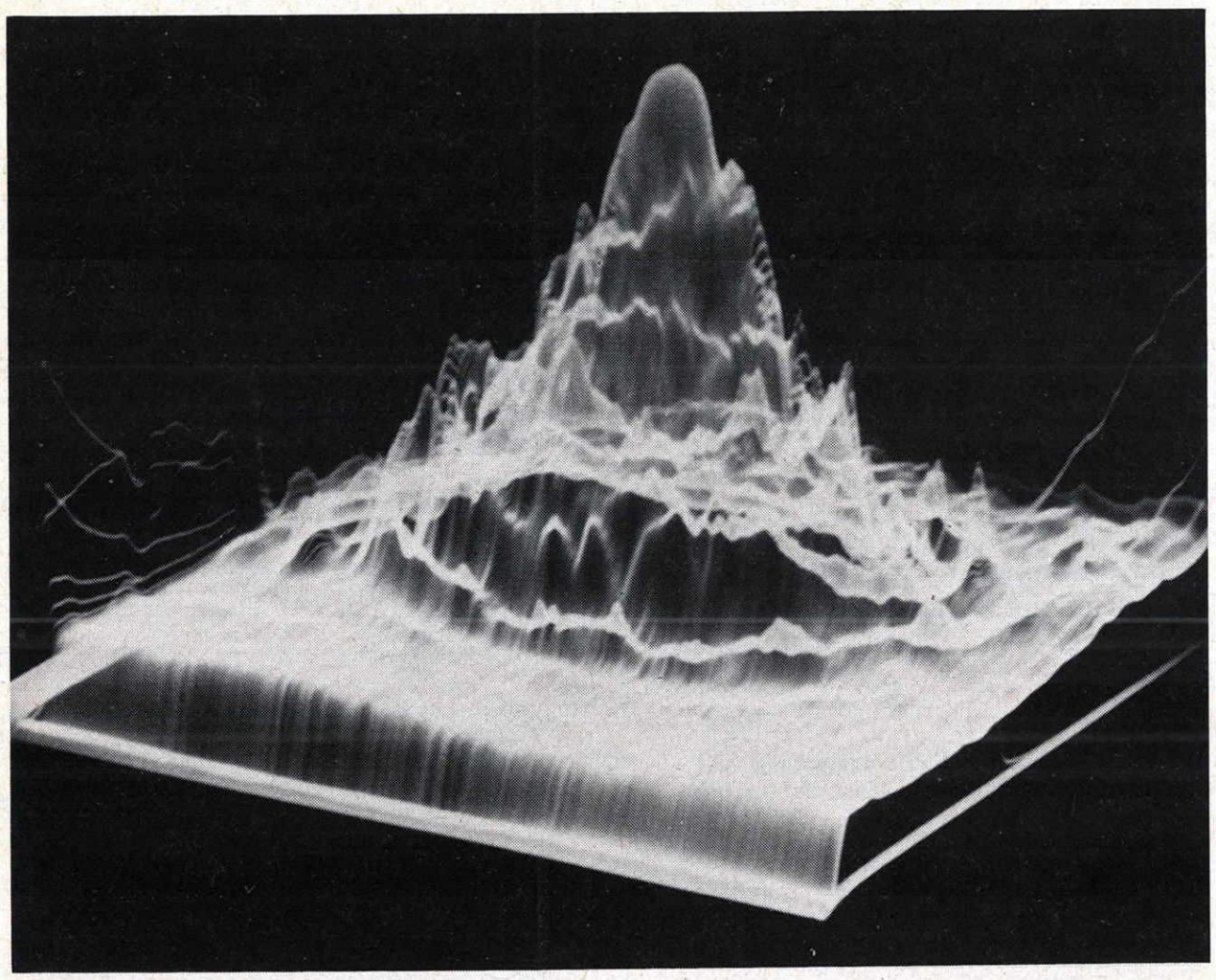
Servicing Extender Set for 414—
(020-0188-00) **$110**

Servicing Extender Set for 413—
(020-0291-00) **$190**

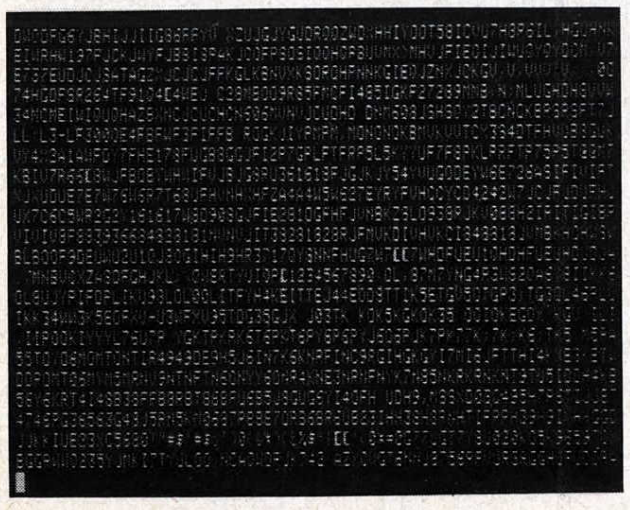
Repair Kit—For No. 4-40 ends on limb cables and electrode wires.
(040-0696-01) **$30**

Display Components

16



The 604A displaying a three-dimensional isometric video image. Courtesy of Optical Electronics, Inc., Tucson, Arizona.



The 634 with alphanumerics display.

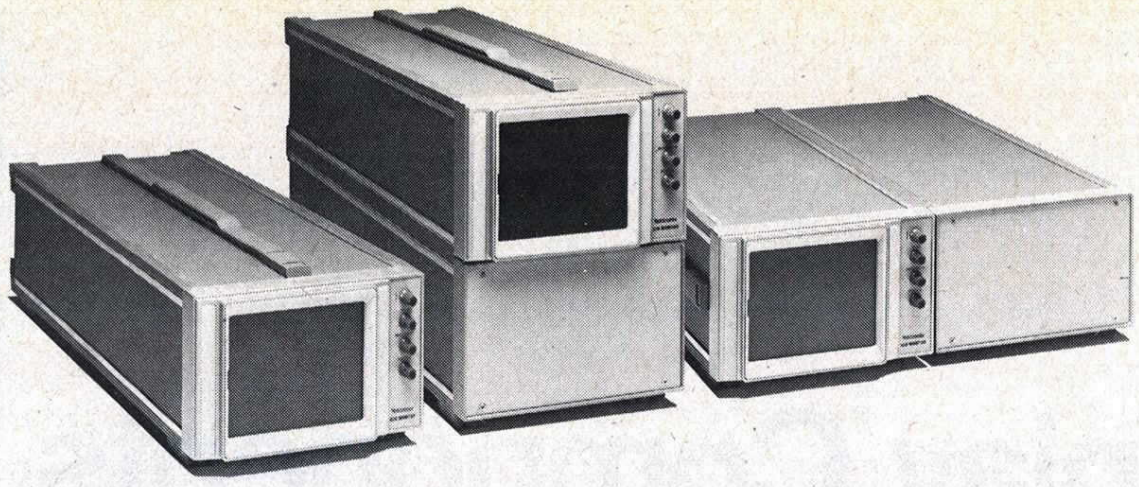
The 608 in M-mode and A-mode ultrasound applications. Courtesy of Advanced Technology Laboratories, Inc., Seattle, Washington.

As the leader in quality OEM displays . . .

We know your needs and we can meet them with the greatest variety of small screen display products in the business. We know that you expect our displays and cameras to do the job they're specified for—day after day. You expect us to offer you the most competitive price/performance packages. To work closely with you in solving your interface requirements. To support you totally, before and after purchase. To grow as you grow, so we can both meet the new technologies, government regulations, and competitive pressures that impact our business . . .

See for yourself.

Our broad product offering is just the beginning: small-screen displays, cameras priced for the OEM, and a wide range of options including UL 544 Listing and Component Recognition and modular packaging. Add in-depth assistance, full service and support programs for a truly profitable working relationship. For additional product information, applications assistance, or a demonstration, simply complete and return the card at the back of the catalog. Or, call Tektronix automatic answering service toll-free: 1-800-547-1512. In Oregon, call collect: 644-9051. For even faster service, call your nearest Tektronix office.



Modular packaging and rack mounting

Dress packaging for the 620.

You can order the 620 in the following configurations:

1. Without handle, feet or covers, for in-system installation.
2. With covers only for stand-alone applications.
3. With covers, plus handle and feet. Covers also come with UL 544 Listing (Option 06).
4. With vertical double height packaging. Included handle is centered on top of the instrument.
5. With horizontal full rack-width packaging. Included handle can be mounted on either side of the instrument. Both vertical and horizontal packages also include feet, and let you put your custom electronic circuitry in the empty compartment and connect it to the display, all in one contemporarily-styled, integrated enclosure.

Vertical dress package. Includes handle, feet and covers.

Order No. 016-0409-00 .....**$145**

Horizontal dress package. Includes handle, feet and covers.

Order No. 016-0410-00 .....**$145**

Rackmount kits for the 620.

Slide-out 19″ rack assembly which rackmounts one 620 and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and combine it with the display. Includes frame, covers and rack slides. Not available with Options 06, 23, 28.

Order No. 016-0404-00 .....**$150**

Slide-out 19″ rack assembly which rackmounts two 620s side by side. Includes covers and rack slides. Not available with Options 06, 23, 28, 31.

Order No. 016-0405-00 .....**$110**

Packaging for other instruments.

New packaging for other instruments is continually being developed to meet the needs of our OEM customers. Your local Tektronix Representative can help you obtain full information.

Rackmounting for the 634

Slide-out 19″ rack assembly which rackmounts one 634 and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display. Includes covers and rack slides.

Order 016-0402-00 .....**$150**

Slide-out 19″ rack assembly which rackmounts two 634 side by side. Includes covers and rack slides.

Order 016-0403-00 .....**$110**

Rackmounting for 603A, 604A, 606A, 607A, 608, 624.

Rackmount and Empty Cabinet Kit for 603A, 604A, 606A, 607A, 608, and 624. Slide-out 19″ rack assembly which mounts a display monitor and an empty compartment horizontally. In the compartment you may put your custom electronic circuitry and connect it to the display, all in one enclosure.

Order 040-0601-00 .....**$150**

Display/Power Module Kit. Allows rackmounting of 603A, 604A, 606A, 607A, 608, and 624 with TM 503 Power Module. Minimizes mechanical design time. Simply design your own electronics using TM 500 Custom Plug-in kits described on p. **167.** Then plug them in. Fits standard 19″ rack.

Order 040-0624-01 .....**$75**

Rackmounting kit for 603A, 604A, 606A, 607A, 608, and 624.

Slide-out 19″ rack assembly which rackmounts any two of the above displays side by side. Includes covers and rack slides.

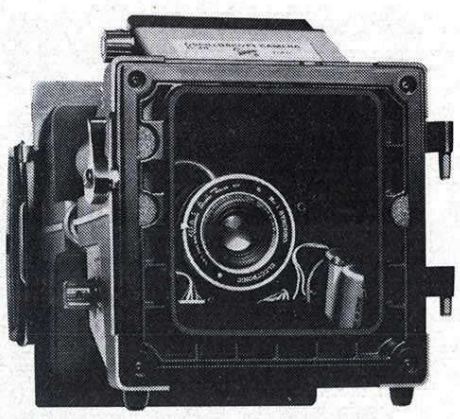
Order 040-0600-00 .....**$110**

Rackmount-to-Cabinet Conversion, required to convert a rackmount 603A, 604A, 606A, 607A, 608 and 624 to a cabinet style.

Order 040-0602-00 .....**$100**

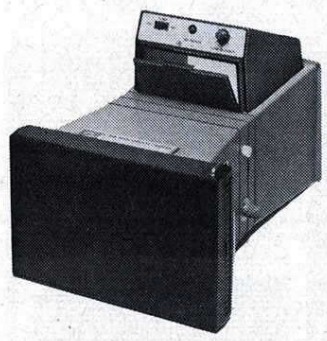
Cameras Priced for the OEM

For complete information on the C-28, the C-5B and other Tektronix cameras, see pages 209-216. For OEM purchasing information, please contact your local Sales Engineer or Representative.



The High Performance C-28 Camera

Features changeable magnification (1:0.67 to 1:0.85), remotely controllable electric shutter, and rigid body design that eliminates trapezoidal distortion. F-stops from f/2.8 to f/16, and 8 shutter speeds (from 1/50 to 2 seconds, plus "bulb" and "open") handle a broad variety of exposure variables. Comes with a combination Graflok[1]/Polaroid[2] film back for 3¼″ x 4¼″ Polaroid film or user's choice of Graflok-compatible accessories such as 70 or 90 mm roll film backs. Three other object-to-image ratio lens mounts are also available.



The Low-Cost C-5B Camera

The C-5B is a light weight, easy-to-use camera that quickly attaches and removes from the display. It features changeable magnification ratios to accommodate both 8 x 10 and 10 x 12 cm displays, an exceptionally reliable electric shutter, and an f16 lens that requires no focusing.

[1]T.M., Singer Education Systems.
[2]T.M., Polaroid Corporation.

Light Filters/Graticules

Monitor	Filters/Graticules	Part No.	Price
603A & 604A	Clear Filter (604A*)	337-1440-00	2.60
	Green Filter (603A*)	337-1440-01	2.50
	Amber Filter	337-1440-02	3.30
	Blue Filter	337-1440-03	3.30
	Gray Filter	337-1440-04	3.30
	Graticule (603A*)	331-0303-00	4.00
607A	Blue Filter	337-1674-00	3.00
	Amber Filter	337-1674-05	3.00
	Smoke-Gray Filter*	337-1674-06	3.00
	Graticule*	331-0391-00	4.00
606A	Smoke-Gray Filter	337-1674-06	3.00
	Blue Filter	337-1674-11	3.00
	Amber Filter	337-1674-12	3.15
	Graticule*	337-1674-10	2.50
	Clear Shield*	337-1674-13	3.00
608 624	Amber Filter	378-0704-00	2.30
	Green Filter	378-0705-00	2.30
	Graticule (608, 624*)	337-2126-02	4.00

*Shipped on or with the standard instrument.

Other Accessories

Lab carts. Provide equipment mobility.

KEY SPECIFICATIONS FOR X-Y DISPLAYS

For options and ordering information, see individual product pages. See product literature for complete specifications.

	603A	604A	606A	607A	608	620	624
Spot Size[1]	0.25 mm (10 mils)	0.36 mm (14 mils)	0.13 mm (5 mils)	0.25 mm (10 mils)	0.26 mm (10 mils)	<15 mil, <25 mil at max drive	0.30 mm (12 mils)
Display Size	10.2 x 12.7 cm	10.2 x 12.7 cm	8 x 10 cm	7.2 x 9 cm	9.8 x 12.2 cm	10 x 12 cm	9.8 x 12.2 cm
Acceleration Potential	3.5 kV	3.5 kV	5.6 kV	12 kV	22.5 kV	12 kV	≈18 kV
Bandwidth, X-Y[2]	≥2 MHz	≥2 MHz	≥3 MHz	≥3 MHz	≥5 MHz	≥2 MHz	≥3 MHz
Bandwidth, Z[2]	≥5 MHz	≥5 MHz	≥10 MHz	≥5 MHz	≥10 MHz	≥5 MHz	≥5 MHz
Rise Time	≤70 ns	≤70 ns	≤35 ns	≤70 ns	≤35 ns		≤70 ns
Input R and C, X-Y[3]	1 MΩ ±1% || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ, || ≤60 pF	1 MΩ || by 47 pF	1 MΩ || <47 pF
Input R and C, Z[3]	1 MΩ || <47 pF	1 MΩ ±1% || <47 pF	1 MΩ <47 pF	1 MΩ <47 pF	1 MΩ, ≤60 pF	1 MΩ <47 pF	1 MΩ || <47 pF
X-Y Phase Difference	≤1° to 500 kHz	≤1° to ≤500 V	<1° to 500 kHz	≤1° to 500 kHz	≤1° to 1.5 MHz	≤1° dc to 500 kHz	<1° to 1.0 MHz
Maximum Input Voltage[4]	±100 V	±100 V	±100 V	±100 V	±100 V	±25 V	±100 V
Linear Common-Mode Signal Range (Opt. 22) X-Y[5]	±15 V	±15 V	±15 V	±15 V	±15 V	Not Applicable	±15 V
Linear Common-Mode Signal Range (Opt. 21), Z	±5 V	±5 V	±5 V	±5 V	±5 V	Not Applicable	±5 V
Common-Mode Rejection Ratio (Opt. 21), X-Y	≥100:1 to ≥100 kHz, ≥50:1 to ≥100 kHz (Opt. 22)	≥100:1 to ≥100 kHz; ≥50:1 (Opt. 22)	≥100:1 to 500 kHz; ≥40:1 (Opt. 22)	≥100:1 to 500 kHz; ≥40:1 (Opt. 22)	≥100:1 to 100 kHz; ≥40:1 (Opt. 22)	Not Applicable	≥100:1 to 100 kHz; ≥40:1 (Opt. 22)
Common-Mode Rejection Ratio (Option 21), Z	≥100:1 to 100 kHz	≥100:1 to 100 kHz	≥100:1 to 100 kHz	≥100:1 to 100 kHz	≥100:1 to 100 kHz	Not Applicable	≥100 to 100 kHz
Recommended Source Impedance, X-Y and Z	≤10 kΩ	≤10 kΩ	≤10 kΩ	≤10 kΩ	≤10 kΩ	≤10 kΩ	≤10 kΩ
Temperature Range	0°C to +50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C	0°C to +50°C
Power Requirements[6]	75 W	56 W	75 W	53 W	61 W	See footnote	61 W
Included Accessories	External program connector; connector cover; external graticule	External program connector; connector cover.	External graticule	External program connector; connector cover; external graticule.	Lined external implosion shield (graticule) for adjustment purposes.	Lined external implosion shield (graticule) for adjustment purposes.	
Recommended Cameras[7]	C-59P, C-5B C-5B Opt. 01, C-28	C-59P, C-5B Opt. 01, C-28	C-28, C-5B Opt. 01, C-59P	C-5B, C-5B Opt. 01, C-28	C-5B, C-59P, C-28	C-5B, C-5B Opt. 01, C-28	C-5B, C-28

1. Measured at 0.5 μA, except for the 606A, measured at 0.1 μA.
2. Full spec would read: "DC to . . ." appropriate figure.
3. "|| <" means "paralleled by less than".
4. (dc + peak ac)
5. With Option 21 = ±3 V (non-attenuated) for all but the 620 where not applicable.
6. Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (±10% on each range). 48 to 440 Hz (except the 624 which excludes 220). Number given shows watt max at nominal line voltage. The 620's power requirements are 90-132 V ac; 48-440 Hz line frequency, 22 W max, 0.2A at 120 V ac 60 Hz.
7. External 15 V dc 750 mA power supply required for C-28.

Small screen measurement display applications.

Additional options may be required to optimize display quality for your application.
See your Tektronix Representative for full details.

	620	634	634 Opt. 01	608	624	606A	607A	603A	604A
Ultrasound									
B-scan		✓	✓						
A-mode	✓			✓	✓				✓
M-mode				✓	✓		✓		
Real time		✓	✓	✓	✓				
Multi-imaging									
Nuclear				✓	✓	✓			
Ultrasound		✓	✓						
Computerized Tomography		✓	✓						
Gamma									
Visual						✓	✓		
Photography		✓	✓			✓			
Computerized Tomography									
Photography		✓	✓						
Electronic Instrumentation	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electronic Test & Measurement	✓		✓	✓	✓		✓		
Mititary/Aerospace	✓	✓	✓	✓	✓	✓	✓	✓	✓
Communications	✓	✓	✓	✓	✓		✓	✓	✓

634 Raster Scan Display Monitor

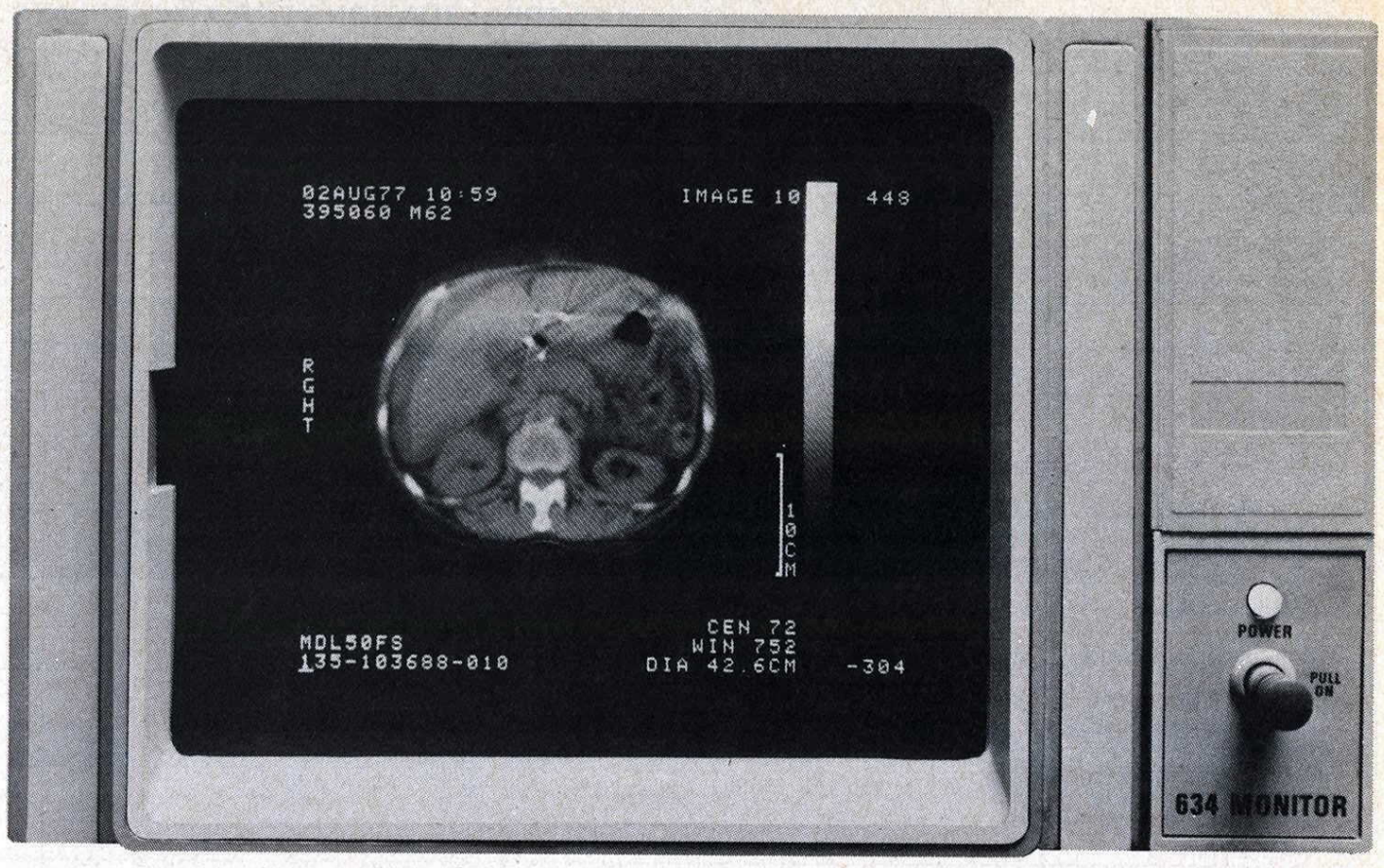
Very High Resolution

1400-line Nominal Resolution—Center Screen at 100 cd/m² (30 fL)

Non-linearity ≤.5% within a 9 cm Circle—≤1% at Corners

Brightness Uniformity Better than ±10%

Modular Construction for Ease of Installation and Servicing



The TEKTRONIX 634 is a very high resolution, low geometric distortion video monitor, designed for applications requiring superior performance. Key specifications include:

Standard resolution of 1400 lines (nominal) — center screen at 100 cd/m² (30 fL). Delivers detailed imaging and optimum gray scale for photography. Especially important when images have large, varied and detailed data content, like those in multi-imaging, ultrasound and computerized tomography or scanning electron microscopy.

System manufacturers requiring less than 1400-line resolution will want the TEKTRONIX 634 Option 01. It offers standard resolution of 800 lines nominal — center screen at 10 cd/m² (30 fL) — while meeting most other 634 specifications including distortion, phosphor uniformity and corner focus.

Non-linearity: ≤.5% within a 9 cm circle, ≤1% at corners — This performance is crucial in applications where highly accurate measurements must be taken from photographs. (1% within a 9 cm circle, 2% at corners with Option 01.)

≤20% phosphor non-uniformity — means there is more consistent gray scale over the entire display surface area. This is essential when comparing tissue densities from different areas of the display.

The P45 phosphor formulation — standard on the 634 — reduces the graininess of photographs taken with blue-sensitive film (like most x-ray film).

SPECIFICATIONS

Note: To save you valuable calibration time, every 634 is calibrated to meet all specifications **before** it leaves the factory.

DISPLAY PERFORMANCE

Crt display — monochrome: 9 cm vertically; 12 cm horizontally; 15 cm diagonal (6 in.); flat screen, magnetic deflection; 4 x 3 aspect ratio.

Resolution — Measured by the shrinking raster method with no interlacing, center screen at 100 cd/m² (30 fL).

	634	634 Option 01
Worst case:	1100 line	650 line
Nominal:	1400 line	800 line

Position Accuracy/Non-linearity — ≤.5% within 9 cm circle, ≤1% in corners. For Option 01: 1% within 9 cm circle, 2% at corners.

Brightness — 515 cd/m² (150 fL) maximum.

Brightness Non-uniformity — Less than ±10% using J16 Photometer.

Phosphor Type — P45 Standard.

Black Level Stability — Back porch dc restoration.

VIDEO INPUT

Description — Video with negative sync.

Signal Level — .35 V p-p to 2 V p-p.

Maximum Safe Input — ±5 V p-p.

Bandwidth — 1 Hz to 10 MHz (Standard). 20 MHz Z-axis bandwidth available as Option 14.

RASTER

Vertical Rate — 60 ramps/sec.

Horizontal Rate — 15,750 ramps/sec. (Adjustable ±10% range).

Note: Our standard instrument will accept the line/field rate of 625/50. 660-1029 rate available as Option 15.

SAFETY

Department of H.E.W. [BRH Rule 1020.10 (C) (1)] — Standard.

U.L. 544 — Listing and Component Recognition (Options 06 and 09).

POWER

Standard — Ac 50 watts, 50-400 Hz. 100, 110, 120, 200, 220, 240 V, ±10%.

Option 20 — Unregulated dc. +9 V at 300 mA with 1 V ripple; +23 V at 1.6 A with 4 V ripple; −22 V at .70 A with 3 V ripple.

OTHER CHARACTERISTICS

Temperature Range for Electrical Specifications — 0° to +50°C.

Included Accessories — Operator's and Instruction Manual; linearity graticule.

Recommended Cameras — C-5B, C-28 (external 15V dc 750 mA power supply required for C-28).

Dimensions	Cabinet	
	cm	in
Height (with feet)	14.9	5.3
Height (without feet and handle)	13.2	5.3
Width	21.3	8.4
Depth (Ac power)	41.9	16.5
Depth (Dc power—Option 20)	36.3	14.3

ORDERING INFORMATION

634 Raster Scan Display Monitor with standard resolution of 1400 lines nominal, 1100 lines worst case (center screen at 100 cd/m₂ [30 fL], without handle, feet and covers **$1195**

Option 01 Standard resolution of 800 lines nominal, 650 lines worse case (center screen at 100 cd/m² [30 fL]) ..... Sub $225

PERFORMANCE OPTIONS

Option 11 External Sync—Switchable ..... Add $25

Option 13 Video Reverse ..... Add $50

Option 14 20 MHz Z-Axis Bandwidth ..... Add $60

Option 15 660-1029 Line Rate ..... Add $120

Option 16 Remote Brightness, Contrast, Focus, Blanking ..... Add $30

Option 17 Contrast, Brightness and Focus Controls are Removed from the Front Panel and Positioned on the Top Side of the Instrument. (Not available with Options 6, 23 or 28) ..... No Charge

Option 20 Dc Supply (±21-25 V +9 V unregulated) ..... Sub $50

SAFETY OPTIONS

Option 06 UL Listing (Not available with Options 17, 20 or 28) ..... Add $75

Option 09 UL Component Recognition (UL 544) ..... No Charge

MECHANICAL PACKAGE OPTIONS

Option 23 With Handle, Feet, and Covers (Not available with Options 17 or 20, 28) .... Add $50

Option 28 Covers Only. (Not available with Options 06, 17, 20, 23) ..... Add $40

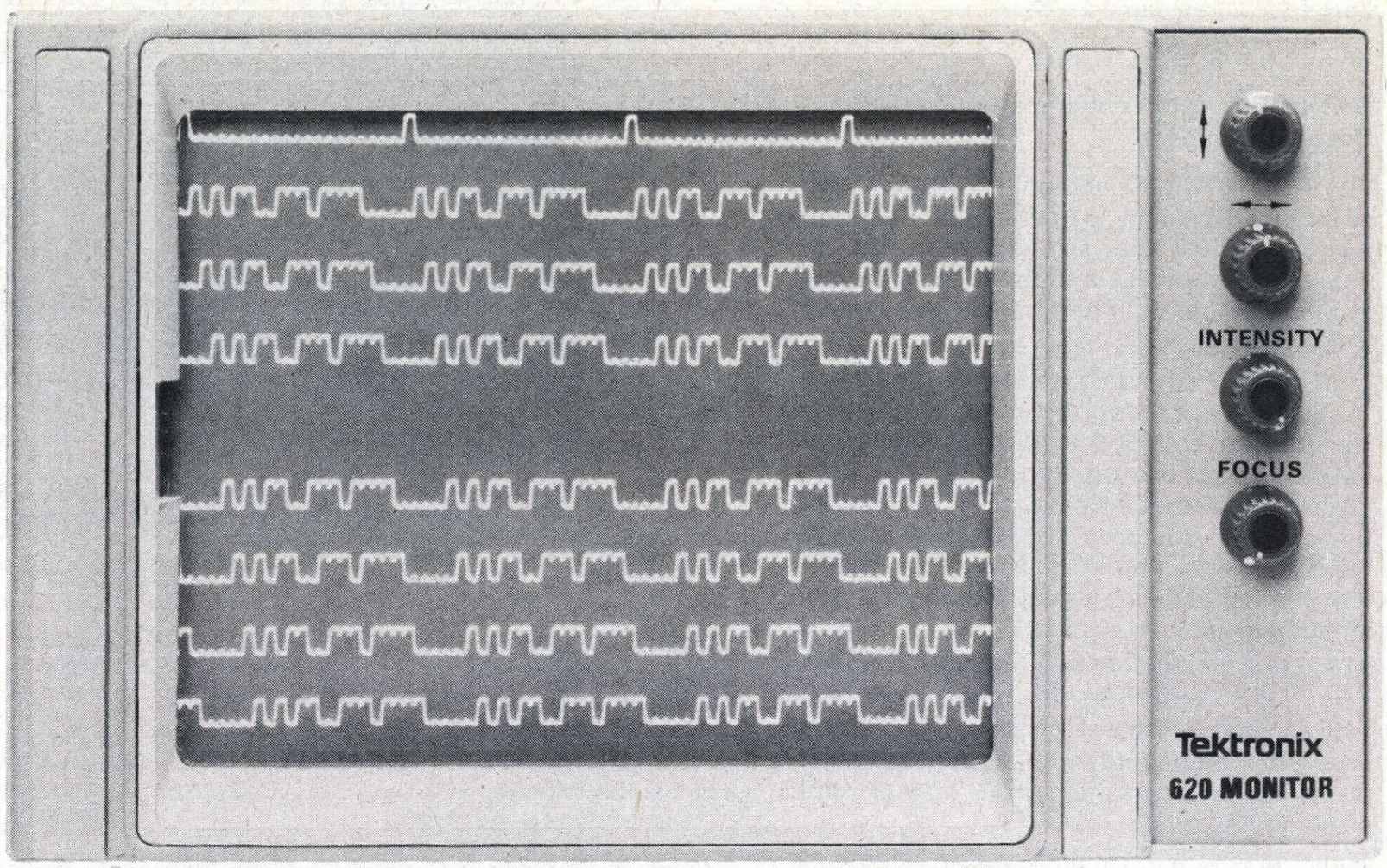
Option 30 Metal Shield ..... Add $35

PHOSPHORS

Option 74 P4 ..... Add $35

See page 202 for information on cameras, filters and packaging.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.



Low Cost Display

15 mil Spot Size

30 fL Brightness

Modular Packaging Available

The TEKTRONIX 620 is a very low-cost, electrostatically deflected display that offers spot size of 15 mils, a 10 x 12 cm screen, and brightness up to 100 cd/m² (30 fl[1]) while still maintaining crisp imaging. A range of options including modular packaging (see p. 202) combine to make the 620 an excellent value in highly competitive price/performance situations where good system/display interface is also required.

You can use the 620 in any situation requiring a low-cost solidly performing X-Y display. Electronic instrumentation applications include pulse height, network, spectrum and signal analyzers/digitizers. Mechanical measurement instrument uses are vibration and engine analyzers and flaw detectors.

[1] *Measured with full screen 60 Hz 300 line raster.*

SPECIFICATIONS

CRT DISPLAY

Cathode Ray Tube — 6½″ flat-faced rectangular crt with P31 Phosphor.

Spot Size — 36 mm (15 mils) at .5μA.

Display Size — 10 cm vertically, 12 cm horizontally.

Graticule — External graticule included as accessory. Internal 8 x 10 cm graticule available as Option 01.

Display Linearity — The voltage required to produce a 2.5 cm deflection from any point on the crt will not vary more than 5%.

Acceleration potential — 12 kV.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth — Dc to 2 MHz.

Setting Time — 1 μs from any point on the crt within 0.05 cm of final position.

Deflection Factor — Adjustable, ≤0.9 V to ≥1.5 V full scale (vertical), ≤0.8 V to >1.2 V (horizontal).

Input R and C — 1 MΩ paralleled by 47 pF.

X-Y Phase Difference — ≤1° dc to 500 Hz.

Max Input Voltage — ±25 V (dc + peak ac).

Recommended Source Impedance — 10 kΩ or less.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth — Dc to ≥5 MHz.

Input Sensitivity Range — Full drive 1 volt.

OTHER CHARACTERISTICS

Power Requirements — 90-132 V ac line voltage; 48-440 Hz line frequency; 22 W, 0.2A at 120 V ac, 60 Hz max power. Dc power (Option 20) +17 to +26 V.

Temperature Range for Electrical Applications — 0° to 50°C.

Finish — Blue vinyl painted aluminum cabinet (optionally available); aluminum castings and extrusions.

Recommended Cameras — C-5B, C-28 (external 15 V dc 750 mA power supply required).

Included Accessories — Instruction manual; external graticule.

Dimensions (without modular packaging)	Cabinet cm	Cabinet in
Height (without feet)	13.3	5.2
Width	21.4	8.4
Length	49.9	19.6
Weight (approx. without handle, feet and covers)	kg	lb
Net	5.3	11.8
Shipping	6.9	15.2

ORDERING INFORMATION

620 Display (without handle, feet and covers) $795

Option 01 — With internal graticule ..... No Charge

Option 06 — UL 544 Listed, includes handle, feet and covers ..... Add $75

Option 09 — UL Component Recognition .. No Charge

Option 10 — Remote 25-pin program connector X, Y and Z axes. Single-ended inputs only (not available with Option 31) ..... Add $40

Option 20 — Delete ac power. External dc power required (+17 to 26 V≃.9A). Not available with Option 31 ..... Sub $30

Option 23 — With handle, feet and covers (not available with Options 06, 28 and modular packaging) ..... Add $50

Option 25 — TTL blanking ..... Add $30

Option 28 — With cover only—no trim strips (not available with Options 06, 23 and modular packaging) ..... Add $40

Option 31 — Delete all real panel BNC's, dc power connector and ac power supply and switch. Option 31 includes provision for external dc power (+17 V unregulated). All power connections and input signals are made to interconnect pins inside monitor. Not compatible with Options 10 or 20. Can be used with 016-0409-00 or 016-0410-00 packaging ..... Sub $30

Modular dress packaging[2]:
Vertical package. Includes handle, feet and covers.
Order No. 016-0409-00 ..... $145

Horizontal package. Includes handle, feet and covers.
Order No. 016-0410-00 ..... $145

RACKMOUNT KITS

Rackmount for one 620 in a 19-inch rack. Includes frame, covers and rack slides. Not available with Options 06, 23, 28.
Order No. 016-0404-00 ..... $150

Rackmount for two 620s side-by-side in a 19-inch rack. Includes covers and rack slides. Not available with Options 06, 23, 28, 31.
Order No. 016-0405-00 ..... $110

[2] *OEM pricing and quantity discounts unavailable on modular packaging.*

See page 202 for information on cameras, filters, and rackmounting.

SPECIAL PRICING, TERMS AND CONDITIONS ARE AVAILABLE TO QUALIFIED OEMS. CONTACT YOUR LOCAL TEKTRONIX REPRESENTATIVE FOR COMPLETE INFORMATION.

624

Large 9.8 x 12.2 cm Screen

Small Spot Size — 12 mils

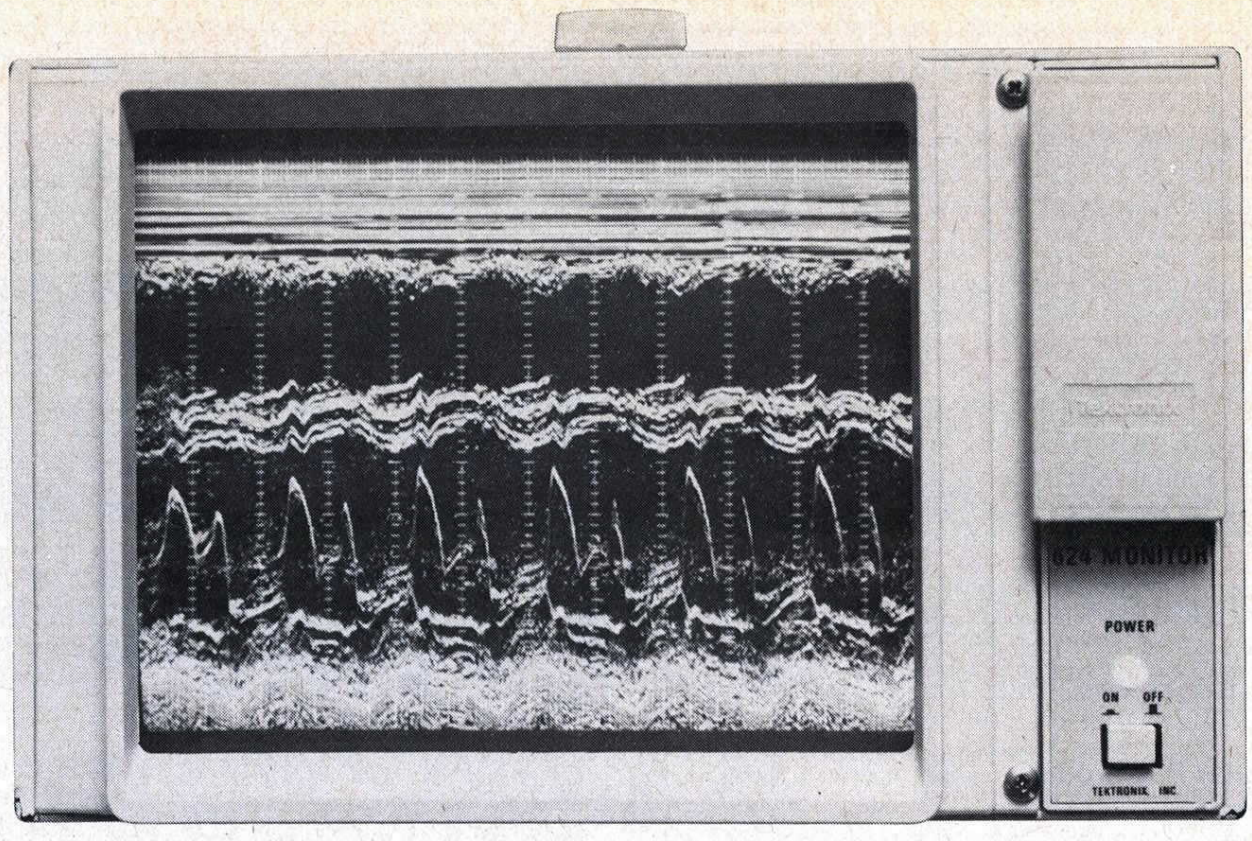
Delivers Up to 40 Footlamberts Usable Brightness[1]

The TEKTRONIX 624 combines large screen size (9.8 x 12.2 cm), 137 cd/m² (40 fl[1]) brightness and small spot size (12 mils). The result: detailed displays that are easy to read in high ambient light and deliver quality photographs.

The small 12-mil spot size makes the 624 an excellent choice for the detailed imaging required for both B-scan and A-mode ultrasound, echocardiography and real-time ultrasound. The 624 delivers a sharp picture that aids the doctor in making more precise measurements, and 40 fl brightness makes the 624 suitable for direct viewing as well as photography.

If you're a manufacturer of spectrum analyzers, logic analyzers, or other electronic test and measurement systems, you can be assured of an accurate, crisp representation of the signal, thanks to the 624's small spot size and linearity.

The 624 readily interfaces with a variety of systems. The wide deflection factor and sensitivity range—adjustable 50 mV to 0.25 V/div. (up to >1.25 V/div with extended gain range option)—facilitates integration with a broad range of designs. Remote program connector option allows control by the user's system, and a TTL blanking option is available for digital control. Dc power option allows the OEM to use his system's own power supply.



[1] Measured with quality area flooded by a 60 Hz raster, 320 horizonal lines.

ORDERING INFORMATION

624 Display Monitor $1335
(without handle, feet and covers)
Option 01 — Internal Graticule ..... No Charge
Option 04 — Time Base ..... Add $175
Option 06 — UL 544 Listed, includes Handle, Feet and Covers ..... Add $75
Option 09 — UL Component Recognition. . No Charge
Option 10 — Remote Program Connector X, Y and Z Single ended inputs only. 25 pin connector ..... Add $30
Option 20— Without ac supply (±18V Unregulated dc supply required not available with Option 06) . Sub $50
Option 21 — Full Differential Inputs (X, Y and Z) ..... Add $30
Option 22 — Extended Gain Range (X5) .... Add $20
Option 23 — Handle, Feet and Covers ..... Add $50
(not available with Options 06 and 28)
Option 25 — TTL Blanking ..... Add $50
Option 26—50 Ω Inputs (X, Y and Z) ..... Add $20
Option 28 — Covers Only ..... Add $40
(not available with Options 06 and 23)
Option 29 — Metal Bezel ..... Add $50
Option 30 — Full Crt Magnetic Shield ..... Add $75
Option 40 — P-39 Phosphor ..... Add $35
Option 74 — P4 Phosphor ..... Add $35
Option 78 — P11 Phosphor ..... Add $35

See page 202 for information on cameras, rackmounts, light filters/graticules.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

608

High Brightness Monitor

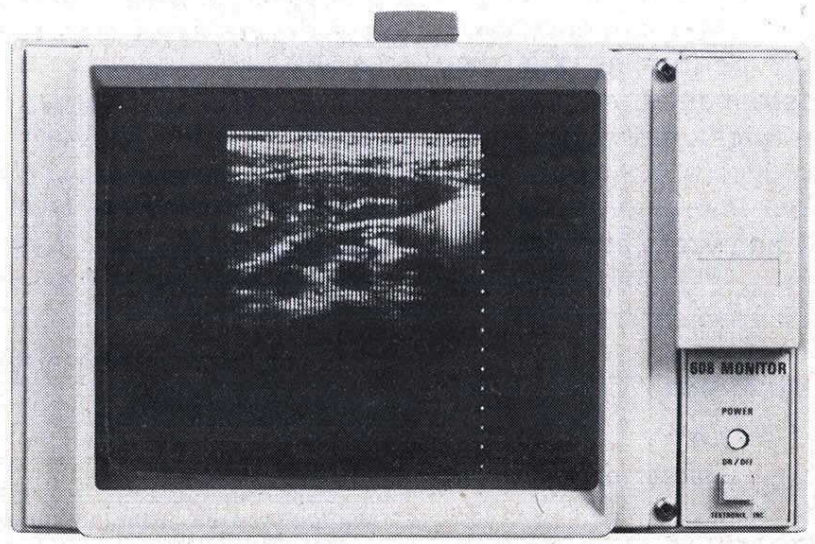
For High Ambient Light Viewing

The 608 accommodates X-Y and raster scan displays with excellent gray scale and detailed dot scans, thanks to the small 10-mil spot size. Imaging is critically sharp from corner to corner for nuclear multi-imaging applications.

The large, bright, flat-faced electrostatic deflection crt displays a clear waveform for excellent presentation of detail for easy reading in high ambient light, and for photographic applications.

B-scan, echocardiography, and real-time ultrasound OEMs will find the 608 extremely well suited for their high performance display applications. Suppression of the expansion mesh halo eliminates annoying stray light that ordinarily gives lower contrast, and the "washed-out" appearance that interferes with high light intensity gray scale displays. The result is a more readable display with subtle and accurate gray scale graduation for precise measurement or diagnosis.

The 608 can also be integrated with non-destructive test systems, electronic instruments such as logic and spectrum analyzers, and with mechanical measurement systems and analytical instruments—and other areas where a high quality, high brightness display is required.



ORDERING INFORMATION

608 Display Monitor $1630
(without handle, feet and covers)
Option 01 — Internal Graticule ..... No Charge
Option 04 — Time Base ..... Add $175
Option 06 — UL 544 Listed, includes Handle, Feet and Covers ..... Add $75
Option 09 — UL Component Recognition .. No Charge
Option 10 — Remote Program-Connector— X, Y and Z, Single Ended Inputs Only. 25 Pin Connector ..... Add $30
Option 20 — Without ac supply — (±18 V Unregulated dc supply required; not available with Option 06) ..... Sub $50
Option 21 — Full Differential Inputs (X, Y and Z) ..... Add $30
Option 22 — Extended gain range (X5) ..... Add $20
Option 23 — Handle, Feet and Covers ..... Add $50
(not available with options 06 and 28)
Option 24 — Linearized Z Axis (gamma correction) ..... Add $50
Option 25 — TTL Blanking ..... Add $50
Option 26 — 50 Ω Inputs (X, Y and Z) ..... Add $20
Option 27 — Internal Gain Adjustments Only . Add $10
Option 28 — Covers Only ..... Add $40
(not available with Option 06 and 23)
Option 29 — Metal Bezel ..... Add $50
Option 30 — Full Crt Magnetic Shield ..... Add $75
Option 40 — P39 Phosphor ..... Add $35
Option 74 — P4 Phosphor ..... Add $35
Option 76 — P7 Phosphor ..... Add $35
Option 78 — P11 Phosphor ..... Add $35

See page 202 for information on cameras, rackmounts, light filters/graticules.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

607A

50-Minute Storage

Adjustable Persistence

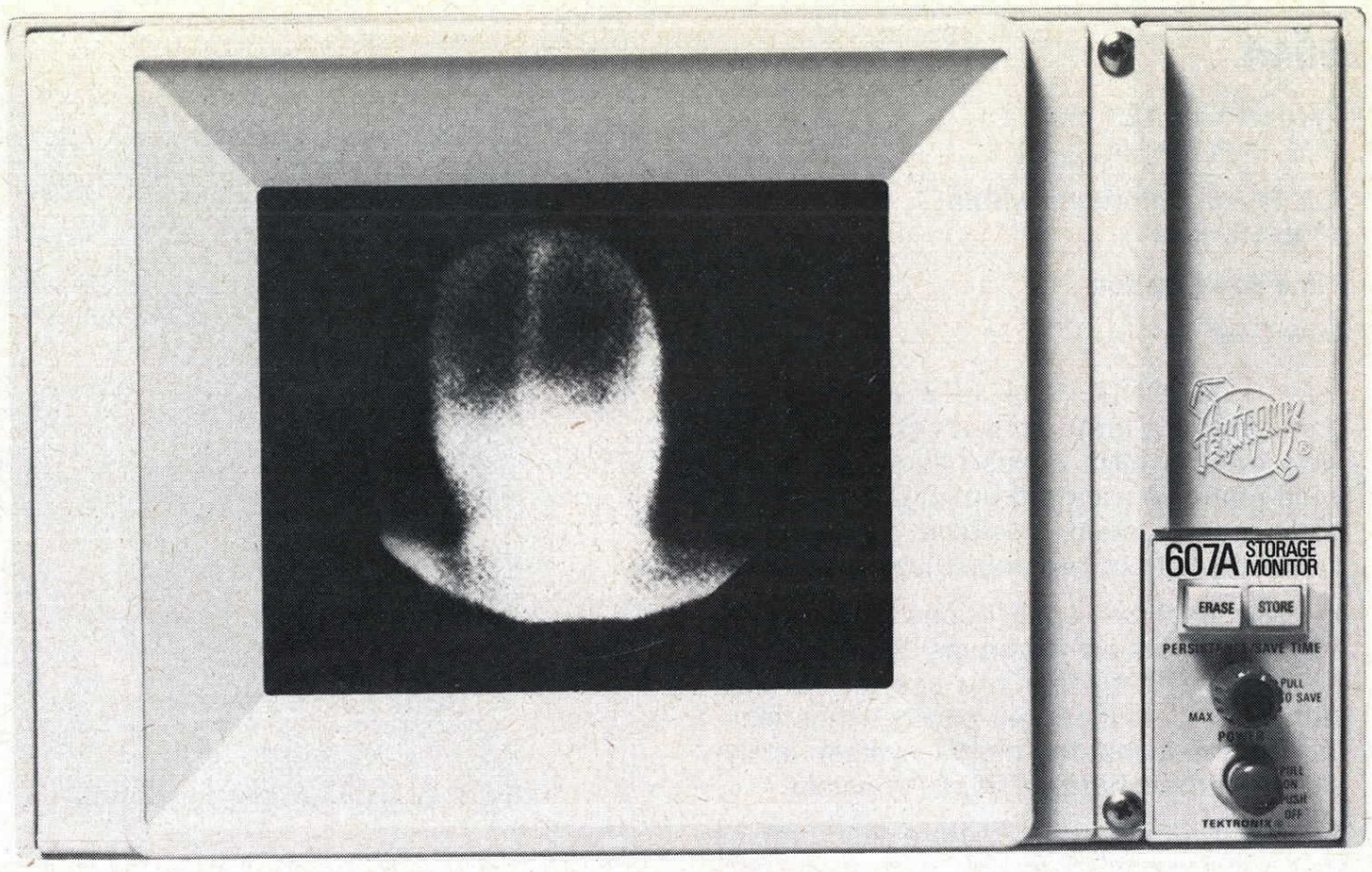
Remotely Programmable Storage Functions

The 607A is a display with variable persistence gray-scale storage lasting up to 50 minutes. It operates in both store and non-store modes.

It is designed as a component for such medical diagnostic equipment as Gamma camera (preview monitor) and M-mode ultrasound as well as for analytical instrumentation, electronic counter-measures equipment and other electronic instrumentation.

In Gamma camera applications, the 607A delivers bright, sharply focused dots over the entire screen. You can adjust the fade time to synchronize with your count rate to insure a complete picture.

When displaying repetitive phenomena the persistence may be adjusted to let the image fade just as the new signal is being repeated. Or, multiple successive events can be simultaneously shown to compare changes over time.



ORDERING INFORMATION

607A Variable Persistence Storage Display Monitor $2000
(without handle, feet and covers)

Option 01 Internal Graticule ..... No Charge
Option 04 Time Base ..... Add $175
Option 06 UL 544 Listed, Includes Handle, Feet and Covers ..... Add $75
Option 08 Fast Writing Speed (200 ns/div), Lower Resolution ..... Sub $75
Option 09 UL Component Recognized .. No Charge
Option 10 Remote Program Connector—Contains Remote Save, Erase, Erase Interval, and Non-store. Single Ended Inputs only. 25 pin Rectangular Connector ..... Add $50
Option 21 Full Differential Inputs (X, Y and Z) ..... Add $30
Option 22 Extended (X5) Gain Range ..... Add $20
Option 23 With Handle, Feet and Covers (not available with Option 06 and 28) ..... Add $50
Option 26—50 Ω Inputs (X, Y and Z) ..... Add $20
Option 28 With Covers Only ..... Add $40 (not available with Options 06 and 23)

See page 202 for information on cameras, rackmounts and filters.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

606A

5-mil or smaller spot size

Ideal for Photography

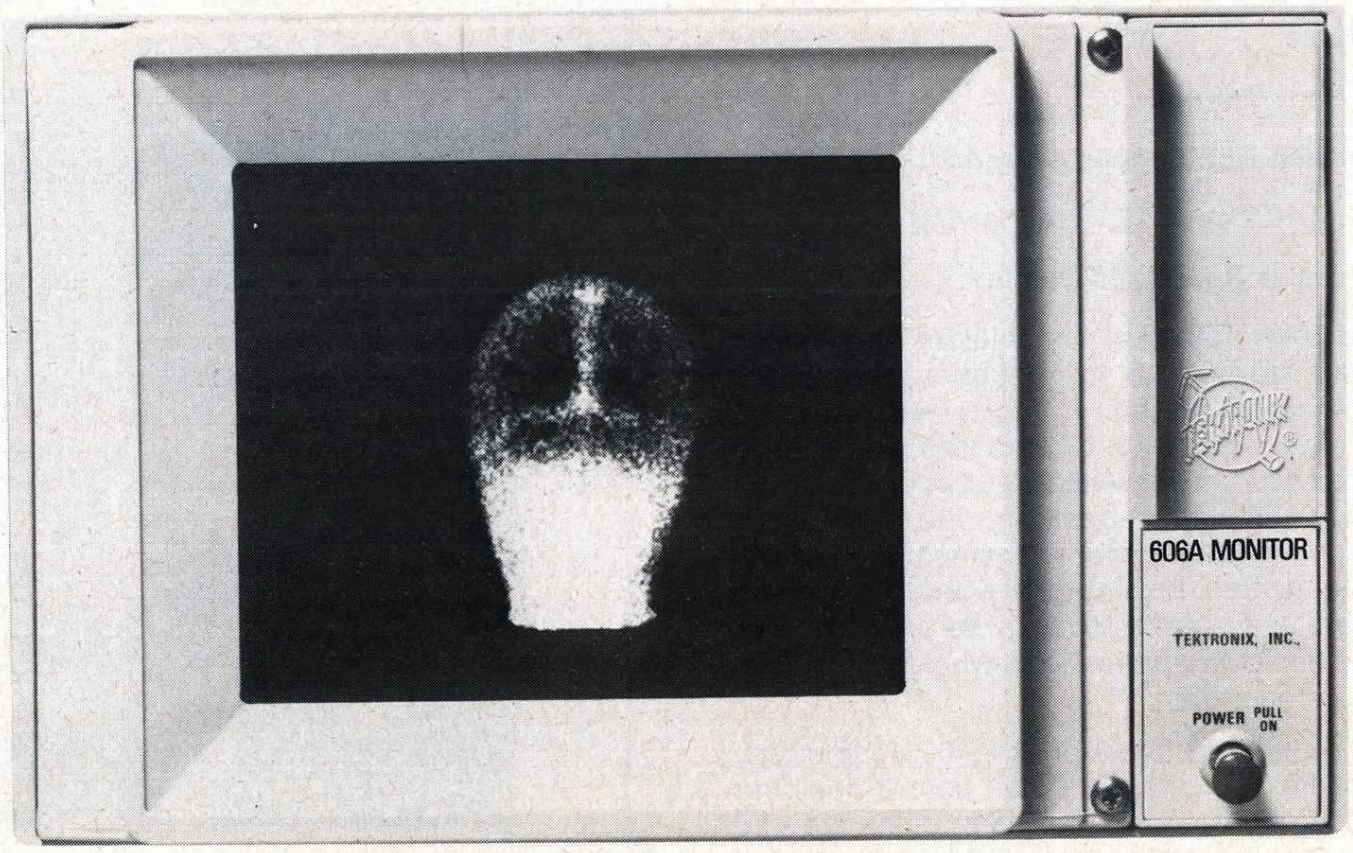
10 MHz Z-axis Bandwidth

Very High Resolution

The TEKTRONIX 606A is a very high resolution display for applications requiring critically sharp photographs and displays. Spot size is only 5 mils (13 mm), measured at 0.1 μA beam current by the shrinking raster method. The Z-axis amplifier is very linear, with 10 MHz bandwidth. Linearized Z-axis (gamma correction) is built into the 606A, providing the excellent gray scale performance necessary for the most accurate, detailed photography.

The 606A also offers excellent image stability. Position shift is only 0.1 cm or less per hour after a 20-minute warm-up. Position shift is less than 0.2 cm in 24 hours.

The sharply detailed imaging provided by the 606A is particularly well suited for photographic recording applications in medical gamma camera systems and nuclear multi-imaging systems. Non-medical applications of the 606A include scanning Auger and electron microscopy.



Shown above: 606A dot scan as accumulated on film.

ORDERING INFORMATION

606A Display Monitor $1735
(without handle, feet and covers)

Option 01 Internal Graticule ..... No Charge
Option 04 Time Base ..... Add $175
Option 06 UL 544 Listed, includes Handle, Feet and Covers ..... Add $75
Option 09 UL Component Recognized ... No Charge
Option 21 Full Differential Inputs (X, Y and Z) ..... Add $30
Option 22 Extended (X5) Gain Range ..... Add $20
Option 23 With Handle, Feet and Covers (not available with Option 06 and 28) ..... Add $50
Option 26 50 Ω Inputs (X, Y and Z) ..... Add $20
Option 28 With Covers Only ..... Add $40 (not available with Options 06 and 23)
Option 29 Metal Bezel ..... Add $50
Option 78 P11 Phosphor ..... Add $35

See page 202 for information on cameras, rackmounts and filters.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

604A
603A | Display Monitor

604A

Large 10.2 x 12.7 cm (6½-inch diagonal) crt

X-Y Phase Difference within 1° to 500 kHz

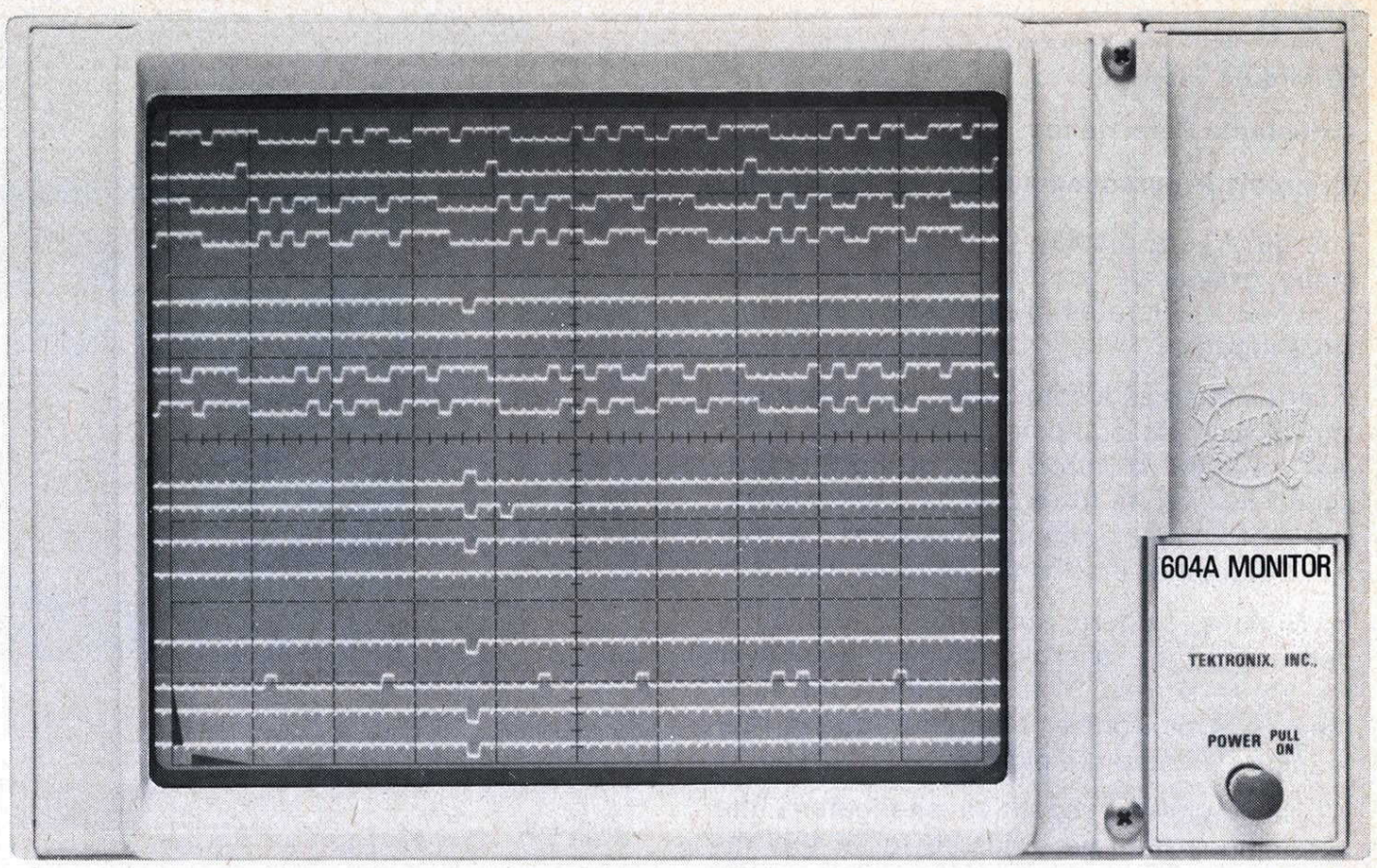
Time Base Option

Low Cost

The TEKTRONIX 604A is a low-cost X-Y display with a large screen (10.2 x 12.7 cm) view area, 5 MHz Z-axis bandwidth, and a wide range of standard options for optimum component/system interface. It combines versatility with truly competitive pricing.

In logic analyzer applications where up to 16 line of timing diagrams must be displayed, the 604A lets you see all 16 lines with good definition and clarity—thus making comparisons for digital system analysis and fault-finding significantly easier.

There's a wide range of features and options that make the 604A easier to interface with a total system. Both vector and SECAM graticules are optionally available for vector display applications. A remote program connector option allows control of X, Y and Z axes by the user's system. An optional time base allows the monitor to supply sweeps for the X-signal.



ORDERING INFORMATION

604A Display Monitor $1195
(without handle, feet and covers)

Option 01 With Internal Graticule .....No Charge
Option 04 Time Base .....Add $175
Option 05 External Vector Display Graticule (P31 Phosphor Only) .....Add $35
Option 06 UL 544 Listed, includes Handle, Feet and Covers .....Add $75
Option 08 External SECAM Vector Graticule .....Add $10
Option 09 UL Component Recognized ..No Charge
Option 10 Remote Program Connector — X, Y and Z. 25-pin rectangular connector, Single-ended inputs only .....Add $30
Option 21 Full Differential Inputs (X, Y, Z). Add $30
Option 22 Extended (X5) Gain Range .....Add $20
Option 23 With Handle, Feet and Covers (not available with Option 06 and 28) .....Add $50
Option 28 With Covers Only .....Add $40 (not available with Option 06 and 23)

See page 202 for information on cameras, rackmounting, and filters.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

603A

10-Hour Storage

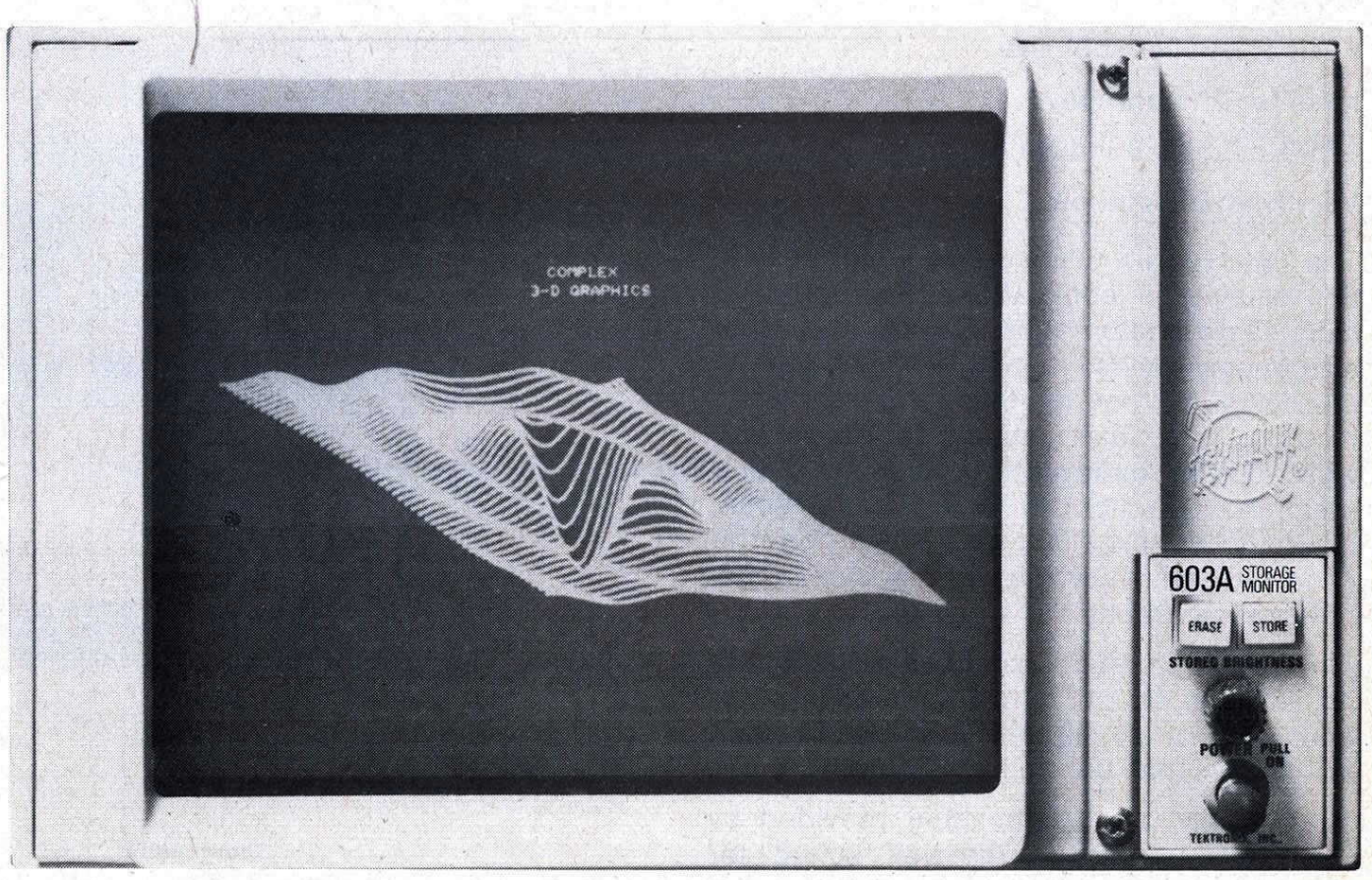
1 Million Dot/Second Stored Writing Speed

Large 10.2 cm x 12.7 cm Viewing Area

Stored or Nonstored Display

The Tektronix 603A bistable storage display offers storage up to 10 hours, one-million dot/second stored writing speed (with Option 02), a small 10 mil spot size, and a large 10.2 x 12.7 cm viewing area. Crt design eliminates display refreshing and associated costly memory devices. The 603A is particularly useful in capturing and recording single, transient events to be viewed up to four hours in applications where gray scale is not required.

As a preview monitor, the 603A lets you examine a display in detail before deciding to photograph it. This can eliminate the cost of unnecessary photographs, as well as the time and effort involved in setting up for "trial and error" shots.



ORDERING INFORMATION

603A Storage Display Monitor $1770
(without handle, feet and covers)

Option 01 Internal Graticule .....No Charge
Option 02 Fast Writing Speed Crt (200 div/ms) .....Add $40
Option 04 Time Base .....Add $175
Option 06 UL 544 Listed, includes Handle, Feet and Covers .....Add $75
Option 09 UL Component Recognized ..No Charge
Option 10 Remote Program Connector.
Contains: Erase interval, non-store, enable/disable, erase and single ended inputs only: 25-pin rectangular connector .....**Add $50**
Option 21 Full Differential Inputs (X, Y, Z). Add $30
Option 22 Extended (X5) Gain Range .....Add $20
Option 23 With Handle, Feet and Covers
(not available with Options 06 and 28) .....**Add $50**
Option 28 With Covers Only .....Add $40 (not available with Options 06 and 23)

See page 202 for information on cameras, rackmounting, and filters.

PLEASE NOTE: PRICES QUOTED ARE ONE-EACH PRICES. EVEN LOWER PRICES ARE AVAILABLE FOR QUALIFIED ORIGINAL EQUIPMENT MANUFACTURERS.

Cameras, Probes, Oscilloscope Carts, and Other Accessories

17

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CHOOSING A TEKTRONIX CAMERA

Overview of TEKTRONIX Camera Families

A camera can be a key part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility. The following pages give information to help you select a camera well suited to your needs.

MOUNTING

The table on page 212 indicates the camera adapters required for most TEKTRONIX Instruments and a few by other manufacturers. In some cases, adapters are available from Hewlett-Packard or DuMont to mount TEKTRONIX Cameras to their instruments.

LENSES

TEKTRONIX Camera lenses differ mainly in light gathering ability, magnification, and field of view.

Speed—The f-number of a lens inversely signifies its aperture area and light gathering ability. For example, the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times the light. The relative light gathering ability of all lenses used in TEKTRONIX Cameras is referenced to the f/1.9, 0.85 magnification lens which is arbitrarily rated at 1.0. For recording a stored or stable recurrent crt display, a lens as slow as the f/16 type used in the C-5B Camera is adequate. However, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types used in the C-31 and C-51 Cameras.

Field of View—The description for each camera includes a statement of its field of view; this signifies how large a crt display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adapter, camera body, film holder, and the image area of the film.

Magnification — Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most TEKTRONIX Cameras are designed for use at one lens magnification. One exception is the C-30A Camera which has a magnification range of 0.7 to 1.5 (at some increase in distortion at the magnification extremes) to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 x 6.3 cm to 8 x 10 cm.

The rated magnification of a lens signifies its image-to-object ratio.

Maximum Magnification to Record Entire Screen

	Screen Size			
	5 x 6.3 cm	7.2 x 9 cm	8 x 10 cm	9.76 x 12.2 cm
Polaroid pack and roll film	1.0	1.0	0.85	0.67
4 x 5 sheet film	1.0	1.0	1.0	0.85 or less
6 x 7 cm format roll film (70 mm, 120, 220, etc.)	1.0	0.67	0.67	not recommended

0.5 magnification is used for high speed recording, since reducing the size of image increases its brightness.

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 107 pack film which has an image area of 73 x 95 mm. In most cases, the magnification is selected to provide the largest possible complete image of a particular display. An exception is in high writing speed applications where a 0.5 magnification lens is usually used to achieve higher writing speed by concentrating the trace light in a smaller area of the film.

SHUTTERS

There are two types of shutters: **mechanical** and **electrical.**

Mechanical shutters are simple to operate and are economical. They are actuated by pressure on a release mechanism.

Electrical shutters permit remote, automatic, or manual release and offer higher reliability. The SPEEDCOMPUTER control box for the C-30-Series electric shutters requires 115 or 230 V ac. They may be actuated by an insulated switch closure.

The C-50, 51, 52, and 53 electric shutters require + 15 V, normally supplied by a 7000-Series Oscilloscope. An optional battery pack is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground. The C-28 Camera requires +15 volts at 750 mA for operation. The shutter may be actuated with either a switch closure or TTL logic.

VIEWING

Except for the C-30-Series, all TEKTRONIX Cameras have a viewing port which provides a binocular view of the crt. All TEKTRONIX Cameras, except the C-5B, are hinge mounted and can be swung aside to allow a wide-angle view of the crt. The lightweight C-5B can easily be slipped off the crt bezel to view the crt. The C-28 and C-50-Series Cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the crt display while excluding ambient light.

FILMS

The three types of backs used on TEKTRONIX Cameras accommodate most of the films that are used for crt trace recording. These include sheet films, roll films, and pack films.

Polaroid films are the most convenient to use. They offer the advantages of development in seconds to a finished dry print with wide spectral response, good resolution, and high sensitivity. ASA ratings do not necessarily give a true indication of how a film will respond in crt recording due to the narrow spectral output range of most phosphors and different spectral sensitivity of various film types.

Many different types of Polaroid film are available in rolls, packs, and 4 x 5 inch single-sheet packets. The types most used in oscilloscope and monitor photography are types 107, 47, 57, and 410.

Technical assistance with Polaroid film and back questions or problems is available directly from The Polaroid Corporation. Call (800) 225-1618 toll free within U.S.

NEW BLACK BODY COLOR STANDARD WITH 1979 MODELS

All TEKTRONIX Cameras (except the C-30A and C-31) are now supplied with a standard black body finish starting with the 1979 models.

The more commonly used films for each type of camera back are listed below.

POLAROID FILMS

Film Type	ASA Equivalent Speed	Develop. Time (Seconds at 75° F)	Format	Resolution Line Pairs/mm	Characteristics	CRT Recording Uses: Repetitive	Stored	TV Type (Gray Scale)	Scintillation Type Medical	Graphics, Alpha Numer.	Single Sweep
PACK FILMS 3¼ x 4¼ in. — Actual image size 7.3 cm x 9.5 cm											
665	75	30	Positive Print Negative Transparency	20-25 160-180	Med. Contrast, wide gray scale	X	X	X			
107	3,000	15-20	Positive Print	20	Medium Contrast	X	X				X
084	3,000	15	Positive Print	20	Medium Contrast			X	X		
667	3,000	30	Positive Print	16	Medium Contrast, no coating required			X	X		
108	75	60	Positive Print	15-17	Color—Balanced for 5500° K	X		X			
668	75	60	Positive Print	15-17	Color—Balanced for Electronic Flash	X		X			
ROLL FILMS 3¼ x 4¼ in. — Actual image size 7.3 x 9.5 cm (46L and 146L are 6.2 x 8.3 cm)											
42	200	15-20	Positive Print	25-28	Med. Contrast, wide gray scale	X	X	X			
47	3,000	15-20	Positive Print	20-22	Medium Contrast	X	X				X
410	10,000	15	Positive Print	20	High Contrast						X
46L	800	120	Positive Trans	35-40	Medium Contrast	X	X	X			
146L	200*	30	Positive Trans	40-50	High Contrast, Blue Sensitive	X				X	
SHEET FILMS 4 x 5 in. — Actual image size 8.9 x 11.4 cm											
51	320*	15-20	Positive Print	28-32	High Contrast, Blue Sensitive					X	
52	400	20	Positive Print	35-40	Medium Contrast, wide gray scale	X	X	X			
55 P/N	50	20	Positive Print Negative Transparency	22-25 160	Medium Contrast, wide gray scale	X	X	X			
57	3,000	15-20	Positive Print	20	Medium Contrast	X	X			X	X
58	75	60	Positive Print	15-17	Color Balanced for 5500° K	X		X			

*Daylight rating.

Blue type indicates most popular films for oscilloscope trace recording.

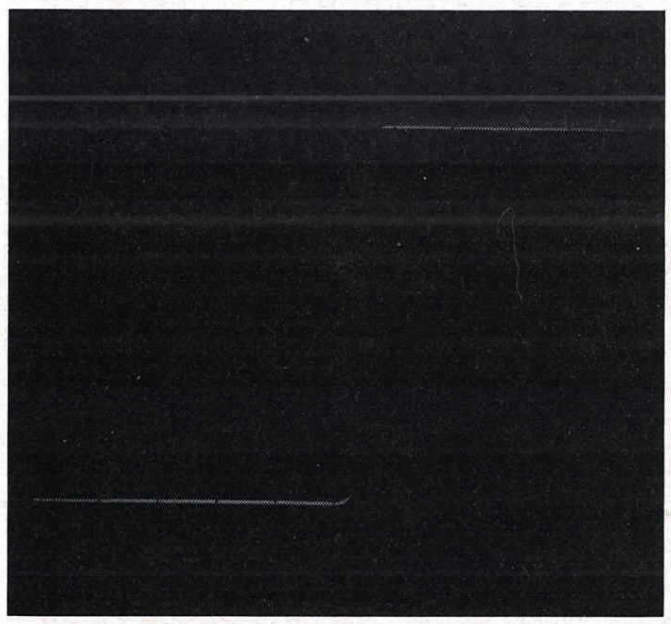
PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the crt phosphor and film used, and the definition of a readable trace image.

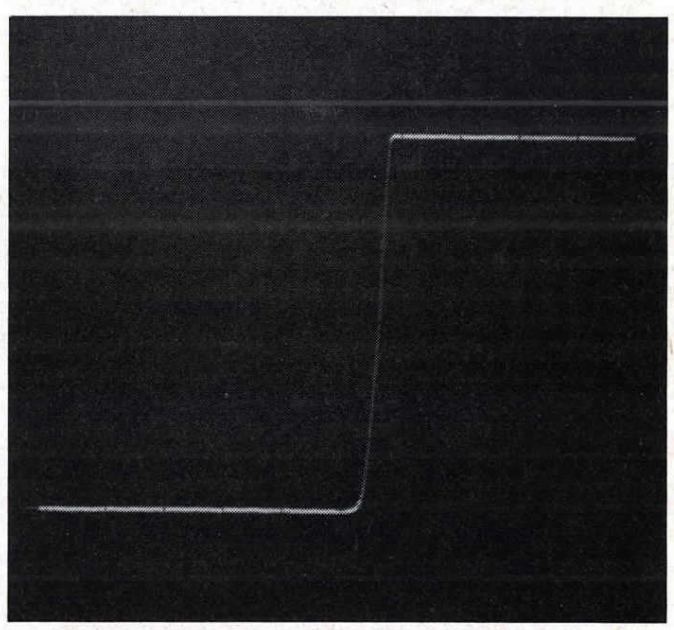
Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The TEKTRONIX Writing Speed Enhancer is designed to fill this need.

The Enhancer installs in minutes, and can be triggered in three ways: by a pushbutton on the control box, remotely with a switch closure to ground (such as provided by the camera-shutter x sync switch), or by the oscilloscope-sweep + gate.

Thus, the film can be fogged before, after, or while the sweep occurs. The techniques are respectively called prefogging, post-fogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic, simultaneous fogging is easily achieved by triggering the Enhancer with the oscilloscope-sweep + gate.



This Polaroid Type 107, 3000-Speed pack film was exposed to the single-trace display of a pulse waveform with a fast rising leading edge too dim to produce a developable image.



Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The Enhancer light supplied the additional photons needed at the weak film development centers formed by the dim leading edge, to produce a visible image of the entire waveform.

Polaroid Film		Relative Film Writing Speed		
Type	ASA Equivalent Speed	Unfogged		Fogged
		Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination*
107	3000	1 (Reference)	Print base is opaque	3
47	3000	1	1.2	3
410	10,000	2	2.2-2.4	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

Oscilloscope Camera/Adapter

TYPE OSCILLOSCOPE	RECOMMENDED CAMERAS	USE	C-5B ADAPTER HOOD PART NUMBER	C-50 SERIES AND C-28 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER
305, 314, 326, 335	C-30A	General Purpose	—	—	016-0327-00[1]
422	C-30A	General Purpose	—	—	016-0306-00
432[1], 434[2], 464, 466	C-30A Opt 01 C-5B Opt 02	General Purpose Low Cost	016-0359-00	—	016-0301-00[3]
453, 453A, 454, 454A	C-30A C-31	General Purpose High Speed	—	—	016-0306-00
455, 465, 475, 475A	C-30A Opt 01 C-31 Opt 01 C-5B Opt 02	General Purpose High Speed Low Cost	016-0359-00	—	016-0301-00[3] (C-30A Opt 01) 016-0269-02[3] (C-31 Opt 01)
485	C-30A C-31	General Purpose High Speed	—	—	016-0306-00
491	C-30A	General Purpose	—	—	016-0306-00
502A	C-59	General Purpose	—	016-0225-03	016-0243-00
503, 504	C-53	General Purpose	—	016-0225-03	016-0243-00
520A, 521A, 522A	C-59	General Purpose	—	016-0295-00	—
528	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00
529	C-59	General Purpose	—	016-0224-00	016-0244-00
530, 540, 550 Series	C-53	General Purpose	—	016-0225-03	016-0243-00
561A, 561B, 564A, 564B	C-53	General Purpose	—	016-0224-00	016-0244-00
565	C-59	General Purpose	—	016-0225-03	016-0243-00
568	C-53	General Purpose	—	016-0224-00	016-0244-00
575	C-53	General Purpose	—	016-0225-03	016-0243-00
576	C-59	General Purpose	—	See Adapter Frame/ Corrector Lens Systems at right	
577[2]	C-5B C-59	Low Cost General Purpose	016-0357-00	016-0249-03	016-0248-00
601, 602	C-30A C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00
603[6 7], 603A[6 7]	C-5B Opt 01 C-59 C-28	Low Cost General Purpose OEM	016-0357-00	016-0249-03	016-0248-00
604[6 8], 604A[6 8]	C-5B C-28	Low Cost OEM	016-0357-00	016-0249-03	016-0248-00
605, 606, 606A, 607, 607A	C-30A C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00
608, 624, 634	C-59 C-5B Opt 01 C-28	General Purpose Low Cost OEM	016-0357-00	016-0249-03	016-0248-00
647, 647A	C-53	General Purpose	—	016-0223-00	—
1420 Series	C-5B	Low Cost	016-0357-00	016-0249-03	016-0248-00
1480 Series	C-59	General Purpose	—	016-0342-00	—
1502[1], 1503[1]	C-30A	General Purpose	—	—	016-0327-00[1]
5030, 5031	C-59	General Purpose	—	See Adapter Frame/ Corrector Lens Systems at right	
5100 Series	C-5B	Low Cost	016-0357-00	016-0249-03[1 6]	016-0248-00[1 6]
5403/D40, 5440, 5444	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03[6]	016-0248-00[6]
5403/D41, 5441	C-5B Opt 01	Low Cost	016-0357-00	—	016-0248-00
7104, 7313[2], 7503, 7504, 7514, 7613, 7623A, 7633, 7704A, 7904, R7903, 7834, 7844	C-53 C-51 C-5B Opt 01	General Purpose High Speed Low Cost	016-0357-00	016-0249-03	016-0248-00

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	USE	C-5B ADAPTER HOOD PART. NUMBER	C-50 SERIES AND C-28 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER
7403N, 7603, 7603-N11S	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03[6]	016-0248-00[6]
SC 502[1], SC 503[2], SC 504	C-30A	General Purpose	—	—	016-0327-01
T900 Series except T922R	C-5B Opt 03	Low Cost	016-0358-00	—	—
T922R	C-5B Opt 01	Low Cost	016-0357-00	016-0249-03	016-0248-00
TELEQUIPMENT Except D83	None	—	—	—	—
TELEQUIPMENT D83	C-59 C-5B Opt 01	General Purpose Low Cost	016-0357-00	016-0249-03[6]	016-0248-00[6]
HP 5″ Round CRT[1]	C-53	General Purpose	—	016-0228-00	—
HP 8 x 10 cm Rectangular CRT[1] except 1740A, 1741A	C-53	General Purpose	—	HP 10362-A[5]	HP 10363-A[5] Plus 016-0306-00
HP 1332A	C-59 C-5B	General Purpose Low Cost	016-0357-00	016-0249-03	016-0248-00
HP 1333A, 1335A	C-5B	Low Cost	016-0357-00	—	016-0248-00
HP 1700 Series except 1740A, 1741A, 1743A	C-30A	General Purpose	—	—	HP 10106-A[5]
HP 1740A, 1741A, 1743A (8 x 10 cm)	C-30A Opt 01	—	—		HP 10377-A[5]
HP 182	None	—	—	—	—
Philips 8 x 10 cm Portables	C-5B Opt. 01[9]	Low Cost	016-0357-00	—	—
600, 5100, 5400, 7000-Series	—	—	014-0045-00	Will mount HP Models 195, 197A Cameras.	

[1]Graticule is nonilluminated and will not photograph.

[2]Graticule is nonilluminated and will not photograph except when crt is in the stored mode.

[3]Increases camera's field-of-view so that the full 8 x 10-cm crt display area can be recorded.

[4]C-50, C-51, C-52, and C-53 Cameras require Battery Pack 016-0270-01 for power when not used with 7000-Series Oscilloscopes.

[5]Available from Hewlett-Packard. See HP catalog for additional compatability information and prices.

[6]Only the C-5B and C-59 Cameras can entirely record the 6½-inch crt display without cropping.

[7]The C-59 is suitable for the standard-model Type 603 but it cannot photograph the nonilluminated graticule of the Option 01 Model.

[8]The C-59 also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

[9]Does not mount on scope, must be hand held.

Adapter part numbers for the C-12 and C-27 Cameras are available upon request. Contact your local field office for more information.

CAMERA ADAPTER PART NUMBERS & PRICES

014-0045-00	$80	016-0263-00	$55
016-0217-00	55	016-0269-02**	75
016-0223-00	50	016-0295-00	50
016-0224-00	50	016-0299-00	55
016-0225-03	50	016-0301-00***	85
016-0226-01	55	016-0306-00†	70
016-0228-00	70	016-0327-01	75
016-0243-00	55	016-0342-00	85
016-0244-00	55	016-0357-00††	15
016-0248-00	70	016-0358-00†††	15
016-0249-03*	65	016-0359-00††††	15

*(Included with C-50 Series Cameras)

**(Adapter with lens included with C-31 Opt 01 Cameras)

***(Adapter with lens included with C-30A Opt 01 Cameras)

†(Included with C-30A, C-31 Cameras)

††(Included with C-5B and C-5B Opt 01 Cameras)

†††(Included with C-5B Opt 03 Cameras)

††††(Included with C-5B Opt 02 Cameras)

see page 216 for extra viewing doors and flash units

ADAPTER FRAME/CORRECTOR LENS
C-50 and C-59 CAMERAS

Expands the field of view of the C-50 and C-59 to fully cover the 6½-inch crt and adjacent scale-readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of the C-50 to 0.55 and the C-59 to 0.5 so they can record the entire display on Polaroid 3¼ x 4¼-inch film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. However, all but the upper one-fourth of the display can be viewed via the viewing tunnel and both cameras can be swung aside to allow a full view of the entire display.

For C-50 Camera, Order 016-0271-00 .....$125

For C-59 Camera, Order 016-0288-00 .....$110

ACCESSORIES FOR GRAFLOK TYPE BACKS
(For C-51 and C-59)

Here are a few of the film holders available for use with the Graflok Backs to allow use of roll film, and Polaroid 4 x 5 inch Film. Order these accessories from the manufacturer or from your local camera store.

RH/10 120 Roll-Film Holder—10 exposures 2¼ x 2¾ inch for 4 x 5 inch Graflok Backs. **(122-0736-01)**

HR/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ inch, for 4 x 5 inch Graflok Backs. **(122-0971-00)**

RH/50 70 mm Holder—50 exposure, 2 x 2¾ inch, for 4 x 5 inch Graflok Backs only. **(122-0967-00)**

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 inch Single Exposure Film Packets. **(016-0201-01)**

Roll film holders are also manufactured by several other companies.

Included Accessories—Focus Plate for Polaroid pack film (387-0893-02), or focus plate for Polaroid roll back (387-0893-01), or focusing screen integral with Graflok type back; mounting adapter for all 7000, 5000, and small 600-Series (016-0249-03).

OPTIONAL CAMERA ACCESSORIES

Mounting Adapters—see table on pages 212 and 213.

Battery Pack—Provides an auxiliary + 15 V power source for the C-50, C-51, C-52, and C-53 with oscilloscopes that don't provide camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000-Series Oscilloscope or an external + 15 V source. Net weight of pack, including batteries, is 1.2 lb. Batteries are not included.
Order 016-0270-01 .....$145

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed by about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

Writing Speed Enhancer for C-51 Camera.
Order 016-0279-00 .....$235

Writing Speed Enhancer for C-53 Camera.
Order 016-0300-00 .....$235

Writing Speed Enhancer for C-59 Camera.
Order 016-0290-00 .....$235

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.
Order 122-0926-01 .....$130

Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.
Order 122-0929-00 .....$170

Graflok Type Film Back, 4 x 5 in—Accepts Polaroid 4 x 5 in film holder, standard cut-film holders, film-pack adapters, roll-film holders (except heavy motorized models). Included with "G" models.
Order 122-0931-01 .....$170

Carrying Case—Holds a complete C-50-Series Camera with extra film-backs and accessories.
Order 016-0177-00 .....$150

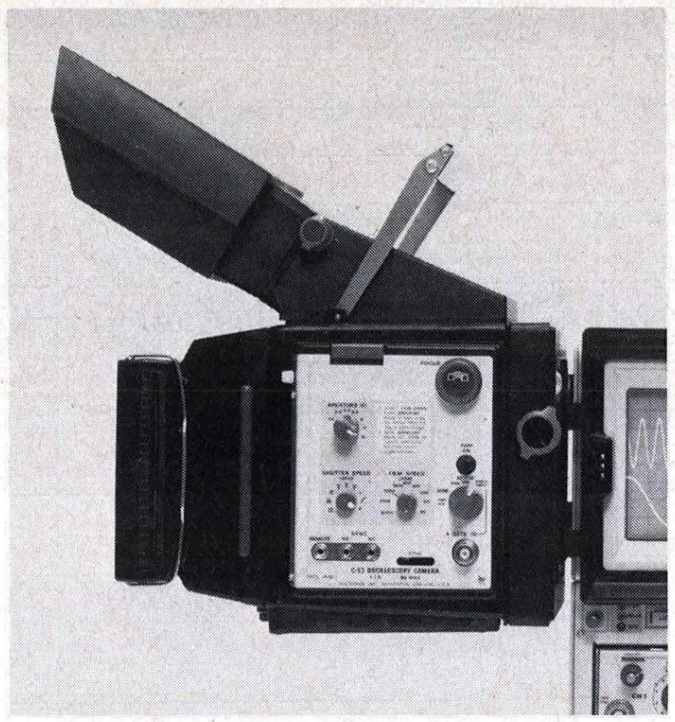
C-50-SERIES COMMON FEATURES

INTERCHANGEABLE FILM BACKS
LIFT-OFF MOUNTING
SWING-AWAY HINGING

The five C-50-Series Cameras are designed for use with all TEKTRONIX 7000-Series Oscilloscopes. They can also be adapted to most TEKTRONIX 5000-Series Oscilloscopes and 600-Series Display Monitors. Please refer to the oscilloscope/camera/adapter guide, pages 212 and 213.

All the C-50-Series Cameras can be ordered for either Polaroid pack or roll film, or a Graflok-type 4 x 5 inch back. All three backs can easily be removed and interchanged without fogging the efilm.

All C-50-Series Cameras have the new black body finish as a standard feature.



C-50, C-51, C-52 and C-53
Electronic-Controlled Shutter
Photometer Exposure Aid
Range-Finder Focusing
Automatic Single-Sweep Control

C-59
Low-Cost
Photometer Exposure Aid
Range-Finder Focusing
Internal Battery Power
For Larger Crt's

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-50	C-51	C-52	C-53	C-59
FEATURES	General purpose for crt's up to 6½ inches; Medium writing speed.	Fastest writing speed (at expense of image size)	Full-size image; Medium writing speed	General purpose for 7000-Series with 8 x 10-cm crt's** Medium writing speed	General purpose low price. For crt's up to 6½ inches; Slow writing speed
LENS SPEED	f/1.9	f/.12	f/1.4	f/1.9	f/2.8
MAGNIFICATION	0.7	0.5	1.0	0.85	0.67
RELATIVE LIGHT GATHERING ABILITY	1.2	3.0	1.4	1.0	0.65
FIELD OF VIEW	10.2 x 12.7 cm with Polaroid pack and roll film	8 x 10 cm with Polaroid pack and roll film	8 x 10 cm	8 x 10 cm with Polaroid pack and roll film	10.2 x 12.7 cm with Polaroid pack and roll film
SHUTTER	Electrically actuated, 4 to 1/60 second, plus Bulb and Time. Provides x sync.				Mechanically actuated 1 to 1/50 sec, bulb and time. Provides x sync.

**The C-53 lens records the largest practical image of an 8 x 10-cm crt display on Polaroid pack and roll film.

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-50P		C-51R		C-52P		C-53P		C-59P	
	In	cm	In	cm	In	cm	In	cm	In	cm
Height	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2
Width	7.5	19.1	9.8	24.8	7.5	19.1	7.5	19.1	7.7	19.3
Length	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3
Weight (Approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	7.5	3.4	9.5	4.3	8.0	3.6	7.5	3.4	7.0	3.2
Shipping	12.0	5.4	15.0	6.8	12.0	5.4	12.0	5.4	11.0	5.0

ORDERING INFORMATION

"P" Models accept Polaroid pack film.

"R" Models accept Polaroid roll film.

"G" Models have Graflok type backs that accept 4 x 5 inch sheet film holders or roll film holders.

C-50
C-50P CAMERA $1450
C-50R CAMERA $1450

C-51
C-51G CAMERA $1500
C-51P CAMERA $1500
C-51R CAMERA $1500

C-52
C-52P CAMERA $1600
C-52R CAMERA $1600

C-53
C-53P CAMERA $1225
C-53R CAMERA $1225

C-59
C-59P CAMERA $750
C-59R CAMERA $750
C-59G CAMERA $750

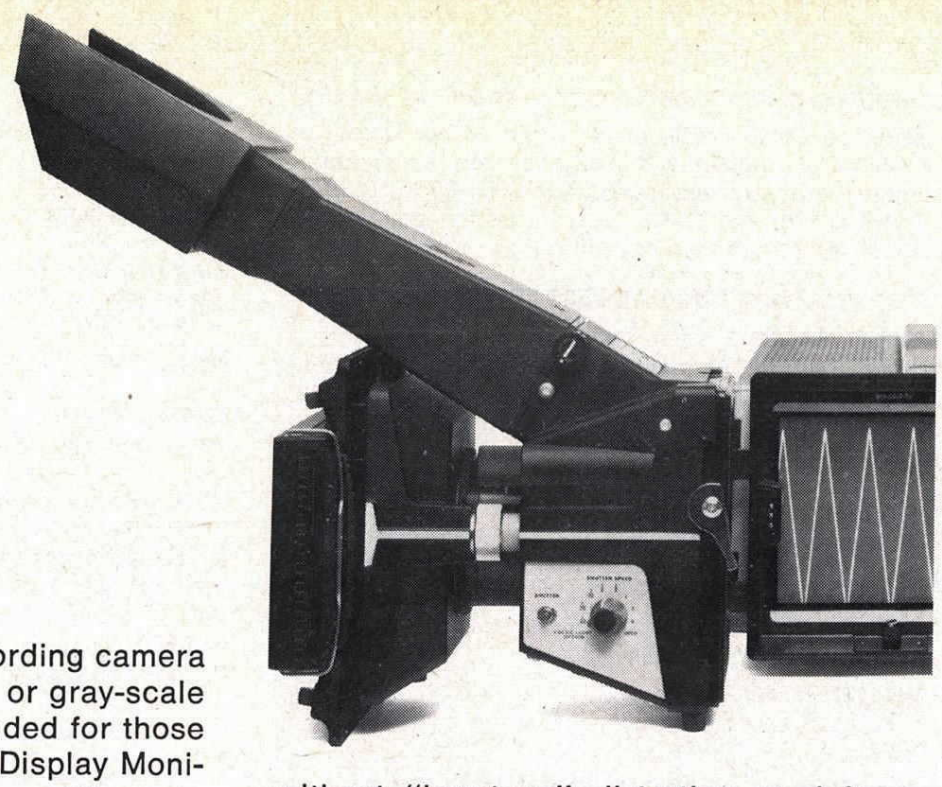
Camera
Reliable Electric Shutter

C-28

Trapezoidal Distortion eliminated

Easy Operation

UL 544 Component Recognition



The C-28 is a high-quality recording camera for systems displaying XY, YT or gray-scale images. It is highly recommended for those using TEKTRONIX 600-Series Display Monitors. It features an f/2.8 lens with user-changeable .67 and .85 magnification ratios to record images from 8 x 10 or 10 x 12 cm crt's. Other magnification ratios are also available as options.

The C-28 shutter is electronically controlled to provide reliable, repeatable operation and to allow remote control by the user's system. Either a TTL low logic level or a switch closure will actuate the shutter. The C-28 has a highly rigid camera body, allowing the use of heavier accessories such as 70 and 90mm motorized rollfilm backs without "keystone" distortion or defocusing. The Polaroid 3¼" x 4¼" film back is easily removed, leaving a Graflok-type interface for Graflok-compatible accessories. The film back can be rotated to allow prints to be pulled to the left, to the right, or downward. Optional range-finder focus lights allow quick focusing without removing the film. The C-28 uses the same mounting adapters as C-27 and C-50 Series. The customer must provide a separate 15 Vdc 750 mA power supply. A connector and an 18-inch power-cable assembly is included.

SPECIFICATIONS

Dimensions
Height: Without viewing tunnel hood, 20.5 cm (8.06 in)
Width: 18.5 cm (7.25 in)
Length: 24.6 cm (9.7 in) maximum with Polaroid pack film lower, mounting adapter, and focus set at maximum extension
Body color—Black
Environmental
Temperature range for specified performance: 0°—50°C
Altitude: 4500m (15,000 ft) operating 15,000m (50,000 ft) non-operating
Weight: 3.8 kg (8.5 lb) with film pack and adapter
Standard Accessories:
6 pin connector and 18 inch power and control cable assembly 131-1794-00, Polaroid pack film holder 352-0505-01, viewing tunnel and hood 122-0719-01

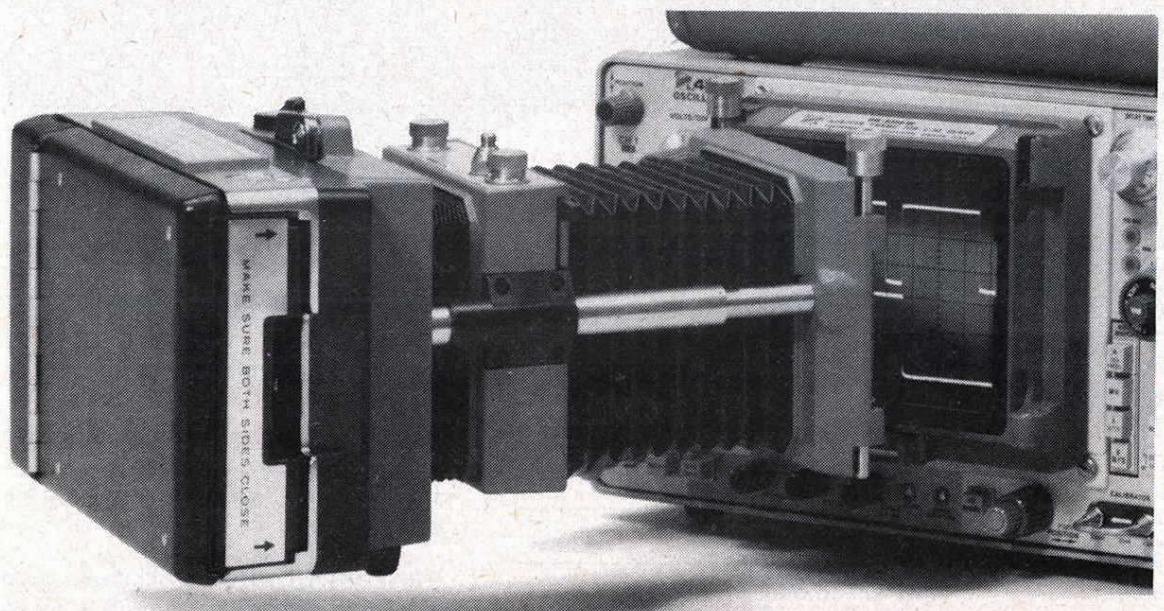
ORDERING INFORMATION

C-28 Camera $1085
Opt. 01 with Focus Lights ..... Add $30
Opt. 02 with Graflok Focus Screen and Hood, 122-0510-00 and 122-0944-00 ..... Add $95
Opt. 03 without Polaroid Film Back 352-0505-01 ..... Subt. $50
Opt. 04 .8 Magnification Only ..... Add $25
Opt. 05 .9 Magnification Only ..... Add $25
Opt. 06 Unity Magnification Only ..... Add $25
Opt. 08 with 016-0249-03 Adapter for 600, 7000, and 5000 Series ..... Add $50

For information about OEM arrangements, contact your Tektronix Representative.

Variable Magnification and High Writing-Speed Camera

C-30A
C-31



Adaptable to Many Instrument Types

Interchangeable Film Backs

The C-30A and C-31 Cameras are primarily designed for use with the 400-Series Portable Oscilloscopes, but are also adaptable to 8x10 cm crt or smaller 7000, 5000, and 600-Series Instruments, and to some others. See chart on pages 212 and 213. The C-30A has variable magnification, permitting it to make use of the entire photo frame even with different crt sizes. The C-31 is designed for maximum writing speed (at the expense of image size).

Option 01 is designed to fit the 455, 464, 465, 466, 475 and 475A. The standard C-30A or C-31 fits the 485.

Camera	Lens Speed	Magnification	Relative Light Gathering Ability	Field of View
C-30A	f/1.9	0.7 to 1.5	1.0	8 x 10 cm
C-31	f/1.2	0.5	2.9	8 x 9 cm

Shutter—Mechanically actuated, with speeds from 1 to 1/60 s plus bulb and time. Provides x sync switch closure for arming oscilloscope single sweep or initiating the event of interest.

Recommended for—485. See pages 212 and 213 for compatibility with other instruments. Also see Option 01.

Included Accessories: Split-image focusing plate for Polaroid pack back (387-0893-02); or for Polaroid roll back (387-0893-01; mounting adapter for 485 size bezel (016-0306-00).

Dimensions	C-30AP		C-31R	
	In	cm	in	cm
Height	5.1	13.0	5.5	14.0
Width	7.5	19.1	9.1	23.1
Length	10.4	25.4	10.6	26.9
Weight (approx)	lb	kg	lb	kg
Net	4.8	2.2	6.8	3.1
Shipping	9.0	4.1	11.0	5.4

ORDERING INFORMATION

"P" Models accept Polaroid pack films.
"R" Models accept Polaroid roll films.

C-30A

C-30AP CAMERA $925
C-30AR CAMERA $925

C-31

C-31P CAMERA $1100
C-31R CAMERA $1100

OPTIONS

C-30A Opt 01 Expanded Field of View—f/1.9, 0.8 magnification lens covers 8 x 10 cm crt screen without vignetting. Relative light-gathering ability is 0.9. Includes 016-0301-00 adapter for 465 size crt bezel. Recommended for—455, 464, 465, 466, 475, 475A.
Specify Option 01 ..... Add $20

C-31 Opt 01, Expanded Field of View—f/1.2, 0.5 magnification lens with relative light gathering ability of 2.9 covers crt screens up to 8 x 10 cm. Includes 016-0269-02 adapter for 465 size crt bezel.

Recommended for—455, 464, 465, 466, 475, 475A.

Specify Opt 01 ..... **Add $20**

Electric Shutter—Allows remote or automatic actuation of the shutter with an insulated switch closure. Includes SPEEDCOMPUTER control box. Provides speeds of 1 to 1/60 s plus bulb and time. Requires 115 V ac, 50-60 Hz.

C-30APE **$1150**

C-31RE **$1480**

Also available with Opt. 01 ..... **Add $20**

CONVERTING OPT 01 MODEL TO STANDARD MODEL

The Option 01 versions of the C-30A and C-31 Cameras can be converted to standard models by simply slipping off the Corrector Lens, removing the Adapter Frame, and adding an 016-0306-00 Adapter. Please refer to pages 212 and 213 for prices and compatibility.

CONVERTING STANDARD MODEL TO OPT 01 MODEL

A standard-model C-30A or C-31 can be converted to an Option 01 model by means of the appropriate Adapter Frame/Corrector Lens: 016-0301-00 for C-30A; 016-0269-02 for the C-31. Please refer to pages 212 and 213 for prices and compatibility.

OPTIONAL ACCESSORIES

Mounting Adapters—See Pages 212 and 213

Writing Speed Enhancer—Increases effective film speed about 3 times for 3000 speed film or about 2 times for 10,000 speed film. Installs in minutes.

Order 016-0284-00 ..... **$235**

Polaroid Pack Film Back—Accepts Polaroid pack film. Included with "P" models.

Order 122-0752-00 ..... **$160**

Polaroid Roll Film Back—Accepts Polaroid roll film. Included with "R" models.

Order 122-0754-00 ..... **$160**

Graflok Type 4 x 5 in Back—Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, film pack adapters, roll film holders (except heavy motorized roll film holders).

Order 016-0487-00 ..... **$170**

Carrying Case—Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18½ x 14½ x 8 in.

Order 016-0587-00 ..... **$65**

X Sync Cable—

Order 012-0364-01 ..... **$16**

C-30A Portra Lens—A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a distance of 21 in. the camera covers 19 x 21 in. Usable with either the C-30A or C-30A Opt 01.

Order 016-0246-02 ..... **$25**

C-5B | Low Cost Camera

Easy to Use

Low Cost

Graticule Illumination

Modular Versatility

Electric Shutter

Improved Lens

The C-5B is a low-cost general-purpose camera with Polaroid Pack-film back and a graticule illuminator. Its lightweight modular design provides three interchangeable adapter hoods that fit most TEKTRONIX Oscilloscopes and small monitors.

All three adapter hoods have an opening in the top for a lift-up viewing door or a Xenon flash unit for illuminating the crt graticule. The flash unit has a flipdown viewing door.

Lens—New, 3-element lens with improved focus uniformity. 0.67 or 0.85 magnification selectable by user. The fixed f/16 aperture provides a wide depth of field and eliminates need for adjustable focus.

The f/16 lens has a relatively low light-gathering ability of 0.02 and is not recommended for photographing single-sweep waveforms.

Shutter—Electric with speeds from .1 to 5 seconds.

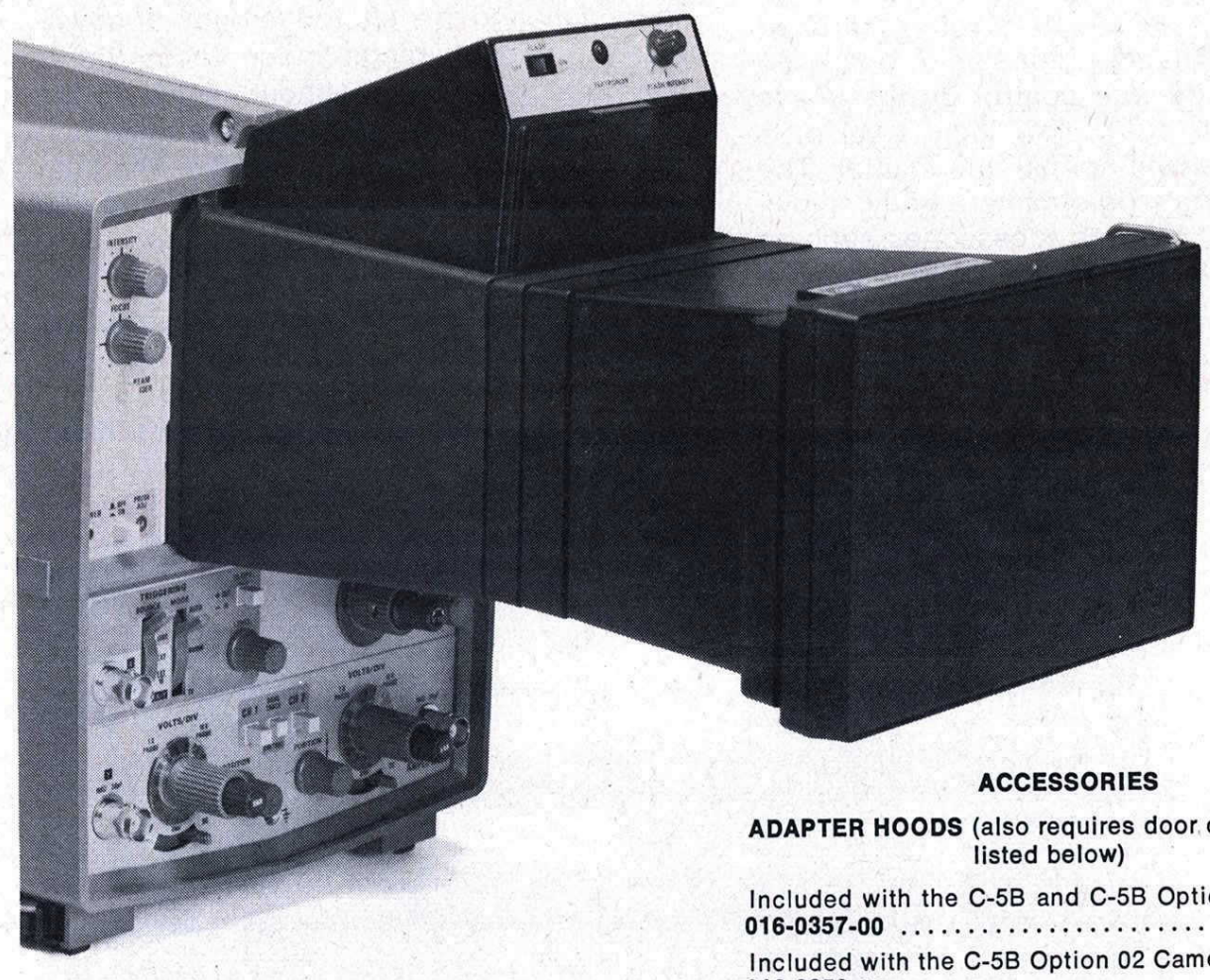
Graticule Illumination—Variable intensity Xenon flash, triggered by shutter opening, evenly illuminates the crt screen to backlight non-illuminated graticules.

Recommended Film—Type 107, 3,000-speed pack film.

Field of view—0.67 mag—9.8 x 12.2 cm, 0.85 mag—8 x 10 cm.

Power Source—(4) AA batteries, not included.

Body color—Black



Dimensions	in	cm
Height	5.5	14
Width	6.6	16.8
Length	10.1	25.7
Weights (approx)	**lb**	**kg**
Weight	3	1.4
Net Shipping	4.1	1.9

ACCESSORIES

ADAPTER HOODS (also requires door or flash listed below)

Included with the C-5B and C-5B Option 01 Cameras.
016-0357-00 ..... **$15**

Included with the C-5B Option 02 Camera.
016-0359-00 ..... **$15**

Included with the C-5B Option 03 Camera.
016-0358-00 ..... **$15**

VIEWING DOOR Fits all three adapter hoods. Mounting screws included. Included with C-5B Opt 01 and Opt 02.

016-0630-00 ..... **$5**

FLASH UNIT Fits all three adapter hoods. Mounting screws included. Included with C-5B and C-5B Opt 03.

016-0642-00 ..... **$70**

Order	For Use With	Adapter Hood (Included) Part Number	Flash Unit Included	Price
C-5B	577, 600-Series with unilluminated graticule, 1420-Series, 5100-Series	016-0357-00	Yes	$395
C-5B Opt 01	528, 600-Series w/o graticule, or with illuminated graticule, 5400-Series, 7000-Series, T922R, TELEQUIPMENT D83	016-0357-00	No	$355
C-5B Opt 02	432, 434, 455, 464, 465, 465M, 466, 475, 475A	016-0359-00	No	$355
C-5B Opt 03	T900 Series except T922R	016-0358-00	Yes	$395

Probes and Accessories

RECOMMENDED PROBES
(P) Passive, (A) Active, (C) Current

7000 SERIES

7A11: Built in FET Probe
7A13: (P)P6009,P6013A,P6015,P6055,P6060,P6062B, P6101 (C)P6021,P6022,P6302/AM 503
7A15A: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (C)P6021,P6022,P6302/AM 503
7A16A: (P)P6009,P6013A,P6015,P6063B,P6101,P6106 (A)P6046,P6201,P6202 (C)P6021,P6022,P6302/AM 503
7A18: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (A)P6202 (C)P6021,P6302/AM 503
7A19: (P)P6056,P6057 (A)P6201,P6202 (C)P6302/AM 503,P6303/AM 503
7A22: P6055,P6060,P6062B,P6101 (C)P6021,P6302/AM 503
7A24: (P)P6056,P6057 (A)P6201,P6202 (C)P6302/AM 503,P6303/AM 503
7A26: (P)P6009,P6013A,P6015,P6063B,P6101,P6106, (A)P6201,P6202 (C)P6022,P6302/AM 503,P6303/AM 503
7A29: (P)P6056,P6057 (A)P6046,P6201,P6202 (C)P6302/AM 503,P6303/AM 503

5000 SERIES

5A13N: (P)P6007,P6013A,P6015,P6055,P6060,P6101 (C)P6021,P6302/AM 503
5A14N: (P)P6007,P6013A,P6015,P6062B,P6101,P6108 (C)P6021,P6302/AM 503
5A15N: (P)6007,P6013A,P6015,P6062B,P6101,P6108 (C)P6021,P6302/AM 503
5A18N: (P)P6007,P6013A,P6015,P6062B,P6101,P6108 (C)P6021,P6302/AM 503
5A21N: (P)P6055,P6060,P6101 (C)P6021
5A22N: (P)P6055,P6060,P6101
5A23N: (P)P6062B,P6101,P6108 (C)P6021,P6302/AM 503
5A26: (P)P6055,P6060,P6101 (C)P6021
5A38: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (C)P6021,P6022,P6302/AM 503
5A45: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (C)P6021,P6022,P6302/AM 503
5A48: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (C)P6021,P6022,P6302/AM 503

400 SERIES

434: (P)P6009,P6013A,P6015,P6101,P6105 (C)P6021,P6022,P6302/AM 503,P6303/AM 503
464/ 466: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (A)P6201,P6202 (C)P6021,P6022,P6302/AM 503,P6303/AM 503
455: (P)P6009,P6013A,P6015,P6062B,P6101,P6105 (A)P6202 (C)P6021,P6022,P6302/AM 503, P6303/AM 503
465: (P)P6009,P6031A,P6015,P6062B,P6101,P6105 (A)P6046,P6201,P6202 (C)P6021,P6022,P6302/AM 503,P6303/AM 503
465M: (P)P6009,P6013A,P6015,P6101,P6104 (A)P6046,P6021,P6202 (C)P6021,P6022,P6302/AM 503, P6303/AM 503
475A/ 475: (P)P6009,P6013A,P6015,P6063B,P6101,P6106 (A)P6046,P6201,P6202 (C)P6021,P6022,P6302/AM 503,P6303/AM 503
485: (P)6009,P6013A,P6015,P6056,P6057,P6063B, P6101,P6106,(A)P6046,P6201,P6202 (C)P6021,P6022,P6302/AM 503,P6303/AM 503

300 SERIES

305: (P)P6101,P6149 (C)P6021,P6302/AM 503,P6303/AM 503
314: (P)P6101,P6149 (C)P6021,P6022,P6302/ AM 503,P6303/AM 503
323: (P)P6101,P6149 (C)P6021,P6022,P6302/ AM 503,P6303/AM 503
326: (P)P6101,P6149 (C)P6021,P6022,P6302/ AM 503,P6303/AM 503
335: (P)P6101,P6149 (C)P6021,P6022,P6302/ AM 503,P6303/AM 503

T900 SERIES

T912: (P)P6007,P6013A,P6015,P6062B,P6101,P6108 (C)P6021,P6302/AM 503,P6303/AM 503
T921: (P)6006,P6007,P6013A,P6015,P6062B,P6101, P6108 (C)P6021,P6302/AM 503,P6303/AM 503
T922/ T922P/ T932A: (P)6006,P6007,P6013A,P6015,P6062B,P6101, P6108 (C)P6021,P6302/AM 503,P6303/AM 503
T935A: (P)6009,P6013A,P6015,P6062B,P6101,P6108 (C)P6021,P6302/AM 503,P6303/AM 503

TM 500 SERIES

SC 502: (P)P6062B,P6108 (C)P6021,P6302/AM 503
SC 503: (P)P6060,P6062B,P6108 (C)P6021,P6302/ AM 503
SC 504: (P)P6062B,P6108 (C)P6021,P6302/AM 503

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below), the resistive component is of primary importance in most probes and should be at least two orders of magnitude greater than the circuit source impedance. For higher frequencies (greater than about 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

For general-purpose use, passive voltage probes offer a wide probe selection for a variety of applications for 1 MΩ inputs.

VOLTAGE PROBES for 1MΩ Inputs

Type[1]	Atten	Length*	Package Number	Loading		Useful[5] BW MHz	Dc Max	Scope C in pF	Readout	Page
P6006	10X	3.5	010-0127-00 Opt 01	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	NO	223
		6	010-0160-00 Std		8.5	25				
		9	010-0146-00 Opt 02		11	25				
		12	010-0148-00 Opt 03		13	12				
P6007	100X	3.5	010-0150-00 Opt 01	10 MΩ	2 pF[2]	25	1.5 kV	15 to 55	NO	223
		6	010-0165-00 Std		2.2	20				
		9	010-0152-00 Opt 02		2.4	15				
		12	010-0154-00 Opt 03		2.6	13				
P6008	10X	3.5	010-0129-00	10 MΩ	7.5 pF	100	600 V	12 to 47	NO	223
P6008 (Environmentalized)	10X	6	010-0129-01 Std	10 MΩ	7.5 pF	100	600 V	12 to 47	NO	223
			Environmentalized −50°C to +150°C							
P6009	100X	9	010-0170-00 Opt 04	10 MΩ	2.5 pF[2]	120	1.5 kV	12 to 47	NO	223
		9	010-0264-01 Std		2.5	100			YES	
P6010	10X	3.5	Furnished with S-5 For other uses see P6105 or P6106							
P6013A	1000X	10	010-0177-01 Std	100 MΩ	3 pF	80	12 kV	15 to 55	NO	224
		25	010-0175-01 Opt 03		3.5	13				
P6015	1000X	10	010-0172-00 Std	100 MΩ	3 pF	75	20 kV	12 to 47	NO	224
P6028	1X	3.5	010-0074-00 Opt 01	1 MΩ	50 pF	17	600 V	ANY	YES	224
		6	010-0075-00 Std		67	10				
		9	010-0076-00 Opt 02		90	7				
		12	010-0077-00 Opt 03		112	4				
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	—
P6053B	10X	3.5	010-6053-11 Opt 01	10 MΩ	9.5 pF	200	500 V	15 to 24	YES	224
		6	010-6053-13 Std		12.5	200				
		9	010-6053-15 Opt 02		13.5	115				
P6055[3]	10X	3.5	010-6055-01 Std	1 MΩ	10 pF	60	500 V	20 to 47	YES	224
P6060[3]	10X	3.5	010-6060-01 Opt 01	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	YES[4]	225
		6	010-6060-03 Std		8.5	25				
P6062B	10X or 1X	3.5	010-6062-11 Opt 01	10 MΩ	13.5 pF	100	500 V	15 to 47	YES	225
				1 MΩ	100	8				
		6	010-6062-13 Std	10 MΩ	14	100				
				1 MΩ	105	6.7				
		9	010-6062-15 Opt 02	10 MΩ	17	95				
				1 MΩ	135	4.5				
P6063B	10X or 1X	3.5	010-6063-11 Opt 01	10 MΩ	11 pF	200	500 V	15 to 24	YES	225
				1 MΩ	80	12				
		6	010-6063-13 Std	10 MΩ	14	200				
				1 MΩ	105	6				
P6101	1X	1 m	010-6101-01 Opt 01	1 MΩ	32 pF	34	500 V	ANY	—	226
		2 m	010-6101-03 Std		54	15.5				
		3 m	010-6101-05 Opt 02		78	8				
P6105	10X	1 m	010-6105-01 Opt 01	10 MΩ	10.5 pF	100	500 V	15 to 47	YES	226
		2 m	010-6105-03 Std		13.0	100				
		3 m	010-6105-05 Opt 02		15.5	95				
P6106	10X	1 m	010-6106-01 Opt 01	10 MΩ	10.5 pF	300[6]	500 V	15 to 24	YES	226
		2 m	010-6106-03 Std		13.0	250				
		3 m	010-6106-05 Opt 02		15.5	150				
P6108	10X	1 m	010-6108-01 Opt 01	10 MΩ	10.5 pF	100	500 V	15 to 47	NO	226
		2 m	010-6108-03 Std		13.0	100				
		3 m	010-6108-05 Opt 02		15.5	95				
P6149	10X	2 m	010-6149-03 Std	10 MΩ	15.5 pF	50	500 V	20 to 62	NO	226

**Length in feet except where specified.*

1. *To convert to uhf connectors, use adaptor 103-0015-00.*
2. *Rating varies with scopes having other than 20 pF inputs.*
3. *Designed for use with scopes having differential inputs.*
4. *Not compatible with crt readout.*
5. *25 Ω source.*
6. *Typically 300 MHz at probe tip with scope bandwidth at least 325 MHz.*

Probes and Accessories

Where higher frequencies (above 250 MHz) are encountered, active FET probes which have high input resistance and low input capacitance through their dynamic range should be used. For 50 Ω systems, see adjacent selection chart of 50 Ω divider probes.

FET PROBES

Type	Atten	Length*	Package Number	Loading	Rise time in ns	INPUT LIMITS: Max dc + pk ac	INPUT LIMITS: Linear Dynamic Range	INPUT LIMITS: Dc Offset Range	Read-out	Page
P6046 Diff/Amp	1X	6.0	010-0232-00 Std	1 MΩ 10 pF	3.5	±25 V	±5 V		NO	219
	10X			10 MΩ 3 pF		±250 V	±50 V			
P6201 FET	1X	6.0	010-6201-01 Std	100 kΩ 3 pF	0.4	±100 V	±0.6 V	±5.6 V	YES	219
	10X			1 MΩ 1.5 pF		±200 V	±6 V	±56 V		
	100X			1 MΩ 1.5 pF		±200 V	±60 V	±200 V		
P6202 FET	10X	2m	010-6202-01 Std	10 MΩ 2 pF	0.7	±200 V	±6 V	±55 V	YES	219
	100X		W/010-0384-00Atn	10 MΩ 2 pF	0.7	±200 V	±60 V	±200 V	NO	

For rise time measurements, the interaction of the probe capacitance with the source impedance is of importance (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

50-Ω DIVIDER PROBES—For use with 50Ω input amplifiers

Type	Atten	Length*	Package Number	Loading	Rise time in ns	INPUT LIMITS: Max dc + pk ac	INPUT LIMITS: Linear Dynamic Range	Read-out	Page
P6056	10X	6.0	010-6056-03 Std	500 Ω 1 pF	0.1	±16 V	±16 V	YES	220
		9.0	010-6056-05 Opt 2						
P6057	100X	6.0	010-6057-03 Std	5 kΩ 1 pF	0.25	±50 V	±50 V	YES	220
		9.0	010-6057-05 Opt 2						

Length in feet except where specified.

For measuring currents from dc to 1000 A, see the adjacent selection chart for current probes.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the milliohm to low ohm range. Current probes can be used for differential measurements, where the probe measures the results of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. To obtain the total picture, a measurement of the current waveform is necessary.

CURRENT PROBES

Type	Bandwidth Hz to MHz	Current/Div Scope at: 10 mV/div	Current/Div Scope at: Any Sensitivity mA/mV	SATURATION: Dc Amps	SATURATION: Pulse Amp-S Product	MAXIMUM CURRENT: dc + pk ac Amp	MAXIMUM CURRENT: ac p-p Amp	MAXIMUM CURRENT: Derate Below	MAXIMUM CURRENT: Derate Above	MAXIMUM CURRENT: Peak Pulse Amp	Page
P6302/ AM503	dc 50	1 mA to 5A		20	$100x10^{-6}$	20	40		1 MHz	50	
P6302/ AM 503 with CT-5	0.5 20	20 mA to 5 kA*			0.1		40 k	20 Hz	1.2 kHz	50 k	220
P6303/ AM503	dc 15	10 mA to 50 A		100	$10,000x10^{-6}$	100	200		20 kHz	500	220
P6021 Passive Term	120 60		2 or 10	0.5	$0.5x10^{-3}$		15	300 Hz	5 MHz	250	221
134	12 38	1 mA to 1A*		0.5	$0.5x10^{-3}$		15	230 Hz	5 MHz	15	
CT/5 Passive Term	120 20		40 or 10 k	20	0.5		2000	300 Hz	1.2 kHz	50 k	
CT-5/134	12 20	20 mA to 1 kA*		20	0.5		2000	230 Hz	1.2 kHz	15 k	
P6022 Passive Term	8.5 k 200		1 or 10	0.2	$9x10^{-6}$		6	3 kHz	10 MHz	100	221
134	100 65	1 mA to 1A*		0.2	$9x10^{-6}$		6	1.3 kHz	10 MHz	15	
CT-1	30 k 1000		5mV/mA	0.2	$1x10^{-6}$		1.4			100	222
CT-2	1.2 k 100		1m/mA	0.2	$50x10^{-6}$		7			100	222

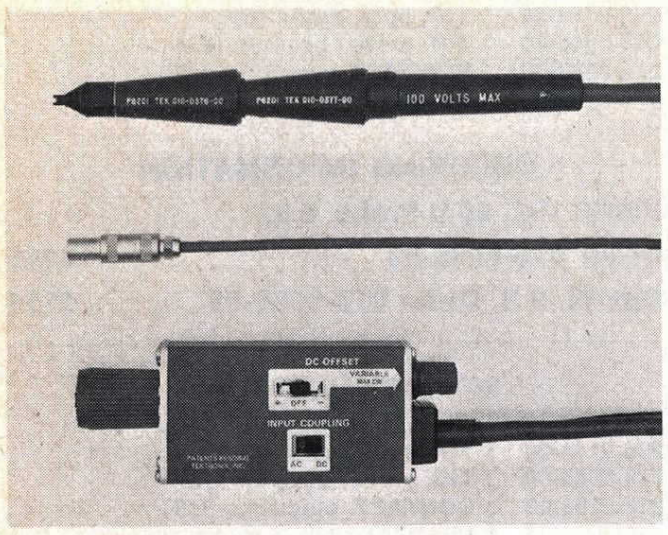
*Scope at 50 mV/div

Recommended Probes—For 7000 Series see page 59, for 5000 Series see page 87, for 400 Series see the individual instrument description.

OTHER PROBES

Probe	Package Number	Function	Use	Page
P6058	010-0260-00	Temperature and Voltage Probe	DM 501 7D13	143,168 79
P6430	010-6430-00	Temperature Probe	DM 44	105
P6104	010-6104-00	Voltage Probe	465M	104
40 kV	010-0277-00	High Voltage Probe	DM 501 DM 502	142,168
P6451	010-6451-03	Data Acquisition Probe	7D01 LA 501W	28 30
P6401	010-6401-01	Logic Probe	TTL Logic	30
P6420	010-6420-03	RF Probe	DM 501 DM 502 DM 44	143 142, 225 105

P6201 Dc to 900 MHz



Unity Gain
Two Plug-on Attenuator Heads that Maintain Scope Readout Factor
Low Input Capacitance
Dc Offset
Ac-Dc Coupling Switch

SPECIFICATIONS

Bandwidth — Dc to 900 MHz (−3 dB). **Rise Time** — 0.4 ns or less. **Probe Gain** — 1X within 3%. **Attenuator Accuracy** — ≤4% with probe (10X and 100X). **Input Impedance** — Probe only. 100 kΩ within 1%, shunted by ≃3.0 pF. Attenuator heads are 1 MΩ within 1%, shunted by 1.5 pF or less. **Dynamic Signal Range** — At least ±600 mV; extended to ±6 V with 10X Attenuator; ±60 V. **Dc Offset Range** — At least −5.6 to +5.6 V without attenuator head. Effective offset is extended by 10X and 100X attenuator heads to ±56 V and ±200 V, respectively. **Noise** — 300 μV or less at output (measured tangentially). **Maximum Input Voltage** — ±100 V, probe only; ±200 V with attenuator heads, derating with frequency. **LF Response** — 10 Hz or lower, −3 dB, ac coupled; 10X attenuator extends Lf response to ≤1 Hz; with 100X attenuator, Lf response is ≤10 Hz.

INCLUDED ACCESSORIES

013-0135-00	1 **TIP,** probe, retractable (BT)
010-0376-00	1 **ATTENUATOR** head 10X
010-0377-00	1 **ATTENUATOR** head 100X
206-0200-00	3 **TIP,** probe (CO)
131-1302-00	1 **CONTACT,** ground (CG)
175-0848-02	1 **LEAD,** ground, 12 in (30 cm) (BB)
103-0164-00	1 **TIP,** probe (CD)
344-0046-00	1 **CLIP,** alligator (AU)
166-0557-00	1 **INSULATING SLEEVE,** electrical (CJ)
342-0180-00	1 **INSULATOR,** ground contact (CT)
016-0156-02	1 **CARRYING CASE**

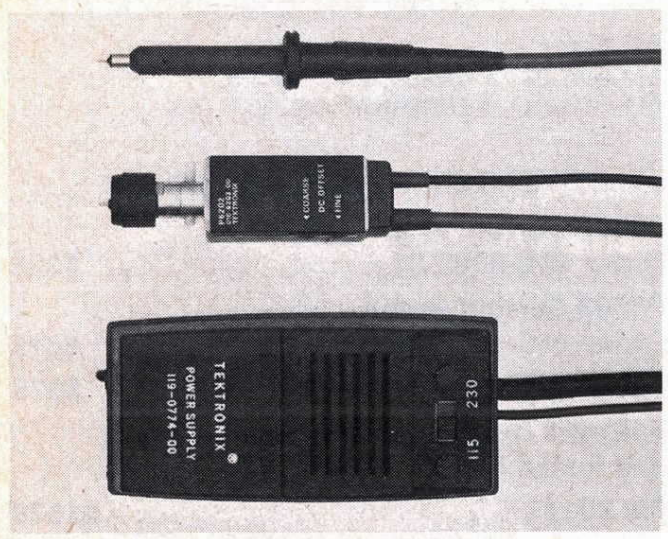
ORDERING INFORMATION

P6201 FET Probe,
Order 010-6201-01 . . . . . $675

1101 Accessory Power Supply, for powering up to four P6201 Probes.

1101 Probe Power Supply,
Order 1101 . . . . . $425

P6202 Dc to 500 MHz



Self-Contained Power Supply
Dc Offset
High Input Impedance through Freq Range
Small Probe Size
Rugged

SPECIFICATIONS

Probe and (Opt 10X Attenuator Head):
Bandwidth — Dc to ≥500 MHz (−3dB). **Rise Time** — 0.7 ns or less. **Attenuation** — 10X within 4% (100X within 2% for Opt 10X Attenuator Head). **Input Impedance** — 10 MΩ within 2% shunted by ≃2 pF. **Dynamic Range** — 0 to ± 6 V. **Dc Offset Range** — −55 V to +55 V (−200 V to +200 V for Opt 10X Attenuator Head). **Noise** (Tangential) — 150 μV or less. **Max Safe Input Voltage** — 200 V dc + peak ac, derated with frequency.

Opt Ac Coupling Cap:

Bandwidth — 16 Hz to ≥500 MHz (−3dB). **Rise Time** — 0.7 ns or less. **Input Impedance** — ≃4 pF. **Max Safe Input Voltage** — 200 V dc + peak ac.

INCLUDED ACCESSORIES

013-0097-01	1 **TIP,** probe, retractable (BO)
352-0351-00	1 **HOLDER,** probe
344-0046-00	2 **CLIP,** alligator (AU)
175-0849-00	1 **LEAD,** ground, 3 in (7.5 cm) (BC)
016-0378-00	1 **CARRYING CASE**
003-0675-01	1 **ADJUSTMENT TOOL,** probe (CU)
175-1017-00	1 **LEAD,** ground, 6 in (13 cm) (BE)
— — — —	2 **TIP,** probe, replaceable*
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)

*Available in package of 10 only, order 206-0230-03 (CR)

ORDERING INFORMATION

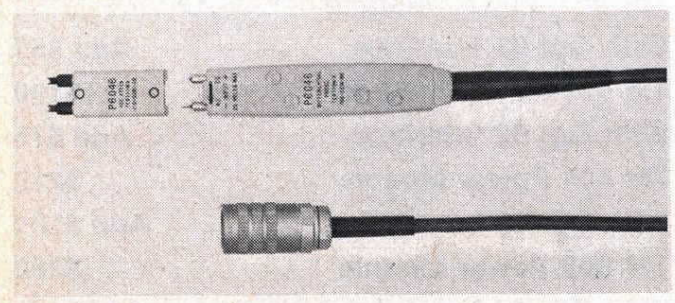
P6202 FET Probe, 2 Meter Cable,
Order 010-6202-01 . . . . . $475

Optional Accessories:

P6202 10X Attenuator,
Order 010-0384-00 . . . . . $45

P6202 Ac Coupling Cap,
Order 010-0360-00 . . . . . $25

P6046 Dc to 100 MHz



1000:1 Cmrr at 50 MHz
±250 V Maximum Voltage with 10X Attenuator
Dual Probe Tips for Greater Cmrr at High Frequencies

SPECIFICATIONS

Cmrr — With deflection factors of 1 mV/div to 20 mV/div: at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, and 1,000:1 at 50 MHz. **Common-mode Linear Dynamic Range** — ±5 V, ±50 V with 10X attenuator. **Bandwidth** — Dc to 100 MHz (−3dB). **Rise Time** — 3.5 ns or less. **Deflection Factor Range** — 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). **Input RC** — 1 MΩ paralleled by 10 pF of less. **Input Coupling** — Ac or dc, selected by a switch on the probe. Low frequency response ac-coupled is −3dB at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise** — 280 mV or less (tangentially measured). **Maximum Input Voltage** — ±25 V (dc + peak ac), ±250 V with 10X attenuation, derated with frequency. **Output Impedance** — 50 Ω through a BNC-connector. 50 Ω termination supplied with amplifier for use with 1-MΩ systems. **Probe Cable** — 6 ft long, terminated with special nine-pin connector. **Amplifier Power Requirements** — 10 W maximum, 48 to 400 Hz. Factory wired for 105 V to 125 V ac (117 V ac nominal) operation. Transformer taps permit operation at 210 V to 250 V ac (234 V ac nominal).

INCLUDED ACCESSORIES

014-0029-00	1 **HANGER ASSEMBLY**
012-0076-00	1 **CABLE ASSY,** Rf (CW)
011-0049-01	1 **TERMINATION,** 50 Ω (BJ)
016-0111-01	1 **CARRYING CASE**

ORDERING INFORMATION

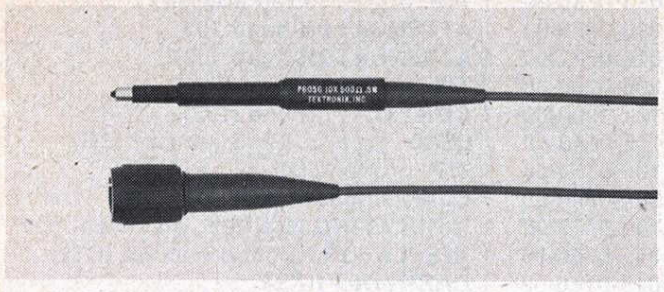
P6046 FET Differential Probe, Amplifier, and Power Supply,
Order 010-0232-00 . . . . . $1250

Opt 05 w/o Amplifier and Power Supply,
Order 010-0213-00 . . . . . $650

Included Accessories with double alpha codes are pictured on pages 227 and 228.

50 Ω Probes

P6056 Dc to 3.5 GHz 10X



50 Ω Probe

SPECIFICATIONS

Bandwidth — 3.5 GHz probe only. **Rise Time** — Less than 100 ps probe only. **Attenuation** — 10X. **Input Resistance** — 500 Ω at dc; ≃ 300 Ω at 1 GHz. **Input Capacitance** — 1.0 pF. **Maximum Input Voltage** — Rf (cw) 22 V; dc 16 V. **Maximum Power Dissapation** — 0.5 W. **Transit Time Variation** — Less than 70 ps probe to probe.

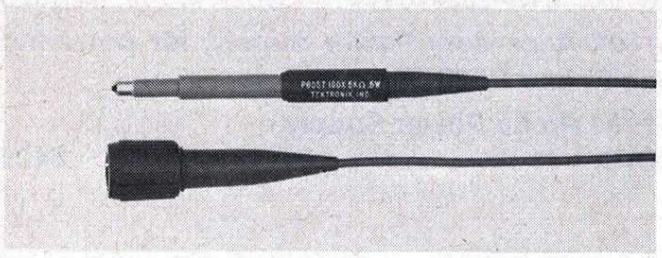
INCLUDED ACCESSORIES

344-0046-00	1 **CLIP,** alligator (AU)
206-0114-00	1 **TIP,** hook probe (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)
214-0283-00	1 **CONTACT,** electrical (CS)
175-0249-00	1 **LEAD,** ground, 3 in (7.5 cm) (AY)

ORDERING INFORMATION

P6056 10X, 50 Ω Probe, 6 ft,
Order 010-6056-03 . . . . . $115
Opt 02, 9 ft, Order 010-6056-05 . . . . . $115

P6057 Dc to 1.4 GHz 100X



50 Ω Probe

SPECIFICATIONS

Bandwidth — 1.4 GHz probe only. **Rise Time** — Less than 250 ps probe only. **Attenuation** — 100X. **Input Resistance** — 5000 Ω at dc; ≃1500 Ω at 1 GHz. **Input Capacitance** — 1.0 pF. **Maximum Input Voltage** — 50 V dc or rms to 500 MHz, decreasing to 21 V at 1 GHz. **Transit Time Variation** — Less than 70 ps probe to probe.

INCLUDED ACCESSORIES

344-0046-00	1 **CLIP,** alligator (AU)
206-0114-00	1 **TIP,** hook probe (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)
214-0283-00	1 **CONTACT,** electrical (CS)
175-0249-00	1 **LEAD,** ground, 3 in (7.5 cm) (AY)

ORDERING INFORMATION

P6057 100X, 50 Ω Probe, 6 ft,
Order 010-6057-03 . . . . . $115
Opt 02, 9 ft, Order 010-6057-05 . . . . . $115

Current Probes (Used with AM 503 Current Probe Amplifier)

P6302 Current Probe

20A Ac and Dc Current Measurements
Dc to 50 MHz Bandwidth
Peak Pulse Measurements to 50A, 50,000A with the CT-5 Current Probe Clip-on Probe
Ac or Dc Coupling
Small Loading—0.1 Ω Insertion Z at 5 MHz, 0.5 Ω at 50 MHz

SPECIFICATIONS

P6302 —

Bandwidth — Dc to ≥50 MHz (−3 dB), 7 Hz to >50 MHz (−3dB) ac coupled; the system's bandwidth may be limited to ≃5 MHz with the AM 503 front panel switch. **Rise Time** — 7 ns or less. **Maximum Current** — 20 A (dc + peak ac), derated with frequency. **Maximum Peak Pulse Current** — 50 A. **Amp Second Product** — 100 Aμs. **Sensitivity** — 1 mA/div to 5 A/div within 3% (in calibrated steps) into a 50 Ω load; indicating device sensitivity 10 mV/div. **Insertion Impedance** — 0.1 Ω at 5 MHz, 0.5 Ω at 50 MHz. **Maximum Voltage (bare connector)** — 500 V. **Maximum Conductor Size** — 0.15 inch.

INCLUDED ACCESSORIES

P6302 —

175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)

P6303 Current Probe

100A Ac and Dc Current Measurements
Dc to 15-MHz Bandwidth
Peak Pulse Measurements to 500 A
Ac or Dc Coupling
1 inch x 0.830 in Jaw Opening
Minimal Loading—0.02 Ω Insertion Z at 1 MHz, 0.15 Ω at 15 MHz

SPECIFICATIONS

P6303 —

Bandwidth — Dc to ≥15 MHz (−3 dB), ≤7 Hz to ≥15 MHz (−3 dB) ac coupled. Bandwidth can be limited to ≃5 MHz with AM 503 front-panel switch. **Rise Time** — 23 ns or less. **Maximum Current** — 100 A (dc + peak ac), derated with frequency. **Maximum Peak Pulse Current** — 500 A. **Amp Second Product** — 10,000 Aμs. **Sensitivity** — 10 mA/div to 50 A/div within 3% (in calibrated steps) into 50 Ω load; indicating device (oscilloscope) sensitivity 10 mV/div. **Insertion Impedance** — 0.02 Ω at 1 MHz, 0.15 Ω at 15 MHz. **Maximum Voltage (bare conductor)**— 700 V. **Maximum Conductor Size** — 0.830 inch (2.1 cm).

INCLUDED ACCESSORIES

P6303 —

016-0622-00	1 **CARRYING CASE**

INCLUDED ACCESSORIES

AM 503 —

012-0057-01	1 **CABLE,** BNC, 50 Ω (CV)
011-0049-01	1 **TERMINATION,** 50 Ω (BJ)

ORDERING INFORMATION

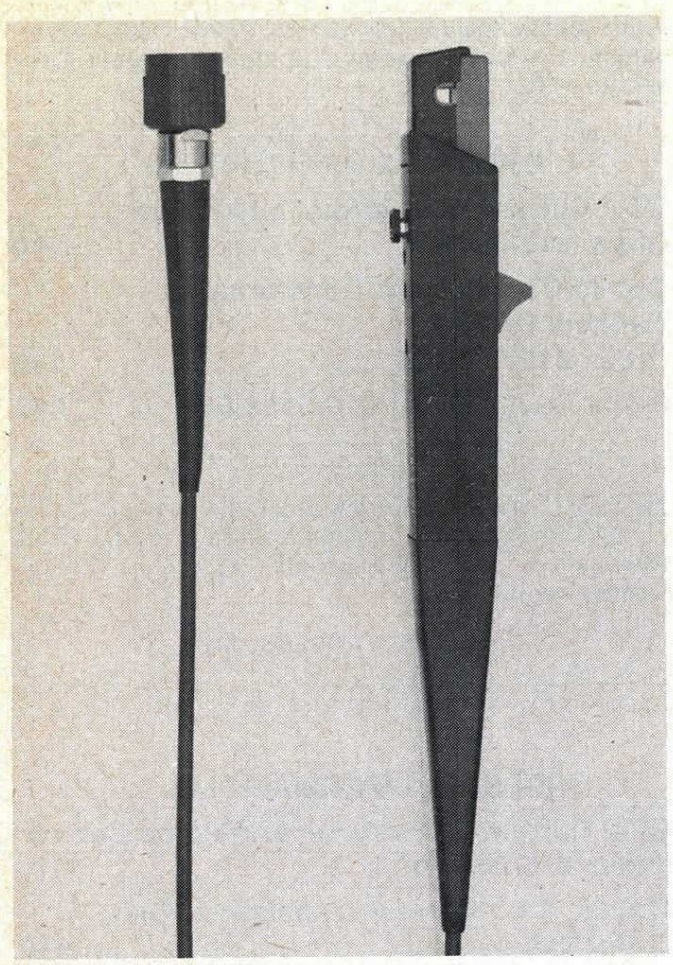
P6302 Current Probe,
Order 010-6302-01 . . . . . $325
P6303 Current Probe,
Order 010-6303-01 . . . . . $675
AM 503 Current Probe Amplifier $675
F5010P3 System (includes assembled and tested P6303, AM 503, and TM 501) $1570
F5010P2 System (includes assembled and tested P6302, AM 503, and TM 501) $1220

The AM 503 Current Probe Amplifier requires one of the TM 500-Series Power Modules listed below. The number of plug-ins the module will accept is designated by the last digit in the part number. The optional interface allows connections between plug-ins to be made through the rear panel on the power module.

TM 501 Power Module $190
With Opt 02 Interface . . . . . Add $55
TM 503 Power Module $190
With Opt 02 Interface . . . . . Add $75
TM 504 Power Module $210
With Opt 02 Interface . . . . . Add $100
TM 506 Power Module $280
With Opt 02 Interface . . . . . Add $150
RTM 506 Power Module (rackmount version) $370
With Opt 02 Interface . . . . . Add $150
TM 515 Traveler Mainframe $360
With Opt 05 Interface . . . . . Add $75
With Opt 06 48-440 Hz Fan . . . . . Add $150

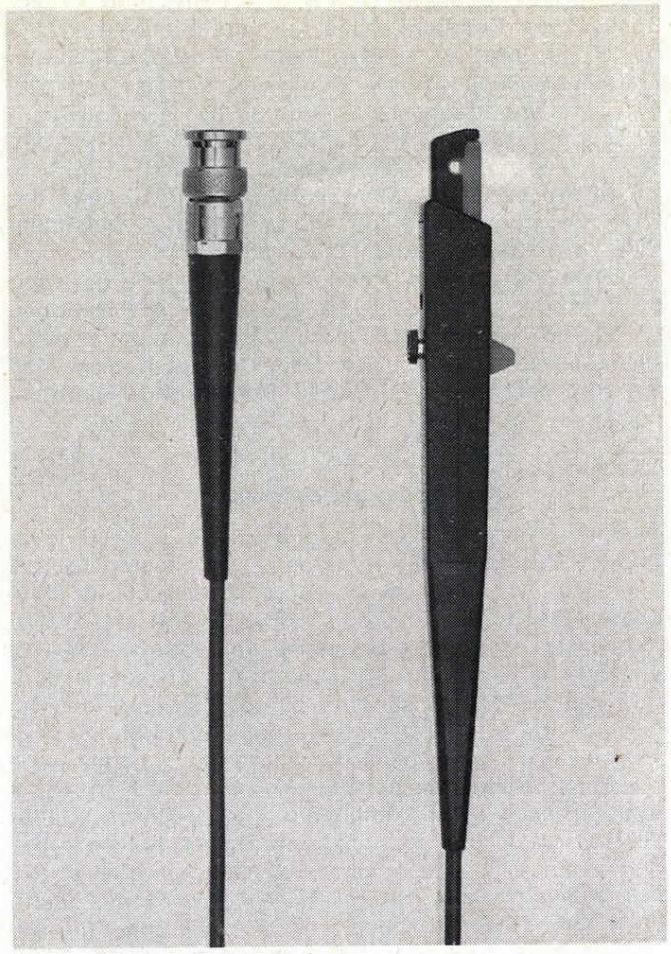
Included Accessories with double alpha codes are pictured on pages 227 and 228.

P6021 w/Term



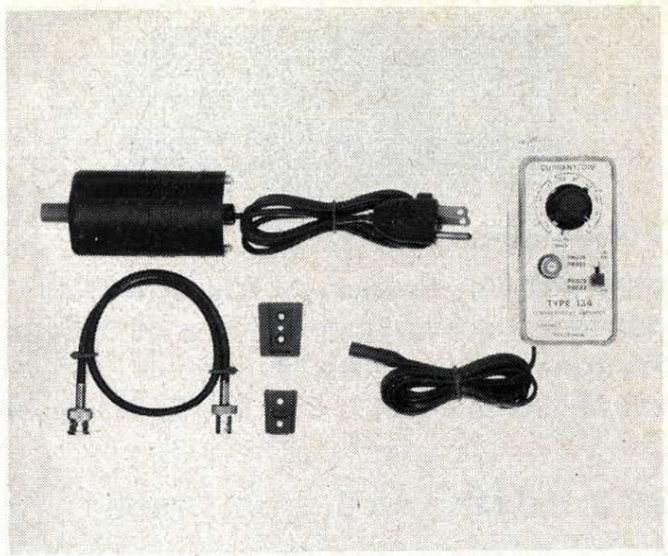
For General-Purpose Applications
120 Hz to 60 MHz
Clip-on Probe

P6022 w/Term



Small Size Suitable for Compact Circuitry
935 Hz to 200 MHz
Clip-on Probe

134 Current Probe Amplifier



Use to Expand the Low Frequency Capability and Sensitivity of Either Probe

SPECIFICATIONS

PERFORMANCE CHARACTERISTICS

		Probe with Passive Termination	Probe with 134 Amplifier
Sensitivity	**P6021**	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ± 3%.	134 Amplifier switchable in steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ± 3%.
	P6022	1 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	
Bandwidth†	**P6021**	2 mA/mV ≤ 450 Hz to 60 MHz 10 mA/mV ≤ 120 Hz to 60 MHz	12 Hz to 38 MHz
Probe Only*	**P6022**	1 mA/mV—≤ 8.5 kHz to 130 MHz 10 mA/mV—≤ 935 Hz to 200 MHz	100 Hz to 65 MHz
Max Current (CW)	**P6021**	15 A p-p sine wave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV.	15 A p-p sine wave between 230 Hz and 5 MHz
	P6022	6 A p-p sine wave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV.	6 A p-p sine wave between 1.3 kHz and 10 MHz
Max Current (Pulse)	**P6021**	250 A peak, not to exceed 500 A-μs or 5 A rms	15 A peak, not to exceed 500 A-μs or 5 A rms
	P6022	100 A peak, not to exceed 9 A-μs or 2 A rms	15 A peak, not to exceed 9 A-μs or 2 A rms
Noise			≤ 150 μA
Max Voltage (bare conductor)		600 V (dc + peak ac)	600 V (dc + peak ac)
Net Weight		≃ 1 lb	≃ 5 lb

†All bandwidths stated are −3dB

**To estimate the scope/probe system bandwidth from the probe only bandwidth, use the relationship*

$$(t_r \text{ system})^2 = (t_r \text{ probe})^2 + (t_r \text{ scope})^2$$

$$t_r = 0.35 \text{ BW}$$

INCLUDED ACCESSORIES (P6021 and P6022)

175-0125-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)

ORDERING INFORMATION

P6021 Current Probe and Term, 5 ft, Order 015-0140-02 ..... $225
Opt 02, 9 ft and Term, Order 015-0140-03 ..... $225
Opt 06, 5 ft w/o Term, Order 010-0237-02 ..... $175
Opt 02 and 06, 9 ft w/o Term, Order 010-0244-02 ..... $175
P6022 Current Probe and Term, 5 ft, Order 015-0135-00 ..... $250
Opt 02, 9 ft and Term, Order 015-0135-01 ..... $250
Opt 06, 5 ft w/o Term, Order 010-0238-00 ..... $200
Opt 02 and 06, 9 ft w/o Term, Order 010-0238-02 ..... $200

INCLUDED ACCESSORIES (134)

014-0029-00	1 **HANGER,** assy
012-0104-00	1 **CABLE** assy (CX)
015-0058-01	1 **POWER SUPPLY,** 110V

ORDERING INFORMATION

134 Current Probe Amplifier, Order 015-0057-02 ..... $425
Opt 04, 230 V ac, Order 015-0057-03 ..... $425

Included Accessories: Same as above but with 230 V power supply (015-0059-01).

OPTIONAL ACCESSORIES

for the P6021, P6022, and 134
Calibrator Adapter, BNC, Order 013-0092-00 ....$33
Carrying Case for P6021 and P6022, and a 134 Amplifier, Order 016-0087-01 .....$18
Passive Termination
For P6021, Order 011-0105-00 .....$85
For P6022, Order 011-0106-00 .....$95

Included Accessories with double alpha codes are pictured on pages 227 and 228.

Current Probes

CT-1 1 GHz Ac Current Probe

1 GHz Maximum Bandwidth

Used with 50 Ω Systems, or Wide Band Non-sampling Oscilloscopes Using a 50 Ω Term Permanently Inserted in 50 Ω Circuit has Minimum Effect in the 50 Ω Environment

SPECIFICATIONS

Sensitivity — 5 mV/mA within ± 3% into a 50 Ω load. **Decay Time Constant**—6.35 μs, approximated by 1% per 50 ns; limit, 1 μs. **Rise Time** — less than 350 ps. **Frequency Response** — 25 kHz to 1 GHz (−3 dB). **Insertion Impedance**—1 Ω shunted by ≃ 6μH with a 50 Ω termination; 2 Ω shunted by ≃5 μH without a 50 Ω termination. **Capacitance Loading**—Typically 1.5 pF for bare #14 gauge wire passing through the CT-1 transformer; 0.6 pF for #20 gauge. **Maximum Voltage of Circuit Under Test**—1000 V (dc plus peak ac). **Direct Current** — Reduces the L/R time constant by a factor of 2 at 75 mA. **Pulse Current Rating**—12 A peak, with a 50 Ω load, with a maximum amp-second product of 1 A μs. **Rms Current Rating**—450 mA maximum with a 50 Ω load. **Temperature Rating**—25°C to ± 65°C. **Transformer Physical Dimensions**—⅜ x 9/16 x 1 13/16 inch; #6-32 x ¼ inch mounting stud. **Probe Cable Impedance**—50 Ω. **Probe Cable Attenuation**—1X. **Cable Length**—18 inches. **Output Connector**—GR type.

ORDERING INFORMATION

CT-1 Current Transformer and Probe, Order 015-0041-00 . . . . . $100

Opt 05 CT-1 Current Transformer (without Probe), Order 015-0040-00 . . . . . $60

Probe Cable, Order 010-0133-00 . . . . . $50

CT-2 100 MHz Ac Current Probe

100 MHz Maximum Bandwidth

Insulated Case for Limited Space Applications

Several CT-2 Transformers Can Be Used in the Circuit and Monitored by One Cable

SPECIFICATIONS

Sensitivity—1 mV/mA within 3% into a 50 Ω load. **Decay Time Constant**—160 μs, approximated by 1% per 1.25 μs; limit, 25 μs. **Rise Time**—0.5 ns. **Frequency Response**—up to 100 MHz; −3dB at 1.2 kHz, −3dB at 200 MHz. **Insertion Impedance**—0.04 Ω shunted by ≃7 μH in series with 0.9 μH with a 50 Ω termination; 0.08 Ω shunted by ≃7μH in series with 0.9 μH without a 50 Ω termination. **Capacitance Loading**—Typically 1.8 pF for a bare #16 gauge wire passing through the CT-2 transformer; 0.7 pF for a #22 gauge wire. **Maximum Voltage of Circuit Under Test**—1000 V (dc + peak ac). **Direct Current**—Reduces the L/R time constant by a factor of 2 at 175 mA. **Pulse Current Rating**—36 A peak, with a maximum amp-second product of 50 A μs. **Rms Current Rating**—1.25 A maximum. **Temperature Rating**—25°C to +65°C. **Transformer Physical Dimensions**—Same as CT-1. **Probe Cable Impedance**—50 Ω. **Probe Cable Attenuation**—1X. **Cable Length**—42 inches. **Output Connector**—BNC type.

INCLUDED ACCESSORIES

010-0164-00—1 **CABLE,** probe
011-0049-01 1 **TERMINATION,** 50 Ω (BJ)

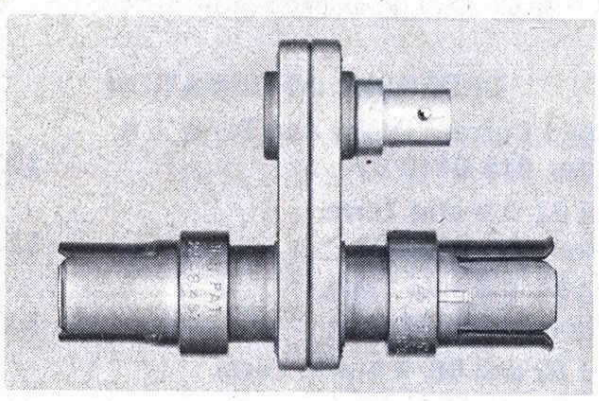
ORDERING INFORMATION

CT-2 Current Transformer and Probe Cable, Order 015-0047-00 . . . . . $105

Opt 05, CT-2 Current Transformer Only, Order 015-0046-00 . . . . . $60

Probe Cable Only, Order 010-0164-00 . . . $37

CT-3 Signal Pickoff



Use with High-Frequency Oscilloscopes

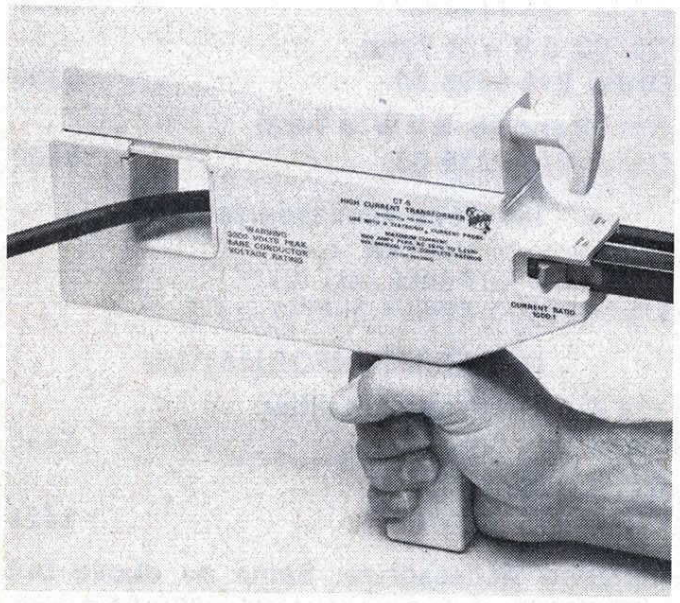
SPECIFICATIONS

Sensitivity—10% of voltage under test, into a 50 Ω load. **Decay Time Constant**—4.5 μs at 0 dc current. **Rise Time**—<0.4 ns. **Frequency Response**—50 kHz to 875 MHz at 0 dc current. **Insertion Impedance**—with a 50 Ω termination is 1 Ω shunted by 4.5 μH, 2 Ω shunted by 4.5 μH without a 50 Ω termination. **Vswr**—<1.2 at 1.5 GHz. **Voltage Rating**—at 0 V dc is 25 V rms, 1-kv pulse peak. The Vs product is 100Vμs. If exceeded, the L/R decay will decay rapidly toward zero.

ORDERING INFORMATION

CT-3 Signal Pickoff, Order 017-0061-00 . . . . . $110

CT-5 High Current Transformer



Pulsed Currents to 50,000 A

20 mA per Division Sensitivity

1.5 Inch Diameter Conductors

Measurements on Bare Conductors to 3000 V

Nullifies Dc Effects to 300 A

CT-5 Current Measurement Combinations

Product	Current Div Scope Set 10 mV/div	Current Div Scope Set 50 mV/div	Bandwidth	A-s Product	Max Current Rms	Max Current Peak Pulse
CT-5/P6302/AM 503	20 mA to 5 kA		0.5 Hz to 20 MHz	0.1	700 A	50 kA
CT-5/P6021/134		20 mA to 1 kA	12 Hz to 20 MHz	0.5	700 A	15 kA
CT-5/P6021/Term	400 mA to 100 A	2A to 500 A	120 Hz to 20 MHz	0.5	700 A	50 kA

SPECIFICATIONS

With P6302/AM 503 or P6021/134 combinations.

Rise Time—17.5 ns or less. **Insertion Impedance**—20 μΩ or less at 60 Hz, increasing to 20 mΩ at 1 MHz. **Current Range**—20 mA/div to 100 A/div with P6302/AM 503, and 20 mA/div to 20 A/div with P6021/134 (20:1 step down ratio); 1 A/div to 5 kA/div with P6302/AM 503, and 1 A/div to 1 kA/div with P6021/134 (1000:1 step down ratio). **Accuracy**—+4%. **Maximum Current**—1000 A peak cw from 20 Hz to 1.2 kHz, derating to 100 A peak at 1 MHz. **Amp-Sec Product**—8 Amp-s.* **Maximum Voltage of Circuit Under Test**—3000 V, bare conductor. **Maximum Dc Bucking Current**—300 mA to buck out 300 A dc (using dc bucking coil). **Dimensions and Weight**—10.5 x 2.3 x 9.5 inches; net weight ≃ 4 lb.

*CT-5 only.

INCLUDED ACCESSORIES

015-0194-00 1 **BUSHING,** high voltage, 12 in
016-0191-03 1 **CARRYING CASE**

ORDERING INFORMATION

CT-5 Current Transformer with Dc Bucking Coil, Order 015-0189-01 . . . . . $775

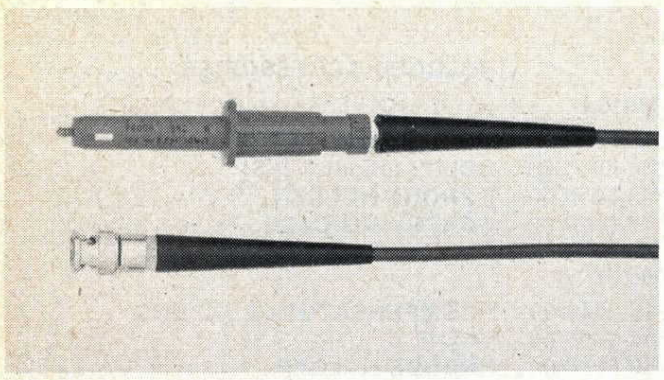
Opt 05 w/o Dc Bucking Coil, Order 015-0189-00 . . . . . $620

OPTIONAL ACCESSORIES

Dc Bucking Coil, Order 015-0190-00 . . . . . $190
High-Voltage Bushing, 4 ft long, inside diameter 1 in, Order 015-0194-01 . . . . . $32

Included Accessories with double alpha codes are pictured on pages 227 and 228.

P6006 Dc to 35 MHz 10X



General Purpose

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation—10X. **Input Resistance**—10 MΩ. **Input Capacitance**—7.5 pF for 3.5 ft probe cable when used with an instrument having 20 pF input capacitance; 8.5 pF for 6 ft version; 11 pF for 9 ft version; 13 pF for 12 ft version. **Bandwidth**—Dc to 35 MHz for 3.5 ft version. **Voltage Rating**—600 V dc, ac peak or dc and ac peak combined. 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.

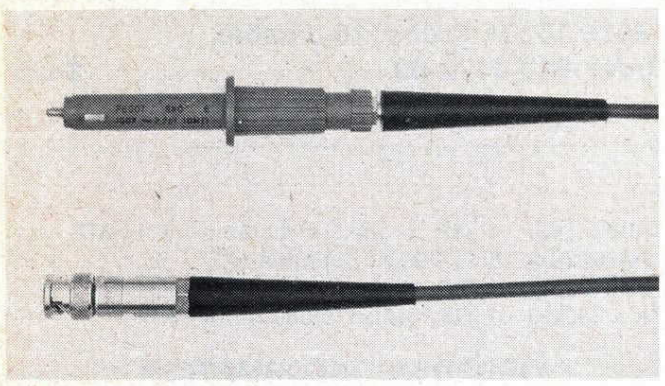
INCLUDED ACCESSORIES

013-0071-00	1	**TIP,** probe, retractable hook (AD)
134-0013-00	1	**PLUG,** tip, banana (AF)
175-0124-01	1	**LEAD,** ground, 5 in (13 cm) (AW)
175-0125-01	1	**LEAD,** ground, 12 in (30 cm) (AX)
206-0015-00	1	**TIP,** probe (0.055 in dia) (AH)
206-0060-00	1	**TIP,** probe (0.080 in dia) (AI)
206-0105-00	1	**TIP,** probe, hood (AM)
344-0046-00	2	**CLIP,** alligator (AU)
352-0090-00	1	**HOLDER,** probe

ORDERING INFORMATION

P6006 10X Probe, 6 ft,
Order 010-0160-00 . . . . . $60
Opt 01, 3.5 ft BNC, Order 010-0127-00 . . $60
Opt 02, 9 ft BNC, Order 010-0146-00 . . . $60
Opt 03, 12 ft BNC, Order 010-0148-00 . . $60

P6007 Dc to 25 MHz 100X



General Purpose

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation—100X. **Input Resistance**—10 MΩ. **Input Capacitance**—2.0 pF for 3.5 ft probe cable when used with an instrument having 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. **Bandwidth**—Dc to 25 MHz. **Voltage Rating**—1.5 kV dc or ac rms, 4.2 kV ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 10 MHz, the maximum allowable p-p voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the instrument used.

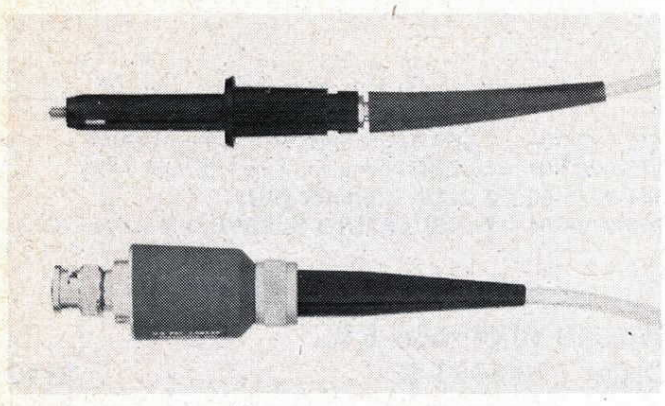
INCLUDED ACCESSORIES

Same as for P6006

ORDERING INFORMATION

P6007 100X Probe, 6 ft,
Order 010-0165-00 . . . . . $72
Opt 01, 3.5 ft, Order 010-0150-00 . . . . . $72
Opt 02, 9 ft, Order 010-0152-00 . . . . . $72
Opt 03, 12 ft, Order 010-0154-00 . . . . . $72

P6008 Dc to 100 MHz 10X



Environmental and Non-Environmental
The P6008 Environmental Probe is designed to operate over −50°C to +150°C for the probe body and cable; the compensation box operates from −15°C to +55°C.
For 1 MΩ Inputs

SPECIFICATIONS

Environmental and Non-Environmental Attenuation—10X. **Input Resistance**—10 MΩ. **Input Capacitance**—≃ 7.5 pF when used with an instrument having a 20 pF input capacitance. **Bandwidth**—Dc to 100 MHz. **Voltage Rating**—600 V dc, ac peak, or dc and ac peak combined. Peak-to-peak voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable p-p voltage is 300 V.

INCLUDED ACCESSORIES

Environmental:

134-0013-00	1	**PLUG,** tip, banana (AF)
344-0045-00	1	**CLIP,** alligator (AT)
175-0925-00	1	**LEAD,** ground, 12 in (30 cm) (BD)
352-0090-00	1	**HOLDER,** probe
013-0071-01	1	**TIP,** probe, retractable hook (AE)

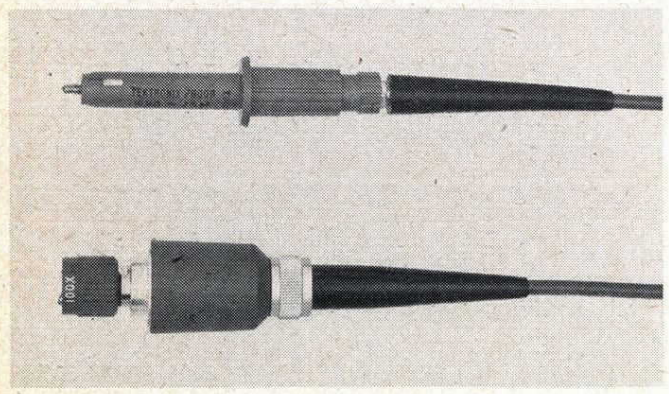
Non-Environmental:

134-0013-00	1	**PLUG,** tip, banana (AF)
344-0046-00	1	**CLIP,** alligator (AU)
175-0125-01	1	**LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1	**LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1	**LEAD,** ground, 3 in (7.5 cm) (AV)
352-0068-00	1	**HOLDER,** probe
013-0071-00	1	**TIP,** probe, retractable hook (AD)
206-0060-00	1	**TIP,** probe (0.080 in dia) (AI)
206-0105-00	1	**TIP,** probe, hook (AM)
206-0015-00	1	**TIP,** probe (0.055 in dia) (AH)
013-0052-00	1	**TIP,** probe, retractable hook (AA)

ORDERING INFORMATION

P6008 Environmental 10X Probe, 6 ft,
Order 010-0129-01 . . . . . $150
P6008 Non-Environmental 10X Probe, 3.5 ft,
Order 010-0129-00 . . . . . $130

P6009 Dc to 120 MHz 100X



120 MHz Bandwidth

General Purpose

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation—100X. **Input Resistance**—10 MΩ. **Input Capacitance**—≃ 2.5 pF when used with instrument having 20 pF input capacitance. **Bandwidth**—Dc to 120 MHz. **Voltage Rating**—1.5 kV dc or ac rms, 4 kV ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 40 MHz, the maximum allowance p-p voltage is 425 V.

INCLUDED ACCESSORIES

175-0125-01	1	**LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1	**LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1	**LEAD,** ground, 3 in (7.5 cm) (AV)
013-0071-00	1	**TIP,** probe, retractable hook (AD)
013-0052-00	1	**TIP,** probe, retractable hook (AA)
344-0046-00	2	**CLIP,** alligator (AU)
206-0060-00	1	**TIP,** probe (0.080 in dia) (AI)
206-0105-00	1	**TIP,** probe, hook (AM)
134-0013-00	1	**PLUG,** tip, banana (AF)
206-0015-00	1	**TIP,** probe (0.055 in dia) (AH)
352-0090-00	1	**HOLDER,** probe

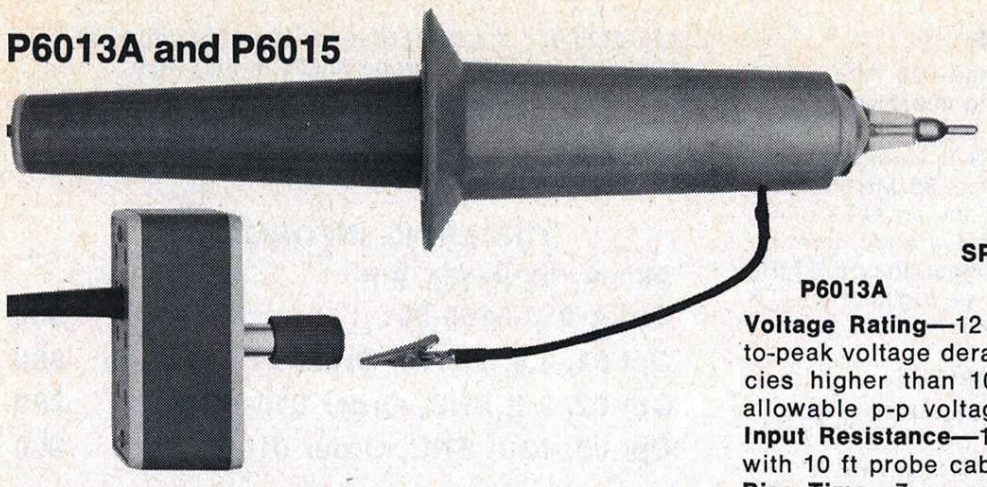
ORDERING INFORMATION

P6009 100X Probe, 9 ft, w/Readout,
Order 010-0264-01 . . . . . $125
Opt 04 w/o Readout,
Order 010-0170-00 . . . . . $120

Included Accessories with double alpha codes are pictured on pages 227 and 228.

Passive Probes

P6013A and P6015



High Voltage Probe

Measure Up to 40 kV Peak Ac or Pulse (P6015)
Up to 20 kV Dc (P6015)

1000X Attenuation

75 MHz Useful Bandwidth

(The P6013A is similar to the P6015 shown in photo.)

For 1 MΩ Inputs

SPECIFICATIONS

P6013A

Voltage Rating—12 kV, peak ac, pulse or dc. Peak-to-peak voltage derating is necessary for cw frequencies higher than 100 kHz. At 1 MHz, the maximum allowable p-p voltage is 5.5 kV. **Attenuation**—1000X. **Input Resistance**—100 MΩ. **Input Capacitance**—3 pF with 10 ft probe cable; 3.5 pF with 25 ft cable. **Probe Rise Time**—7 ns or less with 10 ft probe cable; 13.5 ns or less with 25 ft cable.

P6015

Voltage Rating—40 kV, peak ac and pulse; 20 kV dc or rms continuous at 25°C. Peak-to-peak voltage derating is necessary for cw frequencies higher than 100 kHz or in temperatures above 25°C. At 10 MHz the maximum allowable p-p voltage is 13 kV. **Attenuation**—1000X. **Input Resistance**—100 MΩ. **Input Capacitance**—≃3 pF. **Probe Rise Time**—≃4 ns. **Temperature Range**—10°C to 55°C.

INCLUDED ACCESSORIES

P6013A

015-0083-00	1 **COMPENSATING BOX,** BNC
344-0005-00	1 **CLIP,** alligator (AS)
352-0056-00	1 **PROBE HOLDER**
016-0129-02	1 **CARRYING CASE**

P6015

015-0049-00	1 **COMPENSATING BOX,** BNC
344-0005-00	1 **CLIP,** alligator (AS)
352-0056-00	1 **PROBE HOLDER**
252-0120-00	1 **CAN,** high-voltage dielectric fluid (BH)
016-0128-02	1 **CARRYING CASE**

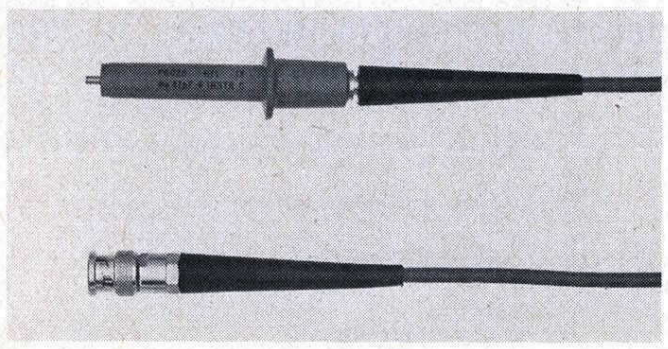
ORDERING INFORMATION

P6013A 1000X Probe, 10 ft cable, Order 010-0177-01 . . . . . $375

Option 03, 25 ft cable, Order 010-0175-01 . . . . . $375

P6015 1000X Probe, 10 ft cable, Order 010-0172-00 . . . . . $425

P6028 Dc to 17 MHz, 1x



For General Purpose Use With 1 MΩ Oscilloscopes and Plug-ins

SPECIFICATIONS

Attenuation — 1X. **Input Resistance** — 1 MΩ, instrument input R included. **Input Capacictance** — 30 pF for 3.5 ft probe cable; 47 pF for 6 ft versions; 70 pF for 9 ft version; 92 pF for 12 ft version, instrument capacitance excluded. For total input capacitance of the system, add input C of instrument. **Probe Rise Time** — ≃10 ns. **Bandwidth** — Dc to 17 MHz. **Voltage Rating** — 600 V dc or ac peak-to-peak. P-p voltage derating is necessary for cw frequencies higher than 1 MHz. At 10 MHz, the maximum allowable p-p voltage is 60 V.

INCLUDED ACCESSORIES

175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
352-0068-00	1 **HOLDER,** probe, molded
344-0046-00	1 **CLIP,** alligator (AU)
013-0071-00	1 **TIP,** probe, retractable hook (AD)
134-0013-00	1 **PLUG,** tip, banana (AF)
206-0105-00	1 **TIP,** probe, hook (AM)
206-0060-00	1 **TIP,** probe, 0.080 in dia (AI)

ORDERING INFORMATION

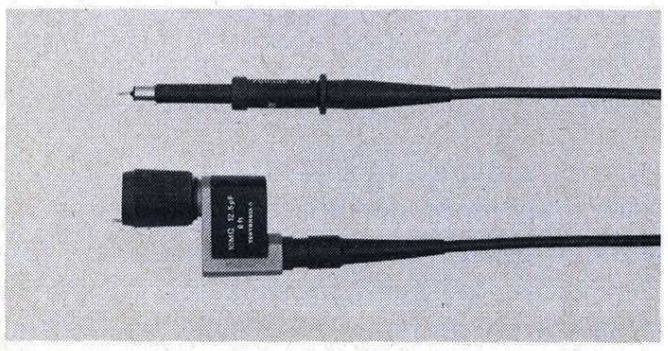
P6028 1X Probe, 6 ft, Order 010-0075-00 . . . . . $36

Option 01, 3.5 ft, Order 010-0074-00 . . . $36

Option 02, 9 ft, Order 010-0076-00 . . . . $36

Option 03, 12 ft, Order 010-0077-00 . . . $36

P6053B Dc to 250 MHz, 10x



For 1 MΩ Inputs

SPECIFICATIONS

Attenuation — 10X. **Input Resistance** — 10 MΩ. **Input Capacitance** — 9.5 pF with 3.5 ft probe, 12.5 pF with 6 ft version, 13.5 pF with 9 ft version. **Bandwidth** (with 225 MHz or greater oscilloscope — ≃200 MHz for 3.5 and 6 ft versions, ≃115 MHz for the 9 ft version. **Voltage Rating** — 500 V (dc + peak ac). Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the max allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

INCLUDED ACCESSORIES

013-0107-03	1 **TIP,** probe, retractable (BS)
352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe, (CK)
013-0085-00	1 **TIP,** probe, bayonet (BM)
	Trace Identify Function for Scopes with Crt Readout
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	2 **INSULATING SLEEVE,** electrical (CH)

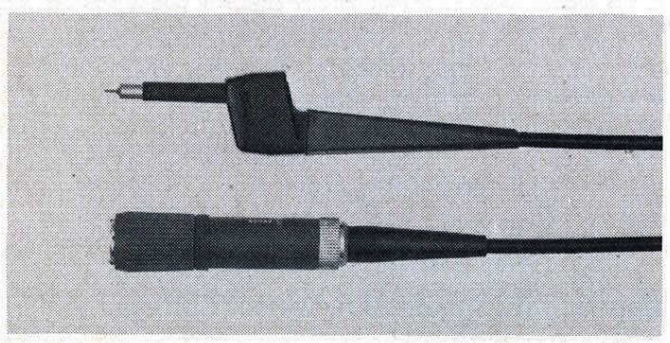
ORDERING INFORMATION

P6053B 10X Probe, 6 ft, Order 010-6053-13 . . . . . $110

Opt 01, 3.5 ft, Order 010-6053-11 . . . . $110

Opt 02, 9 ft, Order 010-6053-15 . . . . . $110

P6055 Differential Probe Dc to 60 MHz



20,000:1 CMRR

For Use With Differential Ampl's

10X Adjustable Attenuation

500 V Maximum Voltage

For 1 MΩ Inputs

SPECIFICATIONS

CMRR — 20,000:1 from dc to 1 kHz derating to 100:1 at 20 MHz. **Attenuation** — Adjustable to 10X. **Input Resistance** — 1 MΩ ±0.5%. **Input Capacitance** — ≃10 pF when used with instrument that has 20 pF input capacitance; 12.5 pF when used with instrument that has 47 pF input capacitance. Maximum Useful Bandwidth — 60 MHz. **Typical Probe Rise Time** — 5.8 ns. **Maximum Voltage** — 500 V (dc + peak ac) from dc to 12 MHz. Peak-to-peak voltage derates to 100 V at 70 MHz.

INCLUDED ACCESSORIES

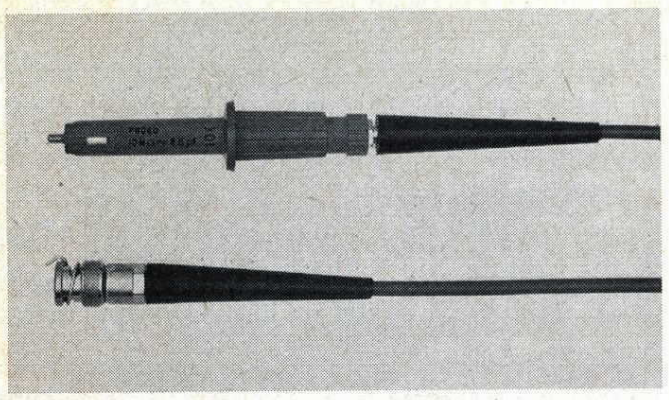
013-0107-03	1 **TIP,** probe, retractable (BS)
003-0675-01	1 **ADJUSTABLE TOOL,** probe (CU)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-1256-00	1 **LEAD,** electrical, 6 in (13 cm) (BG)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
206-0114-00	1 **TIP,** hook probe, (CK)
344-0046-00	2 **CLIP,** alligators (AU)
166-0404-01	2 **INSULATING SLEEVE,** electrical (CH)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6055 10X Differential Probe, 3.5 ft, Order 010-6055-01 . . . . . $180

Included Accessories with double alpha codes are pictured on pages 227 and 228.

P6060 Dc to 35 MHz 10X



General Purpose

Dc to 35 MHz Bandwidth

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation — 10X. Accuracy when used with a 1 MΩ ±0.15% instrument input will be within ±0.4% When used with a 1 MΩ ±2% instrument input the accuracy will be within ±2%. **Input Resistance** — 10 MΩ within ±0.25% within a 1 MΩ ±0.15% instrument input; 10 MΩ within ±0.4% when used with a 1 MΩ ±2% instrument input. **Input Capacitance** — ≃ 6.0 pF for 3.5 ft probe cable when used with instrument having 15 pF input capacitance; ≃ 7.7 pF with 6 ft version; ≃ 9.5 pF with 3.5 ft version when used with 55 pF instruments; ≃ 11.5 pF for 6 ft version. **Cmrr (Probe Pair)** — At least 400:1 (with 5A20N or 5A21N) dc to 30 kHz. **Bandwidth** — at least 35 MHz with 3.5 ft probe (with scope bandwidth of at least 60 MHz); 25 MHz with 6 ft probe. **Maximum Input Voltage** — 600 V dc plus peak ac. Peak-to-peak derating is necessary for cw frequencies higher than 3 MHz. Maximum input voltage at 50 MHz is 50 V.

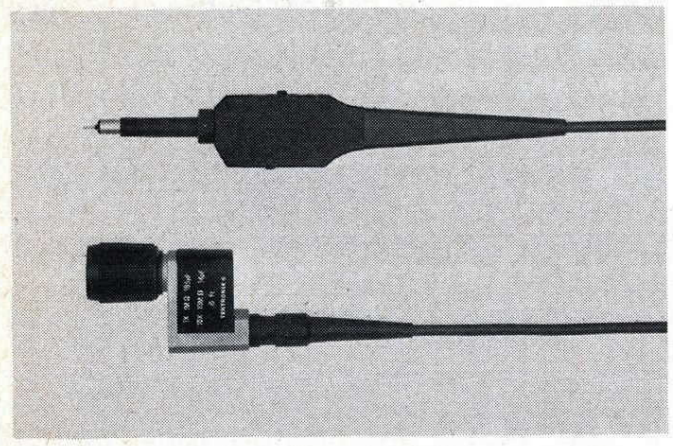
INCLUDED ACCESSORIES

206-0060-00	1 **TIP,** probe (0.080 (AI)
344-0046-00	2 **CLIP,** alligator (AU)
134-0013-00	1 **PLUG,** tip, banana (AF)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
206-0105-00	1 **TIP,** probe, hook (AM)
206-0015-00	1 **TIP,** probe, (0.055 in dia) (AH)
013-0071-00	1 **TIP,** probe, retractable hook (AD)
352-0090-00	1 **HOLDER,** probe

ORDERING INFORMATION

P6060 10X Probe, 6 ft,
Order 010-6060-03 . . . . . $62
Opt 01, 3.5 ft, Order 010-6060-01 . . . . . $62

P6062B Dc to 100 MHz



1X or 10X Selectable Attenuation

BNC Output Attenuation Encoding

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation — 10X and 1X. **Input Resistance** — 1X position, 1 MΩ; 10X position, 10 MΩ ±0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** — 3.5 ft probe cable is 100 pF in the 1X position, 13.5 pF in the 10X position; 6 ft version is 105 pF in the 1X position, and 14 pF in the 10X position. 9 ft probe cable is 135 pF in the 1X position and 17 pF in the 10X position. **Bandwidth** — 10X probe is at least 100 MHz for the 3.5 ft and 6 ft version; 95 MHz for the 9 ft version when used with a 100 MHz Osciloscope. 1X probe is at least 8 MHz for the 3.5 ft version, at least 6.7 MHz for the 6 ft version and at least 4.5 MHz for the 9 ft version. **Voltage Rating** (10X Position) — 500 V (dc + peak ac derated with frequency and oscilloscope input coupling). 1X position, 100 V (dc + peak ac derated with frequency).

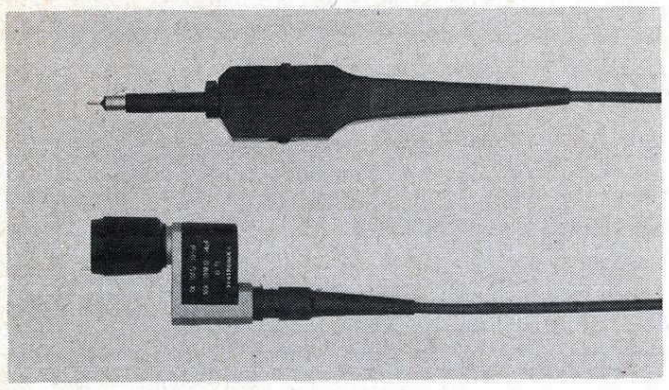
INCLUDED ACCESSORIES

352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe (CK)
013-0107-03	1 **TIP,** probe, retractable (BS)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
016-0521-00	1 **POUCH,** accessory

ORDERING INFORMATION

P6062B Switchable Attenuation Probe, 6 ft,
Order 010-6062-13 . . . . . $115
Opt 01, 3.5 ft, Order 010-6062-11 . . . . $115
Opt 02, 9 ft, Order 010-6062-15 . . . . . $115

P6063B Dc to 200 MHz



1X or 10X Selectable Attenuation

BNC Output Attenuation Encoding

For 1 MΩ Inputs

SPECIFICATIONS

Attenuation — 10X and 1X. **Input Resistance** — 1X position, 1 MΩ, 10X position, 10 MΩ ±0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** — 3.5 ft probe cable is 80 pF in the 1X position, 11 pF in the 10X position; 6 ft version is 105 pF in the 1X position, and 14 pF in the 10X position. **Bandwidth** — 10X probe (3.5 ft and 6 ft versions) is at least 200 MHz when used with an oscilloscope with a bandwidth greater than 225 MHz. 1X probe for the 3.5 ft version is at least 12 MHz and for the 6 ft version at least 6 MHz. **Voltage Rating** — 500 V (dc + peak ac), derated with frequency.

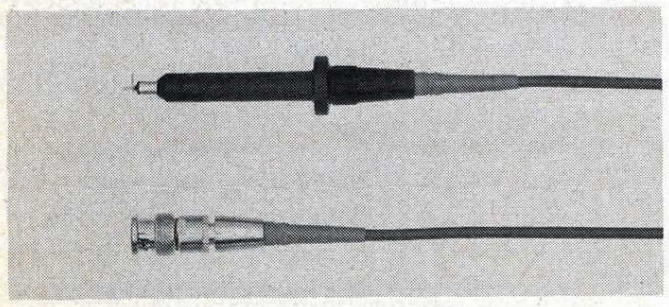
INCLUDED ACCESSORIES

352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** hook probe (CK)
013-0107-03	1 **TIP,** probe, retractable (BS)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
344-0046-00	2 **CLIP,** alligator (AU)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
016-0521-00	1 **POUCH,** accessory

ORDERING INFORMATION

P6063B Switchable Attenuation Probe, 6 ft,
Order 010-6063-13 . . . . . $130
Opt 01, 3.5 ft, Order 010-6063-11 . . . . . $130

P6420 Rf Probe



Modular Construction

Converts Dc Voltmeters to High-Frequency Ac Voltmeters

Frequency Range of 10 kHz to 1 GHz

Designed for Digital Multimeters

Relative Flatness Readings when used with 1 MΩ Inputs

Flat Frequency Response

SPECIFICATIONS

Voltage Range — 5 V to 25 V rms (70.7 V p-p). **Ac to Dc Transfer Ratio Accuracy** — 0.5 V to 5 V rms ±10% (15°C to 35°C). 5.0 V to 25 V rms ±5% (15°C to 35°C). **Frequency Response** — 100 kHz to 300 MHz (±0.5 dB), 50 kHz to 500 MHz (±1.5 dB), 10 kHz to 1 GHz (±3.0 dB). **Input Capacitance** — ≃ 3.7 pF. **Maximum Input Voltage** — 42.4 V (peak ac + dc). **Temperature Range** — Nonoperating; −55°C to +75°C. Operating; +15° to +35°C. **Length** — Probe only 9.6 cm. Cable only 2 meters.

INCLUDED ACCESSORIES

013-0097-01	1 **TIP,** probe, retractable (BO)
344-0046-00	2 **CLIP,** alligator (AU)
175-0849-00	1 **LEAD,** ground, 3 in (7.5 cm) (BC)
175-1017-00	1 **LEAD,** ground, 6 in (13 cm) (BE)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
352-0351-00	1 **HOLDER,** probe
103-0090-00	1 **ADAPTER,** BNC female to dual banana (BN)
— — — —	2 **TIP,** probe, replaceable*

*Available in package of 10 only, order 206-0230-03 (CR).

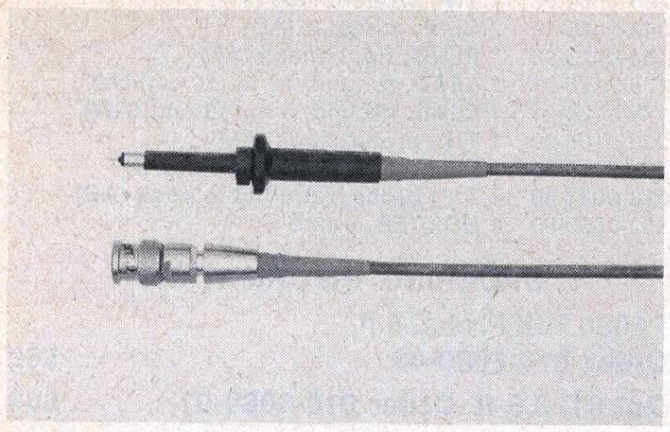
ORDERING INFORMATION

P6420 Rf Probe, 2 m Cable Included,
Order 010-6420-03 . . . . . $95
For a 1 meter length cable, (does not change specifications)
Order 175-1661-00 . . . . . $21
For a 3 meter length cable, (does not change specifications)
Order 175-1661-02 . . . . . $21

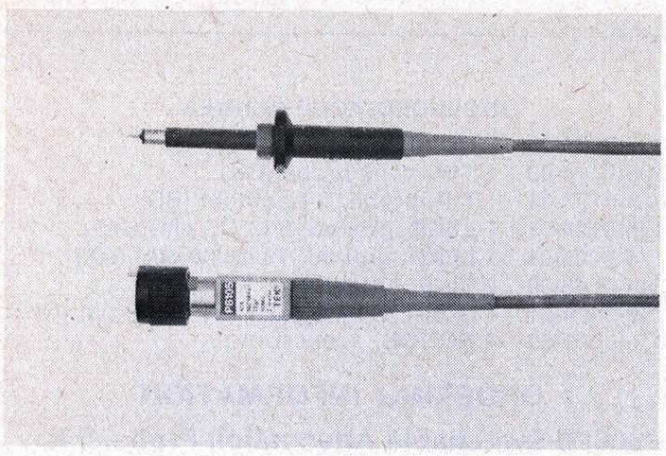
Included Accessories with double alpha codes are pictured on pages 227 and 228.

Modular Probes

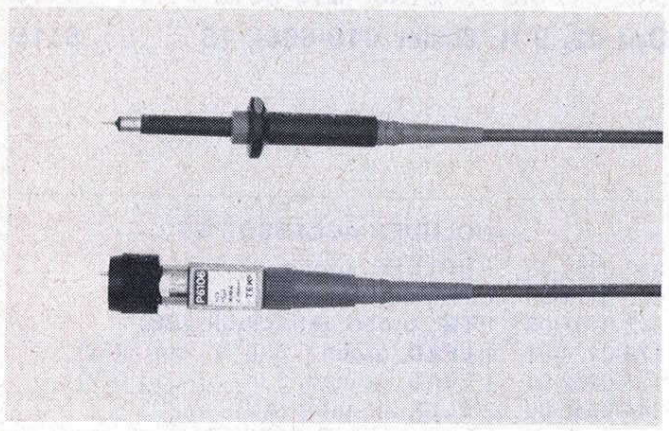
P6101 Dc to 34 MHz 1X



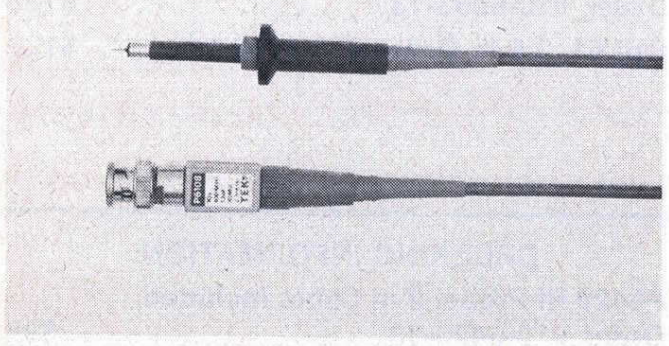
P6105 Dc to 100 MHz 10X



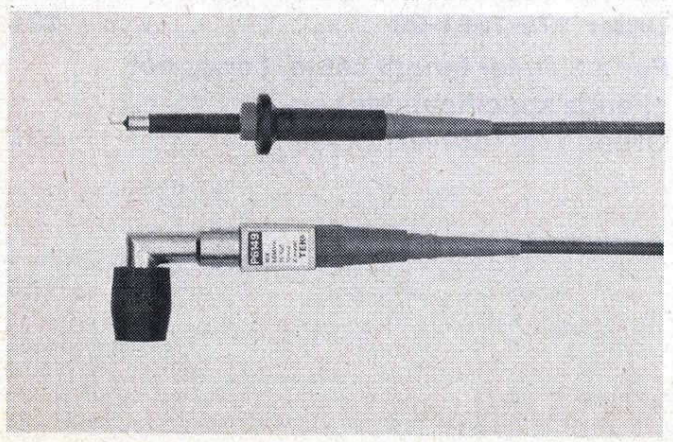
P6106 Dc to 300 MHz 10X



P6108 Dc to 100 MHz 10X



P6149 Dc to 50 MHz 10X



Simplified, Faster Maintenance and Repairs

High Fidelity Signal Acquisition at Low Cost

Rugged for Greater Reliability

Available in Three Lengths

INCLUDED ACCESSORIES

All probes except as noted.

013-0107-03	1 **TIP,** probe, retractable (BS)
166-0404-01	1 **INSULATING SLEEVE,** electrical (CH)
175-0124-01	1 **LEAD,** ground, 5 in (13 cm) (AW)
175-0125-01	1 **LEAD,** ground, 12 in (30 cm) (AX)
175-0263-01	1 **LEAD,** ground, 3 in (7.5 cm) (AV)
206-0191-03	2 **TIP,** probe, replaceable (pkg of 10) (CM)
— — — —	*3 PR **MARKER BANDS,** (black, white, and silver gray) All except P6149
— — — —	*2 PR **MARKER BANDS,** (gray, and silver gray)
344-0046-00	2 **CLIP,** alligator (AU)
352-0351-00	1 **HOLDER,** probe
016-0521-00	1 **POUCH,** accessory

*Available in packages of 9 sets of different colors —016-0633-00.

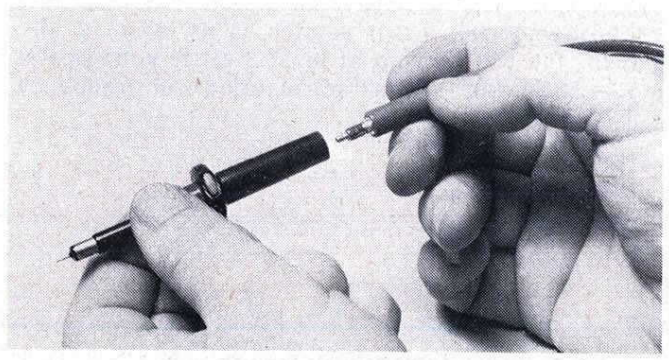
ORDERING INFORMATION

P6101 1X Probe, 2 m, Order 010-6101-03 . . . . . $40
Opt 01, 1 m, Order 010-6101-01 . . . . . $40
Opt 02, 3 m, Order 010-6101-05 . . . . . $40
P6105 10X Probe, 2 m, Order 010-6105-03 . . . . . $75
Opt 01, 1 m, Order 010-6105-01 . . . . . $75
Opt 02, 3 m, Order 010-6105-05 . . . . . $75
P6106 10X Probe, 2 m, Order 010-6106-03 . . . . . $95
Opt 01, 1 m, Order 010-6106-01 . . . . . $95
Opt 02, 3 m, Order 010-6106-05 . . . . . $95
P6108 10X Probe, 2 m, Order 010-6108-03 . . . . . $65
Opt 01, 1 m, Order 010-6108-01 . . . . . $65
Opt 02, 3 m, Order 010-6108-05 . . . . . $65
P6149 10X Probe, 2 m, Order 010-6149-03 . . . . . $70

SPECIFICATIONS

Type	Attenuation	Length	Package Number	Loading	Useful BW MHz	Dc Max	Scope C in pF	Readout
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 MΩ 32 pF 54 pF 78 pF	34 15.5 8	500 V[1]	ANY	——
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 MΩ 10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V[3]	15 to 47	YES
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	10 MΩ 10.5 pF 13.0 pF 15.5 pF	300[5] 250 150	500 V[4]	15 to 24	YES
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 MΩ 10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V[3]	15 to 47	NO
P6149	10X	2 m	016-6149-03	10 MΩ 15.5 pF	50	500 V[3]	20 to 62	NO

[1]Max Input Voltage is 500 V dc + peak ac to 300 kHz derated to 20 V at 30 MHz
[2]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 27 V at 100 MHz
[3]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 30 V at 50 MHz
[4]Max Input Voltage is 500 V dc + peak ac to 1.7 MHz derated to 70 V at 100 MHz
[5]Scope bandwidth must be 325 MHz



Modular parts snap together

Modular probes are an exciting new concept in probe design. The P6101, P6105, P6106, P6108, and P6149 Probes divide into three modules (probe heads, cables, and connector/compensation boxes). The modules snap together making maintenance and repair less expensive, faster, and much easier. Snap-on replacement modules eliminate soldering irons and tools, and modular probes do not have to be sent in to be repaired because spare modules can be ordered and stocked. Strain relief and modular component design make these probes rugged for greater reliability.

The P6101, P6105, P6106, and P6108 are available in three color-coded lengths—blue for one meter, yellow for two meters, and red for three meters. (The P6149 is two meters long.) These probes may be used to acquire high fidelity signals from low source-impedance circuits.

TEKTRONIX Modular Probes are designed for specific TEKTRONIX Instruments, but may be purchased as options for all TEKTRONIX Oscilloscopes with 1 MΩ and appropriate pF inputs as indicated in the above chart. The P6106 is standard with the 475A and 475 oscilloscopes.

The P6105 is standard with the TEKTRONIX 434, 455, 465, and rackmount oscilloscopes. And the P6108 is standard with theT932A andT935A oscilloscopes.

With oscilloscopes that are equipped with vertical scale or crt readout, the P6105 and P6106 will automatically scale the readout by a factor of 10. This makes mental calculations unnecessary. Also ground level can be determined on the display by actuating a button on the probe head, without having to return to the oscilloscope.

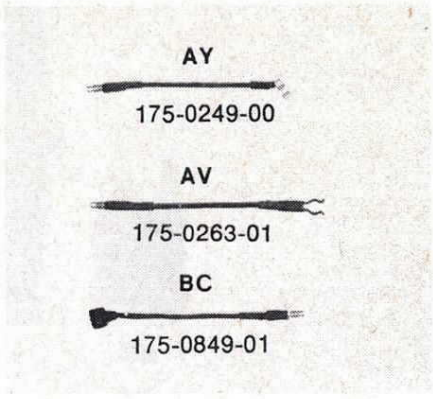
The P6149 features a right angle BNC connector. This can be useful when bench space is limited.

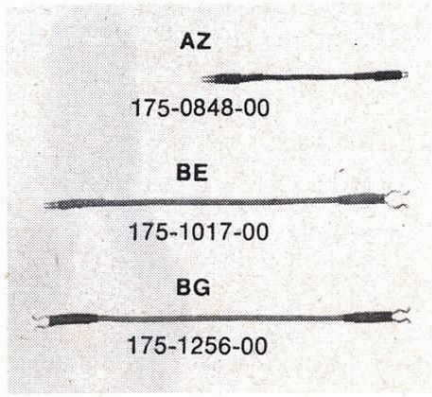
Included Accessories with double alpha codes are pictured on pages 227 and 228.

#6-32 Probe Tips and Accessories

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, P6028, and P6060 Probes.

Probe Ground Leads





CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Bayonet ground assembly	013-0052-00	$ 5.25
AB	Probe tip to BNC adapter	013-0054-00	12.50
AC	Probe tip to BNC adapter (for P6028)	013-0056-00	14.00
AD	Probe retractable hook tip	013-0071-00	2.50
AE	Probe retractable hook tip	013-0071-01	3.00
AF	Probe banana tip	134-0013-00	.50
AG	Probe ground cover (for P6009)	166-0428-00	1.00
AH	Probe straight tip (0.055 in dia)	206-0015-00	.50
AI	Probe spring tip (0.080 in dia)	206-0060-00	.85
AJ	Probe spring tip (accepts 0.065 in dia pin)	206-0061-00	.65
AK	Probe calibration tip (0.063 in dia)	206-0100-00	8.00
AL	Probe long straight tip (0.032 in dia)	206-0104-00	.80
AM	Probe hook up	206-0105-00	.80
AN	Probe pin tip (accepts 0.025 in IBM SLT in)	206-0134-03	3.15
AO	Probe ground lead adapter (#6-32 to 0.025 in square pin)	206-0137-01	1.40
AP	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	1.75
AQ	Probe right angle hook tip	206-0185-00	1.05
AR	IC test tip	206-0203-00	1.00
AS	Alligator clip	344-0005-00	3.00
AT	Alligator clip	344-0045-00	1.00
AU	Miniature alligator clip	344-0046-00	1.00

CODE	DESCRIPTION	LENGTH (in)	PART NUMBER	PRICE
AV	Ground lead*	3	175-0263-01	$ 1.50
AW	Ground lead*	5	175-0124-01	1.50
AX	Ground lead*	12	175-0125-01	1.50
AY	Ground lead for S-3A, P6056, P6057	3	175-0249-00	3.75
AZ	Ground leads for P6053, P6054, P6075	3	175-0848-00	1.25
BA	7A11, and P6201	5	175-0848-01	1.25
BB		12	175-0848-02	1.25
BC	Ground leads for P6202 and P6420	3	175-0849-00	4.50
		6	175-0849-01	4.50
BD	Ground lead for P6008 Environmental	12	175-0925-00	2.50
BE	Ground leads for S-3A, P6202,	6	175-1017-00	2.35
BF	and P6420	12	175-1018-00	2.35
BG	Ground lead for P6055	6	175-1256-00	3.50
BH	High-voltage dielectric fluid		252-0120-00	3.50

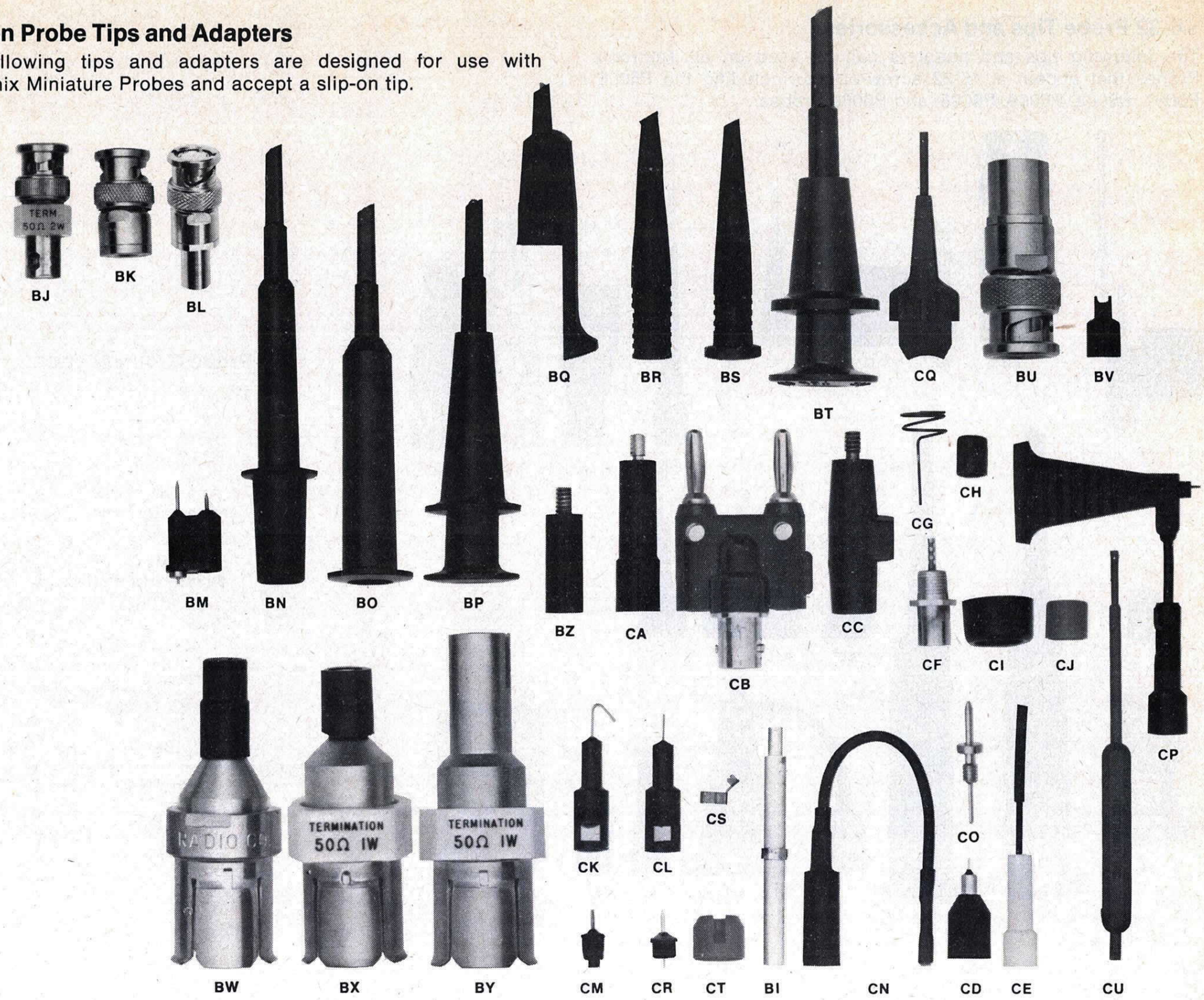
*For the P6053B, P6054A, P6075A, P6101, P6105, P6106, P6108, P6149, and other probes requiring clip-on ground leads.

CABLE MARKER SETS (Not Pictured)

DESCRIPTION	PART NUMBER	PRICE
For 1/8 in dia cable	016-0130-00	$5.00
For 3/16 in dia cable	016-0127-00	3.15
For modular cable	016-0633-00	3.75

Slip-on Probe Tips and Adapters

The following tips and adapters are designed for use with Tektronix Miniature Probes and accept a slip-on tip.

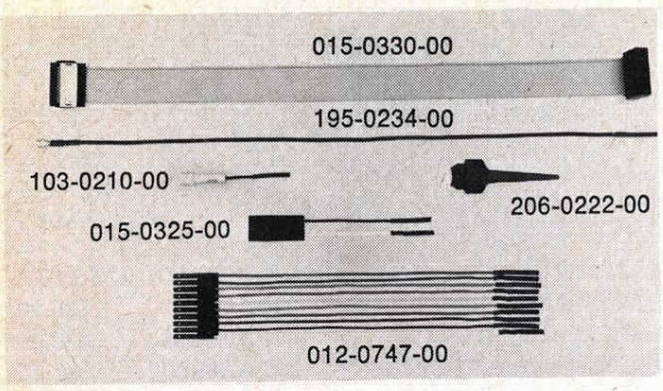


BJ BK BL BM BN BO BP BQ BR BS BT CQ BU BV CG CH BZ CA CB CC CF CI CJ CP BW BX BY CK CL CS CM CR CT BI CN CO CD CE CU

CODE	DESCRIPTION	PART NUMBER	PRICE
BI	Probe tip extractor	003-0825-00	$ 1.00
BJ	Termination, 50 ohm	011-0049-01	25.00
BK	Probe tip to BNC adapter for all probes	013-0084-01	8.00
BL	Probe tip to BNC adapter for all, except P6202	013-0084-02	9.00
BM	Bayonet ground assembly	013-0085-00	5.00
BN	Retractable hook tip (for P6010 and P6048)	013-0090-00	3.00
BO	Retractable hook tip (for S-3A, P6202, and P6420)	013-0097-01	5.25
BP	Retractable hook tip (for all modular probes)	013-0105-00	5.25
BQ	Retractable hook tip (for 7A11 and P6401)	013-0106-00	7.00
BR	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-02	2.50
BS	Retractable hook tip (for P6053B, P6055, P6062B, P6063B, P6101, P6105, P6106, P6108, and P6149)	013-0107-03	2.50
BT	Retractable probe tip (for P6201 only)	013-0135-00	3.00
BU	Probe tip to BNC adapter (for P6201 only)	013-0145-00	11.00
BV	Miniature probe tip cover, IC tester, Package of 10	015-0201-01	2.50
	Package of 100	015-0201-02	10.00
BW	Miniature probe tip to GR adapter	017-0076-00	32.00
BX	Miniature probe tip to GR 50-Ω termination adapter	017-0088-00	42.00
BY	P6201 probe tip to GR 50-Ω termination adapter	017-0094-00	34.00
BZ	Miniature probe to #6-32 adapter (for P6045, P6046, P6202, 7A11, S-3A)	103-0051-00	3.00
CA	Miniature probe to #6-32 adapter (for all miniature probes except P6045, P6202, includes all modular probes)	103-0051-01	3.00
CB	Female to dual banana adapter, BNC	103-0090-00	7.50
CC	Miniature probe to #6-32 adapter with ground connection	103-0131-00	4.00

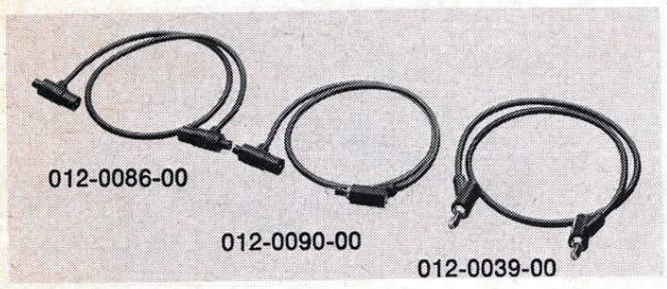
CODE	DESCRIPTION	PART NUMBER	PRICE
CD	Probe tip to test point jack (for P6201 only)	103-0164-00	3.50
CE	Probe tip flexible, adapts miniature probe to retractable hook tip (CQ)	103-0177-01	5.00
CF	Chassis mount test jack (for miniature probes, including modular)	131-0258-00	3.25
CG	Ground contact (for P6201 only)	131-1302-00	.60
CH	Miniature probe tip ground cover, insulating sleeve (for all miniature probes, including modular)	166-0404-01	.20
CI	Ground lead, insulating sleeve (for P6201 only)	166-0433-00	.65
CJ	Insulating sleeve, electrical (for P6201 only)	166-0557-00	.25
CK	Probe tip hook (for all miniature probes, including modular)	206-0114-00	2.10
CL	Probe tip straight (for all miniature probes, including modular)	206-0114-01	2.10
CM	Replaceable probe tip, pkg or 10. All miniature probes including modular except P6202 and P6420	206-0191-03	12.50
CN	Probe tip flexible for 0.025 sq pin	206-0193-00	6.00
CO	Replaceable probe tip (for P6201 only)	206-0200-00	.25
CP	Probe pin tip (accepts 0.025 in IBM SLT pin)	206-0209-00	2.65
CQ	Miniature retractable hook tip for P6451	206-0222-00	2.50
CR	Replaceable probe tip for P6202 and P6420, pkg of 10	206-0230-03	12.00
CS	Electrical contact	214-0283-00	.50
CT	Ground contact insulator (for P6201 only)	342-0180-00	.40
	Cables and Misc. Accessories		
CU	Adjustment tool, probe	003-0675-01	.65
CV	Coaxial cable, 50 Ω, BNC, 42 inch (p. 229)	012-0057-01	15.00
CW	Coaxial cable, 50 Ω, BNC, 18 inch (p. 229)	012-0076-00	15.00
CX	Cable assembly, Rf (p. 229)	012-0104-00	18.00

LOGIC PROBE TEST LEADS

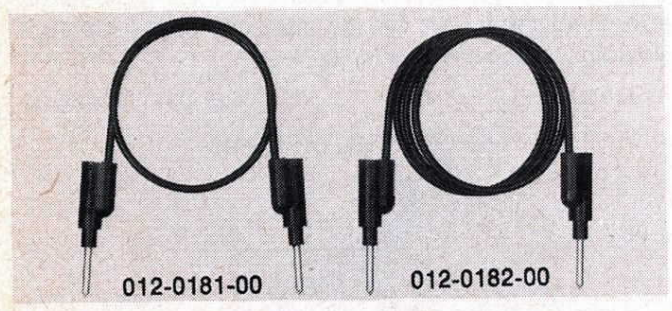


16 pin low profile dip clip (can be used with 14 or 16 pin ICs)	015-0330-00	$25.00
10 wide comb set with 10 grabber tips	012-0747-00	25.00
Miniature retractable hook tip	206-0222-00	2.50
Dual lead adapter for miniature probes	015-0325-00	8.00
Flexible probe tip, P6006 type	103-0210-00	5.00
Ground lead, P6006 type	195-0234-00	4.50

PATCH CORDS

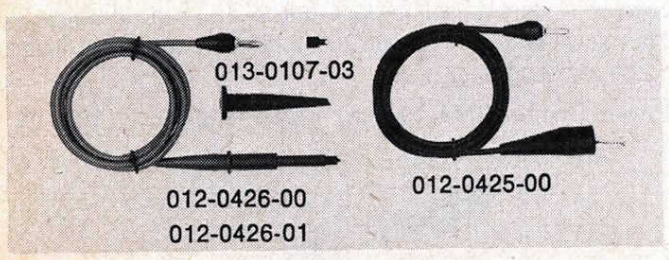


BNC to BNC, 18 in		
Red	012-0087-00	$3.50
Black	012-0086-00	3.50
BNC to banana plug-jack, 18 in		
Red	012-0091-00	$3.50
Black	012-0090-00	3.50
Banana plug-jack to banana plug-jack, 18 in		
Red	012-0031-00	$3.50
Black	012-0039-00	3.50



Pin-Jack to pin-Jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	$3.50
Red, 18 in	012-0180-00	3.50
Black, 8 in	012-0181-00	3.50
Black, 18 in	012-0182-00	3.50

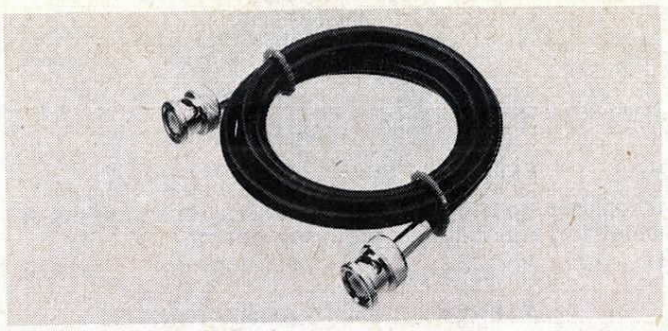
TEST LEADS



Test Lead, Black, 4 ft	012-0425-00	$ 5.50
Test Lead, Red, 4 ft	012-0426-00	10.00
Test Lead, Black, 4 ft	012-0426-01	10.00
Test Lead set of 012-0425-00, 012-0426-00, and 013-0107-03	012-0427-00	17.00

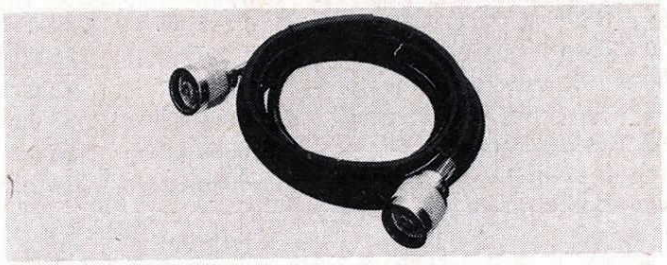
COAXIAL CABLES

BNC Connectors



Coaxial, 50 Ω, 42 in	012-0057-01	$15.00
Coaxial, 75 Ω, 42 in	012-0074-00	15.00
Coaxial, 93 Ω, 42 in	012-0075-00	15.00
Coaxial, 50 Ω, 18 in	012-0076-00	15.00
Coaxial, 50 Ω Precision, 36 in	012-0482-00	25.00

N Connectors 50 Ω



Coaxial N connectors, 6 ft	012-0114-00	$25.00

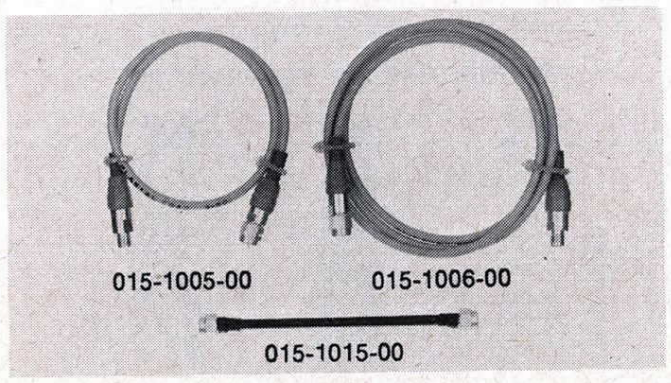
GR Connectors 50 Ω

Coaxial 10 ns RG58A/U	017-0501-00	$45.00
Coaxial 5 ns RG213/U	017-0502-00	45.00
Coaxial 1 ns RG58A/U*	017-0503-00	25.00
Coaxial 20 ns RG213/U	017-0504-00	47.00
Coaxial 2 ns RG58A/U	017-0505-00	45.00
Coaxial 5 ns RG58A/U	017-0512-00	45.00
Coaxial 10 in RG213/U	017-0513-00	45.00
Coaxial 20 in RG213/U	017-0515-00	45.00

*Connector on one end only.

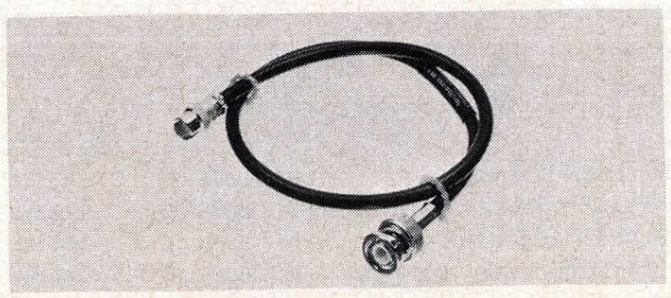
50 Ω CABLES

SMA (3 mm) Connectors 50 Ω



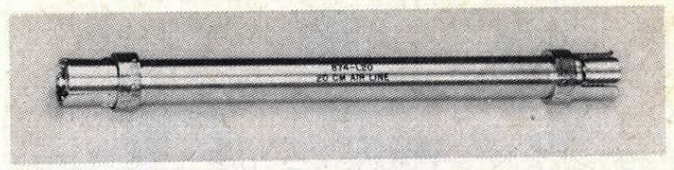
Coaxial 2 ns	015-1005-00	$ 70.00
Coaxial 5 ns	015-1006-00	125.00
Coaxial semirigid 500 ps	015-1015-00	40.00
Coaxial semirigid 750 ps	015-1017-00	35.00
Coaxial 1 ns	015-1019-00	75.00

BNC to BSM Connectors 50 Ω



Coaxial, 10 in, RG58 BSM Female to BNC Male	012-0128-00	$17.00
Coaxial, 18 in, RG58 BSM Female to BNC Male	012-0127-00	17.00

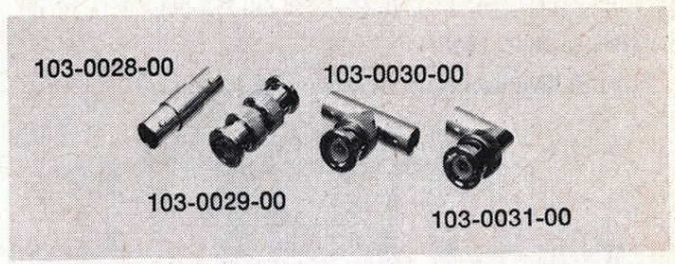
50 Ω AIR LINE



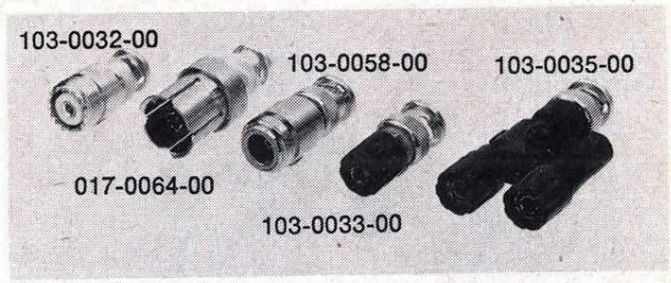
The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$70.00

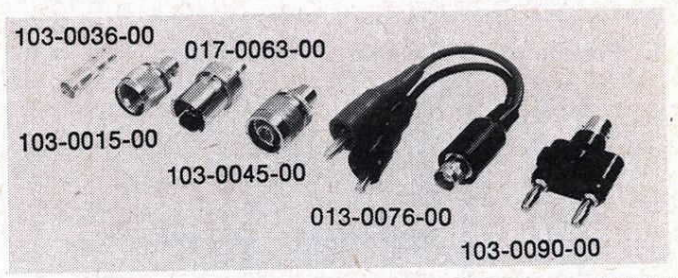
ADAPTERS



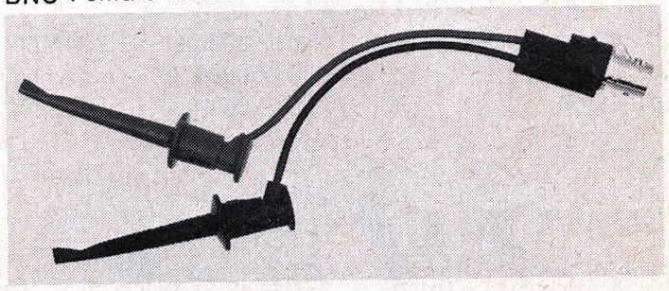
BNC Female to BNC Female	103-0028-00	$ 5.00
BNC Male to BNC Male	103-0029-00	5.50
BNC T	103-0030-00	6.50
BNC Elbow Male to Female	103-0031-00	5.50



BNC Male to GR	017-0064-00	$35.00
BNC Male to uhf Female	103-0032-00	4.75
BNC Male to Binding Post	103-0033-00	4.75
BNC Male to Dual Binding Post	103-0035-00	12.00
BNC Male to N Female	103-0058-00	7.00



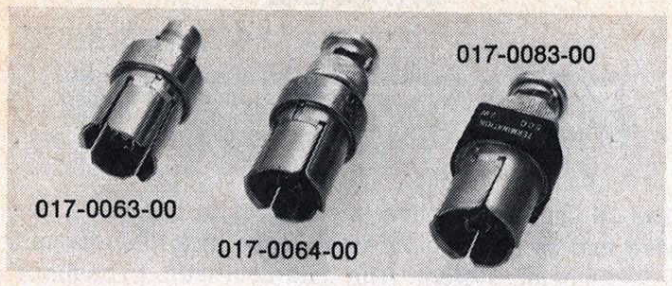
BNC Female to clip leads	013-0076-00	$17.50
BNC Female to GR	017-0063-00	25.00
BNC Female to uhf Male	103-0015-00	4.50
BNC Female to BSM Male	103-0036-00	15.00
BNC Female to N Male	103-0045-00	6.50
BNC Female to Dual Banana	103-0090-00	7.50



BNC Female to EZ Ball	013-0076-01	$17.50

GR to N Male	017-0021-00	$25.00
GR to C Male	017-0027-00	40.00
GR to N Female	017-0062-00	32.00
GR to C Female	017-0065-00	35.00

Accessories



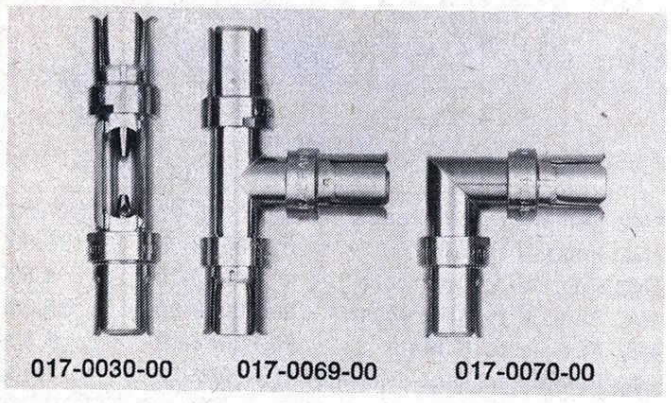
GR to BNC Female	017-0063-00	$25.00
GR to BNC Male	017-0064-00	35.00
50 Ω termination, thru-line	017-0083-00	70.00

*(GR to BNC Male)

*Upper frequency limit vswr not specified

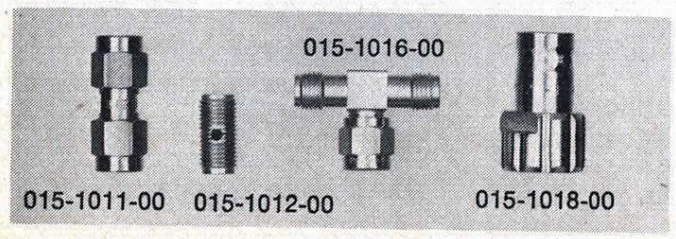
N Male to GR	017-0021-00	$25.00
N Female to GR	017-0062-00	32.00
N Male to BNC Female	103-0045-00	6.50
N Female to BNC Male	103-0058-00	7.00

"F" Female to BNC Male	013-0126-00	$10.00
"F" Female to GR874	017-0089-00	35.00
"F" Male to "F" Male	103-0157-00	7.50
"F" Male to BNC Female	103-0158-00	8.50
"F" Female to "F" Female	103-0159-00	7.50



GR Insertion Unit	017-0030-00	$70.00
GR T	017-0069-00	80.00
GR Elbow	017-0070-00	75.00

SMA Male to GR	015-1007-00	$ 50.00
SMA Female to GR	015-1008-00	55.00
SMA Male to N Female	015-1009-00	50.00
SMA Male to 7 mm APC	015-1010-00	175.00



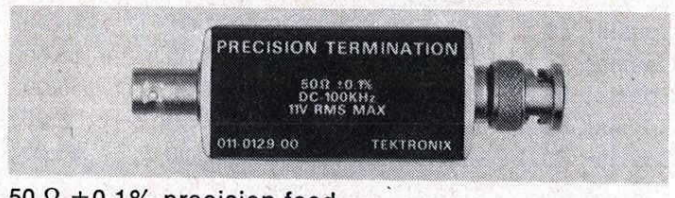
SMA Male to Male	015-1011-00	$20.00
SMA Female to Female	015-1012-00	16.00
SMA T	015-1016-00	30.00
SMA Male to BNC Female	015-1018-00	8.00

ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	$30.00

ATTENUATORS—TERMINATIONS



50 Ω ±0.1% precision feedthrough termination (dc —100 kHz, 11 V rms max)	011-0129-00	$40.00
50 Ω feedthrough termination[1]	011-0049-01	25.00
50 Ω 10X (20 dB) attenuator[2]	011-0059-02	35.00
50 Ω 5X (14 dB) attenuator[2]	011-0060-02	35.00
50 Ω (6 dB) attenuator[2]	011-0069-02	35.00
50 Ω 2.5X (8 dB) attenuator[2]	011-0076-02	35.00
50 Ω feedthrough termination (5 W)[3]	011-0099-00	40.00

Characteristics—Dc resistance is 50 Ω ± 1 Ω. Attenuation accuracy is ± 2% dc, ± 5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

vswr

[1]Less than 1.1 dc—250 MHz and less than 1.2 dc—500 MHz.

[2]Less than 1.1 dc—1.0 GHz and less than 1.2 dc—2.0 GHz.

[3]1.1 dc—100 MHz.

75 Ω feedthrough termination	011-0055-00	$25.00
93 Ω feedthrough termination	011-0056-00	25.00
50 Ω to 75 Ω min loss attenuator	011-0057-00	25.00
50 Ω to 93 Ω min loss attenuator	011-0058-00	25.00
75 Ω 10X attenuator	011-0061-00	30.00
93 Ω 10X attenuator	011-0062-00	28.00
600 Ω feedthrough termination (1 W, dc to 1 MHz)	011-0092-00	30.00
75 Ω to 50 Ω min loss attenuator (ac coupled)	011-0112-00	50.00

CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at dc.

Power rating of attenuators is ½ W and terminations 1 W.

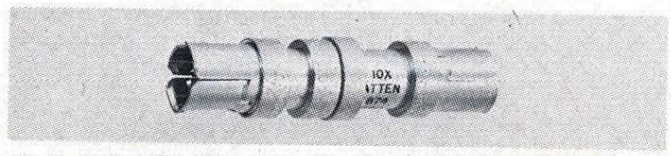
Voltage standing wave ratio (vswr) not specified.

ATTENUATORS and TERMINATORS

Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

10 dB attenuator	011-0085-00	$70.00
20 dB attenuator	011-0086-00	70.00
40 dB attenuator	011-0087-00	90.00

GR

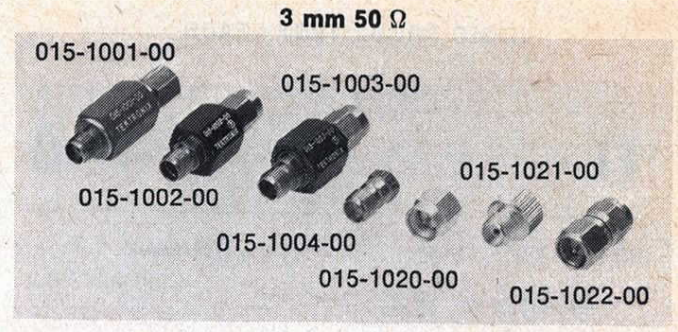


50 Ω 10X attenuator	017-0078-00	$120.00
50 Ω 5X attenuator	017-0079-00	120.00
50 Ω 2X attenuator	017-0080-00	120.00
50 Ω termination, end-line	017-0081-00	90.00

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 W.

3 mm 50 Ω

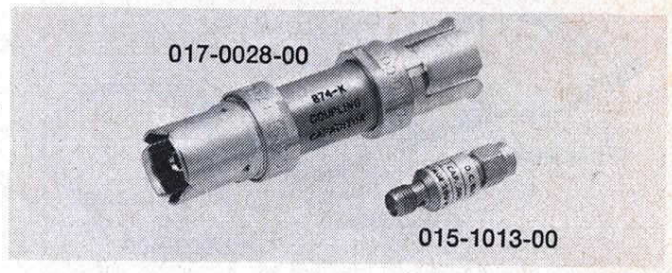


50 Ω 2X attenuator	015-1001-00	$120.00
50 Ω 5X attenuator	015-1002-00	120.00
50 Ω 10X attenuator	015-1003-00	120.00
50 Ω termination Female	015-1004-00	60.00
Short-Circuit termination Male	015-1020-00	17.50
Short-Circuit termination Female	015-1021-00	17.50
50 Ω termination Male	015-1022-00	32.00

CHARACTERISTICS

	Dc — 12.40 GHz		12.41 — 18.00 GHz		Power
	Atten Accuracy	Vswr	Atten Accuracy	Vswr	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W

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), max is 0.03. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	$130.00

The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor GR	017-0028-00	$60.00

50 Ω POWER DIVIDERS

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). Max vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

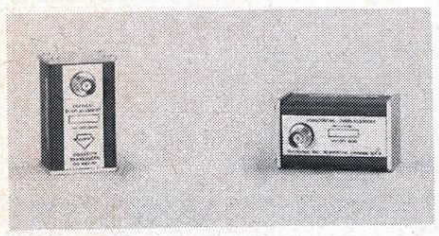
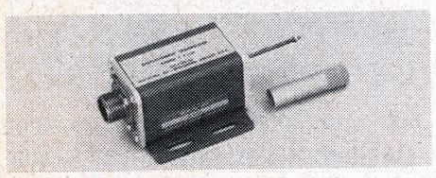
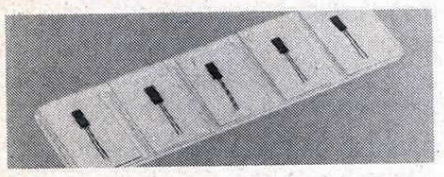
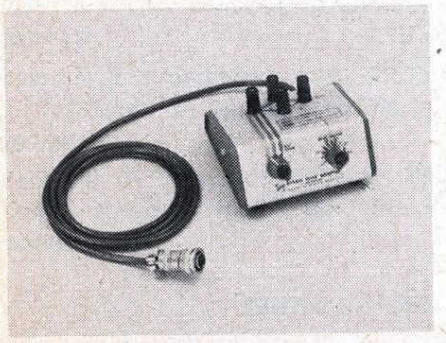
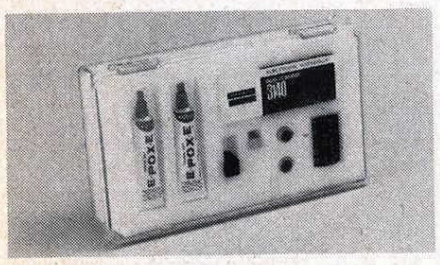
Power Divider SMA (3 mm)	015-1014-00	$200.00

This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. 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.

Power Divider GR	017-0082-00	$225.00

Mechanical Measurement Transducer

for TM 500, 5000-Series and 7000-Series Products

TRANSDUCER PACKAGE	DESCRIPTION	PERFORMANCE	RECOMMENDED ACCESSORIES
PRESSURE 015-0161-00*	RANGE: 3000 psig TYPE: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≃10 Vdc Scale Factor: 3 mV/V f.s. f_n ≃65 kHz	012-0209-00 20 ft multi-conductor cable
PRESSURE 015-0162-00*	RANGE: 300 psig TYPE: Bonded Strain Gage 4 arm 350 Ω bridge Built-in CAL resistor	Accuracy: 1% Excitation: ≃10 Vdc Scale Factor: 3 mV/V f.s. f_n ≃24 kHz	012-0209-00 20 ft multi-conductor cable
PRESSURE (EAS) 015-0117-00	RANGE: 3000 psig (dynamic only) TYPE: Piezoelectric	Accuracy: <5% Sensitivity: 200 pc/psi Max Overpressure: 300% Temp: −40°C to +150°C max	015-0118-00 cooling adapter
ACCELERATION 015-0165-00	RANGE: 0.001 to 1000 g's TYPE: Piezoelectric compression High capacitance (≃ 10,000 pF) NBS traceability	Accuracy: 5% Linearity: 2% Sensitivity: ≃12 mV/g f_n ≃30 kHz	012-0211-00 microdot to BNC 20 ft cable
VIBRATION (EAS) 015-0116-00	RANGE: 0.01 to 100 g's (100 to 10,000 RPM) TYPE: Piezoelectric magnetically mounted	Sensitivity: 6 mV/g (o.c.) C_T ≃3500 pF Temp: −40°C to +150°C f_n ≃11 kHz	012-0137-00 BNC-BNC cable 50 ft
 VERTICAL VIBRATION 015-0166-00 HORIZONTAL VIBRATION 015-0167-00	TYPE: Seismic (geophone) Self generating SIGNALS: Velocity Displacement (integrated velocity) RANGE: 0.050 inch peak to peak	Accuracy: <5% Scale Factor: Velocity ≃ 600 mV/in/s Displacement ≃ 10 mV/0.002 in Freq Range: 10 Hz to 2 kHz f_n ≃ 8 Hz Temp: −40°C to +71°C	012-0136-00 BNC-BNC cable 20 ft long
FORCE (Displacement) 015-0164-00*	RANGE: 50 grams 50 lbs (with load cell) 0.120 mm TYPE: Unbonded 350 Ω Strain Gage 4 arm bridge	Accuracy: 0.5% Excitation: ≃5 Vdc Full Scale Output: 60 to 80 mV Temp: −50°C to +85°C	Included with unit is 50 lb (22-5 kg) load cell connected power cable attachment bracket and tools
 DISPLACEMENT 015-0168-00	RANGE: ±4.0 mm (Calibrated and usable to ±0.2 inch) TYPE: DC to DC LVDT	Accuracy: 2% linearity <1% Excitation: 3 to 11 Vdc Scale Factor: 1 V/mm at 8.5 Vdc 20 mV/0.001 inch at 7.5 Vdc Temp: −54°C to +60°C	012-0209-00 20 ft cable
 STRAIN 015-0171-00	RANGE: 30,000 μ Strain TYPE: Foil Strain Gages 0.125 inch long. Attached leads. Package of five	Resistance: 120 Ω Gage Factor (Nominal) 2.1 Accuracy: 1% Excitation: (bridge), 5 V max	Strain Gage Adapter, 015-0169-00 Cement Kit 015-0172-00
 STRAIN GAGE ADAPTOR 015-0169-00*	Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type PS 501-1 Mod 730E Transducer Power Supply. Has variable shunt resistor for gage factor calibration. The adapter has four binding post terminals and a six-foot cable with 6-pin connector.	Accuracy: Governed by initial calibration and strain gages used. Strain Gage Resistance Range: 30 Ω to 5000 Ω for 4 arm bridges. 120 Ω for 1, 2 or 4 arm bridges. Bridge Volts: Typically 5 V for 120 Ω gages. Gage Factor Correction Range: 1.7 to 2.3	Strain Gage Package, 015-0171-00 Cement Kit, 015-0172-00
 CEMENT KIT 015-0172-00	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.		Strain Gage Package, 015-0171-00

CABLE (012-0136-00) **$30**
20 ft low-noise coaxial cable with BNC connectors on both ends.

CABLE (012-0209-00) **$120**
20 ft low-noise six-conductor cable with 6-pin connector on each end.

CABLE (012-0210-00) **$70**
20 ft six-conductor cable with 6-pin male connector on one end.

CABLE (012-0211-00) **$27**
20 ft low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.

CONNECTOR (131-0618-00) **$25**
Mates Type PS501-1 Transducer Power Supply INPUT 6-pin connector.

TRANSDUCER PACKAGE PRICE LIST

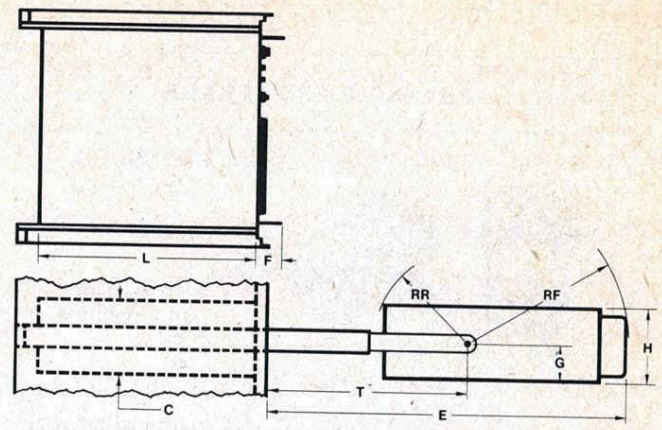
015-0161-00	$500	015-0167-00	$225
015-0162-00	$575	015-0164-00	$550
015-0117-00	$600	015-0168-00	$360
015-0165-00	$390	015-0171-00	$35
015-0116-00	$320	015-0169-00	$225
015-0166-00	$165	015-0172-00	$40

*Requires PS 501-1 custom modified Transducer Power Supply mounted in a TM 500-Series Mainframe. Consult a Tektronix Field Engineer for price and installation information on power supply and adapter.

MOUNTING DIMENSIONS

PRODUCT	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
R434	5.3	13.5	18.0	45.7	1.6	4.0	—	—	—	—	—	—	—	—	—	—	5.3	13.5
R465*, R475*, R475A*	7.0	17.8	16.3	41.4	1.8	4.6	3.5	8.9	20.4	51.8	11.0	27.9	7.9	20.1	9.6	24.4	6.8	17.3
R485*	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	49.0	10.9	27.7	7.9	20.1	9.3	23.6	6.8	17.3
R491*	7.0	17.8	17.4	44.2	2.1	5.1	3.5	8.9	21.1	53.6	11.9	30.2	8.5	21.6	9.3	23.6	6.8	17.3
R5100N, R5400*	5.3	13.5	19.0	48.3	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
R7704*	7.0	17.8	22.4	56.9	2.3	5.8	1.8	4.6	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313*, R7603*, R7613*, R7623*	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	5.3	13.5
R7844*	7.0	17.8	24.8	56.6	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
R7903*	5.3	13.5	22.5	57.2	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	17.8
R7912*	5.3	13.5	26.9	68.3	1.8	4.6	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.5
7912AD	7.0	17.8	26.0	66.0	1.95	5.0	—	—	30.7	78.0	—	—	—	—	—	—	6.9	17.5
RTM506	5.25	13.3	18.9	48.0	1.82	4.7	—	—	—	—	—	—	—	—	—	—	5.25	13.3
T922R	5.2	13.2	17.0	43.2	1.7	4.3	—	—	24.2	61.5	—	—	—	—	—	—	5.2	13.2
016-0115-02	5.3	13.5	16.3	41.4	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
016-0268-00	5.3	13.5	19.8	50.3	1.8	4.6	—	—	—	—	—	—	—	—	—	—	5.2	13.2
040-0551-01	14.0	35.6	22.4	56.9	0.6	1.5	—	—	30.9	78.5	—	—	—	—	—	—	—	—
040-0554-01	15.8	40.1	21.5	54.6	1.9	4.8	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
040-0601-00	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
040-0616-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.25	13.3
040-0617-02	5.3	13.5	16.5	41.9	1.1	2.8	1.8	4.6	24.6	62.5	—	—	—	—	—	—	5.3	13.5
040-0624-01	5.25	13.3	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.3	13.5
437-0031-00	8.8	22.4	9.5	24.1	0.3	0.8	—	—	—	—	—	—	—	—	—	—	5.25	13.3
437-0071-00	7.0	17.8	13.4	34.0	1.4	3.6	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0126-01	5.3	13.5	22.3	56.6	2.0	5.1	—	—	25.2	64.0	—	—	—	—	—	—	6.6	16.8

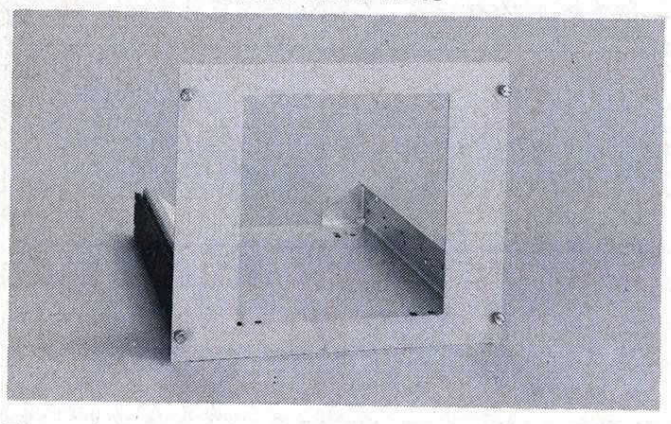
These instruments mount with sliding tracks to a standard 19-inch-wide rack. Rear support for sliding tracks is required, such as an enclosed rack.



DIMENSIONS EXCLUSIVE OF PLUG-IN UNITS AND PROBES

Symbol	Definition
H	Height of front panel.
L	Rack front to rearmost permanent fixture excluding cables.
F	Back of front panel to foremost protrusion.
G	Bottom of front panel to horizontal plane of rotation.
E	Maximum forward clearance with instrument out and horizontal.
RF	Front radius of rotation.
RR	Rear radius of rotation.
T	Rack front to pivot point.
C	Cabinet height.

RACK ADAPTERS



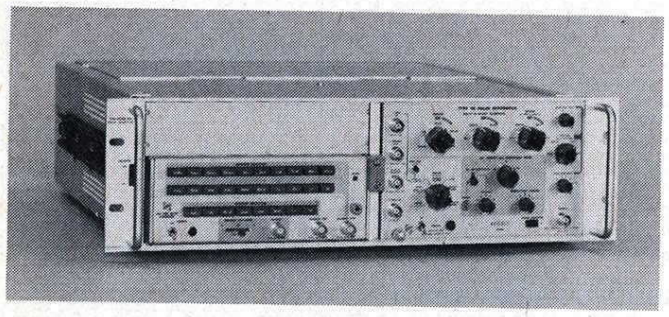
For rackmounting the 7000-Series Oscilloscopes and 611 in a standard 19 in wide rack. Rack adapter includes slide-out assemblies. 7000-Series mask finish is light gray, 611 mask finish is black.

For 7704 and 7904, rack height is 15.75 in, rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0554-01 .....**$370.00**

For 611, rack height is 14 in, rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0551-01 .....**$270.00**

For 455 and 465M, includes cradle mount, rack height 7 in, rack depth 18.75 in.
Order 040-0825-00 .....**$215.00**

RACK ADAPTERS



For rackmounting most TEKTRONIX Generators in a standard 19 in wide rack. The rack height is 5.25 in, rack depth is 19.75 in. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and black 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 .....**$620.00**

284 Mounting Kit includes quarter-rack width blank panel (016-0109-00).
Order 016-0187-00 .....**$60.00**

106, 114, 115, and 191 Mounting Kits.
Order 016-0186-00 .....**$38.00**

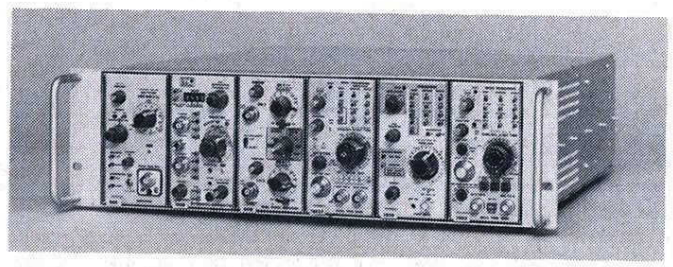
2101 and 2901 Mounting Kits.
Order 016-0188-00 .....**$50.00**

286 Mounting Kit.
Order 016-0190-00 .....**$35.00**

For rackmounting two TM 503's.
Order 040-0616-02 .....**$80.00**

For rackmounting one TM 503.
Order 040-0617-02 .....**$120.00**

STORAGE CABINETS



For 7000-Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.
Order 437-0126-01 .....**$225.00**

For 1-Series and Letter-Series Plug-in Units—Holds 3 plug-in units. Measures 19 in wide, 8¾ in high, 9⅜ in deep. Net weight is approx 9 lb.
Order 437-0031-00 .....**$95.00**

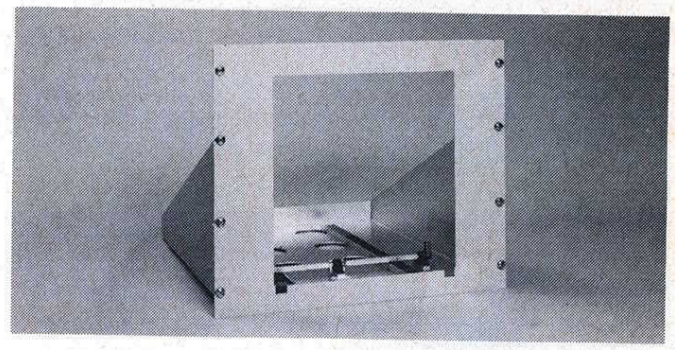
For 2 and 3-Series Plug-in Units—Holds 4 plug-in units. Measures 19 in wide, 7 in high, 13-5/16 in deep. Net weight is approx 10 lb.
Order 437-0071-00 .....**$95.00**

REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19 in backless rack. Shipping weight is approx 3 lb.
For R561B, R564B, and R647A.
Order 040-0344-00 .....**$20.00**

For RM565 and R567.
Order 040-0346-00 .....**$30.00**

CRADLE MOUNTS



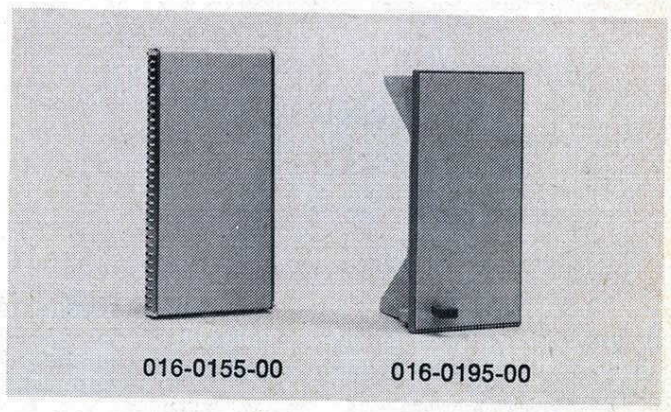
For rackmounting 500 and 7000-Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, and 7000-Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is approx 16 lb.
Order 040-0560-00 .....**$155.00**

For 540 Series and 575, rack height is 17.5 in, rack depth is 21-9/16 in, shipping weight is approx 16 lb.
Order 040-0281-00 .....**$90.00**

For 561B and 564B, rack height is 15.75 in, rack depth is 21-9/16 in, shipping weight is approx 17 lbs.
Order 040-0321-01 .....**$90.00**

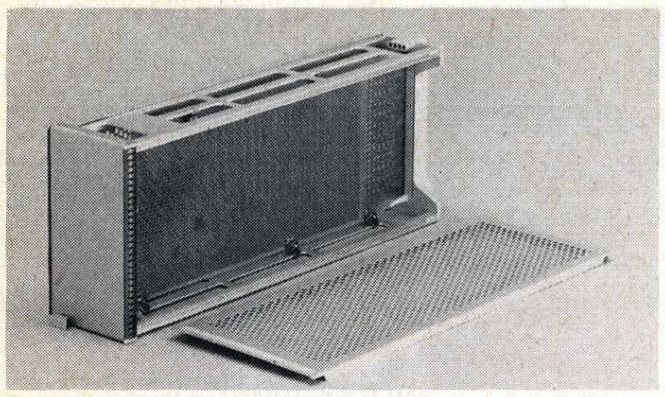
BLANK PANEL



Blank Panel—When operating the 5000/7000-Series Mainframes or the TM 500 or 2600 Series Generators with less than a full complement of plug-ins, the blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMI shielding.

7000 Series, 2600 Series, Order 016-0155-00 ...$20.00
5000 Series, Order 016-0195-02 .....$ 9.00
TM 500 Series, Order 016-0195-03 .....$11.00

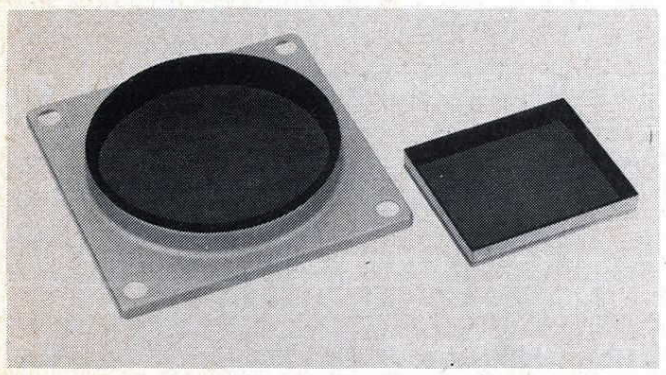
BLANK PLUG-IN CHASSIS



Blank Plug-in Chassis—Available for all TEKTRONIX Mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug securing hardware and plug-in frame.

7000 Series, Order 040-0553-01 .....$68.00
5000 Series, Order 040-0818-02 .....$30.00
TM 500 Series, Order 040-0652-05 .....$35.00
560 Series, Order 040-0245-00 .....$47.00
1 and Letter Series, Order 040-0065-00 .....$47.00

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.

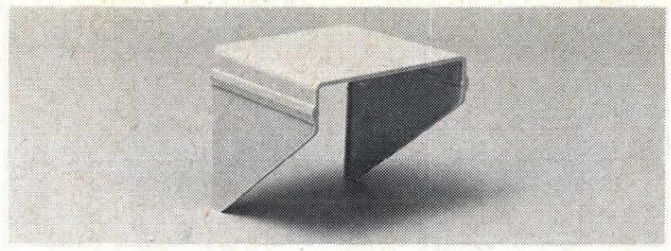
The mesh filter also serves as an emi filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the emi spectrum.

INSTRUMENT*	PART NUMBER	PRICE
314, 326, 335	378-0063-00	$23.00
323, 324	378-0596-00	25.00
432, 434	378-0682-00	33.00
422, 491, 453A, 454A, 485	378-0648-00	20.00
465, 475, 464, 466, 434	378-0726-01	33.00
540 Series, 565	378-0572-00	30.00
529, 561B, 564B, 568	378-0575-00	32.00
7400, 7603	378-0696-00	28.00
7500, 7700, 7800, 7900 Series and 7613, 7623, 7633	378-0603-00	28.00

**For both cabinet and rackmount instruments.*

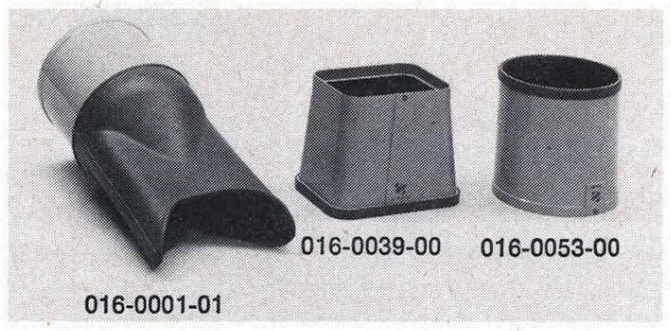
VIEWING ACCESSORIES

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.



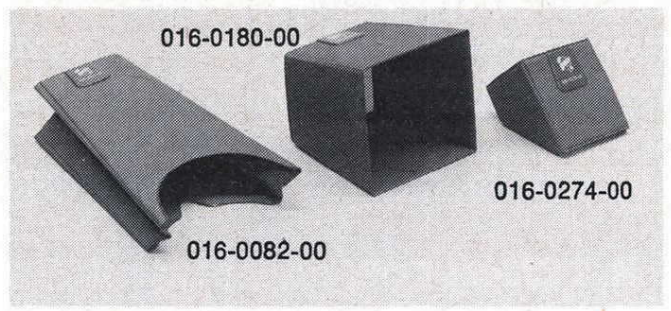
View Hood (folding)—for 200 Series, 314, 323, 324, 326, 335, 400 Series, 576, 577, 5000, and 7000-Series Oscilloscopes.

For 576, order 016-0259-00 .....$10.00
For 577, 5000, and 7000 Series order 016-0260-00 .....$10.00
For 200 Series (not pictured), order 016-0199-01 .....$ 6.15
For 323 and 324 (not pictured), order 016-0247-01 .....$ 7.25
For 326, 314, 335, SC502, SC504 (not pictured), order 016-0297-00 .....$ 6.50
For 464, 466, 455 (not pictured), order 016-0592-00 .....$11.50



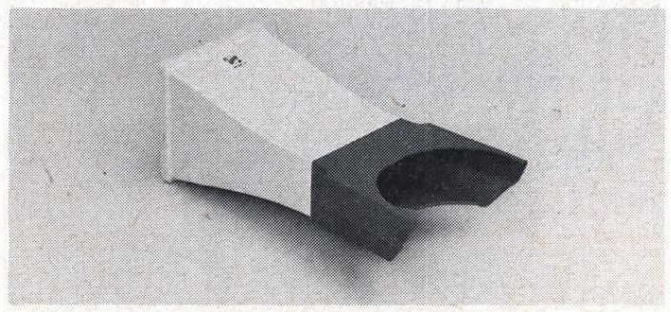
Polarized Viewers—For TEKTRONIX 5 in oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.
Rectangular Viewer, order 016-0039-00 .....$29.00
Plastic Round Viewer, order 016-0053-00 .....$29.00

Viewing Hood—For TEKTRONIX 5 in oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0001-01 .....$27.00



Collapsible Viewing Hood—For oscilloscopes with rectangular crt's. Blue vinyl material, folds flat for convenient storage.
For 422, 453A, 454A, 485, 491, order 016-0082-00 .....$15.00
For 422, 453A, 454A, 485, 491, order 016-0274-00 .....$12.00

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 455, 465, 475, 464, 466, order 016-0180-00 .....$23.00



Viewing Hood—For 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.
For 576, order 016-0153-00 .....$19.00
For 5000 and 700 Series, 601, 602, 603, 604, 528 and 577, order 016-0154-00 .....$19.00

Viewing Hood (folding binoculars)—For some 400 Series.
For 434, 455, 464, 466,
Order 016-0566-00 .....$13.00

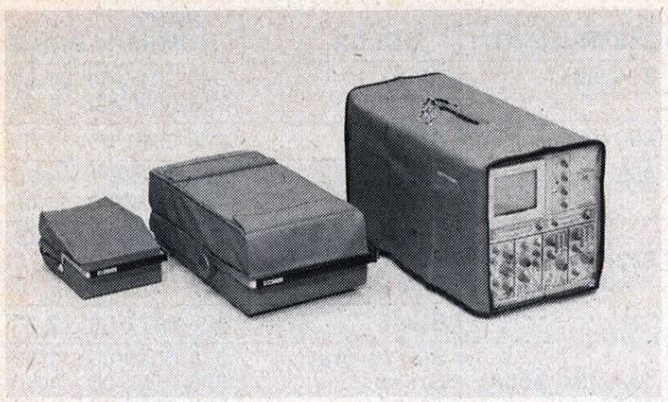
CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
314, 335	Blue	378-2016-00	$1.80
	Amber	378-0843-00	1.80
200 Series	Blue	378-0691-00	1.00
455	Clear	337-2122-01	3.00
	Blue	337-2122-00	3.00
323, 324	Smoke-gray	426-0403-00	2.70
	Blue†	426-0811-00	2.70
	Amber	426-0513-00	2.70
326	Blue†	426-0871-00	2.70
422, 491, 453A, 454A, 485	Smoke-gray	378-0549-00	1.50
	Green	378-0557-00	1.50
	Blue†	378-0664-00	1.50
	Amber	378-0559-00	1.50
465, 475, 464, 466	Blue	337-1674-00	3.00
	Clear	337-1674-01	3.00
	Smoke-gray filter	337-1674-07	3.00
540, 550 Series, 565, 575	Smoke-gray†	378-0567-00	3.00
	Green	378-0568-00	2.30
	Blue	378-0569-00	2.30
	Amber	378-0570-00	3.00
529, 561B, 567, 568	Smoke-gray†	378-0560-00	2.30
	Green	378-0561-00	2.30
	Blue	378-0562-00	2.30
	Amber	378-0563-00	3.00
520A, 521A, 522A	Smoke-gray†	378-0581-00	2.90
576	Blue†	378-0616-00	2.50
	Amber	378-0616-01	2.50
602	Blue	378-0845-00	2.50
	Smoke-gray†	378-0586-00	2.50
	Amber	378-0595-00	6.00
	Graticule	331-0406-00	7.00
603, 604	Clear (603†)	337-1440-00	2.60
	Green	337-1440-01	2.50
	Amber	337-1440-02	3.30
	Blue	337-1440-03	3.30
	Gray	337-1440-04	3.30
	Graticule (8x10 div)	331-0303-00	4.00
605, 606, 607	Blue	337-1674-00	3.00
	Amber	337-1674-05	3.00
	Graticule	337-1674-10	2.50
	Clear Shield	337-1674-13	3.00
	Gray†	337-1674-06	3.00
	Graticule (8x10 div)	331-0391-00	4.00
608	Amber	378-0704-00	2.30
	Green	378-0705-00	2.30
	Graticule†	337-2126-02	4.00
7904, 7844, 7313, 7700 Series, 7613 7623	Blue†	378-0625-00	2.50
	Amber	378-0625-01	2.20
	Gray	378-0625-02	2.50
	Green	378-0625-03	2.50
	Gray Tv Graticule CCIR	378-0625-05	4.25
	Gray Tv Graticule NTSC	378-0625-06	4.25
	Clear Shield With Spectrum Analyzer Graticule	337-1159-02	4.25
7613, 7623, 7623A, 7633	Spectrum Analyzer	378-0625-07	4.25
	Green (UV) Tv Graticule	378-0625-08	2.50
	CCIR Tv Graticule	378-0625-09	4.25
	NTSC	378-0625-10	4.25
7403N, 7603	Blue	378-0684-00	3.20
	Amber	378-0684-01	3.20
	Gray	378-0684-02	3.20
	Green	378-0684-03	3.20
	Gray Tv Graticule CCIR	378-0684-04	5.00
	Gray Tv Graticule NTSC	378-0684-05	5.00
	With Spectrum Analyzer Graticule	337-1439-01	4.00
	Blue Implosion Shield†	337-1700-01	2.30
	Clear Implosion Shield	337-1700-04	3.00
5100 and 5400 Series (except 5441)	Clear	337-1440-00	2.60
	Green	337-1440-01	2.50
	Amber	337-1440-02	3.30
	Blue	337-1440-03	3.30
	Gray	337-1440-04	3.30
5441	Clear†	337-1674-01	3.00
	Gray	337-1674-06	3.00
	Graticule (8x10 div)	331-0391-00	4.00
434	Clear	378-0677-00	1.50
	Blue	378-0678-01	1.50

**For both cabinet and rackmount instruments unless rackmount version is listed.*

†Standard filter supplied with instrument.

OSCILLOSCOPE PROTECTIVE COVERS



The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000-Series Laboratory Oscilloscopes have clear vinyl frontal areas.

PROTECTIVE COVERS

INSTRUMENT	PART NUMBER	PRICE
200 Series	016-0512-00	$15.00
323, 324, 1401A, 1401A-1, 1501	016-0112-00	17.00
314, 335	016-0612-00	55.00
326	016-0532-00	40.00
453A, 454A, 491	016-0074-01	18.00
455	016-0344-00	18.00
434, 464, 466	016-0365-00	19.00
465, 475, 485	016-0554-00	18.00
560 Series (except 565, 567, 568)	016-0067-00	15.00
565, 567, 568	016-0069-00	15.00
540 Series	016-0068-00	15.00
1480C, 1481C, 1482C, 1485C	016-0085-00	15.00
5000 Series	016-0544-00	15.00
7300, 7400, 7600 Series	016-0192-01	15.00
7704A, 7900	016-0531-00	15.00

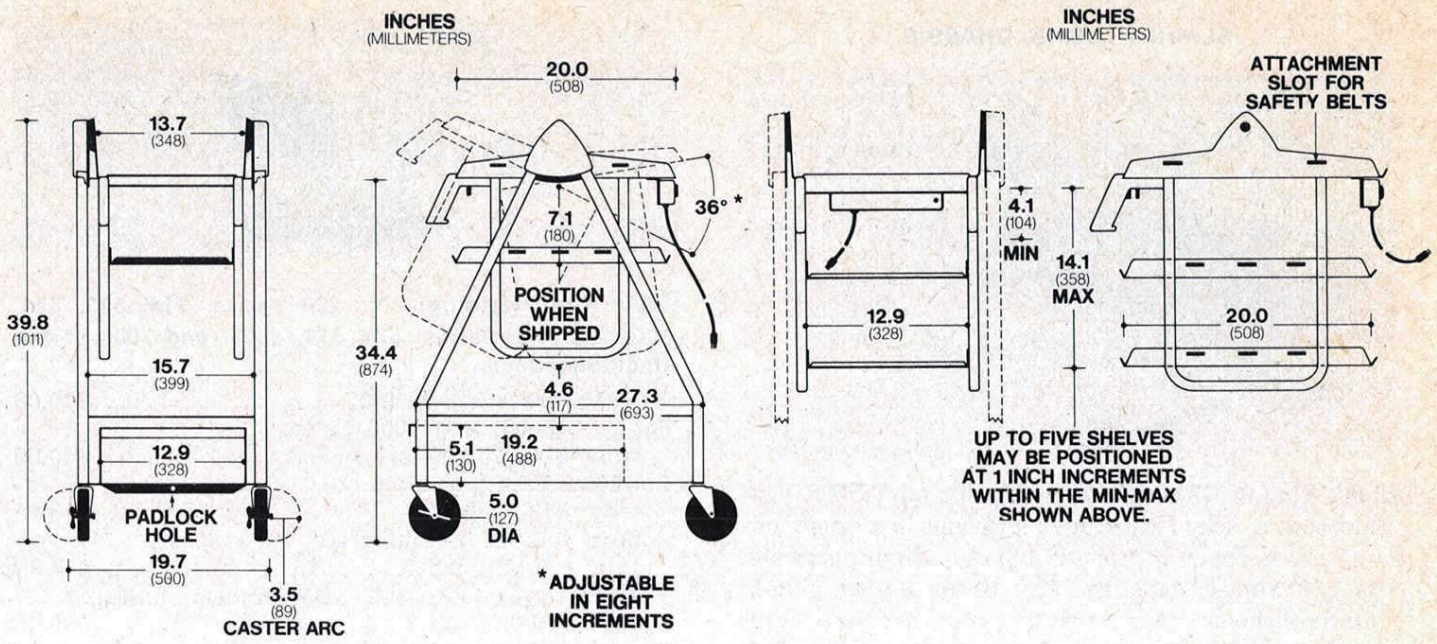
PLUG-IN UNIT CARRYING CASES

CARRYING CASE FOR 2, 3, 10, AND 11 SERIES PLUG-IN UNITS—Accommodates two plug-in units.
Order 437-0070-00 ..... $75.00

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 ..... $50.00

SCOPE-MOBILE® Carts

Give Mobility—Save Bench Space—Provide Storage



TEK LAB CART MODEL 3

Recommended For:

5100, 5400, and 7000-Series three and four plug-in oscilloscopes, all 400-Series, 576, 577, TM 503, and TM 504 mounted on top tray.

TM 503, TM 504 mounted on shelves.

MODEL 3 includes drawer in base with provision for padlock, brakes on all casters, power distribution module (four outlets and 15 ft cord), removable scope lock-down bar on top tray, one shelf, one safety belt, UL Listed. Net weight 57 lb, 25.8 kg. Shipping weight 75 lb, 34 kg. Blue vinyl finish.

Order Model 3 ..... $375

INTERNATIONAL VERSION deletes power module for shipment outside U.S.A.

Order Option 01 ..... No charge

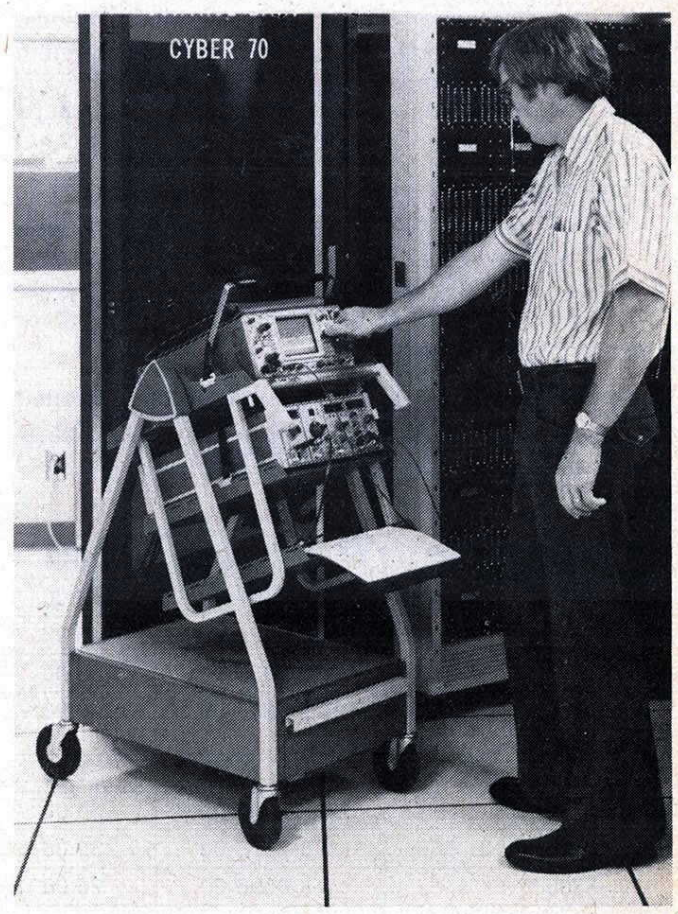
Optional Accessories

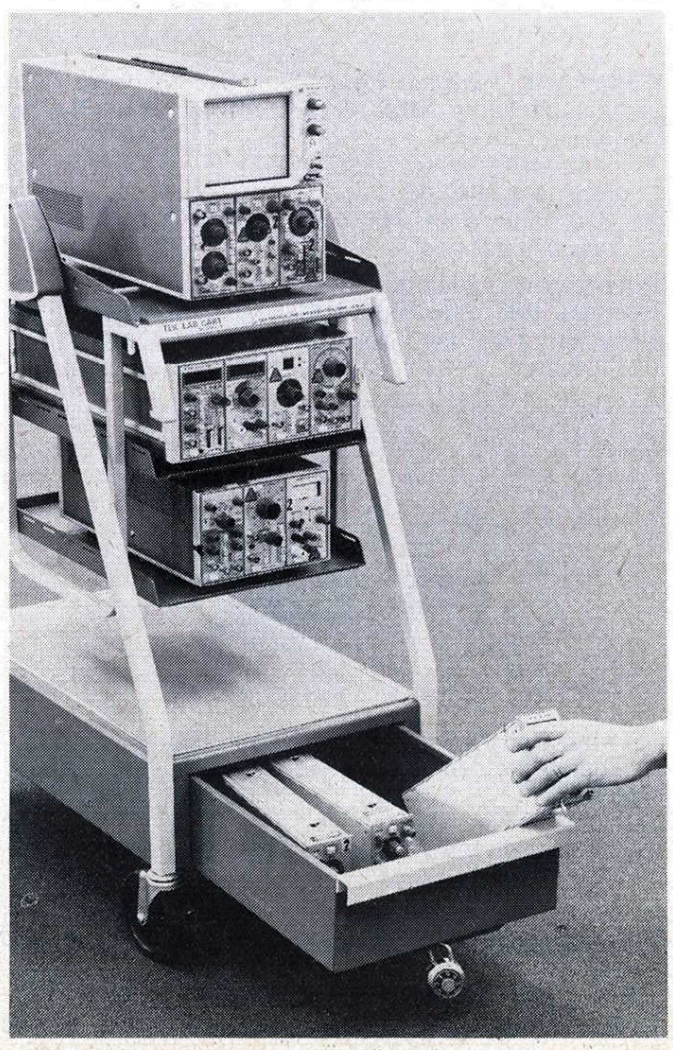
Extra shelf with four mounting screws. Net weight 0.9 lb, 0.4 kg. Shipping weight 3 lb, 1.4 kg.

Order 436-0132-01 ..... $30

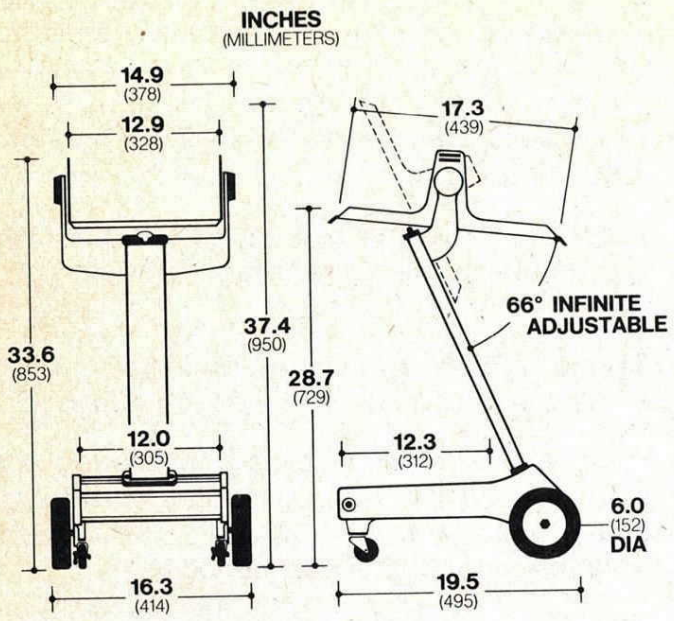
SAFETY BELT to secure instruments on top tray, shelves, or base. (Not needed for 5000- or 7000-Series Scopes on top tray.) Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

Order 346-0136-01 ..... $20





The Model 3 is shown with the 436-0132-01 Optional Shelf.



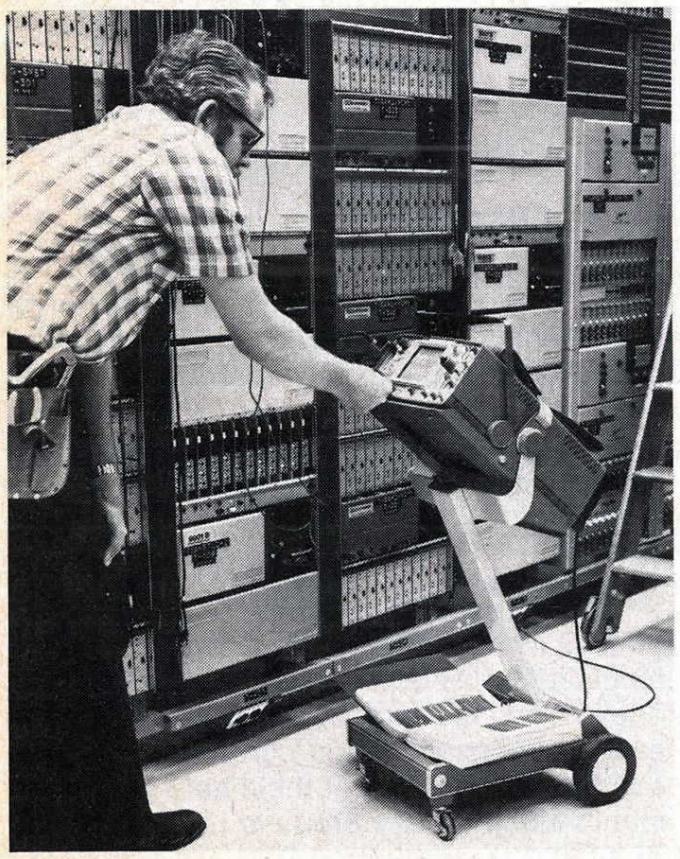
MODEL 200C

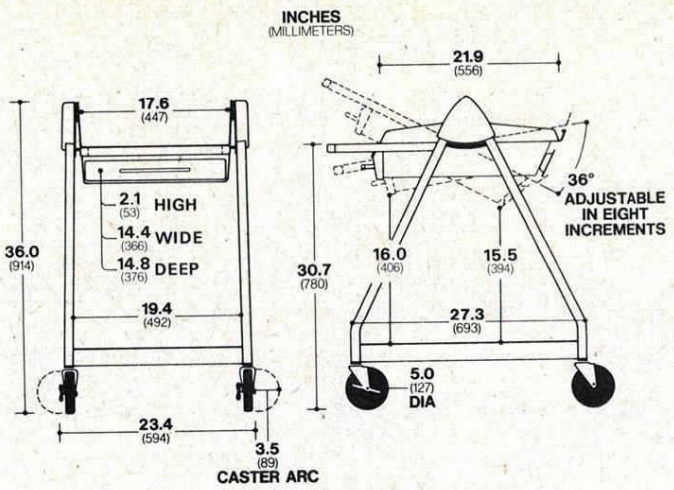
Recommended For:

All 400-Series Portable Scopes.

MODEL 200C includes brakes on front casters, safety belt to secure instrument on top tray. Blue vinyl finish. Net weight 16 lb, 7.3 kg. Shipping weight 27 lb, 12.2 kg.

Order Model 200C **$190**





MODEL 205

Recommended For:

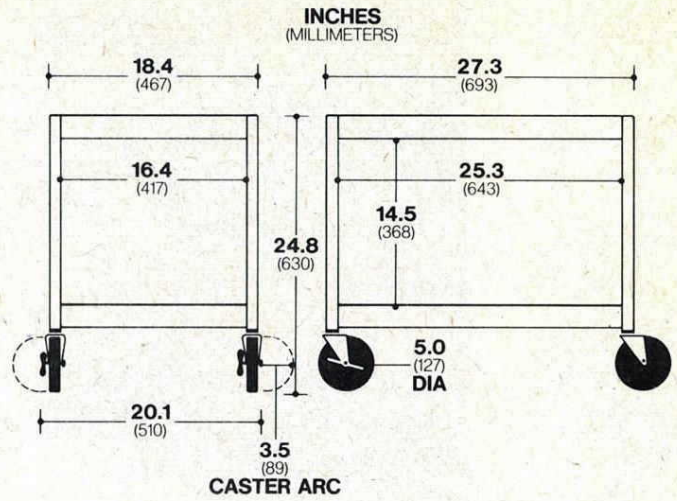
All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray.

MODEL 205 includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Blue vinyl finish. Net weight 43 lb, 19.5 kg. Shipping weight 57 lb, 25.8 kg.

Order Model 205 . . . . . **$300**

OPTIONAL SAFETY BELT recommended to secure instruments on top tray. Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

Order 346-0070-01 . . . . . **$40**



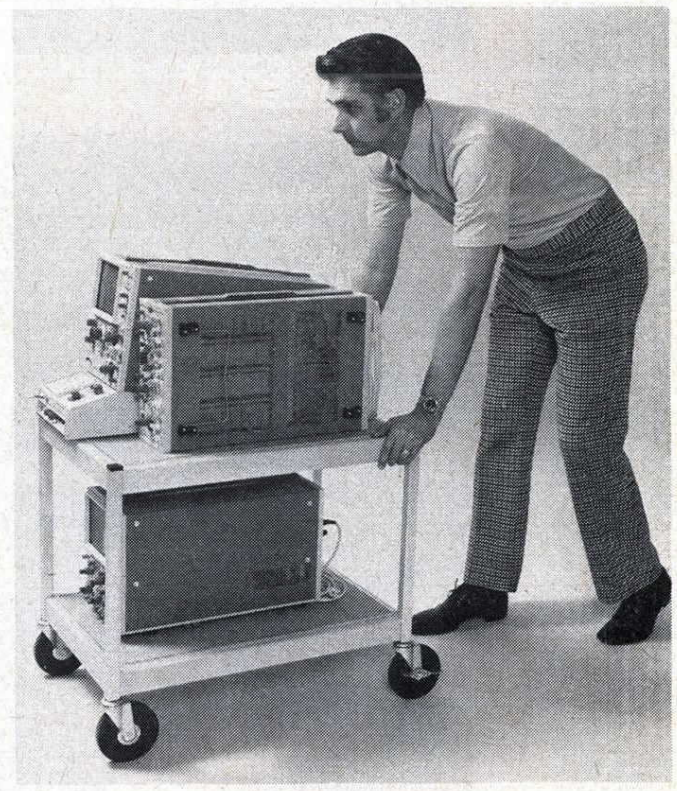
MODEL 206

Recommended For:

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment.

MODEL 206 includes brakes on caster at one end of cart. Plastic laminate on top tray and base. Light gray vinyl finish. Net weight 30 lb, 13.6 kg. Shipping weight 38 lb, 17.2 kg.

Order Model 206 . . . . . **$140**



QUICK REFERENCE

Product	Cart Model
TM 503	3
TM 504	3
TM 506	205
21	206
31	206
432	200C
434	200C
455, 465M	200C
464	200C
465	200C
466	200C
475, 475A	200C
485	200C
491	200C
520-522	205
528	*
530, 540, 550-Series	3
560-Series	3
576	3
577	3
602-607	*
611	205
613	205
632	205
650-Series	205
670-Series	205
1105	*
1140A	205
1340	205
1420-Series	*
4601	206
4610	206
4623	206
4632	206
4661	206
4921	206
4922	206
5100-Series	3
5400-Series	3
7104	3
7313	3
7603	3
7613	3
7623A	3
7633	3
7704A	3
7834	3
7844	3
7904	3

*These products are applicable to several carts—see dimensions and features for your specific needs.

Customer Information

When you buy a TEKTRONIX product, you are buying more than an oscilloscope . . . or a computer terminal . . . or a logic analyzer . . . or any of our numerous test and measurement products. You are also investing in the many people and services behind your TEKTRONIX product.

A staff of Customer Service Representatives serves as your initial interface with the company.

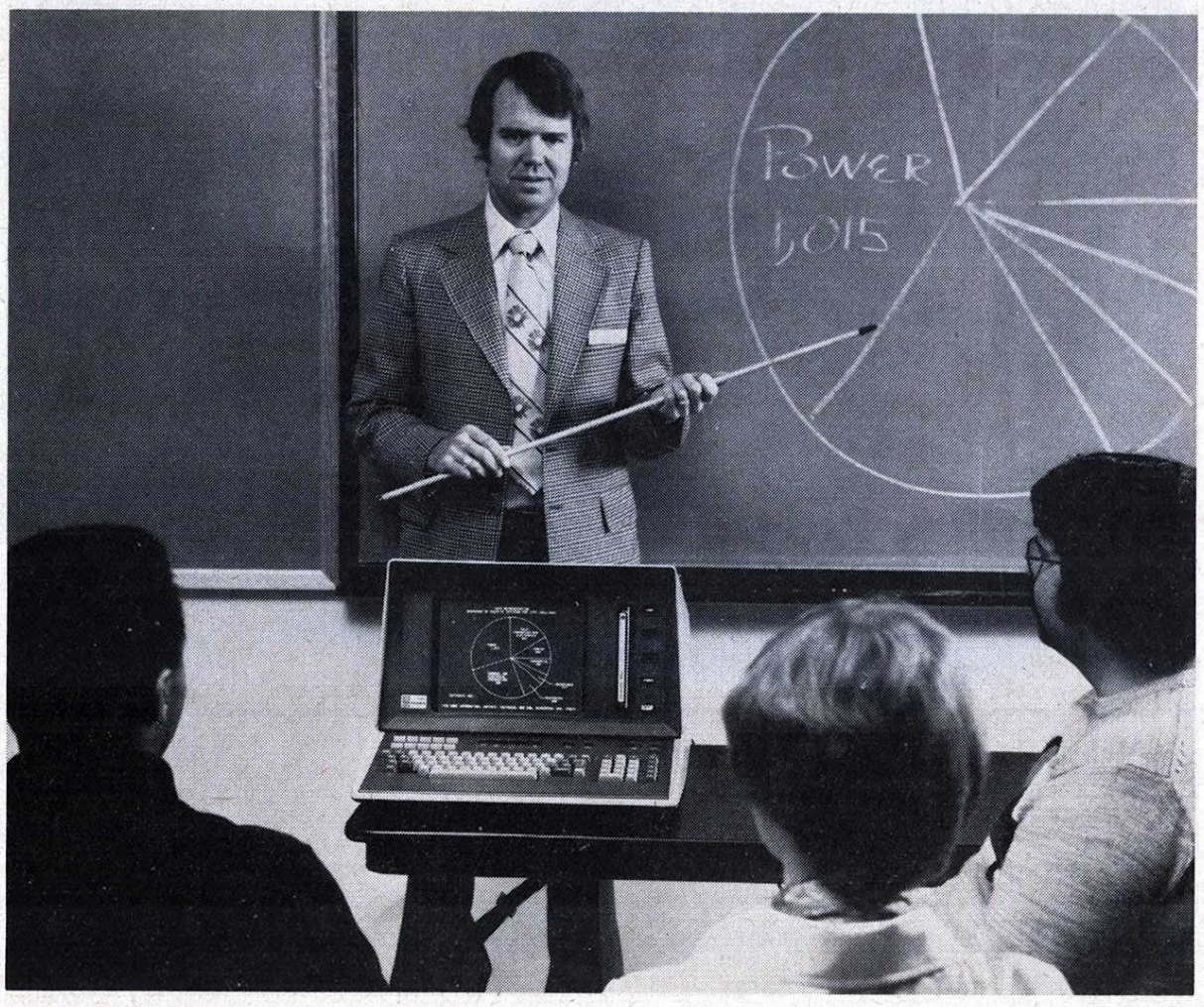
Trained Sales Engineers give you expert service advice and after-the-sale support.

A network of service centers throughout the U.S. and most other parts of the world provides speedy and competent calibration, maintenance, and repair service.

The long term support program insures years of service after a product is removed from the production line.

The training and support program offers classes in TEKTRONIX product theory, operation, maintenance, and repair at our main plant in Beaverton, Oregon and at various locations throughout the world. Audio and video training tapes are also available.

Each of these services adds value to your TEKTRONIX product.



SALES ENGINEERS

Your Sales Engineers are fully prepared to respond to your technical and business requirements. They have a strong technical background and extensive product and business training. Periodic refresher courses fully acquaint them with new products and services. Be sure to take advantage of their services.

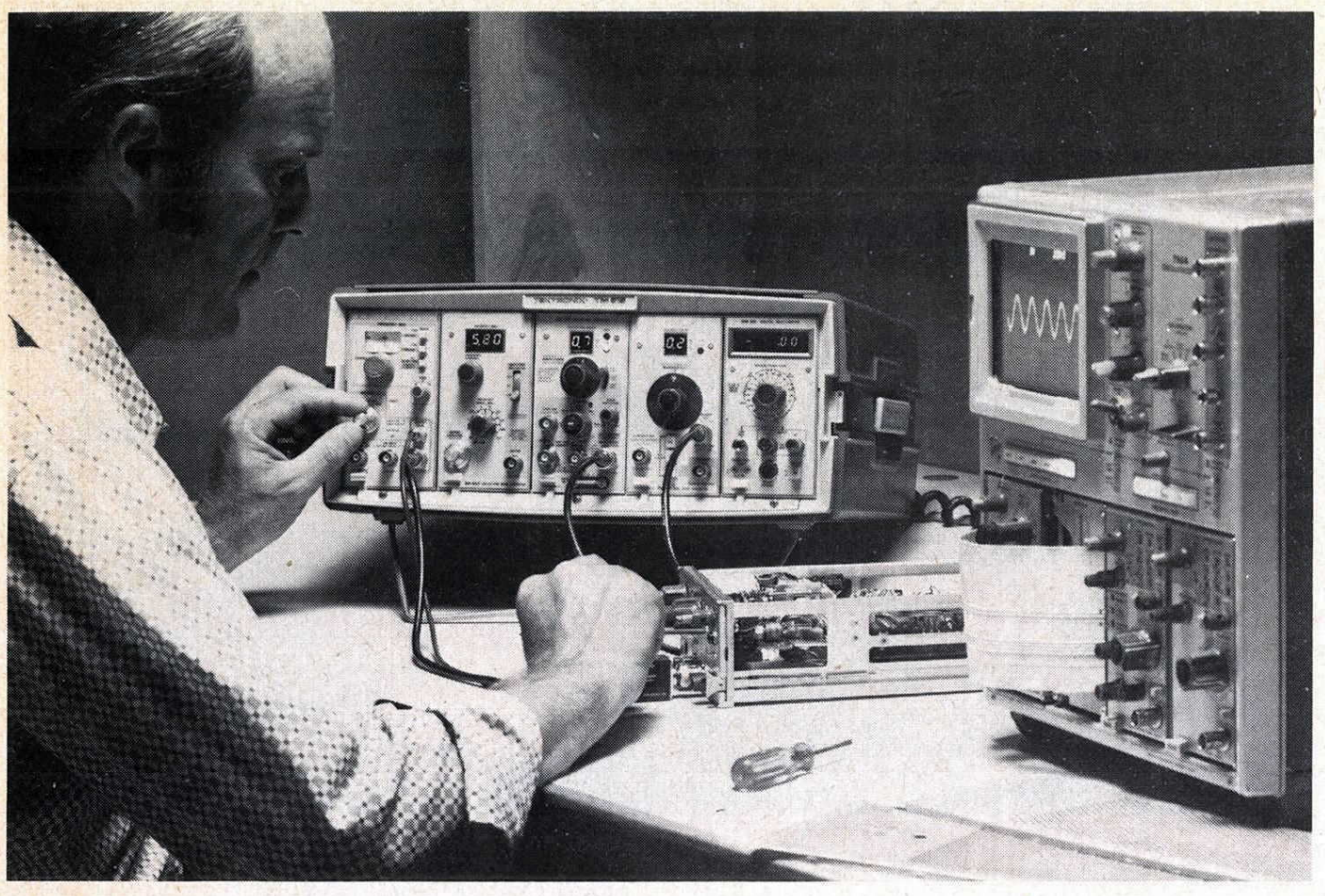
COMMUNICATIONS

Your Sales Engineers are a valuable communication link between you and the factory. They know the exact person to contact in each circumstance, and can reach that person fast and easily. Let them help your communications on any problem related to your TEKTRONIX products.

ORDERING

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

If you are a Purchasing Agent or Buyer, your Sales Engineer or Customer Service Representative can provide information on prices, terms, shipping estimates, and best method of transportation on TEKTRONIX products, accessories and replacement parts.



TRACEABILITY

The reference standards of measurement of Tektronix are compared with the U.S. National Standards through frequent tests by the U.S. National Bureau of Standards.

The Tektronix working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of TEKTRONIX products are controlled by the use of Tektronix reference and working standards and testing apparatus in accordance with established procedures and with documented results. (Reference MIL-C-45662A)

Certificates of traceability to NBS are available with new products, as well as products you may have serviced at a later date.

A certificate of compliance stating that a particular product being shipped conforms to its published (or quoted) specification is also available.

OPERATION

Your TEKTRONIX product can be most useful to you when you are familiar with all control functions. Your Sales Engineer will be glad to demonstrate the use of your product in various applications to help you become more familiar with its operation. If your product is to be used by several engineers or other users, your Sales Engineer will be happy to conduct informal classes on its operation in your location.

CALIBRATION & CERTIFICATION

Services furnished are provided in accordance with all applicable Tektronix specifications. Actual test data can be made available when required.

Tektronix' calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

TEKTRONIX Service Quality Program satisfies the requirements of MIL-I-45208A, and MIL-C-45662A.

CUSTOMER ASSISTANCE

Tektronix willingly assumes much of the responsibility for continued efficient operation of the products it manufactures. If you should experience a stubborn maintenance problem, we will gladly help you isolate the cause. Often a telephone call will help you get your product back in operation with minimum delay. If yours is a large laboratory, we can help your maintenance engineers by conducting informal classes on test and calibration procedures, troubleshooting techniques, and general maintenance.

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 sales engineering. 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. Your Sales Engineer has full details, and will make all the arrangements.

APPLICATIONS

To assist you with in-depth knowledge of specific areas, your Sales Engineers are backed up by specialists in such fields as: Signal Processing Systems, Television Products, Information Display Products, Spectrum Analyzers, Logic Analyzers, and Microprocessor Development Systems. At your request, they will arrange to demonstrate TEKTRONIX instruments for you — in your application, if you wish.

Tektronix Service and Support

PRODUCT SERVICE

To help assure adequate product service and maintenance facilities for our customers, Tektronix has established Field Offices and Service Centers at strategic points throughout the United States. Contact your Sales Engineer or Service Center for details concerning • Warranty • Calibration • Emergency Repairs • Repair Parts • Scheduled Maintenance • Reconditioning and Overhaul • Pickup and Delivery • Maintenance Agreements • On-Site Service for Fixed Installations — Other Services available through these local offices and centers. Outside the United States, service is offered in all countries where the products are locally sold.

EMERGENCY REPAIR

Should an emergency arise — "at home" or on the road — just bring your instrument to the Service Center closest to you. We'll start working on it on a priority basis. In most cases, we'll get you on your way in a matter of minutes. (There is an additional charge for this service.)

MAINTENANCE AGREEMENTS

Your TEKTRONIX products are initially covered by warranty. Several types of contracts are usually available to help you extend that initial coverage. The Blanket Repair Agreement, for example, allows you to establish a "not-to-exceed" amount, it also saves on paperwork by centralizing the billing procedure. Many other aspects of service are negotiable.

If you'd like us to maintain your products on a regular basis, ask a service center about our fixed fee maintenance program. For a fixed cost that you can budget for, we'll remind you when a product is due for calibration, and perform the service within a specified turnaround time.

Contact your service center for a schedule of service fees, more information about maintenance agreements, local services offered, or possible provisions for your special requirements.

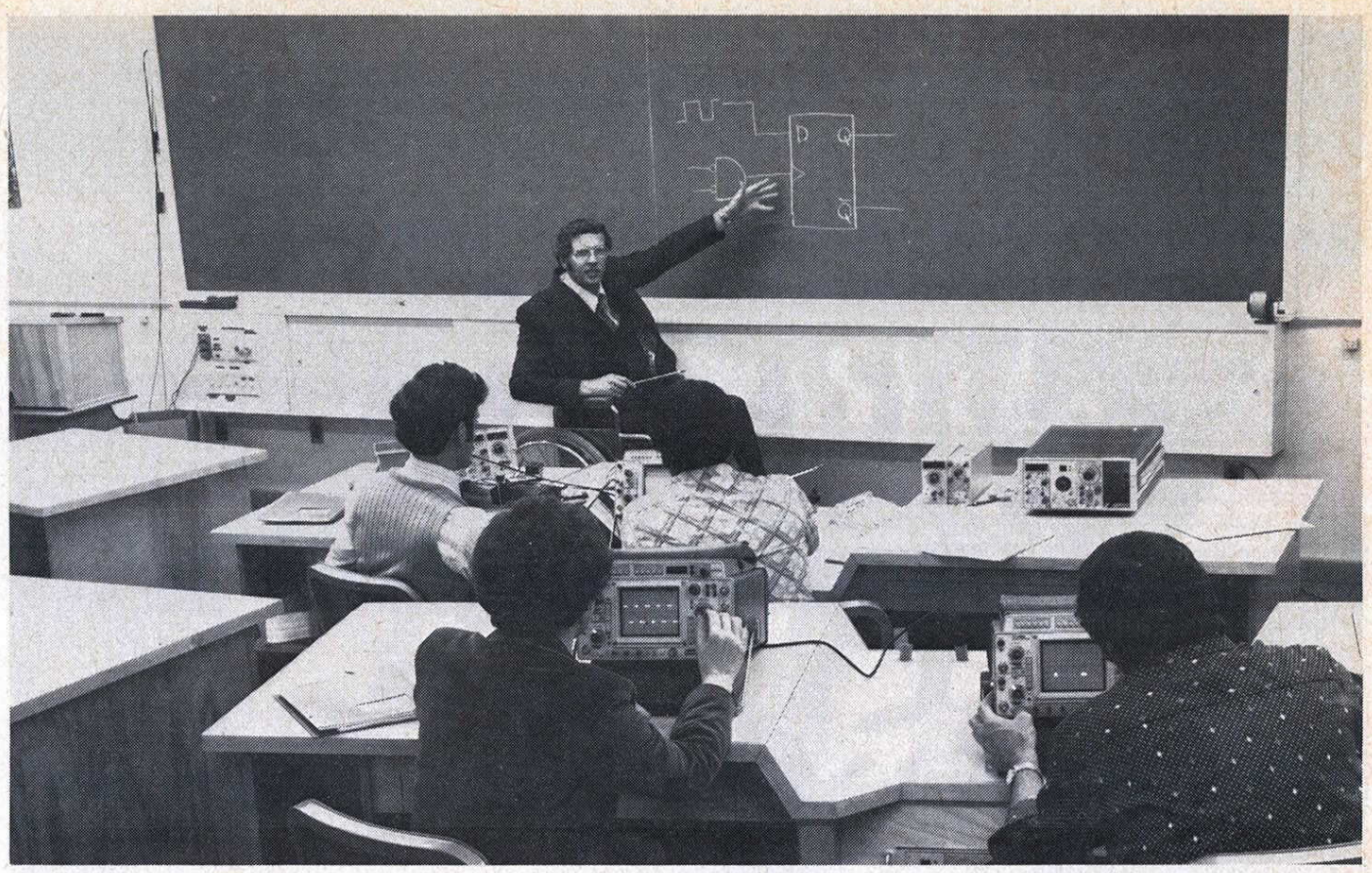
REPAIR PARTS

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

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. The New Products section provides information on products recently introduced, including photos, brief descriptions of unique features, and major specifications for each product.

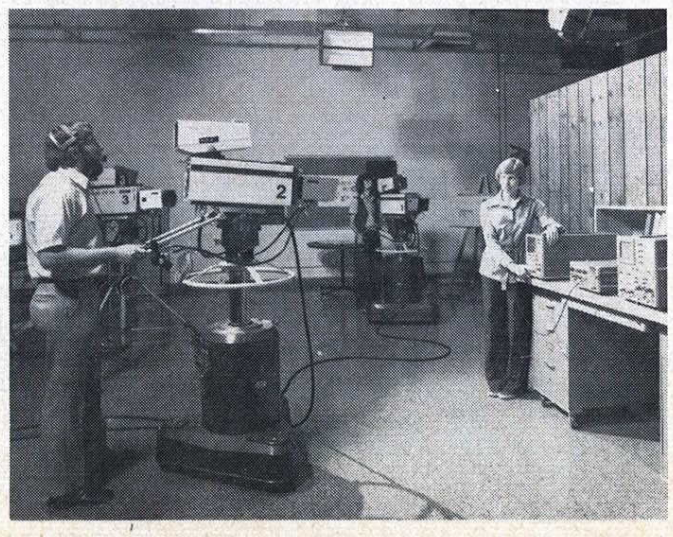
Customer Training



Tektronix products are designed as long-term investments. Tektronix training is designed to enhance the value of your investment. With this in mind, the Marketing Training department has established several types of programs: 1) formal classroom training; 2) audio tapes covering operation, circuit descriptions, and calibration; 3) video tapes on basic concepts, operation, and applications; and 4) a new venture into stand-alone multi-media training packages, combining printed materials with audio and/or video tapes.

MULTI-MEDIA TRAINING MATERIALS

Tektronix produces an extensive list of audio and video training tapes as well as multi-media training packages which are available for customer purchase. These training aids are designed to make your own training programs more effective. Topics covered include circuit and block descriptions, calibration, basic analog and digital concepts, and instrument operation and applications. A complete list of available audio and video tapes and training packages along with descriptions and prices may be found in the current Customer Training catalog which is available from your nearest Tektronix Field Office.



MAINTENANCE CLASSES

Maintenance classes held in Portland, Oregon, and at six Field Office locations teach operation, signal flow, calibration, troubleshooting, and instrument repair in a format which combines lecture and lab sessions.

Detailed descriptions of maintenance classes and tuition charges can be found in the Customer Training catalog. For a copy of the current catalog or to register for a class, contact your nearest Tektronix Field Office. Customers outside the U.S. may obtain a schedule of classes through their Tektronix Representatives.

7704A/7A26/7B80-85 Class
7904/7A19/7B92A/7633 Class

February 19 - March 2, Portland, OR
April 2-6, Irvine, CA*
April 30 - May 11, Portland, OR
May 21-25, Chicago, IL*
June 4-15, Portland, OR
July 23 - August 3, Portland, OR
August, 13-17, Dallas, TX*
August 27-31, Irvine, CA*
September 10-21, Portland, OR
October 8-12, Boston, MA*
November 5-16, Portland, OR
December 10-17, Santa Clara, CA*

*Field classes are held for one week on the 7704A only.

465/475 Class

March 5-9, Portland, OR
March 12-16, Santa Clara, CA
April 30 - May 4, Rockville, MD
May 21-25, Portland, OR
June 18-22, Portland, OR
July 9-13, Santa Clara, CA
July 23-27, Boston, MA
August 6-10, Portland, OR
September 17-21, Rockville, MD
September 24-28, Portland, OR
October 29 - November 2, Irvine, CA
December 3-7, Dallas, TX

TM 504/DC 503/DM 502/TG 501 PG 501/FG 501 Class

February 5-9, Boston, MA
March 12-16, Portland, OR
April 23-27, Dallas, TX
May 14-18, Portland, OR
June 25-29, Portland, OR
August 13-17, Portland, OR
October 1-5, Portland, OR
October 22-26, Santa Clara, CA
October 29-November 2, Rockville, MD

4051/4662 Class

March 19-30, Chicago, IL
April 23 - May 4, Portland, OR
June 4-15, Portland, OR
September 10-21, Portland, OR
October 29 - November 9, Chicago, IL
December 10-21, Portland, OR

4010/4014 - 4610/4631 Class

January 29 - February 2, Portland, OR
March 12-16, Dallas, TX
March 26-30, Portland, OR
May 21-25, Portland, OR
June 4-8, Santa Clara, CA
June 11-15, Boston, MA
July 9-13, Portland, OR
July 16-20, Chicago, IL
August 27-31, Portland, OR
October 15-19, Portland, OR
November 5-9, Dallas, TX
December 3-7, Portland, OR

4025/4027 Class

July 16-20, Portland, OR
August 20-24, Rockville, MD
September 24-28, Santa Clara, CA
October 22-26, Portland, OR

8002 Emulator Modules Class

February 5-16, Irvine, CA
March 12-23, Portland, OR
June 4-15, Portland, OR
August 6-17, Boston, MA
October 22 - November 2, Portland, OR

4081/4905/4641 Class

July 9-20, Portland, OR
October 1-12, Portland, OR

5400 Class

February 12-16, Portland, OR
July 9-13, Portland, OR

Logic Analyzers Class

April 9-13, Portland, OR
July 16-20, Portland, OR
October 8-12, Portland, OR

WDI — 7912/1350 Class

February 26 - March 2, Portland, OR
July 23-27, Portland, OR

DPO — P7001/1350 Class

March 5-9, Portland, OR
July 30 - August 3, Portland, OR

MICROPROCESSOR DESIGN WORKSHOPS

Tektronix Microprocessor Design Workshops are intensive, practical, results-oriented learning experiences. The emphasis is on software development and system integration techniques. The style is shirt-sleeved and hand-on.

Tektronix offers two types of workshops. The first is the 5-day Microprocessor Design Workshop which includes a review of basic principles of microprocessor software, programming, and design organization. At the end of this workshop, you will be able to complete a microprocessor software design — from flowcharting through debugging, operate the Tektronix Microprocessor Development Lab, and be able to understand and solve the problems involved in integrating software and hardware.

In the 3-day Microprocessor Development Lab Workshop, you will learn, in detail, the operation of the Tektronix Development Lab and its role in hardware debugging, software development, and system integration.

Microprocessor Design Workshops

January 22-26, Rockville, MD and Santa Clara, CA
January 29 - February 2, Boston, MA and Chicago, IL
February 12-16, Santa Clara, CA
February 19-23, Chicago, IL
February 26 - March 2, Portland, OR Rockville, IL, and Santa Clara, CA
March 5-9, Boston, MA and Chicago, IL
March 19-23, Rockville, MD
March 26-30, Boston, MA
April 2-6, Rockville, IL and Santa Clara, CA
April 9-13, Boston, MA and Chicago, IL
April 23-27, Santa Clara, CA
April 30 - May 4, Chicago, IL
May 7-11, Rockville, IL and Santa Clara, CA
May 14-18, Boston, MA and Chicago, IL
May 21-25, Portland, OR

Microprocessor Design Lab Workshops

January 15-17, Chicago, IL
February 5-7, Portland, OR
February 12-14, Rockville, IL
February 19-21, Boston, MA
March 19-21, Santa Clara, CA
March 26-28, Chicago, IL
April 16-18, Portland, OR
April 23-25, Rockville, IL
April 30 - May 2, Boston, MA

S-3200 Series Training Classes

Tektronix provides System Application and Maintenance training for the S-3200 Series of Automated Test Systems in order to enable you to make most effective use of your system. Training for two persons is provided at no charge with each system purchased.

BASIC APPLICATIONS CLASS

This course is designed to familiarize the student with the testing capability and usage of the S-3200 Series of Automated Test Systems. Students take part in both lectures and lab work to obtain the skills necessary for writing and debugging basic functional and parametric device test programs.

BASIC MAINTENANCE CLASS

In this course students learn to isolate and replace faulty system modules with the use of software diagnostic programs and become familiar with system calibration procedure.

ADVANCED MAINTENANCE WORKSHOP

This course is intended for customers who wish to assume primary maintenance responsibility without a Tektronix maintenance contract. The course is conducted in a workshop atmosphere with primary attention given to in-depth understanding of system operation and the application of troubleshooting techniques. Significant time is spent in problem-solving on an S-3200 Series system.

SYSTEM PROGRAMMER'S CLASS

Data structures and programming conventions used by the TEKTEST operating system are covered in this course. Ways in which customer-written programs, subroutines, and functions can be added to the operating system are explored.

CLASS SCHEDULES

For additional information on Systems training and class schedules, contact the Semiconductor Test System Training Coordinator at (503) 645-6464, extension 1187.

General Terms Of Sale

Orders should be placed with your Tektronix Field Office listed on page 248.

Tektronix, Inc., 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 Sales Engineer.

NET 30 DAYS

Tektronix, Inc., standard terms of sale are NET 30 days following the date of shipment. As with all credit terms, satisfactory credit accommodations must be arranged.

EXTENDED TERMS OF SALE

Extended terms of 60 to 180 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 invoice. The amount of the service charge depends upon the number of days the terms are extended.

LEASE AGREEMENT

All new and used instruments 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 6, 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 the expense of Tektronix, Inc. 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 installments will be credited toward the purchase price.

The standard Tektronix, Inc., warranty and quantity discount apply to products leased under this installment term.

SECURITY AGREEMENT

This program provides monthly installment payment terms while TEKTRONIX products are in use. 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.

A minimum advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. 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, Inc., 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.

INFORMATION DISPLAY PRODUCTS

Most Information Display Products are available under an *operating lease* program. The minimum fixed terms of this program are 12, 24, 36 months, or longer. Automatic extension on a month-to-month basis with a declining rate is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc., during the terms of the agreement. Rental of Information Display Products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price.

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

WARRANTY

Tektronix intends to provide to its customers excellent value in its products, services and business practices. Tektronix warrants to the original purchaser that the products which it manufactures and sells are free from defects in materials and workmanship. Tektronix will repair or replace, at its option, those products which Tektronix determines to be defective within the warranty period that is specified in the warranty statement accompanying each product.

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.

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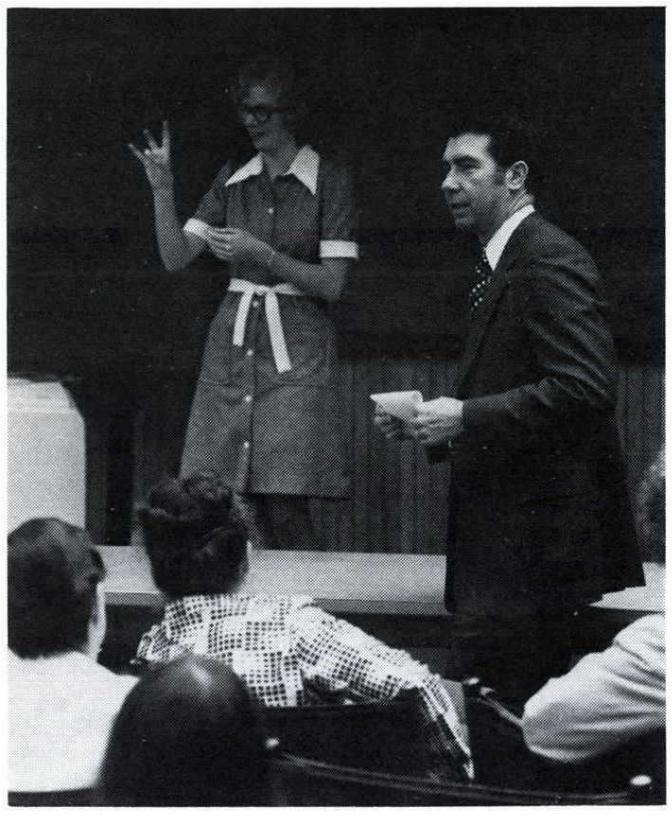

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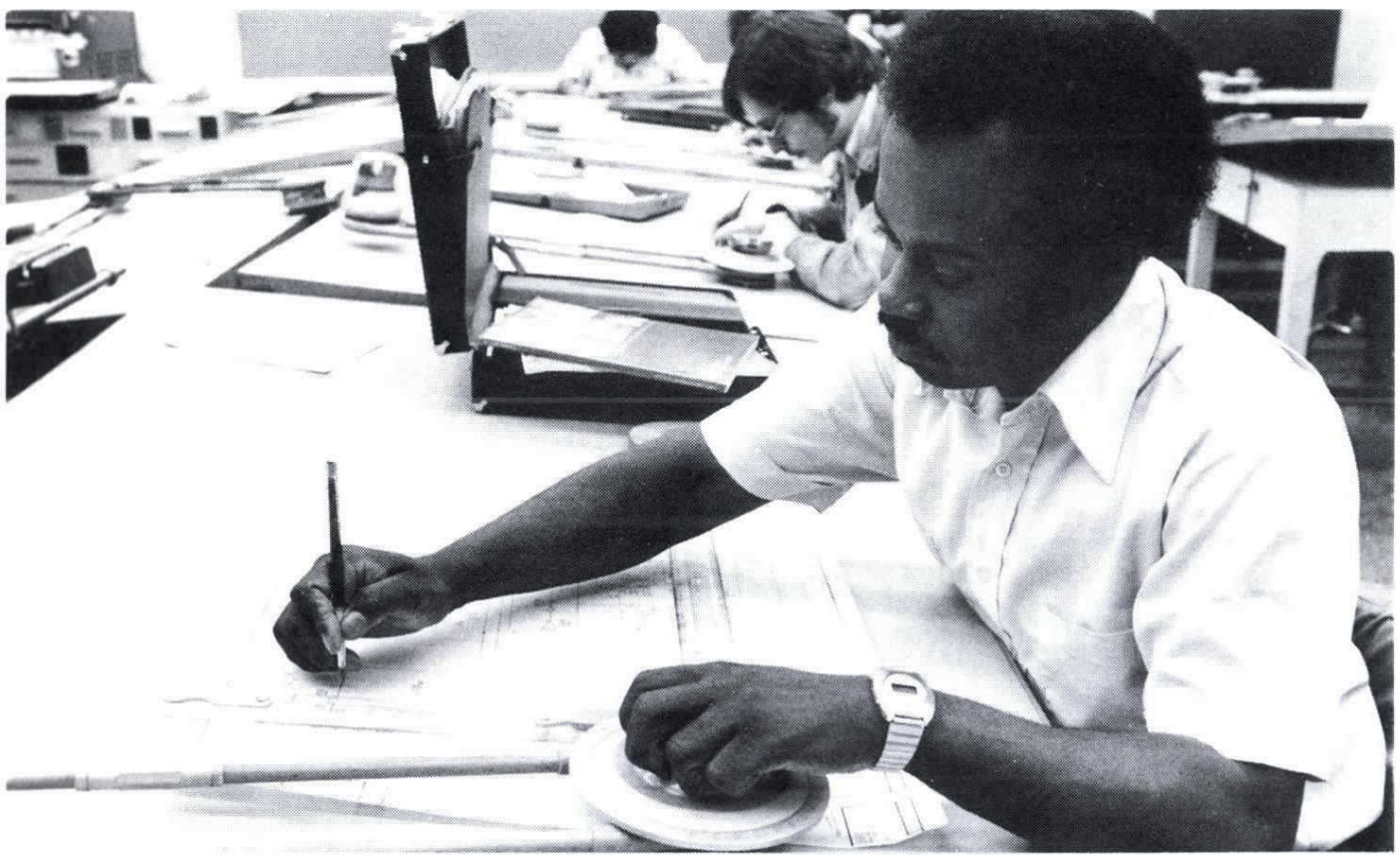

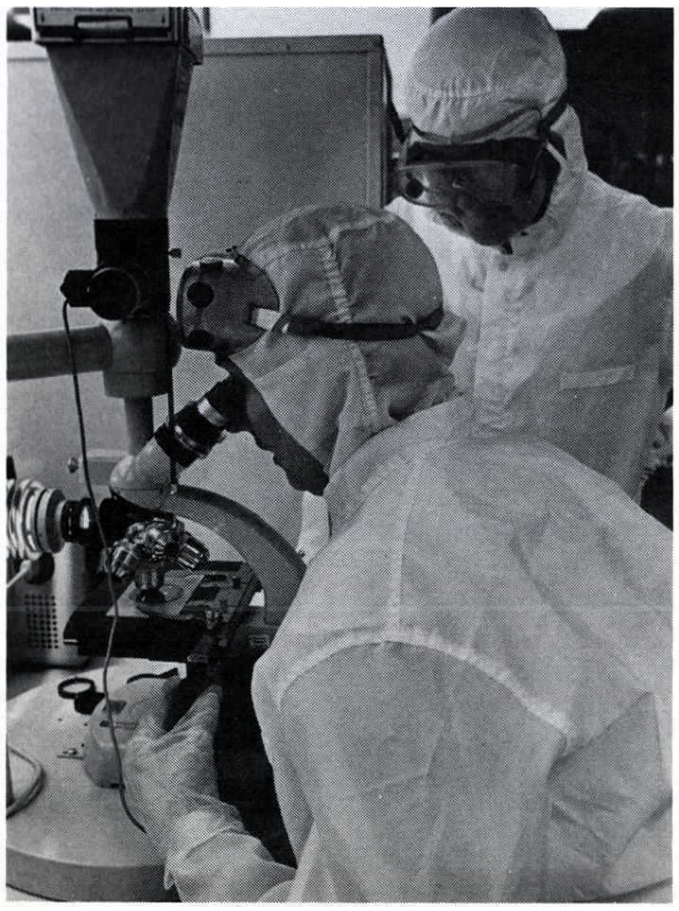

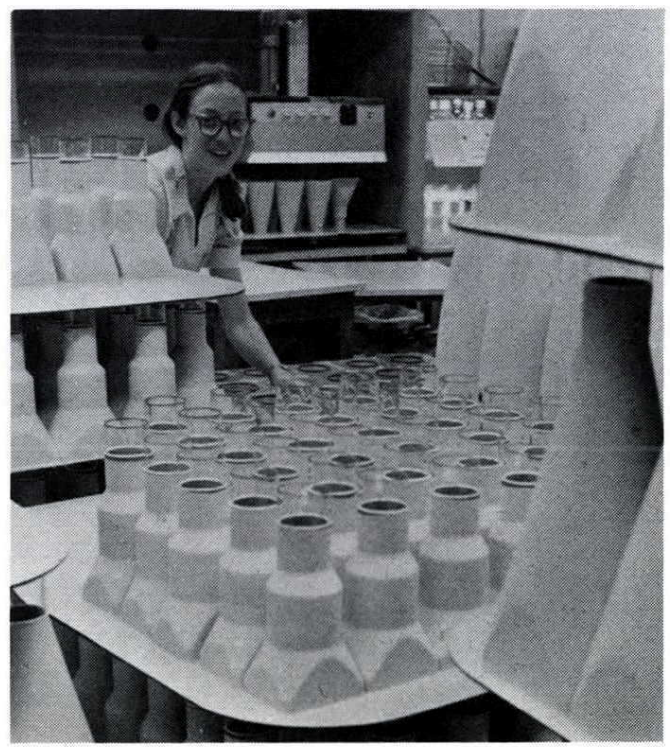

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