TEKTRONIX®

committed to technical excellence

TEKTRONIX PRODUCTS 1974

Added dimensions in measurement

Leadership means never being able to rest.

In the fast-moving field of electronic instrumentation, the challenge placed on leaders is to **keep** leading, to expand the dimensions of measurement.

Product development may be seen as having three "dimensions":

1. Breaking fresh technological ground, enabling new kinds of measurement; then
2. Incorporating these ideas in buildable cost-effective packages designed for individual requirements; and finally
3. Marketing these products in those areas which can receive the greatest benefit from this new technology.

Of these dimensions, the first is the most difficult. To advance the state of the art is an ever-deeper invasion of the unmeasurable.

This catalog describes not only those products that extend existing dimensions (smaller, lighter, faster, brighter, more versatile instruments), but also some that create entirely new measurement capabilities—which will be broadened in future catalogs.

These significant new products include:

Digital Processing Oscilloscope (DPO)

Sandwiching a processor between two halves of a high-performance general purpose oscilloscope marries the scope's great ability to acquire signals and display them, to a computer's unmatched high speed mathematics. This combination is a very powerful one which will enable the user to extract information from CRT displays that he never could before (as just one example, phase shift information from a scope or spectrum analyzer screen). The potential of this powerful tool is unprecedented, and many of its specific uses still lie in the minds of those who will use it.

The R7912 Transient Digitizer

From 50 to 100 times faster than other analog-to-digital converters—captures and changes into digital or video presentation, smaller higher speed single-shot signals than any other technique.

The 4014 and 4015 large screen (19-inch) graphic terminals

Here "more" does mean "better" by letting the user view about 3½ times more information—more than any other storage screen. It just about matches the eye's ability to absorb. This is a giant step forward in putting the human power of pattern recognition to work in making sense of information displays, particularly graphic ones.

Miniscopes

Not new to this catalog, but expanded by addition of the 212 (dual trace) and 214 (dual trace storage)—continue to increase the amount of scope power you can hold in your hand, and carry to wherever the measurement needs to be made.

The 1440 VIR Signal Automatic Video Corrector

For the first time, the television industry is able to automatically correct the errors in the video signal up to and including the transmitter.

The line between adding new dimensions and extending existing ones is admittedly a fine one. Without worrying much about that line, Tektronix will continue to advance on the entire front so that each year's catalog will be, and properly, a reassertion of leadership.

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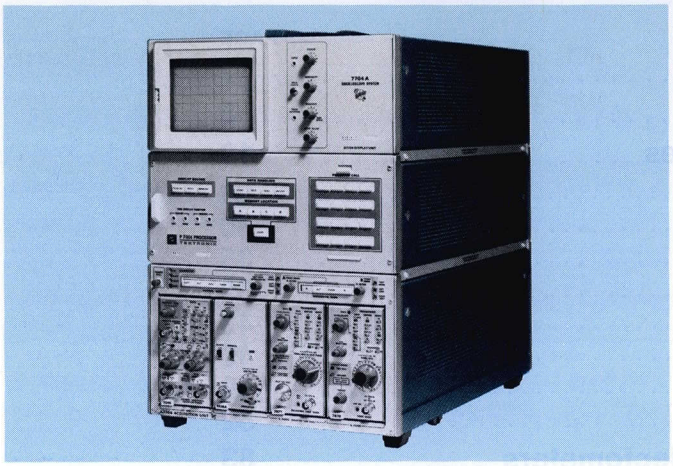
7000-SERIES PLUG-IN OSCILLOSCOPES

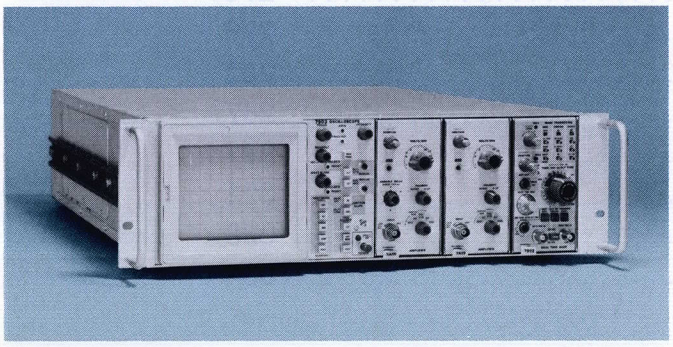


The Digital Processing Oscilloscope consists of three basic sections: Acquisition unit, Display unit, and Processor unit. The acquisition and display units, along with any four of the over 30 plug-ins in the 7000-Series family, comprise a high performance oscilloscope. Adding the Processor unit to this scope greatly expands the waveform measurement capability. The Processor serves as an interface between the oscilloscope and either a minicomputer or a calculator. In addition, the Processor provides realtime analog-to-digital conversion, storage of up to four different waveforms and scale factors in self-contained core memory, and recall and display of stored waveforms.

A wide variety of operations can be performed on waveforms ranging from simple addition or subtraction of two waveforms to sophisticated fast Fourier transforms. The computer has access to the CRT character generator circuits, permitting it to send short messages to the oscilloscope user via the CRT.

Through the use of APD BASIC™ software, the most complicated and sophisticated measurement routines can be easily and quickly programmed. Any one of up to 13 computer-stored measurement routines can be initiated by pressing one of the user-option pushbuttons. The user can assign routines to the pushbuttons from his own programs or programs available from Tektronix, Inc. When not performing in combination, the oscilloscope and the minicomputer or calculator are available for independent use.

For complete description of the Digital Processing Oscilloscope, see page 26.

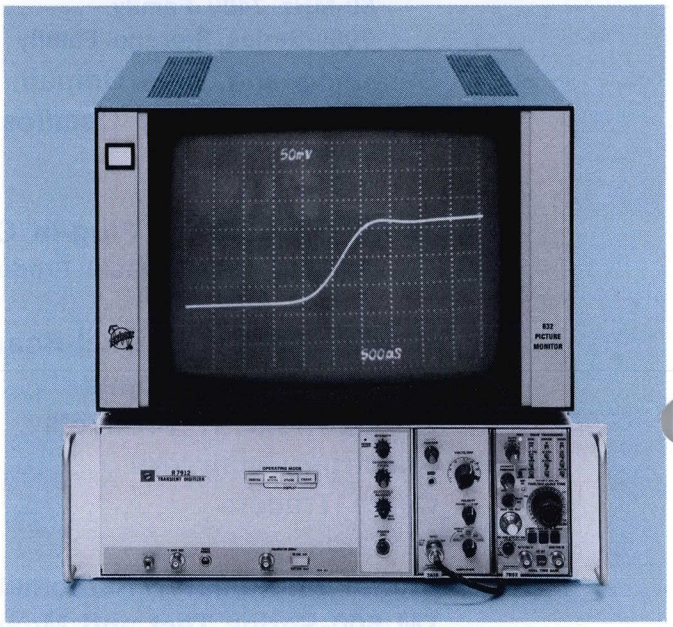


The R7903 Oscilloscope is the widest bandwidth, real-time oscilloscope available in a 5¼-inch rackmount. General-purpose measurements up to 500 MHz at 10 mV/div can be made using the 7A19 Amplifier plug-in. This can be extended to 1 GHz at less than 4 V/div via direct access with the 7A21N Direct Access plug-in. CRT READOUT and vertical amplifier are bypassed and inoperative when direct access is used.

The R7903 accepts any three of over 30 plug-ins available for the 7000 family. CRT READOUT is also available on the R7903 to reduce set-up time and measurement errors. It also increases operator accuracy and speed.

The R7903 accepts any three of over 30 plug-ins available for custom tailoring of the system to meet your measurement requirements.

For complete description of the R7903, see page 35.



The R7912 Transient Digitizer can acquire fast single-shot or repetitive signals and convert them to digital data or to a TV-compatible format. Key component in the instrument is a Tektronix-developed scan-converter tube.

In the digital mode, the R7912 operates as a fast analog-to-digital converter. It takes 512 samples of a waveform in a time window as short as 5 ns. This digital information can be stored in a self-contained memory (optional) or sequenced to a computer or other peripheral such as a digital-to-analog converter for display on an X-Y monitor. Software programs are available from Tektronix, Inc. to assist in your measurements and analysis. In the TV mode, the R7912 processes waveforms into a TV-compatible format (525 lines, 60 Hz field, 2:1 interlace) for bright, large-screen displays on conventional TV monitors such as the TEKTRONIX 630 Series Picture Monitors (as shown in above picture).

Signals are acquired with standard 7000-Series plug-ins. This provides a very flexible and versatile signal acquisition system, allowing selection from over 30 plug-ins, as well as compatibility with the many other instruments in the 7000-Series family.

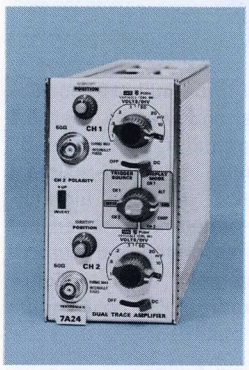
Several options are available to expand the measurement performance of the R7912. The optional semiconductor memory allows the acquired waveform to be stored in the R7912 for

7000-SERIES PLUG-IN OSCILLOSCOPES

later sequence into a computer or into permanent memory storage such as a digital tape system. An electronic graticule option allows an electronically generated dot-pattern to be stored or displayed along with the signal.

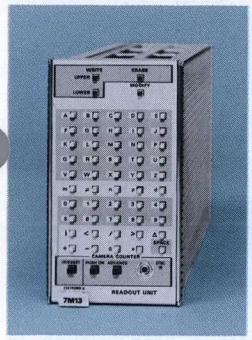
The R7912 is designed to be mounted in a rack with the computer, monitor, or other equipment. It requires only 5¼ inches of rack height.

For complete description of the R7912, see page 30.



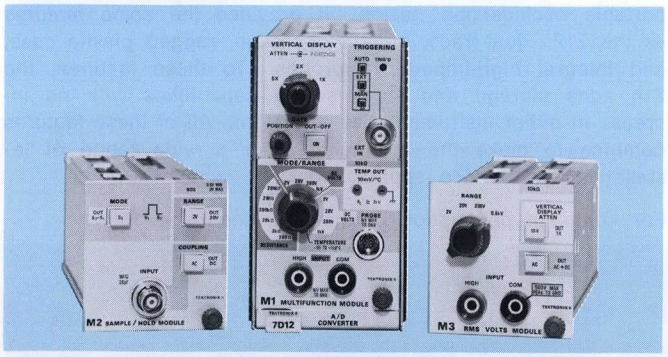
The 7A24 and 7A26 Dual-Trace Amplifier plug-ins provide a maximum bandwidth of 350 MHz with 50-Ω input (7A24) and 200 MHz with 1-MΩ input (7A26), for the 7000-Series mainframes. This bandwidth is constant for all deflection factors from 5 mV to 5 V. Other features include versatile trigger source selection, five operating modes, and a bandwidth limiting switch for low-frequency applications.

For complete description of the 7A24 and 7A26, see page 68.



The 7M13 Readout Unit provides front-panel keyboard operation for generation and display of up to 20 CRT READOUT characters (10 at the top of the CRT, 10 at the bottom). The 7M13 also contains a sequence counter which can be automatically advanced from the x-sync connector of an associated camera to label successive waveform photographs in a sequence.

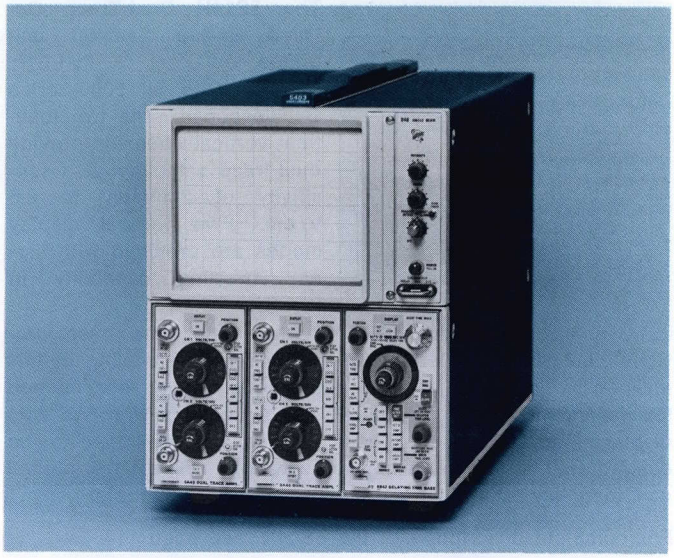
For complete description of the 7M13, see page 82.



The 7D12 A to D Converter utilizes modular construction to provide a versatile and expandable digital measurement system. The 7D12 comprises an accurate and versatile analog to digital converter with an integral display amplifier. Three interchangeable plug-in modules are presently available to allow selection of the measurement capabilities you need: M1 — DC volts, resistance, and temperature; M2 — one- or two-point sample and hold measurements; M3 — true RMS voltage measurements. Other features provided by the 7D12 are: automatic, manual, or external triggering; automatic polarity and over-range indicators; and 100-MHz analog-display capability.

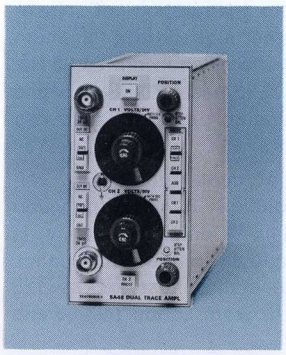
For complete description of the 7D12, see page 76.

5000-SERIES PLUG-IN OSCILLOSCOPES



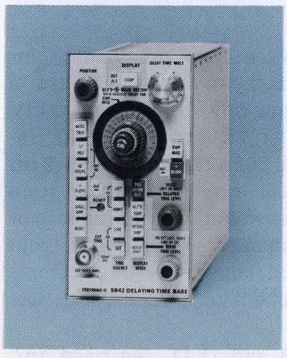
The 5403 Oscilloscope combines outstanding versatility and low cost in a 60-MHz, general-purpose, plug-in oscilloscope system. It features CRT READOUT of plug-in scale factors, three plug-in capability, easy bench-to-rackmount convertibility and choice of 17 plug-ins. The 5A48 and 5B42 provide 60-MHz, dual-trace, delayed-sweep operation. The remaining 15 plug-ins from the established 5100-Series provide a flexible measurement system including single-trace amplifiers, four-trace amplifiers, differential comparators, sampling, and a curve-tracer plug-in. The single-beam display module has a large 6½-inch CRT.

For complete description of the 5403, see page 100.



The 5A48 Dual-Trace Amplifier provides 60-MHz bandwidth for the 5403 Oscilloscope. It features five operating modes, selectable trigger source, and calibrated deflection factors of 1 mV/DIV to 10 V/DIV (bandwidth reduced below 5 mV/DIV).

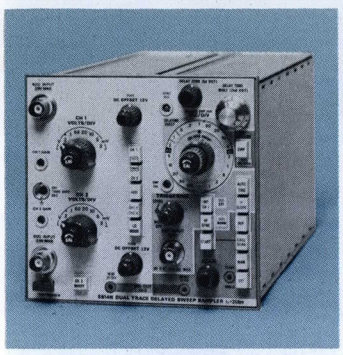
For complete description of the 5A48, see page 102.



The 5B42 Dual Time Base is designed specifically for use with the 5403 Oscilloscope. It provides delayed sweep, triggering to 60 MHz, single-sweep operation, and calibrated sweep rates from 10 ns/DIV to 5 s/DIV.

For complete description of the 5B42, see page 103.

SAMPLING AND TDR



The 5S14N Dual-Trace Delayed Sweep Sampler unit brings low cost DC-to-1 GHz bandwidth to all 5000-Series Oscilloscopes. The two identical vertical channels provide dual-trace sampling at a sensitivity of 2 mV/div to 0.5 V/div. Five vertical display modes are provided with signal inverting capability in Channel 2.

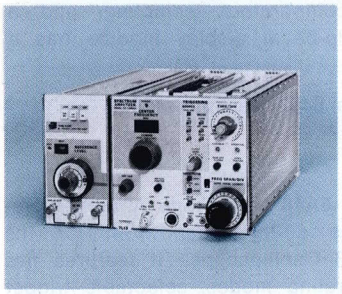
A two-ramp time base provides calibrated delayed sweep operation for sampling in this inexpensive package. A new and unique feature is a method for making accurate time interval measurements with two dots displayed on the screen. These dots can be positioned to the desired points on the displayed waveform. The time interval can then be determined from the front-panel controls.

For complete description of the 5S14N, see page 114.

The 7S14 Dual-Trace Delayed Sweep Sampler is operationally and electrically identical to the 5S14N. It is designed for operation in 7000-Series mainframes and contains the coding circuitry required to operate the CRT READOUT system.

For complete description of the 7S14, see page 88.

SPECTRUM ANALYZERS



The 7L13 Spectrum Analyzer represents a performance breakthrough in spectrum analyzers operating in the 0 to 1800 MHz frequency range. Internal frequency modulation is limited to less than 10 Hz, allowing separation of close-together signals to a minimum resolution bandwidth of 30 Hz. The 7L13 has a 70-dB dynamic range with less than 70-dB intermodulation products when two full-display signals are present.

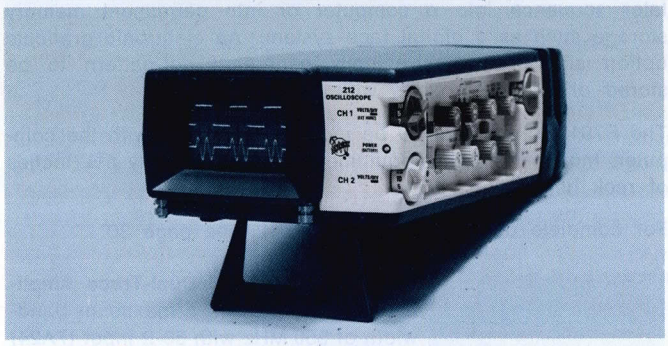
The 7L13 provides CRT READOUT of center frequency, reference level, frequency span, resolution bandwidth, video filter bandwidth, and dB per division. Center frequency is also displayed on a 4-digit LED readout on the front panel. Other features of the 7L13 include automatic phase lock, —125 dBm sensitivity, and an UNCAL light to warn of too fast sweep speeds.

The 7L13 is a triple-width plug-in and is compatible with all 7000-Series mainframes.

The 7K11 CATV Preamplifier is a wide-band preamplifier for use with the 7L12 Spectrum Analyzer. This unit provides a 75-ohm environment which is particularly useful for CATV spectrum-analyzer measurements. The 7K11 provides flat response within 0.5 dB from 50 MHz to 300 MHz and within 2 dB from 30 MHz to 890 MHz. Reference level is variable from +79 dBmV to 0 dBmV in 1 dBmV steps. An internal calibrator provides a 50-MHz output into 75 ohms at +30 dBmV. Input impedance is 75 ohms with an output impedance of 50 ohms. The 7K11 occupies a single compartment of a 7000-Series Oscilloscope.

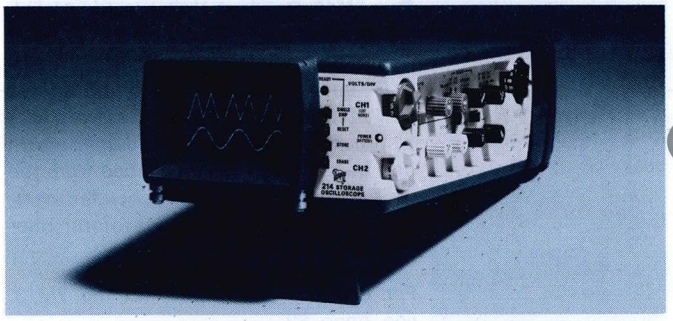
For complete description of the 7L13 and 7K11, see page 167.

PORTABLE OSCILLOSCOPES



The 212 Oscilloscope is a complete dual-trace 500-kHz oscilloscope, yet it is only 3 x 5¼ x 9 inches and weighs just 3.4 pounds. The 212 is double insulated to permit safer "elevated" scope measurements and the case is built of impact-resistant plastics for use in severe environments. Integral high-impedance probes are stored in special compartments when not in use. These probes are color-coded to match the vertical deflection controls to minimize measurement error. Trigger controls are simplified to one rotary control. Up to 5 hours operation is provided from the internal batteries.

For complete description of the 212, see page 155.



The 214 Storage Oscilloscope represents a breakthrough in portable oscilloscope design. It provides the same features as the 212: dual-trace, battery operation, rugged plastic case, and integral high-impedance probes. To these features, the 214 adds storage and single-sweep capabilities with no increase in either instrument size or weight. All of these features combine to make the 214 suitable for a wide range of installation and service applications.

For complete description of the 214, see page 155.

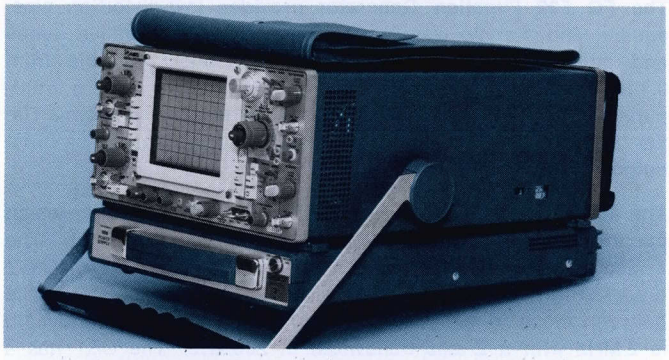
The 1105 Battery Power Supply provides battery operation for instrumentation capable of operating on a 117/230 V 50/60 Hz

PORTABLE OSCILLOSCOPES

squarewave. The 1105 offers battery operation without the sacrifices in gain, bandwidth, sweep speed, or CRT writing rate normally associated with battery-powered instruments.

The 1105, being a separate package, offers advantages over self-contained battery-powered instruments, such as: carry the batteries only when needed; carry two light packages instead of one heavy one; use the instrument from line voltage while the batteries are recharging; provide battery capabilities for a variety of different instruments; and most important, purchase instruments on the basis of performance, rather than only on battery power capabilities.

For complete description of the 1105, see page 163.



The 1106 Battery Pack provides compact battery operation for the Option 7 version of the 465 and 475. The addition of Option 7 allows these scopes to operate on 12 or 24 VDC. The 1106 Battery Pack supplies 24 VDC with 140 watt-hour capability to the instrument.

The 1106 is designed to attach to the feet of the 465 or 475, providing an easily-carried single package. When the walk is a long one, the 1106 can be quickly detached from the scope to provide two packages of almost equal weight, each with its own handle.

The 1106 has a built-in battery charger so the batteries may be charged while the scope is being used elsewhere.

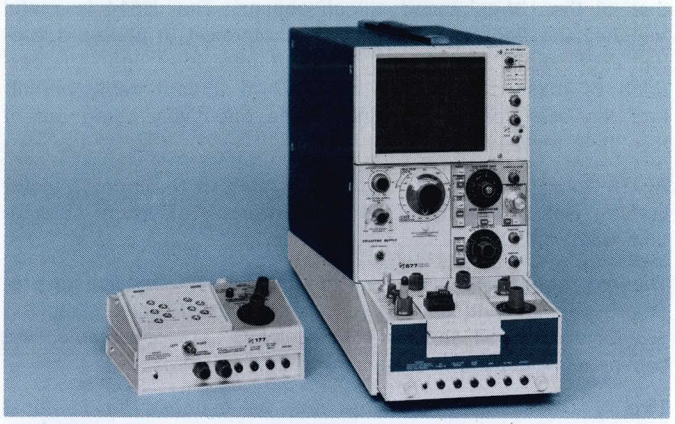
For complete description of the 1106, see page 149.

TELEVISION PRODUCTS

The following new Television Products are available from Tektronix, Inc. An overview of these products is given starting on page 287. Complete information on Tektronix Television Products is contained in the Tektronix Television Products catalog. Return the enclosed inquiry card for further information.

145 PAL Test Signal Generator
147A NTSC Test Signal Generator
149A NTSC Test Signal Generator
1440 VIRS Automatic Video Corrector
1441 VIR Signal Deleter/Inserter
1478 Calibrated Chrominance Level Corrector
653 SECAM Colour Picture Monitor
653-1 SECAM plus RGB Colour Picture Monitor
656 SECAM plus PAL Colour Picture Monitor
656-1 SECAM plus PAL plus RGB Colour Picture Monitor
657 SECAM plus NTSC Colour Picture Monitor
657-1 SECAM plus NTSC plus RGB Colour Picture Monitor
670 Color Television Picture Monitor

CURVE TRACERS

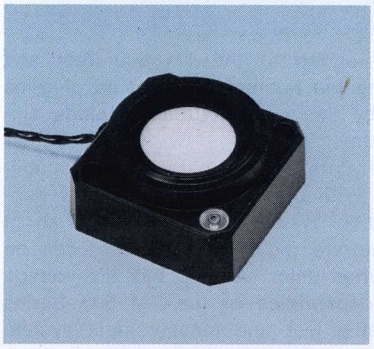


The 577 Curve Tracer is a solid-state system for measuring the parameters of semiconductor devices such as linear ICs, tunnel diodes, zener diodes, signal diodes, rectifier diodes, NPN or PNP transistors, field effect transistors, and silicon controlled rectifiers. The 577 can be used with either the D1 Storage or the D2 nonstorage display module.

Two test fixtures are presently available for the 577. The 178 Linear IC Test Fixture introduces the capability of displaying the characteristics of linear ICs such as: common-mode rejection ratio, power supply rejection ratio, input current, supply current, and 1/F noise. The 177 standard test fixture enables fast, reliable measurements of the characteristics of two-, three- and four-layer semiconductor devices or any device or component for which a voltage versus current plot is desirable.

For complete description of the 577, see page 182.

DIGITAL PHOTOMETER/RADIOMETER



The J6511 Illuminance Probe for the J16 Digital Photometer is designed specifically for the illumination engineer. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces. A multi-layer glass filter and silicon sensor combination ensure a close match to the CIE photopic curve. The response is accurately cosine corrected to simulate an ideal 180° field of view detector. This low-profile probe (1 inch high x 2 inches wide) has a level indicator to enable precise measurements from uneven surfaces where the illumination comes from sources near the horizon. Readout is in footcandles or lumens/m^2 (lux—J6511 opt 2).

The J6512 Irradiance Probe is a low-profile probe corrected to provide a flat spectral response within 7% over the spectral range of 400 to 950 nanometers. Applications include laser research experiments and measurements of radiant efficiency. Readout is in microwatts/cm^2 or milliwatts/m^2 (J6512 opt 2).

The J6514 Uncorrected Probe is a low-profile probe to measure relative light levels. This probe has the widest spectral range because no correction filters are used; the response is

DIGITAL PHOTOMETER/RADIOMETER

that of the UV-enhanced silicon sensor. The J6514 is useful for checking light sources used in photoresist or photoprocessing applications and comparisons of ultraviolet light sources. Each of these probes has an attached 25-foot cable, permitting the user to take readings while effectively being out of the "field of view".

A J16-Color TV Test Package is available to facilitate TV color monitor set-up as described in Tektronix Television Application Note #7.

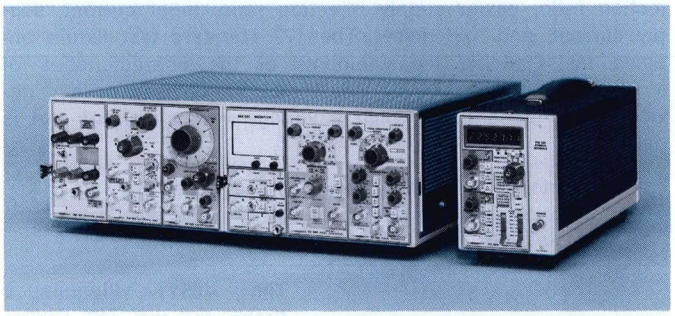
The red, green and blue guns are individually adjusted to predetermined intensities, both at 10 and 100 IRE units. Tracking problems between low and high levels are observable and can be corrected before becoming appreciable.

Two or more similar monitors may be matched for identical color. Exact numbers and procedures are available for adjustment of TEKTRONIX 650 and 670 to D 6500°K.

This package includes the battery-operated J16 Digital Photometer/Radiometer, J6502 Irradiance Probe, Light Occluder, and Probe Extension Cable.

For complete description see page 215.

TM 500 TEST AND MEASUREMENT PRODUCTS



Eleven plug-ins have been added to the TM 500 Test and Measurement Series, bringing the number of available plug-ins to 24. Capabilities added by these new plug-ins include signal processing and waveform monitoring. One new counter and several waveform generators greatly extend the capabilities of the TM 500 Series. With the addition of the new generators, a complete calibration system, which provides all of the signals required to calibrate most oscilloscopes, can be assembled using TM 500-Series units. Add to this the voltage measurement and counter capabilities of the TM 500 Series and you have a very versatile test and measurement system in a minimum of space.

The AM 501 Operational Amplifier is a high-gain unit with a wide output voltage swing centered about zero. It also has a high common-mode rejection ratio and a high slewing rate. Terminals are provided on the front panel for input and output signals and for connection of feedback components or various input loading configurations. Pads are also provided on the circuit board for more permanent mounting of the feedback components or loading configurations.

The AM 502 Differential Amplifier provides high gain with DC coupling and excellent common-mode rejection ratio. Calibrated gain is selectable between X1 and X100,000 with front-panel controls. DC offset capability permits nulling of up to one volt of DC to allow amplification of low-level, low-frequency

TM 500 TEST AND MEASUREMENT PRODUCTS

signals impressed on a DC voltage without the degradation often introduced by AC coupling. Both the upper and lower —3 dB bandwidth points are selectable. A front-panel lamp indicates excessive input signal, gain, or offset.

The DC 505 Universal Counter features direct counting to 225 MHz. Both the A and B channels have equal response to 225 MHz for maximum flexibility in measurement of ratio, width, interval, and events occurring at input A during the width of a pulse at input B. Averaging from 1 to 10^5 cycles is available in ratio, period, interval, and width modes. Clock rate is independently selectable for period, interval, and width measurements with resolution to 10 ns.

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 and can be controlled either from a front-panel dial or electronically swept by an external voltage. The FG 502 can be gated by an external pulse for pulse-burst output.

The MR 501 Monitor is a small CRT, X-Y display monitor which occupies a single TM 500-Series plug-in compartment. The X and Y deflection factors are calibrated at steps of 10 mV/div, 100 mV/div, and 1 V/div and are continuously variable between steps to a maximum of 10 V/div. X and Y bandwidth is 2 MHz with a Z-axis bandwidth of 200 kHz. The CRT has a 6 x 10 division (0.203 inch/div), internal, non-illuminated graticule. The MR 501 can be used with an RG 501 Ramp Generator as a triggered-sweep oscilloscope.

The PG 502 Pulse Generator provides high repetition rates to 250 MHz, narrow pulse width, fast rise and fall time, and independent control of the pulse top and bottom levels. Both the pulse duration and the pulse period can be controlled. The generator may be externally triggered, manually triggered for single pulse operation, and provides a pretrigger output. Other features include selectable square-wave output, complementary pulse output for high duty factors, and selectable back termination in the pulse output circuitry. All other inputs and outputs are terminated internally in 50 ohms.

The PG 505 Pulse Generator provides output pulses up to 80 V and repetition rates to 100 kHz with independent selection of pulse period, duration, risetime, falltime, and amplitude. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. Triggering level from an external signal may be selected at any point between zero and ten volts to provide fully adjustable delay when driven by a signal such as the RG 501 Ramp Generator.

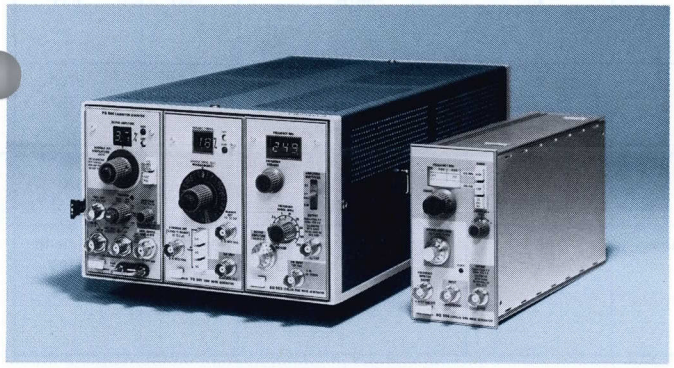
The PG 506 Calibration Generator provides fast, accurate calibration of oscilloscope vertical sensitivity. It features three types of outputs at repetition rates from 100 Hz to 1 MHz. The signals include low-level fast-rise (less than 0.5 ns) square waves of both plus and minus polarities (simultaneously), very clean high-amplitude (up to 60 volts) square waves, and standard amplitude-calibrated square waves from sub-millivolt levels to 100 volts. A unique feature in the amplitude-calibration mode is a variable output combined with a digital readout which directly indicates oscilloscope vertical sensitivity percentage error when the square-wave amplitude is adjusted by the operator for exact alignment with the graticule divisions. A trigger output is also provided in all modes.

TM 500 TEST AND MEASUREMENT PRODUCTS

The SG 503 Leveled Sine Wave Generator provides a regulated, constant-amplitude sine-wave output, variable from 250 kHz to 250 MHz, plus a 50-kHz reference signal. The frequency is indicated by a built-in three-digit frequency counter with LED readout on the front panel. Accurately-calibrated output voltage into 50 ohms is variable from 5 mV to 5 V peak to peak. Frequency modulation by an external signal is possible above 50 MHz.

The SG 504 Leveled Sine Wave Generator provides a regulated, constant-amplitude sine-wave output variable from 245 MHz to 1050 MHz plus a 50-kHz reference signal. A frequency monitor output jack is provided for connection to an external frequency counter or other monitoring instrument. Output voltage into 50 ohms is variable from 5 mV to 5 V peak to peak. The generator may be frequency-modulated by an external signal.

The TG 501 Time Mark Generator speeds calibration of oscilloscope horizontal time bases. It provides highly accurate, crystal-controlled time marks from five seconds to one nanosecond. In addition to the crystal-derived markers, the generator provides variable time markers in conjunction with a front-panel two-digit LED readout. When the operator adjusts the generator so that the markers coincide with the oscilloscope graticule divisions, the readout shows directly the percentage error of the time base. A trigger output is provided for the oscilloscope.



The TM 500 calibration system provides the signals required to calibrate most oscilloscopes. This system consists of the PG 506 Calibration Generator, SG 503 and SG 504 Sine Wave Generators, and the TG 501 Time Mark Generator. Any of the other TM 500-Series plug-ins can be used along with these units to comprise a complete test and measurement system.

Complete description of the AM 501, AM 502, MR 501, PG 502, and PG 505, is given starting on page 218.

For further information on the DC 505, FG 502, PG 506, SG 503, SG 504, and TG 501, return the enclosed inquiry card.

COMPUTER TERMINALS

The following new Computer Terminal Products are available from Tektronix, Inc. An overview of these products is given starting on page 270. Complete information on Tektronix Computer Terminal Products is contained in the 1973 Tektronix Computer Display Catalog. Return the enclosed inquiry card for further information.

4014 Computer Display Terminal
4015 Computer Display Terminal
4023 Computer Display Terminal

DISPLAY PRODUCTS

The 4503 Scan Converter is a low-cost, high-performance instrument which features gray-scale storage, variable persistence, selective erase, and frame freeze. Displayed resolution is 500 lines per picture height with 50% modulation at center screen. Any one of 8 video output line rates can be generated by changing an internal crystal. The sync generator can be externally synchronized for any TV line rate from 525 to 2048 lines.

For complete description of the 4503, see page 267.

The 4632 Video Hard Copy Unit makes facsimile copies from refreshed CRT display terminals or analog TV signals. It accepts video information, consisting either of composite video or separate video and composite sync, and produces a sharp copy of the displayed information.

For complete description of the 4632, see page 266.

CALCULATORS

The TEK 21 and TEK 31 Calculators remove the machine language barrier from programmable calculators. These new calculators provide easy interaction between you and the machine. Natural English-like programming keys and a simple keyboard that does math exactly the way you write it makes operation easy. The TEK 21 and TEK 31 adapt to a wide variety of requirements, including the most sophisticated disciplines.

For complete description of the TEK 21 and TEK 31, see page 276.

PLUG-IN OSCILLOSCOPES

Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
500 MHz†	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	7904 R7903	35 35	$3400* 2900*
250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	7704A opt. 9	39	2400*
200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	7704A	39	2400*
100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	7603	43	1600*
60 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	7403N	49	950*
60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	10 ns	X	5403	100	1175*
50 MHz	5 mV/div at BW 10 μV/div	up to 8 Dual Beam	10 ns	X	556	133	4100*
50 MHz	5 mV/div at BW 50 μV/div	up to 2	10 ns	X	Telequipment D83	164	800*
10 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 8 Dual Beam	50 ns	X	565	120	2100*
10 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	50 ns	X	561B	117	695*
2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual Beam	100 ns	X	5103N/D12 5103N/D13	104 104	870* 1370*
2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns	X	5103N/D10 5103N/D11 5103N/D15	104 104 104	540* 1020* 1095*
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	7603N opt. 11s	46	3025 with plug-ins

*Price does not include plug-ins.

**Bandwidths are realtime, sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

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

DIGITAL PROCESSING OSCILLOSCOPE

The Digital Processing Oscilloscope consists of three basic sections: Acquisition Unit, Display Unit, and Processor Unit. The acquisition and display units, along with any four of the over 30 plug-ins in the 7000-Series family, comprise a high performance oscilloscope. Addition of the processor unit greatly expands the waveform measurement capability. This unit serves as an interface between the oscilloscope and a minicomputer. In addition, the processor provides realtime analog-to-digital conversion, storage of up to four waveforms, scale factors in self-contained core memory, recall and display of stored waveforms.

A wide variety of operations can be performed on waveforms ranging from simple addition or subtraction to sophisticated fast fourier transforms. The computer can send short messages to the oscilloscope user via the CRT.

Through the use of APD BASIC™ software, the most sophisticated routines can be easily programmed. Up to 13 computer-stored measurement routines can be initiated by pressing one of the user-option pushbuttons.

STORAGE OSCILLOSCOPES

Maximum Stored Writing Rate	Maximum View Time	Type of Storage	Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Delayed Sweep	Plug-in	Model Number	Page	Price
220 div/μs 30 div/ms 0.5 div/μs	until erased until erased 1 min	Fast Bistable Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7623 opt. 12	55	$3350*
100 div/μs 30 div/ms 0.5 div/μs	until erased until erased 1 min	Fast Bistable Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7623	55	2850*
5 div/μs	60 min	Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7613	57	2500*
5,000 div/ms	4 hrs	Split-screen Bistable	25 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7313	59	2000*
20 div/ms	10 hrs	Bistable	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	5103N/D11	104	1020*
200 div/ms	10 hrs	Bistable Dual-Beam	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	5103N/D13	104	1370*
800 div/ms	10 hrs	Bistable	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	5103N/D15	104	1095*
500 div/ms	1 hr	Bistable Split-screen	10 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	564B	118	1195*
5,000 div/ms	4 hrs	Bistable	25 MHz	10 mV/div at BW 1 mV/div	up to 2			434	150	2150
500 div/ms	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			214	155	985
250 div/ms	1 hr	Bistable	10 MHz	10 mV/div at BW 1 mV/div	up to 2			Telequipment DM64	164	1095

*Price does not include plug-ins.

**Bandwidths are realtime, sampling plug-ins that extend bandwidths to 14 GHz are available for most mainframes.

R7912 TRANSIENT DIGITIZER

The R7912 Transient Digitizer can acquire fast singleshot or repetitive signals and convert them to much slower digital or analog signals.

In the digital mode, the R7912 operates as a fast analog-to-digital converter. It takes up to 512 samples of a waveform in a time window as short as 5 ns. This digital information can be stored in an optional memory or sent to a computer for processing. Using a D/A converter, the digitized signal may be displayed on a storage display monitor such as the Tektronix 613. A Software Operating System is available from Tektronix, Inc. for control of the computer. In the TV mode, the R7912 processes waveforms into a TV compatible analog format (525 lines, 60 Hz field, 2:1 interlace) for bright, large-screen displays on one or more conventional TV monitors such as the Tektronix 630 Series Picture Monitors.

Signals are acquired with standard 7000-Series plug-ins. This provides a very flexible and versatile signal acquisition system, allowing a choice of over 30 plug-ins, as well as compatibility with the many other instruments in the 7000-Series family.

Several options are available to expand the usefulness of this system. An optional core memory allows the acquired waveform to be stored in the R7912 for later sequence into a computer or into permanent memory such as a digital tape system. An electronic graticule option allows an electronically generated dot-pattern graticule to be stored and displayed along with the signal.

The R7912 is designed to be mounted in a rack along with the computer, monitor, or other equipment. It requires only 5¼ inches of rack height.

PORTABLE OSCILLOSCOPES

Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
350 MHz	5 mV/div at BW	X	1 ns/div	X	485	142	$4200
200 MHz	2 mV/div at BW	X	1 ns/div	X	475	146	2500
100 MHz	5 mV/div at BW	X	5 ns/div	X	465	146	1725
25 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div		434	150	2150
25 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div		432	150	1585
15 MHz	10 mV/div at BW 1 mV/div	X	50 ns/div		422	153	1600
10 MHz	10 mV/div at BW 1 mV/div	X	100 ns/div		326	157	1725
10 MHz	10 mV/div at BW 2 mV/div		200 ns/div		324	159	1325
4 MHz	10 mV/div at BW 1 mV/div		500 ns/div		323	161	995
500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		214	155	985
500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		212	155	725
500 kHz	10 mV/div at BW 1 mV/div		1 μs/div		211	155	545

NON-PLUG-IN OSCILLOSCOPES

Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
25 MHz	10 mV/div at BW	X	40 ns/div	X	Telequipment D67	165	$975
25 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div		Telequipment D66	165	795
10 MHz	10 mV/div at BW	X	40 ns/div		Telequipment D54	165	595
10 MHz	10 mV/div at BW		40 ns/div		Telequipment S54A	166	450
3 MHz	100 mV/div at BW		≈500 ns/div		Telequipment S51B	166	245

BEHIND THE FRONT PANEL . . .

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

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

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

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

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

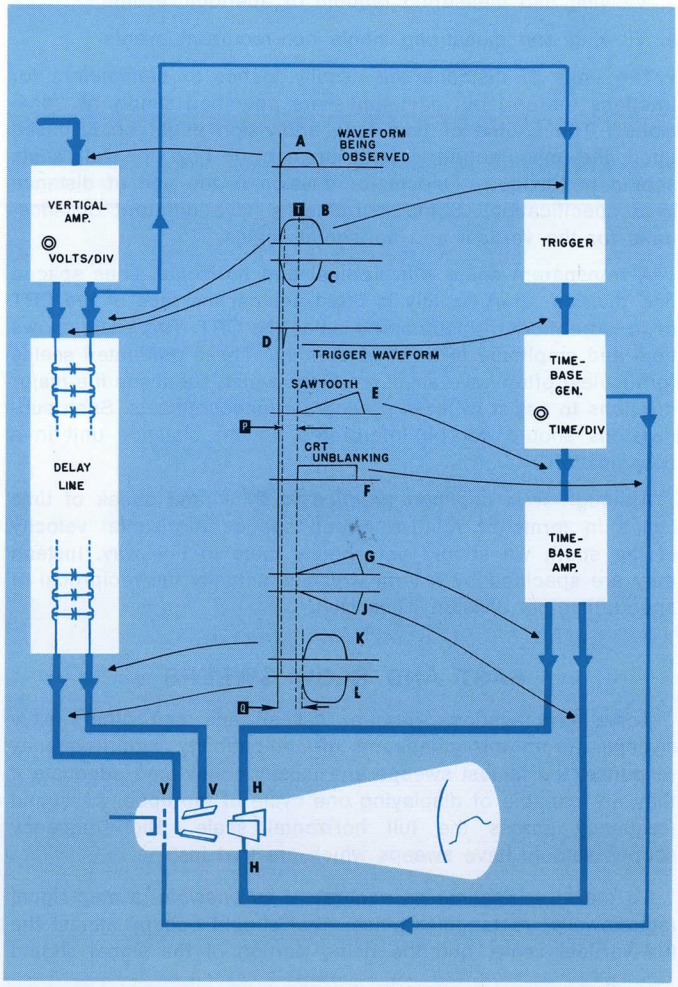
A rectangular "unblanking" wave *(F)* derived from the time-base generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds to the duration of the positive-going or run-up part of the time-base output, so that the beam is switched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

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

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

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

THE OSCILLOSCOPE BLOCK DIAGRAM



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

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

SCALES AND SWEEPS

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

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

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

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

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

FAST AND SLOW SWEEPS

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

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

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

SINGLE-SWEEP OPERATION

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

SWEEP MAGNIFICATION AND SWEEP DELAY

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

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

DELAYING SWEEP

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

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

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

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

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

SWEEP SWITCHING

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

RISETIME AND HIGH-FREQUENCY RESPONSE

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

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

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

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

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

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

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

SWITCHED INPUTS AND DUAL-BEAM SCOPES

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

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

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

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

The chopping rate (frequency) should be as high as possible so long as the resulting traces are not broadened significantly by distortion of the chopping signal. When the chopped mode is used with relatively fast non-recurrent sweeps, the traces are not continuous but are made up of separate segments, the number of segments depending on the chopping rate and the sweep duration. For instance, if the chopping rate is 1 MHz and the sweep duration is 0.1 millisecond, there will be 100 segments in each trace. How well these separate segments depict all the detail in the two waveforms establishes the limits of usefulness of the chopped mode compared to an alternately-switched display or a dual-beam scope.

DIFFERENTIAL, BALANCED OR PUSH-PULL INPUTS

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

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

COMMON-MODE REJECTION

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

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

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

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

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

FACTORS WHICH AFFECT CMRR

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

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

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

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

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

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

"SUMMING" INPUTS

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

DIGITAL PROCESSING OSCILLOSCOPE

The Digital Processing Oscilloscope is a new concept in measurement capability. It is general purpose—consisting of a general purpose plug-in oscilloscope and a general purpose mini-computer. Fingertip selection of complex calculations provides results in seconds. For more information, refer to page 26.

TRANSIENT DIGITIZER

The Transient Digitizer combines computer intelligence with the flexibility and performance of the 7000-Series acquisition units (plug-ins). Single events with subnanosecond and longer risetimes or recurring events can be acquired, displayed, and digitized. For more information, refer to page 30.

SAMPLING OSCILLOSCOPES

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

The sampling method, however, provides a means for examining fast-changing signals of low amplitude that cannot be examined in any other way. The system is capable of resolving events that occur in less than 30 picoseconds, on an "equivalent" time base of less than 20 picoseconds per division and which have less than 5 mV of peak amplitude.

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

1. Signals with no source of pretrigger can be observed.
2. The inherent risetime 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 prior to, 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.

The main limitation of random sampling is that the signal repetition rate must not be too low.

TIME-DOMAIN REFLECTOMETRY

Maintaining the fidelity of electronic signals that have to be transmitted from point to point is of concern to many who design, build, and maintain electronic equipment. The coaxial transmission line is most commonly used for communications work. Determining transmission line performance may vary from a simple visual inspection to use of elaborate instrumentation that requires a great deal of skill and time. Time-Domain Reflectometry is a sophisticated but simple technique of identifying and locating trouble spots.

A time-domain reflectometer is basically like radar, employing a pulse generator and a display device for reflections. The pulse generator output is coupled to the vertical input of the displayed device and to the one end of the coaxial cable under test. The pulse travels down the cable and any discontinuities it encounters causes voltage to be reflected and displayed. TDR not only identifies a discontinuity . . . it locates it in time and distance.

STORAGE OSCILLOSCOPES

Storage CRT's have the ability to retain and display the image of an electrical waveform on their tube face after the waveform ceases to exist. This image retention may be for only a few seconds or it may be for hours. The stored display may be erased to make way for storage of a later waveform. Storage tubes may also be operated as conventional (non-storage) tubes.

Storage oscilloscopes allow easy, accurate evaluations of slowly changing phenomena that would appear only as a slow moving dot and of rapidly changing nonrepetitive waveforms whose image would flash across the CRT. 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.

TEKTRONIX oscilloscopes use three types of storage CRT's —the TEKTRONIX proprietary bistable phosphor storage tube, a new fast transfer tube, and a variable persistence tube.

Recent developments in transmission storage tubes at Tektronix, Inc. have resulted in a very fast stored writing speed — 222 div/μs or 200 cm/μs. Although similar types of storage have been used for storing relatively slow signals, Tektronix, Inc. has refined the techniques to make them applicable to storage of high-speed oscilloscope displays.

The fast transfer CRT is a mesh tube with a normal (P31) phosphor. This CRT has four modes of operation — fast transfer, bistable, variable persistence and nonstore. Fast transfer storage is unique for the storing and long-term viewing of fast, nonrepetitive signals. The waveform will remain visible until erased.

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

Applications for variable persistence storage are with 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 only those portions of a repetitive signal which are coincident are displayed. Any aberration or jitter which is not common to all repetitive traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed. This type of storage provides the best display when storing displays which have varying intensities, such as delayed sweep or with Z-axis intensity modulation. Variable persistence provides very good photographs due to the contrast of dark background and bright waveforms when in the stored mode.

The bistable mode allows waveforms to be stored and displayed until erased.

The bistable phosphor CRT utilizes a special phosphor having two stable states — written and unwritten. Bistable phosphor CRT's have two modes of operation — storage or conventional.

Bistable phosphor CRT's have a split-screen viewing area which allows each half to be used individually for storage displays. The split-screen feature provides many unique applications. 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 with only the reference portion operating in the stored mode and the other half in nonstore. A unique application of this split-screen technique has been in speech therapy where 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. Of course with split-screen operation, the lower half may be erased as many times as desired without affecting the stored upper screen.

SPECTRUM ANALYZERS

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

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

PLUG-IN OR NON-PLUG-IN

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

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

Other types of mainframes may also contain the vertical-deflection amplifier and the entire horizontal-sweep circuit. With this type, only a vertical preamplifier is contained in a plug-in unit (550 Series). Still another type of mainframe may contain the horizontal-sweep amplifier and the vertical-deflection amplifier in which case the vertical preamplifier is contained in one plug-in unit, and the time base or sweep generator is contained in another plug-in unit. This is the design of the 7000, 5100, and 5400 Series. The 5100 and 5400 Series accept two vertical preamplifiers and one time base; the 7000 Series, two vertical preamplifiers and one or two time bases.

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

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

Turn to pages 8 thru 10 for a brief description of the outstanding features offered by each oscilloscope series.

ENVIRONMENTAL CHARACTERISTICS

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

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

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

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

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

CATHODE-RAY TUBE PHOSPHOR DATA

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option.

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 peaked in its response in the yellow-green region and falls off on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

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

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

Phosphor Burning

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

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

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

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

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

PHOSPHOR DATA CHART

Phosphor	Fluorescence	Phosphorescence Where Different From Fluorescence	Relative Luminance[1]	Relative Photographic Writing Speed[2]	Decay to 0.1% (in ms)	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	—	50%	20%	95	Medium	Replaced by P31 in most applications.	71
P2	Bluish-green	Yellowish-green	55%	40%	120[3]	Medium high	Good compromise for high- and low-speed applications.	72
P4	White	—	50%	40%	20	Medium high	Television displays.	74
P7	Blue	Yellowish-green	35%	75%	1500[3]	Medium	Long decay, double-layer screen.	76
P11	Purplish-blue	—	15%	100%	20	Medium	For photographic applications.	78
P31	Yellowish-green	—	100%	50%	32	High	General purpose, brightest available phosphor.	80

[1]Taken with a Spectra Brightness Spot Meter 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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

dual beam—A multi-trace cathode-ray tube which produces two separate electron beams that may be individually or jointly controlled. In contrast to dual-trace operation, waveforms are not chopped or switched, they are generally brighter and have minimum phase-relationship error.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Introduction

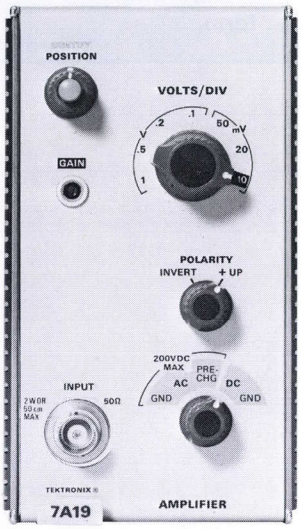
TEKTRONIX 7000 Series

Tektronix, Inc. has always sought to provide products and services which are superior—those which excel in today's technology and have the growth potential for the tomorrows. We believe that such criteria safeguard your instrument investment and work to our mutual best interests. The 7000-Series products and accessories described in this catalog meet these criteria. They offer more performance than any other general-purpose plug-in oscilloscope system available. And there is room for additional growth.

In developing the TEKTRONIX 7000 Series we pioneered many instrument concepts. Their implementation into the 7000 Series provides a degree of flexibility, versatility, and operating convenience not available in any other oscilloscope system. Yet, the 7000-Series prices are very competitive.

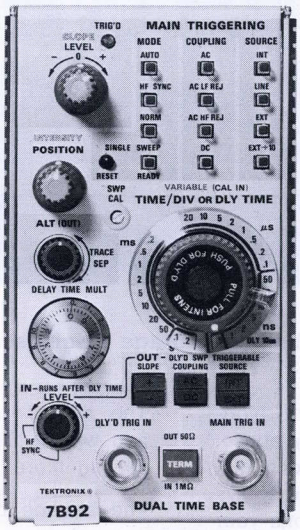
Please read the next 6 pages. They describe the overall advantages and features of the Tek 7000 Series and tell why the 7000 Series is more than just an oscilloscope. The pages following describe and list the specifications for the mainframes and plug-ins.

. . . more than just an oscilloscope . . . it's superior performance in real-time measurements.



500 MHz

The Single-Trace 7A19 Amplifier delivers the widest-real-time-bandwidth presently available when used in combination with either the 7904 or the 5¼-inch rack-mount R7903. A variable delay option for the 7A19 allows you to match the channel transit times (thru the probe and plug-in) to better than 50 ps.

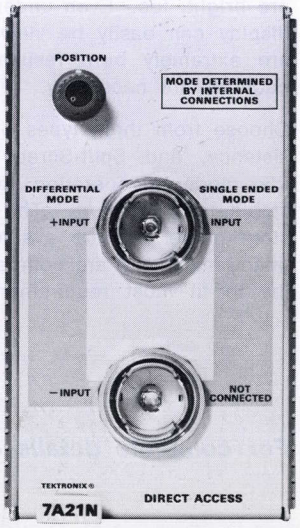


500 ps

The exceptionally fast sweep speed of the 7B92 matches the ultra-high bandwidth of the 7904/R7903 mainframes. Four display modes contribute more to the superior performance of the overall package. They are normal, intensified delaying sweep (controllable contrast), delayed sweep and alternate. Alternate mode, when selected, displays the main sweep with the intensified portion and the delayed waveform at the same time.

1 GHz

Use the 7900 CRT up to its maximum bandwidth with the 7A21N. Install the vertical amplifier bypass cables and circuit boards and plug in the 7A21N. The 50-ohm input (single ended or differential) is directly coupled to the CRT for 20-kHz to 1-GHz BW with a 350-ps T_r. The deflection factor is less than 4 V/div. When using the 7A21N the Vertical Amplifier functions are bypassed and the CRT READOUT is inoperative.



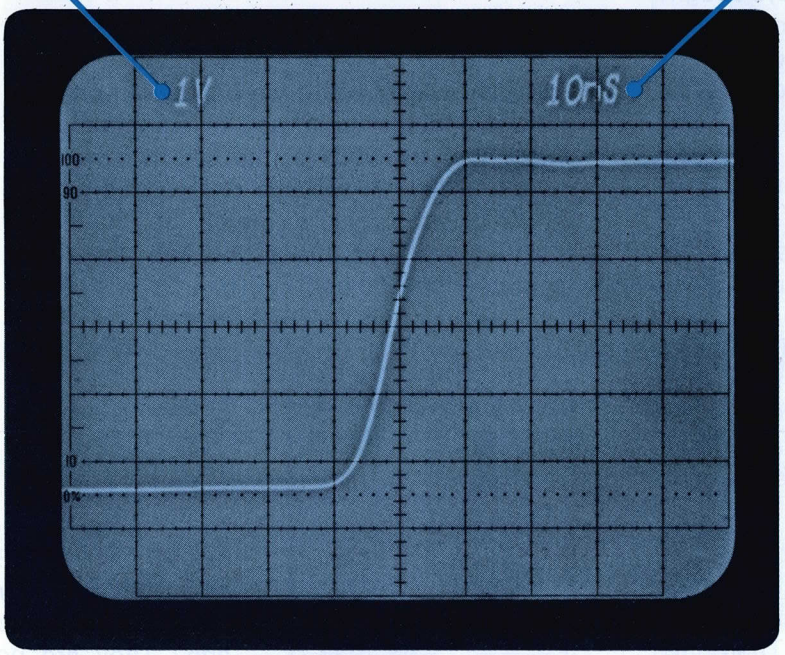
For complete details on fast-signal acquisition, see pages 30 thru 38.

. . . more than just an oscilloscope . . . it gives you superior performance in storage.

Selected vertical sensitivity (in this case 1 V) is conveniently stored along with the waveform.

- **FAST STORED WRITING SPEEDS**
- **LONG VIEW TIMES**
- **BRIGHT DISPLAYS**
- **EXTREMELY BURN RESISTANT CRT's**

This fast-rise pulse is stored at a sweep speed of 10 ns/div (0.9 cm/div) or a writing speed of over 200 cm/μs.



7623 Multimode Storage Oscilloscope

TEKTRONIX 7000-Series Storage offers you excellent high-speed trace retention ability as exhibited by the display above. And, directly coupled to this fast storage ability are long display times, 10's of hours, even days if necessary. The displays are bright, too. Even under high ambient light conditions your display can easily be viewed. All TEKTRONIX Storage CRT's are extremely burn resistant, and no special operating precautions are necessary.

Choose from three types of storage: Multimode, Variable Persistence, and Split-Screen Bistable. Multimode storage has four modes of operation: fast bistable, variable persistence, bistable, and nonstore. The other two types also have a nonstore mode. All are available in either cabinet or rackmount mainframes, and are compatible with a large selection of plug-ins to fit most requirements.

The list of measurement requirements increases every day, and with it, TEKTRONIX 7000-Series storage oscilloscopes are solving more and more of these needs.

The storage oscilloscope's long display retention feature lets you: view a nonrecurrent signal, compare changes in a given signal with respect to time or environment, compare two or more signals occurring at different times or at different places, view low repetition rate signals without annoying flicker, and view very slowly moving traces so that the entire trace is displayed.

Moreover, storage oscilloscopes give advantages over conventional oscilloscopes not normally thought of. These include the ability to: view, in normal ambient light, a signal that otherwise would be too dim to see, view a noisy signal with an effectively reduced noise level, enhance other trace-recording techniques such as photographing the display, and (in many cases) even replace alternative recording techniques such as oscillographic recorders.

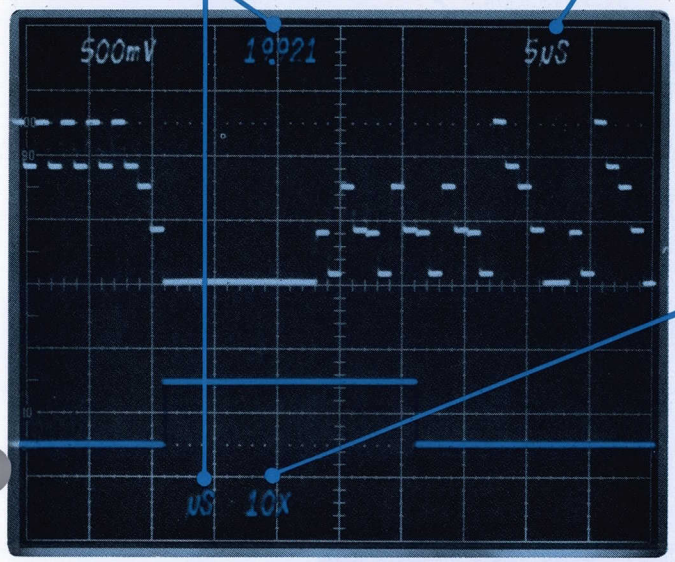
For complete details on storage, see pages 30 thru 33 and 52 thru 60.

. . . more than just an oscilloscope. It's also a . . .

- UNIVERSAL COUNTER/TIMER
- 525-MHz DIRECT FREQUENCY COUNTER
- DIGITAL MULTIMETER WITH TEMPERATURE MODE
- DIGITAL DELAY BY TIME AND EVENTS
- VERSATILE 0.01% A/D CONVERTER WITH VERTICAL AMPLIFIER

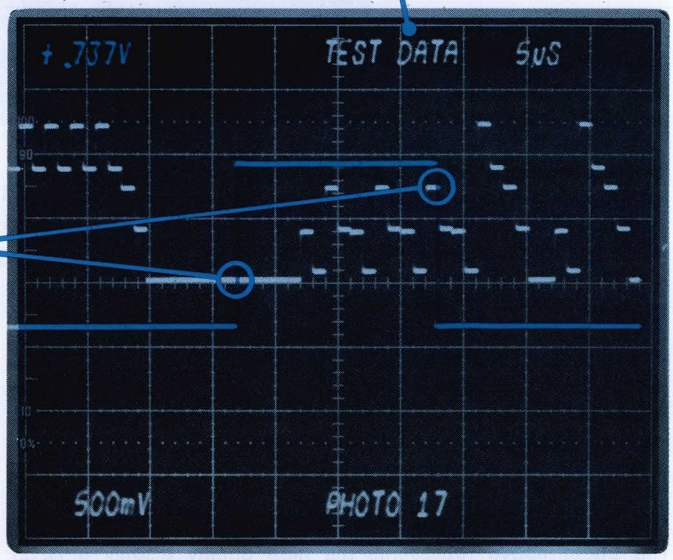
A 7D15 Universal Counter/Timer measures a time interval of 19.921 μs, accurate to within 0.1%. (Lower trace, highlighted in blue, is the counter's measurement interval.)

With a sweep speed of 5 μs/div you can compare the digital measurement with the analog display. However, the analog display accuracy is 2% while the digital measurement accuracy is 0.1%.



The 10X readout indicates the 7D15's measurement average. A range of averages in decade steps is available from 1X to 1000X. Increasing the averages by a factor of 10 increases the accuracy a factor of 10.

A 7M13 Readout Unit identifies this waveform as TEST DATA—PHOTO 17.



A 7D12/M2 Sample and Hold DVM measures a difference voltage of +0.737 V between two points (indicated by blue dots) on a complex waveform. The 7D12/M2 display gate (highlighted in blue) is gated externally to permit independent control of each point.

TEKTRONIX 7000-Series digital plug-ins provide many unique and superior measurement capabilities for solving today's complex measurements. Together, with a 7000-Series mainframe, they give you the advantage of seeing what you're measuring and the accuracy of digital techniques.

Combining digital measurement capabilities with the 7000-Series mainframe brings you many advantages over separate test units:

- scope-controlled digital measurements
- see what you're counting
- measuring convenience and confidence
- increased accuracy
- easier and faster solutions to complex problems
- fewer dollars invested
- more bench working space
- signal conditioning

Add to these, the new dimension of scope-controlled measurements and you realize that the 7000 Series is more than just an oscilloscope.

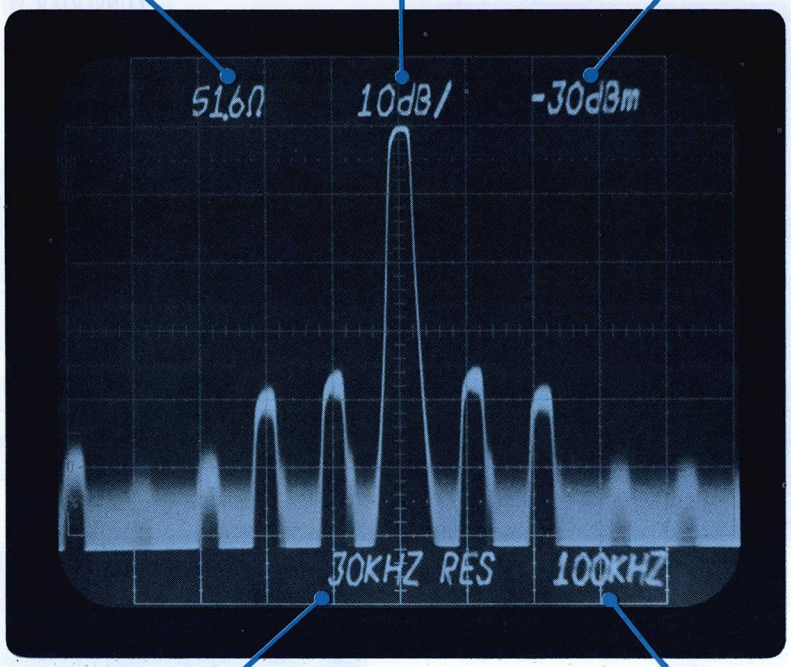
For complete details on the Digital Plug-ins, see pages 74 thru 82.

. . . more than just an oscilloscope . . . it provides superior spectrum analyzer displays from 0 to 1800 MHz.

7D13 Digital Multimeter (extra plug-in) measures 51.6 Ω on a test termination

Y-axis calibration 10 dB per division

Reference level at top line —30 dBm



7623 Storage Oscilloscope/7L12 Spectrum Analyzer

Resolution bandwidth 30 kHz

Frequency span 100 kHz per division

The photo above represents the high quality display a 7L12/7000-Series mainframe produces. The 7L12 combines with any 7000-Series mainframe to make an absolutely-calibrated spectrum analyzer.

Spurious-free measurements are an outstanding ability of the 7L12. Products of intermodulation in the 7L12 are substantially more than 70 dB below full screen.

When the 7L12 is used in a four-plug-in compartment mainframe, you can employ both time & frequency-based displays simultaneously. This is a very powerful measurement system for measurements such as pulsed RF analysis.

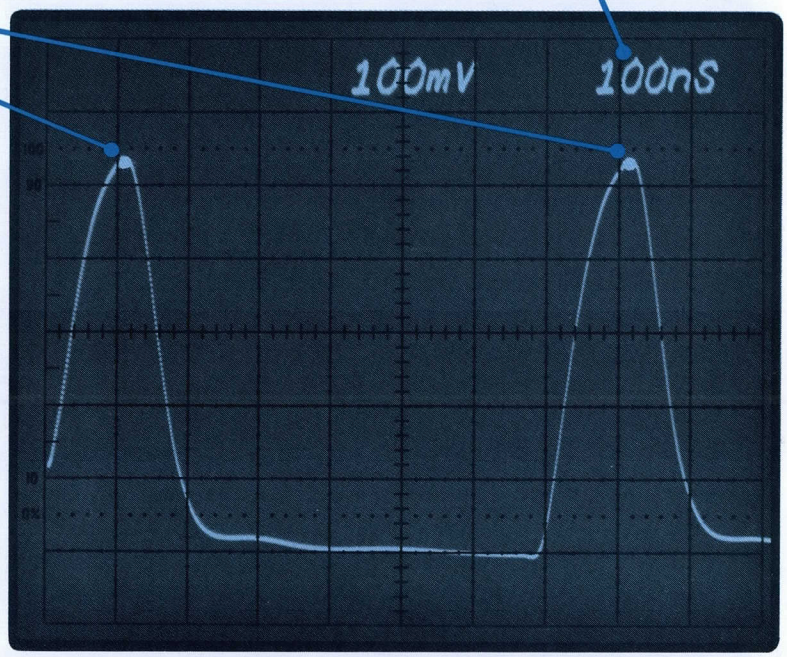
The CRT READOUT located on the upper and lower portions of the CRT photo above is an extremely helpful measurement aid. It displays analyzer parameters, as well as others, right on the CRT where you see, measure and record your data.

For complete details on spectrum analysis, see pages 167 thru 179.

. . . . more than just an oscilloscope . . . . it gives you superior performance in sampling and high-resolution TDR.

The bright dots positioned at the peak of each pulse indicate the time between peaks more accurately than CRT-scale interpolation. The time is read from a DTM dial.

Horizontal time is calibrated in μs, ns or ps. The risetime of the 7S14 is 350 ps.



7313 Storage Oscilloscope/7S14
Dual Trace Delayed Sweep Sampler

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

TEKTRONIX 7000-Series sampling plug-in units provide some unique and important measurement capabilities not available in other sampling oscilloscopes. Compared to conventional scopes, you can get better bandwidth, distortionless overscan, and the capability of chart records from your trace.

Also, consider these advantages compared to other sampling scopes:

- Low cost storage CRT for slow scans
- Random Mode; see leading edges without pretrigger or bandwidth-limiting delay line
- Sampling and conventional at the same time
- Sampling Head Versatility (7S11, 7S12)
  - —Wide choice, minimal cost
  - —Dual trace if and only if you need it
  - —Dual trace with different type heads
  - —Extendable or plug-in

For complete details on Sampling and TDR, see pages 83 thru 97.

the CRT . . . superior performance in data display

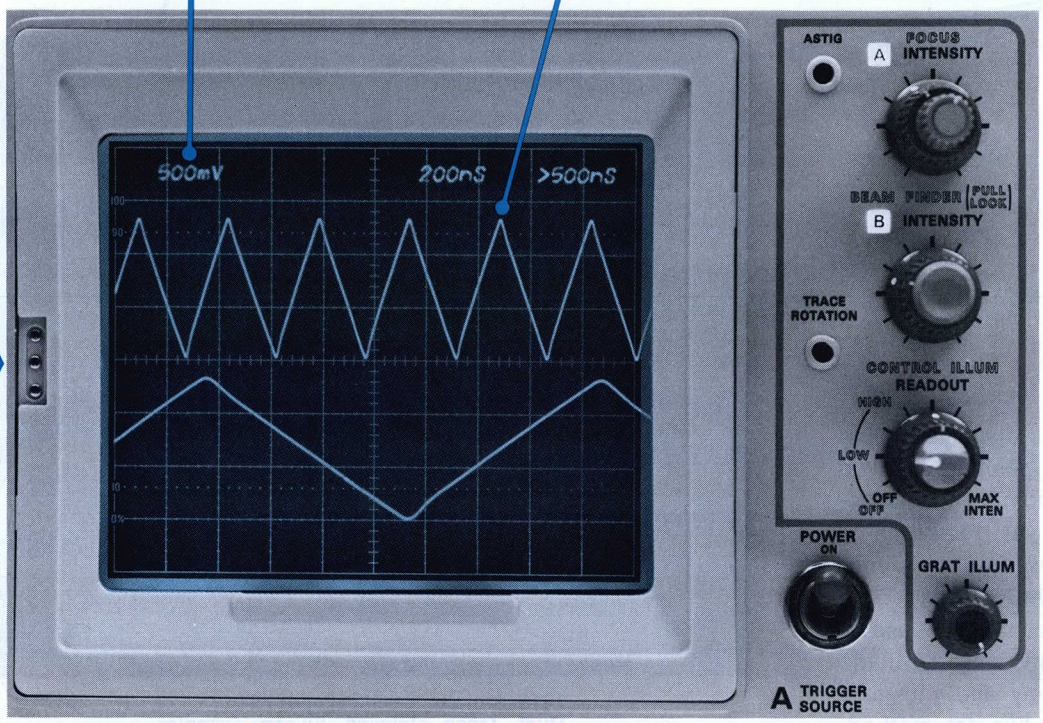
CRT READOUT really tells you the full story. It takes the guesswork out of oscilloscope measurements by displaying the measurement parameters right on the CRT. Look at it, photograph it, and you'll find that with CRT READOUT you can make your measurements a lot quicker, easier and with increased accuracy.

Bright Trace

The 7000-Series Oscilloscope CRT's are very bright and have excellent photographic writing speeds. For applications requiring maximum writing speeds most mainframes have an optional 4 cm x 5 cm reduced-scan CRT.

Large Display

The display area is 8 cm x 10 cm with a parallax-free, illuminated graticule. The 7603 and 7403N have a 10 cm x 12 cm area. The optional fast writing speed, reduced-scan CRT's have a 4 cm x 5 cm area.



Three intensity controls allow independent adjustment of "A" sweep, "B" sweep, and READOUT brightness. When making measurements, you adjust the intensity of each sweep to the level that's best for your applications.

Auto focus—after the focus is initially set, an autofocus circuit reduces the need for additional manual adjustments assuring a focused trace with changes in intensity.

Adjustable graticule illumination means easier viewing and better photos.

Camera power and control signals are conveniently available. A standard bezel connector matches all TEKTRONIX C-50-Series Cameras and 7000-Series mainframes.

Operator convenience is a user's byword for the 7000 Series. All the display controls are aimed at one area, the CRT. Here everything is brought together and operation is made easier.

Wrong answers due to overlooked control settings are now passé. More speed, perception and convenience is realized because the CRT READOUT actively displays your measurement parameters.

Your measurement data is all put together on the CRT in a TEKTRONIX 7000-Series Oscilloscope.

the mainframe . . . superior performance in data acquisition

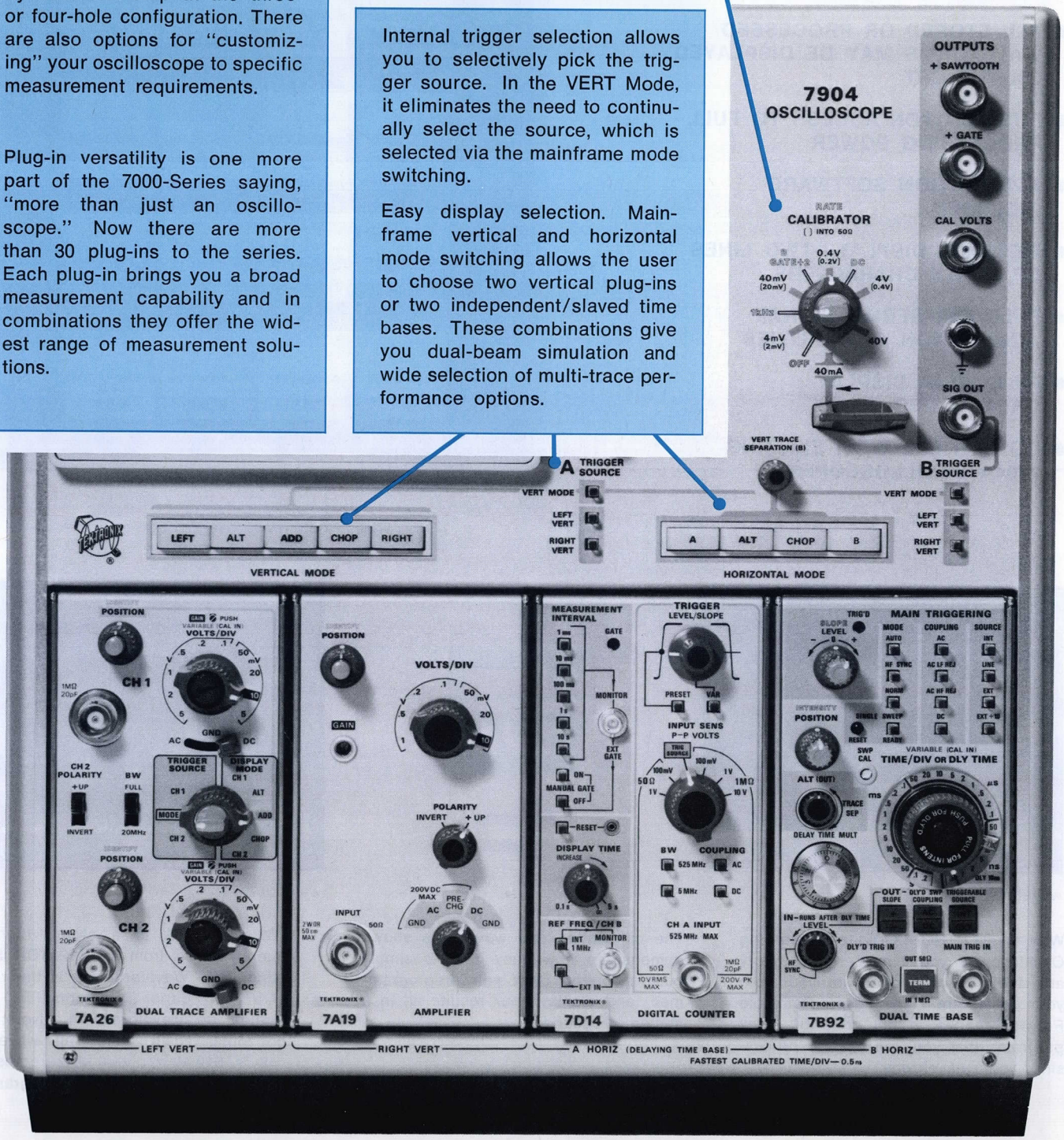
Flexibility begins with the mainframe, and the addition of the 7000-Series plug-in versatility results in more measurement solutions than offered by any other oscilloscope. Mainframe flexibility does not stop at the three- or four-hole configuration. There are also options for "customizing" your oscilloscope to specific measurement requirements.

Plug-in versatility is one more part of the 7000-Series saying, "more than just an oscilloscope." Now there are more than 30 plug-ins to the series. Each plug-in brings you a broad measurement capability and in combinations they offer the widest range of measurement solutions.

The Calibrator . . . a multi-function generator. A "standard" for calibrating plug-ins and compensating probes. Signal outputs are also available to use when a signal generator is not handy.

Internal trigger selection allows you to selectively pick the trigger source. In the VERT Mode, it eliminates the need to continually select the source, which is selected via the mainframe mode switching.

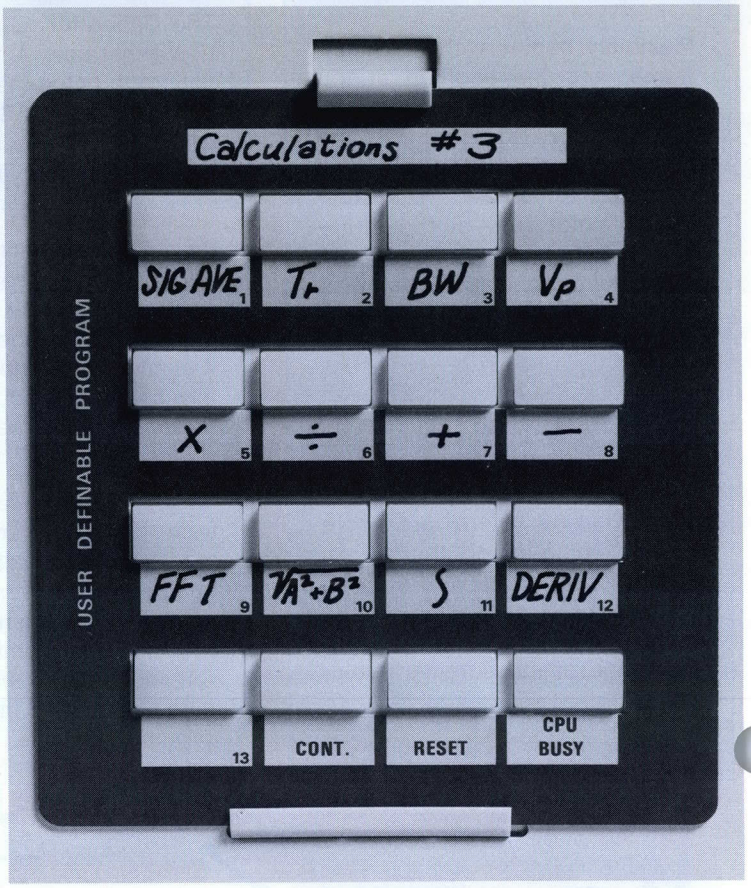
Easy display selection. Mainframe vertical and horizontal mode switching allows the user to choose two vertical plug-ins or two independent/slaved time bases. These combinations give you dual-beam simulation and wide selection of multi-trace performance options.

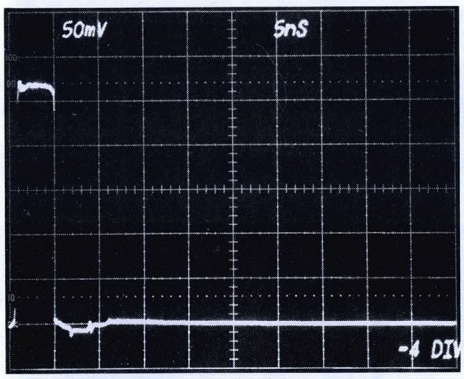


New

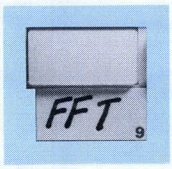
your choice of completely new measurement capabilities with the Digital Processing Oscilloscope.

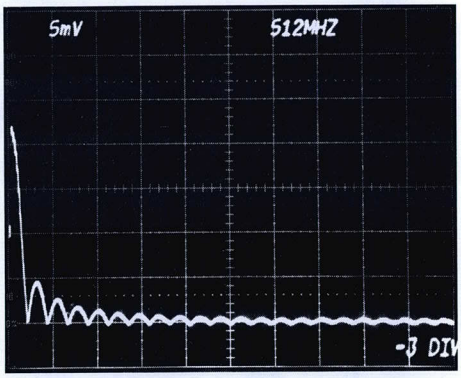
- **ANY WAVEFORM ON THE DISPLAY MAY BE STORED IN MEMORY AND PROCESSED**
- **ALL STORED OR PROCESSED WAVEFORMS MAY BE DISPLAYED ON THE CRT**
- **PUSH-BUTTON ACCESS TO FULL PROCESSING POWER**
- **APPLICATION SOFTWARE INCLUDED**
- **MESSAGE DISPLAY—TWO LINES OF FORTY CHARACTERS**
- **FULL 7000-SERIES SIGNAL ACQUISITION CAPABILITIES**
- **FULL 7704A DISPLAY CAPABILITIES**
- **COMPATIBLE WITH EXISTING 7704A OSCILLOSCOPES**





waveform #1





waveform #2

With the TEKTRONIX Digital Processing Oscilloscope you can perform nearly any type of calculation derived from your waveform. The User Definable Program above is only one of many programs that you can use for processing your waveforms.

The calculation and waveforms shown demonstrate how easy it is to simply push a button (that you preprogrammed) and display your results all in a matter of seconds.

Waveform #1 is a stored high-frequency pulse from a 7S12 TDR Sampling unit. Waveform #2 is the result of a Fast Fourier Transform (FFT) performed on waveform #1. Note: the horizontal scale factor on waveform #2 is 512 MHz/div (0 MHz represents left edge of CRT, 5.12 GHz represents right edge of CRT).

processing . . . the 7000-Series Oscilloscope's new link between acquisition and display.

Display Module—This portion is the top half of a 7704A Oscilloscope System. All data, digital and analog is displayed on its CRT.

Processing Module—This portion and its accompanying PDP-11/05 minicomputer (bottom of SCOPE-MOBILE® cart) along with included software perform analog-to-digital conversions and mathematical operations on variables derived from your waveforms.

Acquisition Module—This portion is the lower half of the 7704A Oscilloscope System. All the 7000-Series plug-ins are compatible for signal acquisition, and greatly contribute to the vast measurement solving power of the Digital Processing Oscilloscope.

Just how significant is this new measurement capability? Very, very significant, because if your variables in a calculation are obtained from waveforms on an oscilloscope, then the Digital Processing Oscilloscope will provide you with your answers. And, you get the advantages of speed, accuracy, lower-cost and convenience over alternate techniques. Often these advantages are so large that alternate techniques will not exist.

The waveform examples on the preceding page dramatize the before-and-after results you can achieve with push-button ease. How many calculations can be performed? We know for sure, that the amount is beyond our ability to count today.

The configuration of your Digital Processing Oscilloscope is determined by your application. For the optimum system and the various unit prices, please consult with your local Tektronix Field Engineer. The configuration shown consists of a 7704A oscilloscope system, a P7001 Processor, vertical plug-ins 7A12, 7A16A, horizontal plug-ins 7B71, 7B72, a DEC PDP-11 computer, and a SCOPE-MOBILE® cart.

The price of this system is $19,245.

TEKTRONIX 7000 Series
. . . more than just an oscilloscope

New

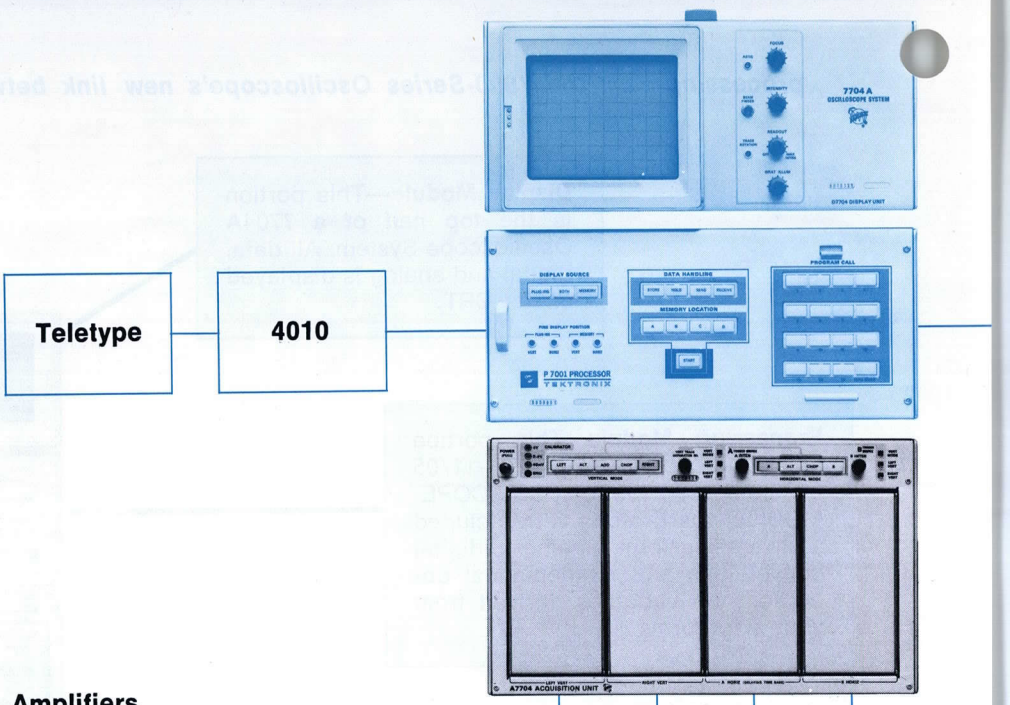
the acquisition system . . .

The TEKTRONIX A7704 Acquisition unit accepts up to four 7000-Series plug-in units. The 7000-Series plug-in family introduced in 1969 now includes 32 plug-ins with more to come. An enormous range and variety of signals may be captured for digital processing. Conventional plug-ins include eight single-trace amplifiers, two dual-trace amplifiers, four single time base units and two dual time base units. Other plug-ins include four digital units, three sampling units, a general-purpose sampling and Time Domain Reflectometry (TDR) unit, a general-purpose sampler, and a spectrum analyzer.

The single- and dual-trace vertical amplifier plug-ins have sensitivities ranging from 10 microvolts per division to many kilovolts per division. Since most all TEKTRONIX Signal Acquisition Probes are usable, signal amplitudes up to 40 kV peak values may be accepted. Signal bandwidths as wide as DC to 175 MHz are available in conventional plug-ins. Sampling offers up to 14 GHz bandwidths.

The single time bases available may be operated alone or in pairs when delaying sweep operation is desired. The two dual time base units offer single and delaying sweep operation in a single width plug-in, thereby leaving one horizontal plug-in compartment for other uses. Calibrated sweep speeds range from as fast as 2 ns per division to 10 s per division. Flexible trigger circuits with push-button selection of triggering modes permit accurate and easy triggering.

The four digital plug-in units offer a digital delay with digital delay readout, a digital multimeter capable of measuring DC volts, DC current, resistance and temperature, a 525-MHz digital counter and a universal counter timer which offers oscilloscope control of time and frequency measurements. While these units provide no analog signal on the display unit the results of the digital measurements are visible on the CRT readout. All information visible on the CRT is accessible to the processing system. Therefore, the

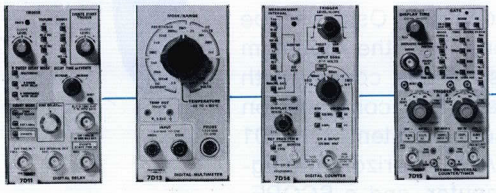


Amplifiers

Amplifiers

Dual-Trace Amplifiers

Digital Plug-Ins

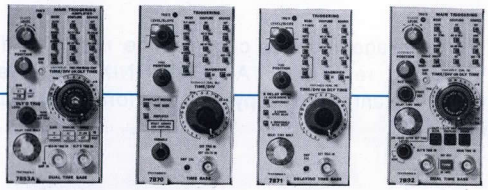


Acquisition System lets you choose functions for 4 separate channels

PDP-11/05

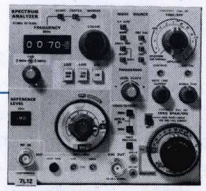
Nova

Time Bases



Sampling Plug-Ins

Spectrum Analyzers



TDR

and more plug-ins on the way

digital measurements may be computer processed either alone or in conjunction with P7001 digitized waveform information.

The sampling vertical amplifier and time base units may be operated to provide single- or dual-trace operation at bandwidths from DC up to 14 GHz. The TDR plug-in is used for high resolution cable fault testing with a system risetime of 45 ps and cable distances ranging to 32 feet in any cable. The spectrum analyzer plug-in unit permits fully calibrated frequency displays over a range of 0 to 1800 MHz.

The A7704 Acquisition unit will operate with any combination of up to four of the plug-in units. For time based measurements a vertical amplifier unit and a time base may be paired. At the same time if one parameter is to be plotted as a function of another, a vertical plug-in unit may be installed in a horizontal position of the acquisition unit for an X-Y plot display. X-Y displays may be directly stored for processing provided that Y is a single valued function of X. This ability to use different plug-ins to meet differing requirements provides extreme flexibility. As new 7000-Series plug-ins are announced, this flexibility will further increase.

The Digital Processing Oscilloscope will be useful for those doing research and development measurement work in other than electronic fields such as optics, chemistry, physics, mechanical studies, fluidics, pressure studies, etc. The use of suitable transducers ahead of a vertical amplifier plug-in unit permits quick, easy computer processing of information in many fields. A single Digital Processing Oscilloscope may serve in lieu of many different highly specialized and expensive measuring systems by reconfiguring software and signal acquisition units.

for complete information on the Digital Processing Oscilloscope check the reply card next to inside front cover

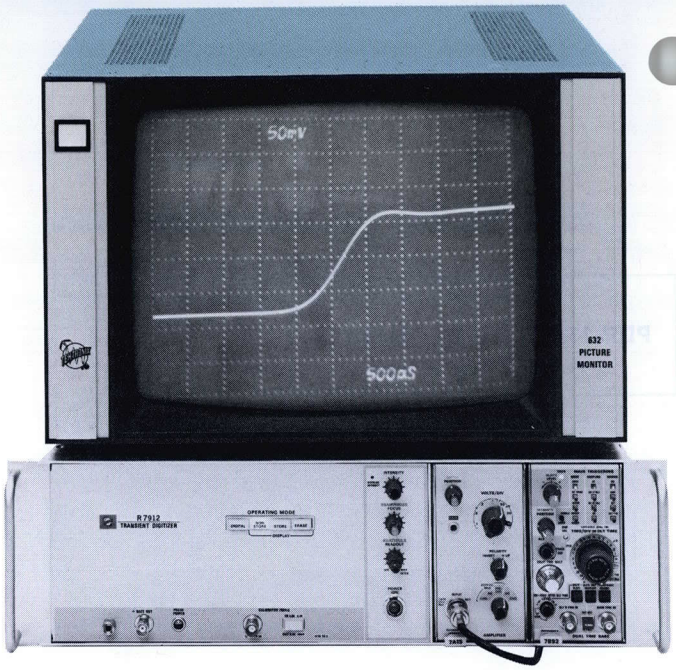
New

DIGITIZE SINGLE EVENTS with SUBNANOSECOND RISETIMES

- **RESOLUTION of 320 by 400 LINES**
- **512 by 512 ADDRESSABLE POINTS**
- **WRITING RATE EQUIVALENT to 8,000 div/μs**
- **PROCESS WAVEFORMS at YOUR CONVENIENCE**

TV COMPATIBILITY

- **LARGE, BRIGHT DISPLAY**
- **REMOTE MONITORING**
- **MEASUREMENT RESOLUTION to 0.3%**
- **8½ by 11-inch HARD COPIES WITHIN SECONDS**
- **30,000 div/μs EQUIVALENT PHOTOGRAPHIC WRITING RATE**



The R7912 Transient Digitizer can acquire subnanosecond or longer risetime single events or repetitive signals. It either digitizes the analog signal or converts the fast analog signal to video for TV compatibility.

The R7912 utilizes two plug-ins (one vertical and one horizontal), selected from the more than 30 7000-Series plug-ins.

DIGITAL MODE

When operated in the Digital mode the R7912 performs as an analog-to-digital converter with characteristics not available until now. A single event occurring in a time window as short as *5 ns* may be digitized with an equivalent variable clock rate of up to 100 GHz. Vertical and horizontal resolution is 512 increments with each increment represented by a nine bit word.

The digital data, representing the waveform, may be stored indefinitely in the R7912's optional self-contained 4096-word memory. Waveform data from memory is available for use with any digital storage device or computer for immediate analysis with appropriate interfacing, or a digital-to-analog converter for immediate viewing of the waveform on an X-Y monitor. Computer processed waveforms can be displayed on a TEKTRONIX Terminal, and instant hard copy is available on 8½ by 11-inch paper with a TEKTRONIX Hard Copy Unit. The computer is able to perform control functions on peripheral equipment interfaced to the computer independent to the R7912 interface.

Gathering data on tape provides for unattended data logging, and the tapes are easily transported. Sequencing data through a TEKTRONIX Digital to Analog Converter to a storage monitor gives you storage oscilloscope performance with a stored writing speed of 8,000 div/μs.

A low-cost monitor such as the TEKTRONIX 604 is an ideal display for a quick look at the contents of the R7912 memory. This quick look enables the operator to determine whether to sequence the data to the computer or hard copy unit, or to reject it.

A TEKTRONIX 611 storage monitor can also be used for display, offering increased resolution. A TEKTRONIX 4601 Hard Copy unit provides instant hard copy of waveform, graticule, and scale factors.

TV MODE

In this mode, the R7912 acquires the signal and processes it with an electronic graticule and scale factors into a TV compatible format. For convenient viewing and quick, accurate measurements, you can display your waveform on a TV monitor such as the TEKTRONIX 631. The bright, high contrast, large screen TV monitor makes your waveforms highly visible. The TV mode offers you the convenience of visually measuring subnanosecond risetime signals of low repetition rate under normal room lighting conditions. Measurement accuracy is maintained by generating an electronic graticule in the R7912, and processing it through the same circuitry as your signal for display on the monitor.

The TV mode also lets you view outputs from several R7912's simultaneously on one monitor, one R7912 on several monitors simultaneously, record one or several R7912s' outputs on video tape recorder for instant, slow motion, or single frame replay, and any combination of all of the above. Eight-and-a-half by eleven-inch copies are available within seconds using the TEKTRONIX 4602 Hard Copy unit.

Analog signal outputs (X, Y, and Z) are provided for driving an oscilloscope, and allowing photographic writing speeds to 30,000 div/μs. These outputs can be used to drive a low-cost storage monitor such as the TEKTRONIX 603, providing storage oscilloscope performance with a writing speed of 8,000 div/μs, eliminating the need for the optional internal memory.

Depending upon your application, measurement difficult may occur with sweep windows longer than 100 ms.

CHARACTERISTICS

VERTICAL SYSTEM

Channels—Left-hand plug-in compartment; compatible with all 7000-Series plug-ins. Bandwidth (up to 1 GHz) determined by mainframe and plug-in units (see charts later in this section).

Chopped Mode—Chop rate determined by the vertical plug-in selected.

Delay Line—Permits viewing the leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—Right-hand plug-in compartment; compatible with time bases of the 7B70 and 7B90 sequences. 7000-Series vertical amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Speed— 500 ps/div with the 7B92.

X-Y Mode—Phase shift: within 2° from DC to at least 35 kHz.

SCAN CONVERTER CRT

Type—Double ended, dual gun CRT.

Orthogonality—Adjustable to zero.

Target Scan Time—Approximately 65 ms in the digital mode.

Resolution—Digital Mode: binary, 512 by 512-point matrix; lines per scan area: 320 vertically by 400 horizontally. TV Mode: at least 500 TV lines when viewed on a TEKTRONIX Type 632 monitor or equivalent.

Writing Rate (+10°C to +40°C)—Photographic (with X-Y monitor or oscilloscope) 30 div/ns; digitized, 8 div/ns; (0°C to +10°C), one-half or more of the +10°C to +40°C values.

MEMORY OPTION

Type—Static semiconductor memory; non-destructive readout.

Size— 4,096-word by 10 bits.

Cycle Time— 1 μs per word or slower.

Output—Bits parallel; word serial; 9 data bits plus 10th bit flag.

OUTPUTS

Gate (BNC)—Output voltage: +0.5 V (±10%) into 50 Ω or +10 V (±10%) into 1 MΩ. Risetime— 2 ns or less into 50 Ω.

Video Output—Conforms to EIA RS-170 (525/60).

Video Linear (BNC)— 1 V into 75 Ω per full white signal.

Video Binary (BNC)—Either 0 V (±0.1 V) or 0.75 V (±0.1 V) both into 50 Ω.

Video Composite (BNC)—Binary video plus sync, 1 V p-p nominal.

Sync Out (BNC)—At least 4 V into 75 Ω.

Sync In (Loop Through—BNC)— 2 V to 8 V, 75 Ω.

Data Outputs (104 pin connector):—

Data Out Connector— 12 data-out lines (2 reserved); 4 ground lines; 9 control and status lines.

All are TTL Levels except signal sweep indicators.

Logical 1—Voltage output 2.4 volts or greater; current output at least 400 μA.

Logical 0—Voltage output 0.4 volts or less; current sink at least 16 mA.

Single sweep ready indicator—Voltage output, +5 V from 47 Ω to 0 V from open circuit.

Single sweep indicator—Voltage output, +4.2 V from 500 Ω to +0.8 V from 500 Ω.

Fast Rise Calibrator (BNC):—

Rise Time— 1.3 ns or less at 400 mV into 50 Ω.

Frequency—Internally selectable; 1 MHz ±0.1%, 1 kHz ±15%.

Amplitude—Switch selectable: 4 V or 400 mV open circuit; 400 mV or 40 mV into 50 Ω; accuracy: ±1% from +15°C to +35°C; ±2% from 0°C to +15°C and +35°C to +40°C.

Waveshape—Positive-going squarewave with baseline approximately at ground. Duty cycle is 40% to 60%.

ELECTRONIC GRATICULE

Modes—Triggered at end of sweep or controlled via data connector.

Display— 8 x 10 major divisions consisting of a dot matrix. The dots represent minor division tick marks.

Intensity—Adjusted or disabled from front panel.

Stability— ±0.1% from +20°C to +30°C, ±0.5% from 0°C to +20°C and +30°C to +40°C.

POWER REQUIREMENTS

Line Voltage— 115 V nominal (90 to 132 V) or 230 V nominal (180 to 264 V); switch selectable.

Line Frequency— 48 to 66 Hz, option available for 400 Hz.

Maximum Power Consumption— 243 watts, 2.5 amperes at 60 Hz, 115 volt line.

SYSTEM ENVIRONMENTAL SPECIFICATIONS

Operating temperature range is from 0°C to +40°C. Operating altitude to 15,000 feet; non-operating to 50,000 feet.

DIMENSIONS AND WEIGHTS

Height	5.2 in	13.5 cm
Width	17.6 in	44.7 cm
Length	22.9 in	68.3 cm
Net weight	39.5 lb	17.92 kg
Domestic shipping weight	61.25 lb	27.78 kg
Export-packed weight	81 lb	36.74 kg

INCLUDED ACCESSORIES

Rackmounting hardware and power cord.

OPTIONAL ACCESSORIES

Digital Interconnect Cable Assembly—(8 feet long, connectors attached). Order 012-0486-00 ..... $225.00

Display Interconnect Cable Assembly—(8 feet long, connectors attached). Order 012-0487-00 ..... $75.00

Connector Kit (Digital)—(one unassembled connector as in cable 012-0486-00; includes contact pin insertion tool). Order 015-0243-00 ..... $55.00

Connector Kit (Display)—(one connector as in cable 012-0487-00). Order 015-0244-00 ..... $25.00

The three examples shown are intended to point out some of the most important combinations of the many possible uses of the R7912.

A particular application may require a combination of any or all of the examples; i.e., you may want the convenience of viewing a high speed repetitive signal on a TV monitor for one experiment, and then digitize for computer analysis a high speed single transient from a different experiment. You may also want to view the memory content before sending the information to the computer.

USING THE R7912 WITH A TELEVISION MONITOR

(Relates to Example #1 on Selection Chart)

In the TV Mode, you can use the R7912 as a very large screen oscilloscope. The R7912 performs all "normal" oscilloscope functions with some very important additions:

Remote Display—TV monitor may be physically separated from the R7912 by a considerable distance.

Permanent Waveshape Record—With a TEKTRONIX Type 4602 Hard Copy unit (8½" x 11" paper copy of display) or with a video tape recorder.

Very Bright Displays—On high speed, low repetition rate signals, viewing hoods, or dark cloths, etc. are not needed.

USING THE R7912 WITH A MONITOR TO DISPLAY ITS MEMORY CONTENTS

(Relates to Example #2 on Selection Chart)

In the Digital Mode you can acquire a subnanosecond transient and store the data in the (optional) internal digital memory. By using a digital to analog converter and display monitor, you can accomplish the following:

Visual Analysis—The original transient can be reconstructed and displayed.

Hard Copy—8½" x 11" paper copy may be made with the TEKTRONIX Type 4601.

USING THE R7912 WITH A COMPUTER

(Relates to Example #3 on Selection Chart)

In the Digital Mode, you can acquire and store a subnanosecond single transient in its optional internal digital memory. This digital information (digital waveform) may be sent to a computer for quick and detailed analysis such as statistical analysis, integrations, correlations, Fourier transforms, etc.

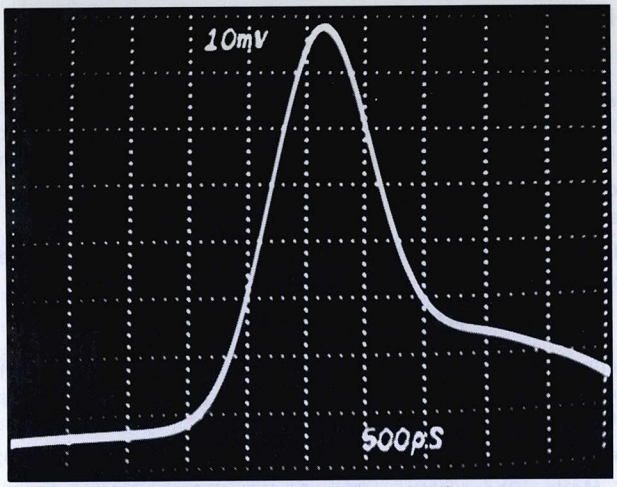


Fig. 1—TV display of one nanosecond wide impulse.

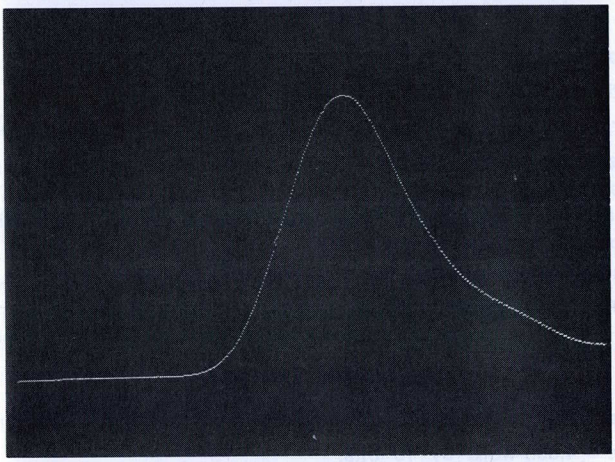


Fig. 2—The impulse in Fig. 1 was digitized by the R7912 and reconstructed on a TEKTRONIX 611.

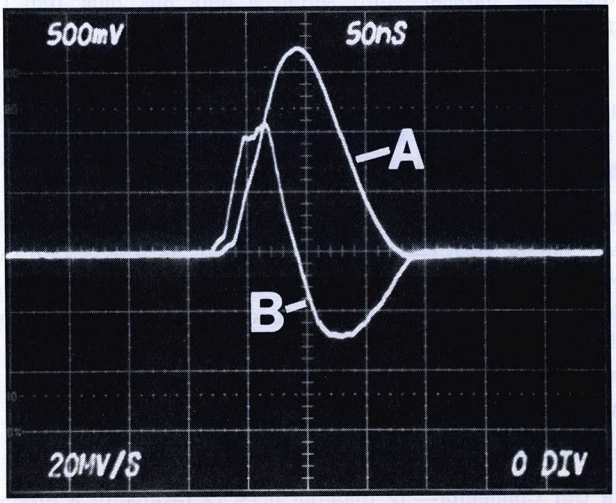


Fig. 3—An example showing an impulse (A) and the result of computer differentiation (B).

R7912 SELECTION CHART

ITEM	PRICE	YOUR SELECTION	EXAMPLE #1 TV DISPLAY	EXAMPLE #2 MEMORY DISPLAY	EXAMPLE #3 WITH COMPUTER
MAINFRAME					
R7912 Transient Digitizer	$8,400		Required	Required	Required
Option 1 Without Scale Factor Readout	Less $400				
Option 3 With EMI Shielding	Add $75				
Option 5 With Line Frequency Change to 400 Hz	Add $250				
Option 6 With Electronic Graticule	Add $400		Suggested	Suggested	Suggested
Option 13 TV Scan Change to 625/50	N/C				
Option 14 With Internal Memory of 4K words	Add $1,500			Required	Required
PLUG-INS					
Vertical Amplifier (1 ea) Timebase (1 ea)	From plug-in chart below		Required Required	Required Required	Required Required
DISPLAYS					
TV Monitor (TEKTRONIX Type 631 Suggested)	$735		Required		
4602 Hard Copy Unit	$3,750		Suggested		
X-Y Monitor (TEKTRONIX Type 611 Suggested)	$3,175			Required	Suggested
4601 Hard Copy Unit, Option 1	$3,750			Suggested	
Refer to appropriate section in this catalog for complete information on display and plug-in products.			$10,460	$14,400	$11,225

TIME BASES

TIME BASE	PERFORMANCE FEATURE	MAX SWEEP RATE	TRIGGERING FREQUENCY RANGE	PRICE
7B70	Single Sweep	2 ns/div	DC to 200-MHz	$625
7B71	Single Sweep	2 ns/div	DC to 200-MHz	$725
7B92	Display Switching	0.5 ns/div	DC to 500-MHz	$1400

Notes:

1. *For interface and software information, contact your local Field Engineer.*
2. *Examples #1, 2, and 3 may be combined and used concurrently.*
3. *Total cost of all examples were computed using 7A19 and 7B70 plug-ins and only required items.*

500 MHz — 7900 FAMILY — VERTICAL SYSTEMS SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	T_r	ACCURACY*	PRICE
7A11	Low-Capacitance Built-In FET Probe Amplifier	5 mV/div	250 MHz	1.4 ns	2%	$950
7A13	Differential, DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053B 105 MHz P6055 65 MHz	3.4 ns 5.4 ns	1.5%	$1250
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 55 MHz P6022 120 MHz	6.4 ns 2.9 ns	—	$700
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div†)	80 MHz	4.4 ns	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	225 MHz	1.6 ns	2%	$475
7A17	Low-Cost, Easy-to-Customize 50 Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	Adjustable	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	2%	$535 (7A18) $500 (7A18N)
7A19	Wide-Bandwidth 50 Ω Input Amplifier	10 mV/div	500 MHz	0.8 ns	3%	$700
7A21N**	Direct CRT Access	< 4 V/div	1 GHz	350 ps	—	$350
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz +9%	—	2%	$575
7A24	Dual-Channel, 50 Ω Input Amplifier	5 mV/div	350 MHz	1.0 ns	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	200 MHz	1.8 ns	2%	$1050

System Environmental Specification—Operating temperature range is from 0°C to +40°C (7A19 system bandwidth is 500 MHz from +20°C to +30°C, 400 MHz from 0°C to +40°C). Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

†*Obtained with X10 gain at reduced bandwidth of 10 MHz.*

**Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.*

***These N-Series plug-ins do not include readout capability.*

BANDWIDTH FAMILIES

FAMILY	MAINFRAME	PAGE	BANDWIDTH
7900	7904/R7903 R7912†	35	DC to 500 MHz*
7700	7704A Opt 9	39	DC to 250 MHz
	7704A	39	DC to 200 MHz
	R7704	39	DC to 175 MHz
7600	7603/R7603 7603N Opt 11**	43	DC to 100 MHz
7400	7403N/R7403N	49	DC to 60 MHz

*1 GHz Direct Access with 7A21N plug-in.
**Refer to Ruggedized Oscilloscope System.
†Refer to Transient Digitizer.

SPECIAL APPLICATION OSCILLOSCOPE FAMILIES

FAMILY	MAINFRAME	PAGE	APPLICATION
STORAGE	7623/R7623	55	200 cm/μs Stored Writing Speed, Multi-mode Storage
	7613/R7613	57	Variable Persistence Storage
	7313/R7313	59	Split-Screen Bistable Storage
Ruggedized Oscilloscope System	7603N Opt 11S	46	Qualified under MIL-O-24311(EC) and appears on U.S. Navy QPL-24311.

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A14	7A15A 7A15AN	7A16A	7A17	7A18 7A18N	7A19	7A21N	7A22	7A24	7A26
PAGE			61	62	63	63	64	65	65	66	66	67	68	68
PERFORMANCE FEATURE			Low-Capacitance FET Probe Amplifier	Differential DC Offset, High-Freq CMRR Amplifier	AC Current Probe Amplifier (2 current probes)	Low-Cost Conventional Input Amplifier	Wide-Band width Conventional Input Amplifier	Low Cost, Easy to Customize Amplifier	Dual-Channel Amplifier	Wide-Band-width 50-ohm 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	1 mA/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
ACCURACY[1] WITHOUT PROBE			2% (Integral)	1.5%	_____	2%	2%	Adjustable	2%	3%	_____	2%	2%	2%
7900 FAMILY	7904 R7903 R7912[7]	BW	250 MHz	105 MHz P6053B 65 MHz P6055	120 MHz P6022 55 MHz P6021	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz[4]	1 GHz	1 MHz ±10%	350 MHz	200 MHz
		Tr	1.4 ns	3.4 ns P6053B 5.4 ns P6055	2.9 ns P6022 6.4 ns P6021	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ps	350 ns ±9%	1.0 ns	1.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B 65 MHz P6055	100 MHz P6022 50 MHz P6021	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	_____	1 MHz ±10%	140 MHz	140 MHz
7700 FAMILY	7704A Opt. 9	BW	180 MHz[3]	100 MHz P6053B 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	170 MHz[3]	150 MHz	75 MHz	250 MHz[3]	_____	1 MHz ±10%	250 MHz	170 MHz
		Tr	2.0 ns	3.5 ns P6053B 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.1 ns	2.4 ns	4.7 ns	1.5 ns	_____	350 ns ±9%	1.5 ns	2.1 ns
		SIG OUT BW	70 MHz	60 MHz P6053B 50 MHz P6055	55 MHz P6022 40 MHz P6021	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	_____	1 MHz ±10%	70 MHz	70 MHz
	7704A	BW	170 MHz	100 MHz P6053B 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	160 MHz	150 MHz	75 MHz	200 MHz	_____	1 MHz ±10%	200 MHz	150 MHz
		Tr	2.1 ns	3.5 ns P6053B 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.2 ns	2.4 ns	4.7 ns	1.8 ns	_____	350 ns ±9%	1.8 ns	2.4 ns
		SIG OUT BW	70 MHz	60 MHz P6053B 50 MHz P6055	55 MHz P6022 40 MHz P6021	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	_____	1 MHz ±10%	70 MHz	70 MHz
	R7704	BW	150 MHz	100 MHz P6053B 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	_____	1 MHz ±10%	150 MHz	140 MHz
		Tr	2.4 ns	3.5 ns P6053B 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	_____	350 ns ±9%	2.4 ns	2.5 ns
		SIG OUT BW	60 MHz	55 MHz P6053B 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	_____	1 MHz ±10%	60 MHz	60 MHz
7600 FAMILY and STORAGE FAMILY	7603 R7603 7603N Opt. 11[6] 7613[5] R7613[5] 7623[5] R7623[5]	BW	100 MHz	75 MHz P6065A 55 MHz P6055	80 MHz P6022 50 MHz P6021	65 MHz	100 MHz	100 MHz	75 MHz	105 MHz	_____	1 MHz ±10%	100 MHz	100 MHz
		Tr	3.5 ns	5.0 ns P6065A 6.4 ns P6055	4.4 ns P6022 7.0 ns P6021	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.4 ns	_____	350 ns ±9%	3.5 ns	3.5 ns
		SIG OUT BW	60 MHz	55 MHz P6065A 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	_____	1 MHz ±10%	60 MHz	60 MHz
	7313 R7313	BW	25 MHz	25 MHz P6052 24 MHz P6055	25 MHz P6022 24 MHz P6021	25 MHz	25 MHz	25 MHz	25 MHz	25 MHz	_____	1 MHz ±10%	25 MHz	25 MHz
		Tr	14 ns	14 ns P6052 15 ns P6055	14 ns P6022 15 ns P6021	14 ns	14 ns	14 ns	14 ns	14 ns	_____	350 ns ±9%	14 ns	14 ns
		SIG OUT BW	60 MHz	55 MHz P6052 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	_____	1 MHz ±10%	60 MHz	60 MHz
7400 FAMILY	7403N R7403N	BW	60 MHz	55 MHz P6065A 45 MHz P6055	55 MHz P6022 40 MHz P6021	50 MHz	60 MHz	50 MHz	50 MHz	65 MHz	_____	1 MHz ±10%	60 MHz	60 MHz
		Tr	5.9 ns	6.4 ns P6065A 7.8 ns P6055	6.4 ns P6022 8.8 ns P6021	7.0 ns	5.9 ns	7.0 ns	7.0 ns	5.4 ns	_____	350 ns ±9%	5.9 ns	5.9 ns

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. Non-operating 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]System temperature range from +20°C to +30°C. Over the temperature range of 0°C to +50°C, 7704A specifications apply.

[4]System bandwidth is 500 MHz from +20°C to +30°C, 400 MHz from 0°C to +20°C and +30°C to +50°C.

[5]System temperature range from 0°C to +35°C. Refer to Storage FAMILY System specification for +35°C to +50°C.

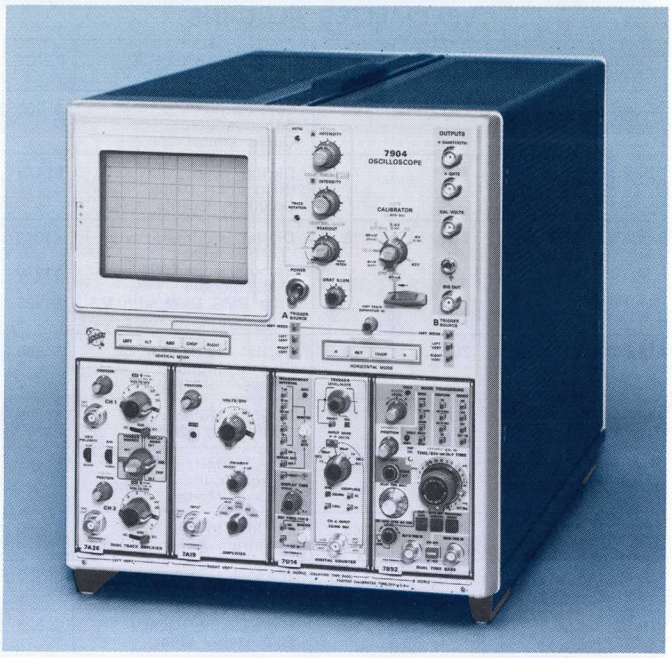
[6]Refer to Ruggedized Oscilloscope System.

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

New

7900-FAMILY OSCILLOSCOPES
500-MHz Oscilloscopes 7904 and R7903

- 500 MHz at 10 mV/DIV
- 1-GHz DIRECT-ACCESS PLUG-IN (LESS THAN 4 V/DIV)
- 500 ps/DIV DELAYED SWEEP
- GREATER THAN 15 cm/ns ENHANCED WRITING SPEED
- CRT READOUT
- CHOOSE FROM 29 COMPATIBLE PLUG-INS
- 900-MHz FET PROBE AVAILABLE



The 7904 and 5¼-inch rackmount R7903 are the widest-real-time-bandwidth, general-purpose oscilloscopes available today. For instance, the 7A19 Amplifier/7904 Mainframe combination delivers 500 MHz at 10 mV. A 7A19 variable delay option allows the matching of signal transit times of two plug-ins and their probes to better than 50 ps. A new 1X FET probe brings you high impedance and wide bandwidth performance. It has a 900-MHz BW by itself and in combinations with the 7A19/7904, provides a system BW of 450 MHz at 10 mV.

PLUG-IN VERSATILITY

Plug-ins are available to make virtually any measurement desired. Examples are:

- Digital Delay
- 525-MHz Direct Counter
- Digital Multimeter
- Digital Time Interval
- Universal Counter/Timer
- Sampling to 14 GHz
- 45-ps Risetime TDR
- Delay Line
- 1.8 GHz Spectrum Analyzer
- Curve Tracer
- 1 mA/Div Current Amplifier
- 10 μV/Div Differential
- Differential Comparator
- Single Trace
- Dual Trace
- Multi-Trace
- Single Time Base
- Mixed Sweep
- Dual Time Base
- 500-ps Dual Time Base

500 MHz — 7900 FAMILY — VERTICAL SYSTEMS SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	SIG OUT BW	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low-Capacitance Built-in FET Probe Amplifier	5 mV/div	250 MHz	1.4 ns	140 MHz	2%	$950
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053B 105 MHz	3.4 ns	100 MHz	1.5%	$1250
			P6055 65 MHz	5.4 ns	65 MHz		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 55 MHz	6.4 ns	50 MHz	———	$700
			P6022 120 MHz	2.9 ns	100 MHz		
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	80 MHz	4.4 ns	70 MHz	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	225 MHz	1.6 ns	140 MHz	2%	$475
7A17	Low-Cost, Easy-to-Customize 50-Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	Adjustable	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	70 MHz	2%	$535 (7A18) $500 (7A18N)
7A19	Wide-Bandwidth 50-ohm Input Amplifier	10 mV/div	500 MHz	0.8 ns	300 MHz	3%	$700
7A21N**	Direct CRT Access	<4 V/div	1 GHz	350 ps	———	———	$350
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	$575
7A24	Dual-Channel, 50-Ω Input Amplifier	5 mV/div	350 MHz	1.0 ns	140 MHz	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	200 MHz	1.8 ns	140 MHz	2%	$1050

System Environmental Specifications—Operating temperature range is from 0°C to +50°C. (7A19 system bandwidth is 500 MHz from +20°C to +30°C, 400 MHz from 0°C to +50°C.) Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

†Obtained with X10 gain at reduced bandwidth of 10 MHz.

*Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%.

**These N-Series plug-ins do not include readout capability.

New

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	192	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	74	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	76	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1050 $1410 $1225
Digital Multimeter	7D13	78	Digital Multimeter Plus a unique Temperature Probe	$ 560
Digital Counting	7D14	79	Directly Gated Counter to 525 MHz	$1400
Universal Counter/ Timer	7D15	80	DC - 225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	168	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	170	100 kHz to 1.8 GHz Spectrum Analyzer	$6500
Delay Line	7M11	90	High Quality Dual 50-Ω Delay Line	$ 325
Readout Unit	7M13	82	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	84	Accepts Plug-In Sampling Heads	$ 575
TDR and Sampling	7S12	84	TDR and Sampling Applications	$1200
Calibrated Delayed Sweep Sampler	7S14	88	General Purpose Dual-Channel Sampler	$1850
Sampling Sweep	7T11	89	Random or Sequential, Equivalent or Real-Time Sampling	$1625

The CRT, focal point of all scope systems, is the major contributor to the performance of the 7904 and R7903. It has excellent visual brightness and an 8 x 10-cm display area. Photographic writing speeds of at least 9 cm/ns are achieved by using the C-51-R Camera, Writing Speed Enhancer, 10,000 ASA film and P11 phosphor. Greater speeds, up to 15 cm/ns, are possible when using an optional max brightness CRT with a 4 x 5-cm display area.

Use the CRT up to its maximum BW with the 7A21N. Install the vertical amplifier bypass cables and circuit boards and plug in the 7A21N. The input (single ended or differential) is coupled directly to the CRT for a 20-kHz to 1-GHz BW and a 350-ps T_r. When using the 7A21N, an 80-ns pretrigger should be provided to view the leading edge of your signal. If this is impractical, use a 7M11 Dual Delay line in the signal path. The CRT READOUT and Vertical Amplifier functions are bypassed and inoperative.

An optional EMI modification provides considerable EMI protection to either scope, however; additional shielding techniques may be required in the most severe EMI environments.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAINFRAME FAMILY	NOTE	PRICE
7B70	71	Single Time Base (Used also as Delayed Time Base)	7700/7900	1	$625
7B71	71	Single Time Base with delaying Swp Function	7700/7900	1	$725
7B92	73	Dual Time Base with Display Switching	7700/7900	2	$1400

All Time Bases (exc. 7B92) have EXT Amplifier
1 Usable up to 2 ns/div on 7900 Family
2 Usable up to 2 ns/div on 7700 Family

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 approximately 1 MHz.

Trace Separation Range (dual-sweep modes)—The B trace can be positioned 4 div above or below the A trace (7904 only).

Delay Line—Permits viewing leading edge of displayed waveform when using 7B70 and 7B90 sequence Time Bases.

7904 — HORIZONTAL SYSTEM

Channels—Two right-hand plug-in compartments; compatible with Time Bases of the 7B70 and 7B90 sequences. 7000-Series Vertical Amplifiers and Specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate—500 ps/div with the 7B92.

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

X-Y Mode—PHASE SHIFT is within 2° from DC to 35 kHz without phase correction (DC to 1 MHz with phase correction opt 2) 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 7B70 and 7B90 sequences. 7000-Series Vertical Amplifiers and Specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate— 500 ps/div with the 7B92.

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 1, Without CRT READOUT—Deletes CRT READOUT.

Option 4, Maximum Brightness CRT—Internal 4 x 5-cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard. This provides extremely high photographic and information writing speed and increases the visibility of low rep rate high speed signals.

Option 78, P11 Phosphor—No charge.

Ref charts in 7000 Series incorrectly list bandwidth of 7L13 @ 100 kHz. The tuning range extends to 10 kHz. This is described correctly in the S. A. section.

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 can be pulsed by the event, an external ground closure, or a front panel push button. If the mainframe is equipped with CRT READOUT, Opt 10 provides additional controls and inputs for CRT READOUT pulsed operation.

Minimum Photographic Writing Speed—Using Polaroid[1] film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information).

CRT	WRITING SPEED cm/ns				CAMERA	LENS
	P31		P11			
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
Standard 8 X 10 cm	2.8	1.4	6.1	3.1	C-51-R	f/1.2 1:0.5
	1.1	0.6	2.6	1.3	C-52-R	f/1.4 1.1
Option 4 4 X 5 cm	5.0	2.5	10.0	5.0	C-51-R	f/1.2 1:0.5
	2.0	1.0	4.3	2.1	C-52-R	f/1.4 1:1

[1]Registered Trademark Polaroid Corporation

Auto-Focus—Reduces the need for additional manual focusing with changes in intensity after focus control has been initially 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. Maximum 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, DC or B Gate ÷ 2.

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

Current Output— 40 mA DC or 1 kHz.

R7903 — CALIBRATOR
(Not available with Opt 10)

Output Waveshape—Rectangular positive-going from ground, 1 kHz.

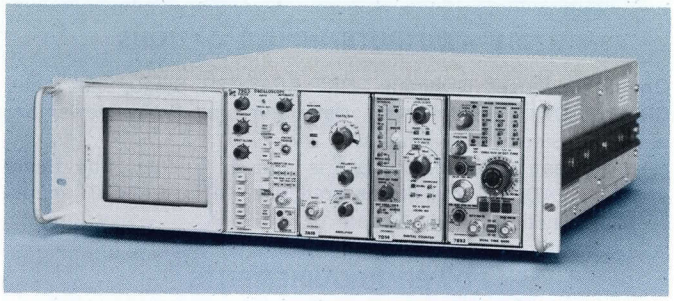
Voltage Ranges— 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω.

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 (±15%) 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. Risetime is 5 ns or less into 50 Ω, output R is approx 950 Ω.



The R7903 requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

Sig Out—Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in. See the 7900 Family 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 Aux Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Risetime 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. The bandwidth depends on the vertical plug-in. See the 7900 FAMILY 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, 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.

CRT READOUT, Inhibit—Ground closure, rear panel BNC input locks out CRT READOUT. Not available with Option 10.

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 Opt 10.

New

R7903 — OUTPUTS/INPUTS OPTIONS

Option 10, Pulsed Graticule—CRT READOUT Single-Shot input, CRT READOUT Inhibit input, Calibrator, and Probe Power are deleted. 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 1.

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.

DIMENSIONS AND WEIGHTS

DIMENSIONS	HEIGHT		WIDTH		LENGTH	
	in	cm	in	cm	in	cm
7904	13.5	34.2	12.0	30.5	23.3	59.0
R7903	5.3	13.5	19.0	48.3	22.8	57.9
SINGLE-WIDTH PLUG-INS	5.0	12.7	2.8	7.1	14.5	36.9
DOUBLE-WIDTH PLUG-INS	5.0	12.7	5.5	14.0	14.5	36.9
WEIGHTS (Approx)	**NET**		**DOMESTIC SHIPPING**		**EXPORT PACKED**	
	lb	kg	lb	kg	lb	kg
7904	32.0	14.5	52.0	23.5	63.0	28.6
R7903	27.0	12.3	42.8	19.0	55.0	25.0
SINGLE-WIDTH PLUG-INS	2.0	0.9	5.0	2.3	10.0	4.5
DOUBLE-WIDTH PLUG-INS	9.0	4.1	12.0	5.4	17.0	7.7

7904 Included Accessories—Test adapter (012-0092-00); two 18-inch test leads (012-0087-00); 9-pin cable-mount plug (134-0049-00).

R7903 Included Accessories—Jack, BNC-post (012-0092-00); two 18-inch patch cords (012-0087-00); rackmounting hardware.

7904 ORDERING INFORMATION

(Plug-ins not included)

7904 OSCILLOSCOPE $3400

7904 OPTIONS

Option 1 W/O CRT READOUT ..... Sub $400
Option 2 X-Y HORIZ COMP ..... Add $75
Option 3 EMI MODIFICATION ..... Add $75
Option 4 MAX BRIGHTNESS CRT (Specify phosphor) .... Add $350
Option 78 P11 PHOSPHOR ..... No Charge

7904 CONVERSION KITS

040-0605-01 CRT READOUT $400
040-0606-00 X-Y HORIZ COMP $75
040-0570-00 EMI MODIFICATION $105

R7903 ORDERING INFORMATION

(Plug-ins not included)

R7903 OSCILLOSCOPE $2900

R7903 OPTIONS

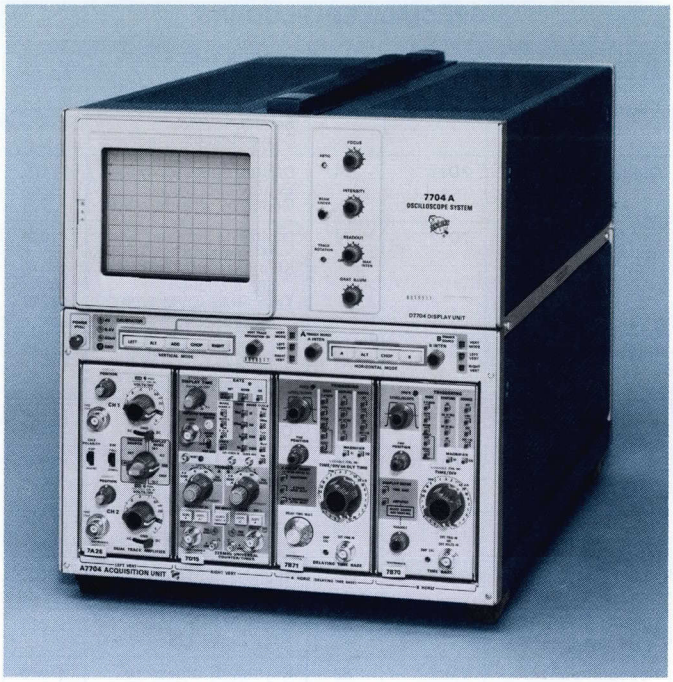
Option 1 W/O CRT READOUT ..... Sub $400
Option 3 EMI MODIFICATION ..... Add $75
Option 4 MAX BRIGHTNESS CRT (Specify phosphor) .... Add $350
Option 10 PULSED GRATICULE ..... Add $100
Option 78 P11 PHOSPHOR ..... No Charg

R7903 CONVERSION KITS

040-0605-01 CRT READOUT $400
040-0647-00 EMI MODIFICATION $110

- DC-to-200 MHz OPTIMUM PULSE RESPONSE
- DC-to-250 MHz BANDWIDTH OPTION
- GREATER THAN 15 cm/ns ENHANCED WRITING SPEED
- CRT READOUT
- MODULAR
- CHOOSE FROM 30 COMPATIBLE PLUG-INS
- 900-MHz FET PROBE AVAILABLE

The 7700 FAMILY is an advanced general-purpose oscilloscope measurement system. Together with the established and growing 7000-Series plug-ins, virtually any measurement desired is possible.



PLUG-IN VERSATILITY

Plug-ins are available to make virtually any measurement desired. Examples are:

- 525-MHz Direct Counter
- Digital Multimeter
- 45-ps Risetime TDR
- Digital Delay
- 1.8 GHz Spectrum Analyzer
- 1 mA/Div Current Amplifier
- 10 μV/Div Differential
- Universal Counter/Timer
- Sampling to 14 GHz
- Differential Comparator
- Curve Tracer
- Delay Line
- Dual Time Base
- Delayed Sweep
- Single Time Base
- Mixed Sweep
- Single Trace
- Dual Trace
- Multi-Trace Combinations

250 MHz——7700 FAMILY——VERTICAL SYSTEMS SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	7704A BW	7704A Tr	7704A SIG OUT BW	R7704 BW	R7704 Tr	R7704 SIG OUT BW	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	170 MHz	2.1 ns	70 MHz	150 MHz	2.4 ns	60 MHz	2%	$950
7A13	Differential DC Offset High-Freq CMRR Amplifier	1 mV/div	P6053B 100 MHz	3.5 ns	60 MHz	100 MHz	3.5 ns	55 MHz	1.5%	$1250
			P6055 65 MHz	5.4 ns	50 MHz	65 MHz	5.4 ns	45 MHz		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 50 MHz	7.0 ns	40 MHz	50 MHz	7.0 ns	40 MHz	———	$700
			P6022 105 MHz	3.4 ns	55 MHz	105 MHz	3.4 ns	50 MHz		
7A15A 7A15AN‡	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	75 MHz	4.7 ns	55 MHz	75 MHz	4.7 ns	50 MHz	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	160 MHz	2.2 ns	70 MHz	150 MHz	2.4 ns	60 MHz	2%	$475
7A17	Low-Cost, Easy to Customize 50-Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	150 MHz	2.4 ns	15 MHz	Adjustable	$95
7A18 7A18N‡	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	55 MHz	75 MHz	4.7 ns	50 MHz	2%	$535 (7A18) $500 (7A18N)
7A19	Wide-Bandwidth 50-Ohm Input Amplifier	10 mV/div	200 MHz 250 MHz**	1.8 ns 1.5 ns	80 MHz	175 MHz	2.0 ns	65 MHz	3%	$700
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	$575
7A24	Dual-Channel, 50-Ω Input Amplifier	5 mV/div	200 MHz 250 MHz**	1.8 ns 1.6 ns	70 MHz	150 MHz	2.5 ns	60 MHz	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	150 MHz	2.4 ns	70 MHz	140 MHz	2.5 ns	60 MHz	2%	$1050

System Environmental Specifications—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

†Obtained with X10 gain at reduced bandwidth of 10 MHz.

**Obtained with 7704A Option 9 (+20°C to +30°C) at 20 mV/div.

*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%.

‡These N-Series plug-ins do not include readout capability.

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	192	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	74	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	76	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1050 $1410 $1225
Digital Multimeter	7D13	78	Digital Multimeter Plus a unique Temperature Probe	$ 560
Digital Counting	7D14	79	Directly Gated Counter to 525 MHz	$1400
Universal Counter/ Timer	7D15	80	DC - 225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	168	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	170	100 kHz to 1.8 GHz Spectrum Analyzer	$6500
Delay Line	7M11	90	High Quality Dual 50-Ω Delay Line	$ 325
Readout Unit	7M13	82	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	84	Accepts Plug-In Sampling Heads	$ 575
TDR and Sampling	7S12	84	TDR and Sampling Applications	$1200
Calibrated Delayed Sweep Sampler	7S14	88	General Purpose Dual-Channel Sampler	$1850
Sampling Sweep	7T11	89	Random or Sequential, Equivalent or Realtime Sampling	$1625

The 7704A Oscilloscope offers you the choice of either 200 MHz with optimized transient response or 250 MHz with optimized bandwidth. Aberrations are reduced below the normal level in the optimized transient response version. Simplified circuitry makes this instrument exceptionally reliable. Modular design contributes to its easy service and maintenance. The R7704 is the only four-plug-in rackmount oscilloscope available today. It offers 175 MHz bandwidth.

The modular design of the 7704A makes service and maintenance much easier, but most important it permits the addition of a Processing Module. With this addition and a general-purpose minicomputer, the 7704A is converted into a Digital Processing Oscilloscope. See pages 26 thru 29 for more details and check the appropriate box on the reply card inside the front cover of this catalog to receive an illustrated booklet with complete specifications.

There are two CRT designs available for the 7704A: 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-51-R Camera, P11 phosphor and 10,000 ASA film) without enhancement and 8 cm/ns with the

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURES	MAINFRAME FAMILY	NOTE	PRICE
7B53A	70	Dual Time Base with Mixed Swp	7600/7700/ Storage	1	$850
7B53A Opt. 5	70	7B53A with TV Sync Triggering	7600/7700/ Storage	1	$910
7B53AN	70	No READOUT Dual Time Base with Mixed Sweep	7400/7600/ 7700/Storage	1	$750
7B53AN Opt. 5	70	7B53AN with TV Sync Triggering	7400/7600/ 7700/Storage	1	$810
7B70	71	Single Time Base (Used also as Delayed Time Base)	7700/7900	2	$625
7B71	71	Single Time Base with delaying Sweep Function	7700/7900	2	$725
7B92	73	Dual Time Base with Display Switching	7700/7900	3	$1400

All Time Bases (exc. 7B92) have EXT Amplifier
1 Usable up to 5 ns/div on 7700 Family
2 Usable up to 2 ns/div on 7900 Family
3 Usable up to 2 ns/div on 7700 Family

TEKTRONIX Writing Speed Enhancer. With the optional CRT and our new 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.

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 7700-FAMILY Vertical System Specification Chart.

Option 9 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 the 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 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 7B70, 7B71 or 7B92.

Chopped Mode (between horizontal plug-ins)— 7704A, repetition rate is internally selectable, approx 20 kHz or 200 kHz; R7704, fixed 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 2, 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 1, Without CRT Readout—Deletes CRT READOUT.

Option 4, Maximum Brightness CRT (7704A only)—Internal 4 x 5-cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard. This provides extremely high photographic and information writing speed and increases the visibility of low rep rate high speed signals.

Option 78, P11 Phosphor—No charge.

Minimum Photographic Writing Speed—Using Polaroid[1] film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information).

MAINFRAME	WRITING SPEED cm/ns				CAMERA	LENS
	P31		P11			
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
7704A R7704 8 x 10 cm	2.8	1.4	5.3	2.7	C-51-R	f/1.2 1:0.5
	1.1	0.6	2.2	1.1	C-52-R	f/1.4 1:1
7704A Option 4 4 x 5 cm	5.0	2.5	10.0	5.0	C-51-R	f/1.2 1:0.5
	2.0	1.0	4.3	2.2	C-52-R	f/1.4 1:1

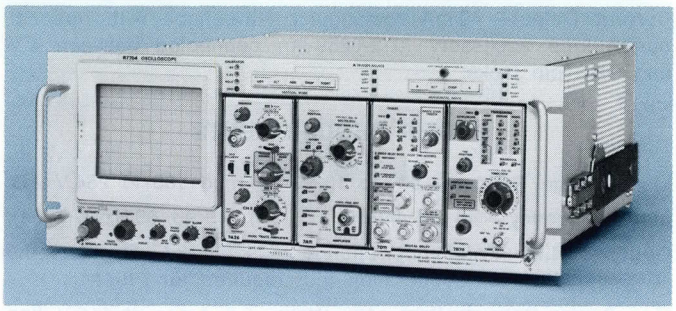
[1]Registered Trademark Polaroid Corporation.

Auto-Focus—Reduces the need for additional manual focusing with changes in intensity after focus control has been initially 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. Maximum 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%. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC. High Speed Input:



The R7704 requires 7 inches of rack height and is the only four-plug-in rackmount oscilloscope available today; it offers 175 MHz bandwidth.

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%. Maximum 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. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω nominal.

Sig Out—Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in; see 7700-FAMILY Vertical System Specifications Chart. Output R is 950 Ω nominal.

External Single-Sweep Reset—Ground closure, rear panel input to reset sweep.

Option 7, Without Signal Outputs/Inputs (7704A only)—Deletes previously described Outputs/Inputs and External Z-Axis Input.

Camera Power—Three-prong connecter 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 1 of 7704A.

CALIBRATOR

Voltage Output—Rectangular waveshape, positive-going from ground. (40 V and 40 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 5, Line Frequency Change (50 - 400 Hz)—Converts the R7704 to 50 - 400 Hz operation (not required for 7704A).

Max Power Consumption— 180 Watts, 2.5 Amps at 115 V line 60 Hz (7704A); 225 Watts, 2.8 Amps at 115 V line, 60 Hz (R7704).

DIMENSIONS	HEIGHT		WIDTH		LENGTH	
	in	cm	in	cm	in	cm
7704A	13.6	34.5	12.0	30.6	22.7	57.7
R7704	7.0	17.8	19.0	48.2	22.4	56.9
SINGLE-WIDTH PLUG-INS	5.0	12.7	2.8	7.1	14.5	36.9
DOUBLE-WIDTH PLUG-INS	5.0	12.7	5.5	14.0	14.5	36.9
WEIGHTS (Approx)	**NET**		**DOMESTIC SHIPPING**		**EXPORT PACKED**	
	lb	kg	lb	kg	lb	kg
7704A	30.0	13.6	50.0	22.7	61.0	27.6
R7704	44.0	20.0	59.0	27.0	79.0	36.0
SINGLE-WIDTH PLUG-INS	2.0	0.9	5.0	2.3	10.0	4.5
DOUBLE-WIDTH PLUG-INS	9.0	4.1	12.0	5.4	17.0	7.7

Included Accessories—For 7704A: 20-inch cable, two-pin-to-BNC, (175-1178-00). For R7704: 42-inch BNC 50-Ω cable (012-0057-01); 20-inch cable, two-pin-to-BNC, (175-1178-00); rack-mounting hardware.

ORDERING INFORMATION
(Plug-ins not included)

7704A	OSCILLOSCOPE	$2400
R7704	OSCILLOSCOPE	$2650

7704A OPTIONS

Option 1	W/O CRT READOUT (W/O Probe Power)	Sub $400
Option 3	EMI MODIFICATION	Add $75
Option 4	MAX BRIGHTNESS CRT (Specify phosphor)	Add $350
Option 7	W/O SIG OUT/IN	Sub $50
Option 9	BANDWIDTH CHANGE (250 MHz)	No Charge
Option 78	P11 PHOSPHOR	No Charge

R7704 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 2	X-Y HORIZ COMP	Add $75
Option 3	EMI MODIFICATION	Add $75
Option 5	LINE FREQ CHANGE (50 - 400 Hz) (Not required for 7704A)	Add $50
Option 78	P11 PHOSPHOR	No Charge

7704A CONVERSION KITS

040-0613-00	CRT READOUT	$400
040-0612-00	EMI MODIFICATION	$105
040-0619-00	SIG OUT/IN	$50

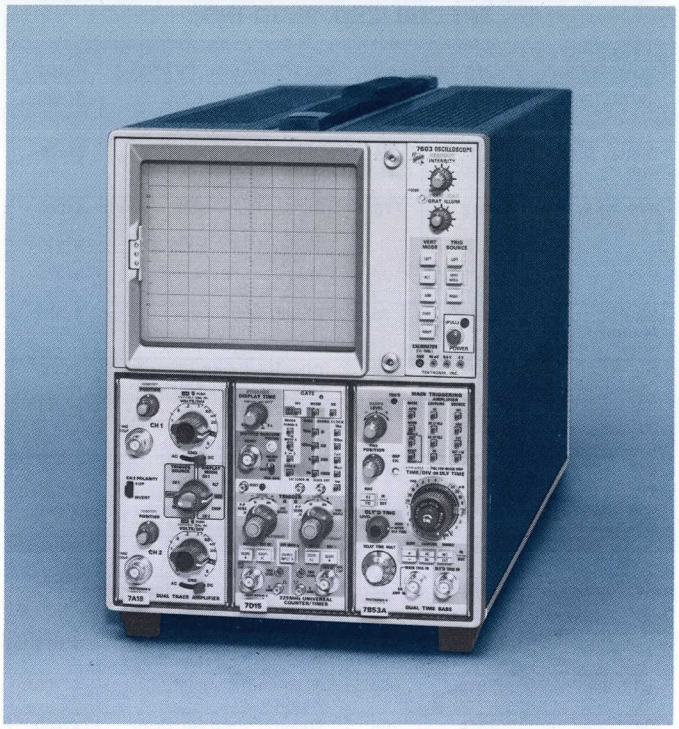
R7704 CONVERSION KITS

040-0533-01	CRT READOUT	$400
040-0529-00	X-Y HORIZ COMP	$7
040-0562-00	EMI MODIFICATION	$110

DIGITAL PROCESSING OSCILLOSCOPE

The modular design of the 7704A enables it to be expanded into a Digital Processing Oscilloscope (see pages 26 thru 29), with many capabilities never before available in any oscilloscope system. To receive an illustrated booklet with complete details, check the appropriate box on the reply card inside the front cover of this catalog.

- DC-to-100 MHz BANDWIDTH
- 6½-INCH CRT
- CRT READOUT
- 5¼-INCH RACKMOUNT
- CHOOSE FROM 26 COMPATIBLE PLUG-INS



The TEKTRONIX 7603 and Rackmount R7603 Oscilloscope provide a wide performance range through plug-in and mainframe versatility. They represent the best price/performance ratio available in the 100-MHz plug-in-oscilloscope market today.

The CRT in these oscilloscopes is a large 8 x 10 div (1.22 cm/div). It 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, affords increased visual brightness and photographic writing speed.

Other 100-MHz mainframes are available, the TEKTRONIX 7613 and 7623 Storage Oscilloscopes, described in the Storage FAMILY and the TEKTRONIX 7603N Option 11 Ruggedized Oscilloscope described in the Ruggedized Oscilloscope Family.

PLUG-IN VERSATILITY

Plug-ins are available to make virtually any measurement desired. Examples are:

- 525-MHz Direct Counter
- Digital Multimeter
- 45-ps Risetime TDR
- Digital Delay
- 1.8 GHz Spectrum Analyzer
- 1 mA/Div Current Amplifier
- 10 μV/Div Differential
- Universal Counter/Timer
- Sampling to 14 GHz
- Differential Comparator
- Curve Tracer
- Delay Line
- Dual Time Base
- Delayed Sweep
- Single Time Base
- Mixed Sweep
- Single Trace
- Dual Trace
- Multi-Trace Combinations

100 MHz——7600 FAMILY——VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	SIG OUT BW	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low-Capacitance Built-in FET Probe Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$950
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053B 75 MHz	5.0 ns	55 MHz	1.5%	$1250
			P6055 55 MHz	6.4 ns	45 MHz		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 50 MHz	7.0 ns	40 MHz	———	$700
			P6022 80 MHz	4.4 ns	50 MHz		
7A15A 7A15AN**	Low-cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	65 MHz	5.4 ns	50 MHz	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$475
7A17	Low-Cost Easy-to-Customize 50-Ω Input Amplifier	50 mV/div	100 MHz	3.5 ns	15 MHz	Adjustable	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	50 MHz	2%	$535 (7A18) $500 (7A18N)
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	$575
7A26	Dual-Channel Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$1050

System Environmental Specifications—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

†Obtained with X10 gain at reduced bandwidth of 10 MHz.

**These N-Series plug-ins do not include readout capability.

*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%.

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	192	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	74	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	76	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1050 $1410 $1225
Digital Multimeter	7D13	78	Digital Multimeter Plus a unique Temperature Probe	$ 560
Digital Counting	7D14	79	Directly Gated Counter to 525 MHz	$1400
Universal Counter/Timer	7D15	80	DC-225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	168	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	170	100 kHz to 1.8 GHz Spectrum Analyzer	$6500
Delay Line	7M11	90	High Quality Dual 50-Ω Delay Line	$ 325
Readout Unit	7M13	82	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	84	Accepts Plug-In Sampling Heads	$ 575
TDR and Sampling	7S12	84	TDR and Sampling Applications	$1200
Calibrated Delayed Sweep Sampler	7S14	88	General Purpose Dual-Channel Sampler	$1850
Sampling Sweep	7T11	89	Random or Sequential, Equivalent or Real-Time Sampling	$1625

Note—All 7000-Series plug-ins with lighted push buttons do not light in the vertical or horizontal compartments.

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 7600 Family Vertical System Specifications Chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

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 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 1, Without CRT READOUT—Deletes CRT READOUT.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURES	MAINFRAME FAMILY	NOTE	PRICE
7B50	69	Single Time Base	7400/7600/ Storage	1	$450
7B53A	70	Dual Time Base with Mixed Sweep	7600/7700/ Storage	2	$850
7B53A Opt. 5	70	7B53A with TV Sync Triggering	7600/7700/ Storage	2	$910
7B53AN	70	No READOUT Dual Time Base with Mixed Sweep	7400/7600/ 7700/Storage	2	$750
7B53AN Opt. 5	70	7B53AN with TV Sync Triggering	7400/7600/ 7700/Storage	2	$810

All TIme Bases (exc. 7B92) have EXT Amplifier
1 7313 limited to 20 ns/div
2 Usable up to 5 ns/div on 7700 Family

Option 4, Maximum Brightness CRT—Internal 8 x 10-cm graticule with variable illumination. Accelerating potential is 18 kV with P31 phosphor standard.

Optional Phosphors (Specify)—P1, P2, 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 (see Camera Section for more information).

MAINFRAME	WRITING SPEED cm/μs				CAMERA	LENS
	P31		P11			
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
Standard 8 X 10 div (1.22 cm/div)	980	490	1320	660	C-51-R	f/1.2 1:0.5
	180	90	245	125	C-59-R	f/2.8 1:0.6
Option 4 8 X 10 cm	1500	750	2000	1000	C-51-R	f/1.2 1:0.5
	300	150	400	200	C-59-R	f/2.8 1:0.67

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

Auto-Focus—Reduces the need for additional manual focusing with changes in intensity after focus control has been initially 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. Risetime is 20 ns or less into 50 Ω, output R is 950 Ω with 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. The bandwidth depends upon vertical plug-in, see 100-MHz Family Vertical System Specification Chart. Output R is 950 Ω within 2%.

*Registered Trademark Polaroid Corporation

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.

Option 7, Without Signal Outputs/Inputs—Deletes previously described Outputs/Inputs.

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 Hz to 400 Hz (7603), 50 Hz to 60 Hz (R7603).

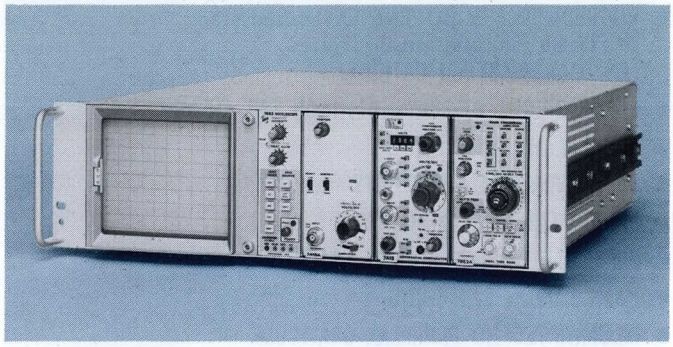
Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7603 to 50 - 400 Hz operation (not required for 7603).

Max Power Consumption—180 Watts, 2.0 Amps at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

DIMENSIONS AND WEIGHTS

DIMENSIONS	HEIGHT		WIDTH		LENGTH	
	In	cm	In	cm	In	cm
7603	11.4	28.9	8.7	22.1	24.0	60.9
R7603	5.25	13.3	19.0	48.2	24.7	62.9
SINGLE-WIDTH PLUG-INS	5.0	12.7	2.8	7.1	14.5	36.9
DOUBLE-WIDTH PLUG-INS	5.0	12.7	5.5	14.0	14.5	36.9
WEIGHTS (Approx)	**NET**		**DOMESTIC SHIPPING**		**EXPORT PACKED**	
	lb	kg	lb	kg	lb	kg
7603, R7603	30.0	13.6	42.0	19.0	55.0	25.0
SINGLE-WIDTH PLUG-INS	2.0	0.9	5.0	2.3	10.0	4.5
DOUBLE-WIDTH PLUG-INS	9.0	4.1	12.0	5.4	17.0	7.7

Included Accessories—(For 7603 and R7603) 20-inch cable (two-pin-to-BNC) (175-1178-00); CRT filter (Blue 337-1700-01, Clear 337-1700-04). The R7603 includes rackmounting hardware.



The R7603 requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

ORDERING INFORMATION

(Plug-ins not included)

7603 OSCILLOSCOPE	$1600
R7603 OSCILLOSCOPE	$1700

7603 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $75
Option 4	MAX BRIGHTNESS CRT (Specify phosphor)	Add $75
Option 7	W/O SIG OUT/IN	Sub $50

R7603 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $50
Option 4	MAX BRIGHTNESS CRT (Specify phosphor)	Add $75
Option 5	LINE FREQ CHANGE (50 - 400 Hz) (Not required for 7603)	Add $100
Option 7	W/O SIG OUT/IN	Sub $50

7603 CONVERSION KITS

040-0654-00	CRT READOUT	$400
040-0662-00	EMI MODIFICATION	$75
040-0629-00	SIG OUT/IN	$50

R7603 CONVERSION KITS

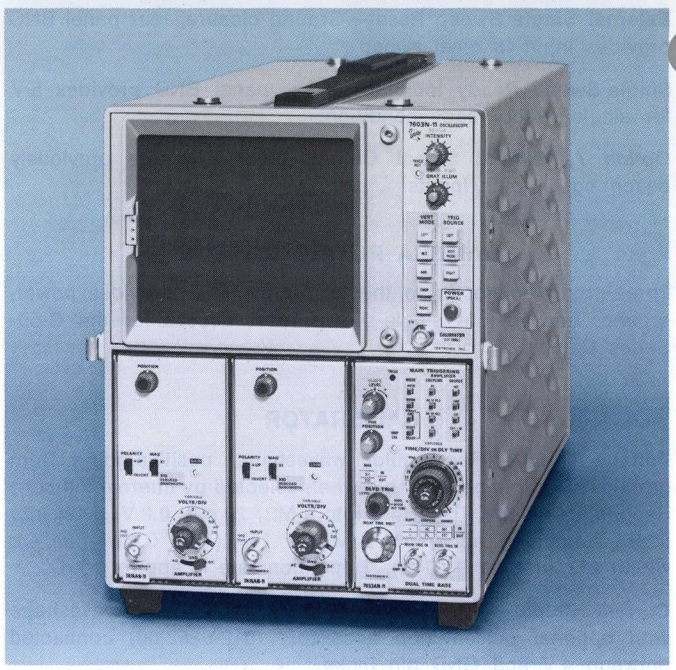
040-0674-00	CRT READOUT	$400
040-0679-00	EMI MODIFICATION	$75
040-0633-00	SIG OUT/IN	$50

PHOSPHOR OPTIONS (7603/R7603)

Option 71	P1 PHOSPHOR	No Charge
Option 72	P2 PHOSPHOR	No Charge
Option 76	P7 PHOSPHOR	No Charge
Option 77	P7 PHOSPHOR WITH INTERNAL SPECTRUM ANALYZER GRATICULE	No Charge
Option 78	P11 PHOSPHOR	No Charge

RUGGEDIZED OSCILLOSCOPE SYSTEM
7603N Option 11S

- RUGGEDIZED FOR EXTREME ENVIRONMENTS MEETS OR EXCEEDS MIL-0-24311(EC) (AN/USM-281 SPECIFICATIONS)
- LARGE BRIGHT DISPLAY—6½-INCH CRT (15 kV)
- 5 ns/DIV DELAYING SWEEP
- 0.5 mV VERTICAL SENSITIVITY
- THREE-PLUG-IN FLEXIBILITY
- VERSATILE TRIGGER SOURCE SELECTION
- PUSH-BUTTON SWITCHING
- ILLUMINATED NO PARALLAX GRATICULE
- COLOR-KEYED PANELS
- PROTECTIVE COVER WITH ACCESSORIES



The 7603N Option 11S Ruggedized Oscilloscope System meets rigid environmental and electrical specifications required by the military. The complete system is qualified under MIL-0-24311 (EC) and appears on U.S. Navy QPL-24311. Tektronix, Inc. has developed and built into this system, performance which is unmatched in versatility and flexibility. 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, the TEK 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.

The entire system (mainframe and plug-ins) is compatible with the TEKTRONIX 7000-Series product line, providing added measurement convenience and flexibility. TEKTRONIX 7000-Series Plug-Ins include Amplifiers, Samplers, Spectrum Analyzer, TDR, Curve Tracer, Differentials and other Time Bases. (The system, however, does not have CRT READOUT, and thus can not use the digital plug-ins.)

The 7603N Option 11S system is excellent for those with military contracts requiring militarized scopes and for those needing extreme environmental ruggedized construction. Also available without MIL-nomenclature is a similar system: 7603N Option 11SA.

A system (conventional and rackmount) having similar electrical specifications but without the rigid environmental requirements is available in the TEKTRONIX 7000-Series.

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 feet, operating sea level to 15,000 feet.

Vibration (operating)— 5 to 15 Hz at 0.060 inches ±0.012 inches P-P amplitude, 16 to 25 Hz at 0.040 inches ±0.008 inches P-P amplitude, 26 to 33 Hz at 0.020 inches ±0.004 inches P-P amplitude.

Blue shading indicates the specification exceeds MIL-0-24311(EC) requirements

Shock (operating)— 9 consecutive 400 pound hammer blows without failure from 1, 3 and 5 feet 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.

Dripproof (nonoperating)—As per MIL-STD-198.

Salt Spray (nonoperating)—As per MIL-E-16400.

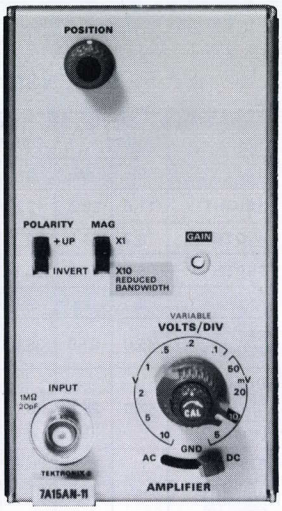
Electromagnetic Interference—As per MIL-STD-462 performed by MIL-STD-461 for the following tests:

CE01	30 Hz to 20 kHz	Power lead emission
CE03	20 kHz to 50 MHz	Power lead emission
CS01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS06	Spike Test	Power lead, spike susceptibility
RE01	30 Hz to 30 kHz	Instrument radiation, magnetic
RE02	14 kHz to 10 GHz	Instrument radiation, electric
RS01	30 Hz to 30 kHz	Instrument susceptibility, magnetic
RS03	14 kHz to 10 GHz	Instrument susceptibility, electric

Reliability—Optimum performance and reliable service is provided during continuous or interrupted operation. The MIL-0-24311(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 inches ±0.008 inches 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 actually achieved during testing.

VERTICAL SYSTEM

(Includes two 7A15AN Option 11 plug-ins)



Channels—Two left-hand plug-in compartments, with a delay line which allows the leading edge of 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. Maximum sensitivity is 0.5 mV at 10 MHz with X10 gain. AC coupling lower −3 dB point is less than 2 Hz. Risetime is 5.4 ns with less than 2% aberrations.

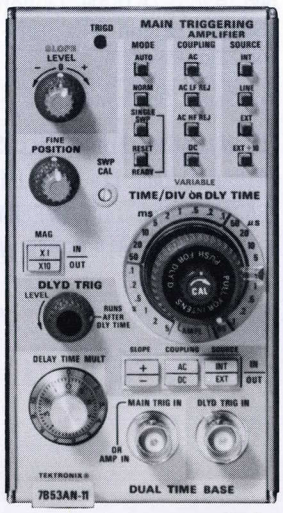
Input R and C— 1 MΩ within 2%, less than 27 pF.

Max Input Voltage— 400 V (DC + Peak AC).

DC Stability—Less than 1 div/hr drift at 25°C.

HORIZONTAL SYSTEM

(Includes one 7B53AN Option 11 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. Risetime is less than 175 ns. Using the 7B53AN Option 11 time-base external amplifier, 10 mV, 100 mV and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN Option 11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN Option 11, 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. Slope is plus or minus with external level range ±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 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.

Blue shading indicates the specification exceeds MIL-0-2431(EC) requirements

Graticule—Internal 8 x 10 cm with variable illumination. The 6½-inch 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. Maximum input voltage is 10 V (DC + Peak AC).

OUTPUTS

Calibrator—(BNC connector on front panel) 1 V within 1%, 1 kHz squarewave within 20%.

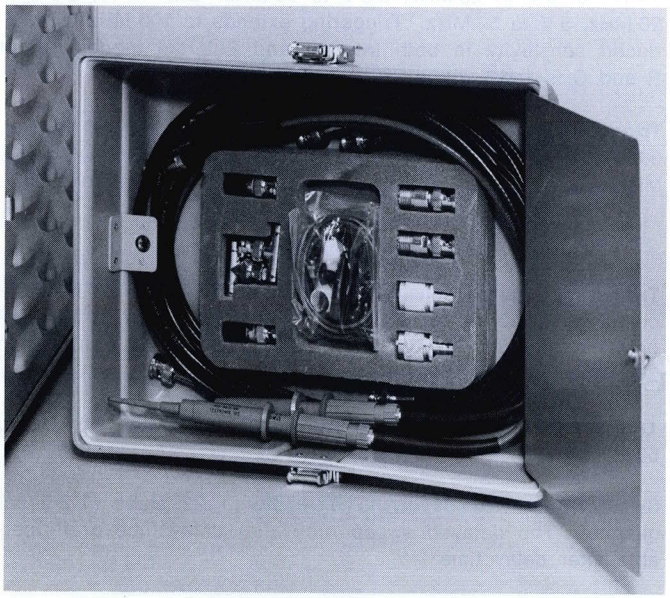
Horizontal—Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

POWER REQUIREMENTS

Input Voltage— 100, 110, 120, 220 and 240 V AC ± 10% internally selectable with quick-change jumpers with 47.5 Hz to 440 Hz single phase line frequency. Maximum power consumption is 125 watts.

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

	7603N Option 11S		7603N Option 11		7A15AN Option 11		7B53AN Option 11		C281	
	in	cm	in	cm	in	cm	in	cm	in	cm
HEIGHT	11.5	29.2	11.5	29.2	5.0	12.7	5.0	12.7	10.9	27.7
WIDTH	9.7	24.6	9.7	24.6	2.8	7.1	2.8	7.1	9.7	24.6
DEPTH	25.2	64.0	23.5	59.7	14.5	36.9	14.5	36.9	3.3	8.3
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
NET WEIGHT	45.0	21.0	36.0	16.3	1.8	0.8	2.8	1.3	2.8	1.3
DOMESTIC SHIPPING WEIGHT (approx)	57.0	25.8	48.0	21.7	5.0	2.3	6.0	2.7	7.0	3.2
EXPORT-PACKED WEIGHT (approx)	70.0	31.7	61.0	27.6	10.0	4.5	11.0	5.0	12.0	5.4

ORDERING INFORMATION

7603N Option 11S OSCILLOSCOPE SYSTEM (AN/USM-281C) .. $3025

System Includes—One each 7603N Option 11 Oscilloscope, two each 7A15AN Option 11 Amplifier Plug-ins, one each 7B53AN Option 11 Time Base, and one each C281 Cover with Accessories.

To Order Separately:

7603N Option 11 OSCILLOSCOPE (OS-245(P)/U) $1500
7A15AN Option 11 AMPLIFIER PLUG-IN (AM-6565/U) $275
7B53AN Option 11 TIME BASE PLUG-IN (TD-1085/U) $885
016-0553-00, C281 COVER W/ACCESSORIES $90

System Without MIL-Nomenclature

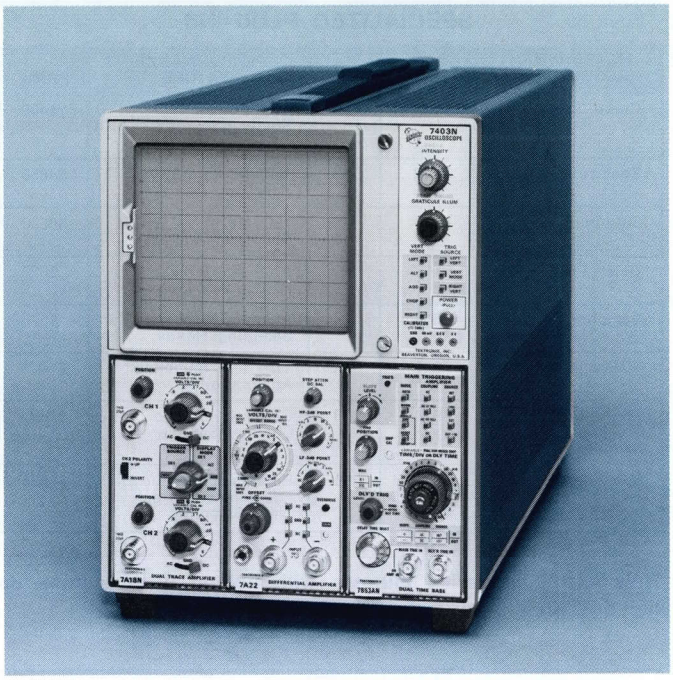
7603N Option 11SA OSCILLOSCOPE SYSTEM $3025

System Includes—One each 7603N Option 11A Oscilloscope, two each 7A15AN Option 11A Amplifier Plug-ins, one each 7B53AN Option 11A Time Base, and one each C281A Cover with Accessories.

To Order Separately:

7603N Option 11A OSCILLOSCOPE $1500
7A15AN Option 11A AMPLIFIER PLUG-IN $275
7B53AN Option 11A TIME BASE PLUG-IN $885
016-0553-01, C281A COVER W/ACCESSORIES $90

Blue shading indicates the specification exceeds MIL-0-24311(EC) requirements



- DC-to-60 MHz BANDWIDTH
- 6½-INCH CRT
- 5¼-INCH RACKMOUNT
- CHOOSE FROM 18 COMPATIBLE PLUG-INS

The TEKTRONIX 7403N and Rackmount R7403N Oscilloscopes provide a wide performance range through plug-in and mainframe versatility. They are the lowest priced mainframes in the 7000-Series product line.

The CRT in these oscilloscopes is a large 8 x 10 div (1.22 cm/div). It 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, affords increased visual brightness and photographic writing speed.

PLUG-IN VERSATILITY

Plug-ins are available to make virtually any measurement desired. Examples are:

- Sampling to 14 GHz
- Delay Line
- 45-ps Risetime TDR
- 1.8-GHz Spectrum Analyzer
- 1 mA/Div Current Amplifier
- 10 μV/DIV Differential
- Differential Comparator
- Curve Tracer
- Mixed Sweep
- Dual Time Base
- Delayed Sweep
- Single Time Base
- Single Trace
- Dual Trace
- Multi-Trace Combinations

60 MHz — 7400 FAMILY — VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low-Capacitance Built-In FET Probe Amplifier	5 mV/div	60 MHz	5.9 ns	2%	$950
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053B 55 MHz	6.4 ns	1.5%	$1250
			P6055 45 MHz	7.8 ns		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 40 MHz	8.8 ns	———	$700
			P6022 55 MHz	6.4 ns		
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	50 MHz	7.0 ns	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	60 MHz	5.9 ns	2%	$475
7A17	Low-Cost, East-to-Customize 50-Ω Input Amplifier	50 mV/div	50 MHz	7.0 ns	Adjustable	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	50 MHz	7.0 ns	2%	$535 (7A18) $500 (7A18N)
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1.0 MHz ±10%	350 ns ±9%	2%	$575

System Environmental Specifications—Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Non-operating to 50,000 feet.

†Obtained with X10 gain at reduced bandwidth of 10 MHz.

**These N-Series plug-ins do not include readout capability.

*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%.

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	192	Low Power Semiconductor Curve Tracer	$400
Spectrum Analysis	7L12	168	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	170	100 kHz to 1.8 GHz Spectrum Analyzer	$6500
Delay Line	7M11	90	High Quality Dual 50-Ω Delay Line	$325
Sampling	7S11	84	Accepts Plug-In Sampling Heads	$575
TDR and Sampling	7S12	84	TDR and Sampling Applications	$1200
Calibrated Delayed Sweep Sampler	7S14	88	General Purpose Dual-Channel Sampler	$1850
Sampling Sweep	7T11	89	Random or Sequential, Equivalent or Real-Time Sampling	$1625

Note—All 7000-Series plug-ins with lighted push buttons do not light in the vertical or horizontal compartments.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins (except Digital plug-ins). Bandwidth determined by mainframe and plug-in unit, see 7400 FAMILY Vertical System Specification chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

Channels—One right-hand plug-in compartment; compatible with all 7000-Series plug-ins (except Digital Plug-ins).

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

Fastest Calibrated Sweep Rate— 5 ns/div.

X-Y Mode—The phase shift between vertical and horizontal channels is 2° from DC to 35 kHz. Bandwidth is 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 standard.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURES	MAINFRAME FAMILY	NOTE	PRICE
7B50	69	Single Time Base	7400/7600/ Storage	1	$450
7B53AN	70	No READOUT Dual Time Base with Mixed Sweep	7400/7600/ 7700/Storage	2	$750
7B53AN Opt. 5	70	7B53AN with TV Sync Triggering	7400/7600/ 7700/Storage	2	$810

All Time Bases (exc. 7B92) have EXT Amplifier
1 7313 limited to 20 ns/div
2 Usable up to 2 ns/div on 7700 Family

Option 4, Maximum Brightness CRT—Internal 8 x 10-cm graticule with variable illumination. Accelerating potential is 18 kV with P31 phosphor standard.

Optional Phosphors (Specify)—For Standard CRT; P1, P2, P7, P11, P7/SA (Phosphor/Spectrum Analyzer graticule combination). For Maximum Brightness CRT: P11.

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

Minimum Photographic Writing Speed—Using Polaroid[1] film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera section for more information).

MAINFRAME	WRITING SPEED cm/μs				CAMERA	LENS
	P31		P11			
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
8 x 10 div Standard (1.22 cm/ div)	980	490	1320	660	C-51-R	f/1.2 1:0.5
	180	90	245	125	C-59-R	f/2.8 1:0.67
Option 4 8 x 10 cm	1500	750	2000	1000	C-51-R	f/1.2 1:0.5
	300	150	400	200	C-59-R	f/2.8 1:0.67

Beam Finder—Limits display within graticule area.

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.

[1]Registered Trademark Polaroid Corporation

CALIBRATOR

Voltage Output—Rectangular waveshape, positive-going from ground. 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° 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 VAC ±10%; internally selectable with quick-change jumpers.

Line Frequency— 50 Hz to 400 Hz (7403N), 50 Hz to 60 Hz (R7403N).

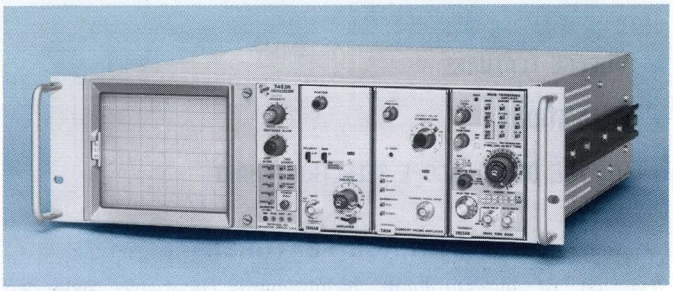
Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7403N to 50 - 400 Hz operation (not required for 7403N).

Max Power Consumption—130 Watts, 2.0 Amps at 115 V line, 60 Hz (7403N); 168 Watts, 2.1 Amps at 115 V line, 60 Hz (R7403N). Cooling is provided by a fan for the rackmount version.

DIMENSIONS AND WEIGHTS

	7403N		R7403N	
	In	cm	In	cm
HEIGHT	11.4	28.9	5.3	13.3
WIDTH	8.7	22.1	19.0	48.2
LENGTH	24.0	60.9	24.7	62.9
	lb	kg	lb	kg
NET WEIGHT	30.0	13.6	30.0	13.6
DOMESTIC SHIPPING WEIGHT	≈42.0	≈19.0	≈42.0	≈19.0
EXPORT-PACKED WEIGHT	≈55.0	≈25.0	≈55.0	≈25.0

Included Accessories—20-inch cable (two-pin-to-BNC) (175-1178-00); The R7403N includes rackmounting hardware.



The R7403N requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

ORDERING INFORMATION
(Plug-ins not included)

7403N OSCILLOSCOPE $950
R7403N OSCILLOSCOPE $1050

7403N OPTIONS

Option 4 MAX BRIGHTNESS CRT (Specify phosphor) .... Add $75

R7403N OPTIONS

Option 4 MAX BRIGHTNESS CRT (Specify phosphor) .... Add $75
Option 5 LINE FREQ CHANGE (50 - 400 Hz) ..... Add $50
(Not required for 7403N)

PHOSPHOR OPTIONS (7403N/R7403N)

Option 71 P1 PHOSPHOR ..... No Charge
Option 72 P2 PHOSPHOR ..... No Charge
Option 76 P7 PHOSPHOR ..... No Charge
Option 77 P7 PHOSPHOR WITH INTERNAL SPECTRUM ANALYZER GRATICULE ..... No Charge
Option 78 P11 PHOSPHOR ..... No Charge

- STORAGE FEATURES
- APPLICATIONS
- STORAGE OSCILLOSCOPE SELECTION CHART

STORAGE FEATURES

The list of measurement requirements is being extended every day. Increasingly the storage oscilloscope is contributing to these needs.

Storage oscilloscopes and display units permit the retention of display waveforms or data for longer times than the brief persistence of standard phosphors. There are several types of storage CRT's. This reference provides information only on the three types of 7000-Series storage: Multimode, Variable Persistence (Halftone), and Bistable Phosphor.

For further information on other TEKTRONIX storage instruments and products, see the appropriate catalog section; e.g., Computer Display Terminals, Portables, Storage Display Units, Telequipment, 560 Series, and 5100 Series. Also, further information on storage CRT's is available in the TEKTRONIX Concept Book "Storage Cathode-Ray Tubes and Circuits" (part number 062-0861-01) and the July 1972 issue of TEKSCOPE.

The storage oscilloscope's long display retention feature lets you: view a nonrecurrent signal; compare changes in a given signal with respect to time or environment; compare two or more signals occurring at different times or at different places; view low repetition rate signals without annoying flicker; and view very slowly moving traces so that the entire trace is displayed.

Moreover, storage oscilloscopes give advantages over real-time oscilloscopes not normally thought of. These include the ability to: view, in normal ambient light, a signal that otherwise would be too dim to see; view a noisy signal with an effectively reduced noise level; enhance other trace-recording techniques such as photographing the display; and (in many cases) even replace alternative recording techniques such as oscillographic recorders.

Up until recently, there were two main kinds of commercial storage designs in oscilloscopes: Bistable Phosphor and Halftone. In 1962, Tektronix, Inc. introduced its first storage oscilloscope—the 564. It used a proprietary Direct-View, Bistable Phosphor Storage design. Direct-View Storage means that the stored display is viewed directly on the storage CRT. Bistable Phosphor Storage means that the storage takes place on the CRT phosphor; this, in contrast to other storage designs (to be discussed later) in which storage takes place on a storage mesh.

The 564's storage design brought real price/performance advantages to the emerging storage world. Moreover, the 564 was rugged and easy to operate and had a long viewing time.

Another feature the 564 introduced was Split-screen Storage. This TEKTRONIX innovation permitted joint or independent storage or conventional operation on the two halves of the CRT. Today, the 564 (now a "B" version) continues to deliver measurement solutions at an optimum price/performance ratio.

Storage device research yielded improvements in Bistable Phosphor performance and led to the design and development of the TEKTRONIX 549 Storage Oscilloscope, introduced in 1965. The major performance improvement was an increase of stored writing speed from 500 cm/ms in the 564 to 5000 cm/ms in the 549. In 1971, storage was introduced in TEKTRONIX 7000-Series with the 7514.

The Bistable Phosphor Storage oscilloscopes continued to find wide use. However, the ever increasing performance requirements demanded new design approaches: faster stored writing speeds, longer viewing times, brighter displays, and greater target burn resistance.

Research and design for satisfying these requirements resulted in the development of the three storage CRT designs in the 7000-Series Storage Family. The new family was introduced in July 1972. It consists of the Multimode Storage 7623/R7623, the Variable Persistence Storage 7613/R7613, and the Bistable Phosphor Storage 7313/R7313.

WRITING SPEED IN TERMS OF SIGNAL AMPLITUDE

MAX WRITING SPEED	MAX USABLE SWEEP SPEED	SINEWAVE (5 or more Cycles/Display πdF*)	STEP RESPONSE		
			RISETIME VIEWED ON CRT	PEAK-TO-PEAK AMPLITUDE	SWEEP SPEED USED
50 div/μs	20 ns/div	6.3 div - 2.5 MHz	10 ns	0.5 div	50 ns/div
		3.1 div - 5 MHz	20 ns	1.1 div	
		1.5 div - 10 MHz	50 ns	2.8 div	
		0.5 div - 20 MHz	100 ns	5.6 diiv	
100 div/μs	10 ns/div	6.3 div - 5 MHz	5 ns	0.5 div	20 ns/div
		3.1 div - 10 MHz	10 ns	1.1 div	
		1.5 div - 20 MHz	20 ns	2.2 div	
		0.5 div - 40 MHz	50 ns	5.4 div	
222 div/μs	5 ns/div	3.5 div - 20 MHz	5 ns	1.2 div	10 ns/div
		1.6 div - 40 MHz	10 ns	2.4 div	
		0.6 div - 80 MHz	20 ns	4.9 div	

*d = Amplitude in vertical divisions, F = Frequency of sinewave.

APPLICATIONS

Storage oscilloscopes complement the many measurement solutions provided by conventional scopes and open the way to many other measurement solutions. Here are some examples:

(1) Observing changes in a signal: making circuit adjustments; setting up a circuit or system where many set ups are needed before arriving at the final configuration; recording tests of near yield limits where repeated testing would change the characteristics of the tested device; checking for repeatability of a signal; noting the effects of jitter, drift, etc. on a signal versus time of environment.

(2) Comparing two or more signals: checking out design or production components against a standard; comparing a complex digital waveform with a reference; comparing X-Y plots over long viewing times; and (sometimes) replacing X-Y recorders, strip chart or other graphic recorders.

(3) Reducing annoying flicker on low repetition rate signals, such as power line signals, TV field signals, and low duty cycle digital signals.

(4) Observing the entire display of a slowly occurring signal, such as the slowly moving trace of a spectrum analyzer, a sampling system, or a digital waveform.

(5) Increasing the brightness of a repetitive signal, such as very fast risetime, low repetition rate pulses.

(6) Reducing the brightness of noise on a signal when the noise occurs randomly, and the signal, periodically.

(7) Unattended oscilloscope monitoring when waiting for transients to occur, mechanical stress, or other unpredictable signals in nuclear, medical, mechanical, or electronic fields.

(8) Photographing a display when many set ups are needed or for a multitrace display; the storage oscilloscope helps reduce film costs expended during the set up and positioning of the different traces.

(9) Troubleshooting intermittents and looking for cause-and-effect relationships; a dual-trace storage oscilloscope can be used to monitor the equipment unattended and record the trouble as it occurs.

STORAGE OSCILLOSCOPE SELECTION CHART

OSCILLOSCOPE	PAGE	PERFORMANCE FEATURES	MEASUREMENT REQUIREMENTS AND APPLICATIONS (Refer to above applications)
7623/R7623	**55**	Multimode Storage 200 cm/μs stored writing speed Long viewing time DC-to-100 MHz bandwidth	4-in-1 operation: Fast Bistable, Variable Persistence, Bistable, and nonstore Applications: all Captures high-speed single-shot events Stores for long viewing time
7613/R7613	**57**	Variable Persistence DC-to-100 MHz bandwidth	Variable Persistence and nonstore operation Applications: 1, 2, 3, 4, 5, 6 Especially useful when a high contrast is needed between stored image and CRT background
7313/R7313	**59**	Split-screen Bistable Storage DC-to-25 MHz bandwidth	Split-screen Bistable and nonstore operation Applications: all except number 6

PLUG-IN VERSATILITY

Plug-ins are available to make virtually any measurement desired. Examples are:

- 525-MHz Direct Counter
- Digital Multimeter
- 45-ps Risetime TDR
- Digital Delay
- 1.8 GHz Spectrum Analyzer
- 1 mA/Div Current Amplifier
- 10 μV/Div Differential
- Universal Counter/Timer
- Sampling to 14 GHz
- Differential Comparator
- Curve Tracer
- Delay Line
- Dual Time Base
- Delayed Sweep
- Single Time Base
- Mixed Sweep
- Single Trace
- Dual Trace
- Multi-Trace Combinations

STORAGE FAMILY — VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	7313		7613 and 7623				SIG OUT BW (MHz)	ACCURACY* WITHOUT PROBE	PRICE
			BW (MHz)	Tr (ns)	BW (MHz)	Tr (ns)	BW (MHz)	Tr (ns)			
7A11	Low-Capacitance Built-In FET Probe Amplifier	5 mV/div	25	14	0° C to +35° C: 100	3.5	+35° C to +50° C: 90	3.9	60	2%	$950
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6065A 25	14	75	4.8	70	5.0	55	1.5%	$1250
			P6055 24	15	55	6.4	55	6.4	45		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 24	15	50	7.0	45	7.8	40	2%	$700
			P6022 25	14	80	4.4	75	4.7	50		
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	25	14	65	5.4	60	5.9	50	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	25	14	100	3.5	90	3.9	60	2%	$475
7A17	Low-Cost, Easy-to-Customize 50-Ω Amplifier	50 mV/div	25	14	100	3.5	90	3.9	15	Adjustable	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	25	14	75	4.7	70	5.0	50	2%	$535 (7A18) $500 (7A18N)
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 ± 10%	350 ns ±9%	1 MHz ±10%	350 ns ±9%	1 ± 10%	350 ± 9%	1 ± 10%	2%	$575
7A26	Dual-Channel Amplifier	5 mV/div	25	14	100	3.5	90	3.9	60	2%	$1050

System Environmental Specifications—Operating temperature range is from 0°C to +50°C (except where noted). Operating altitude to 15,000 feet. Non-operating to 50,000 feet.

†Obtained with X10 gain at reduced bandwidth of 10 MHz,

*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%.

**These N-Series plug-ins do not include readout capability.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURES	MAINFRAME FAMILY	NOTE	PRICE
7B50	69	Single Time Base	7400/7600/ Storage	1	$450
7B53A	70	Dual Time Base with Mixed Sweep	7600/7700/ Storage	2	$850
7B53A Opt. 5	70	7B53A with TV Sync Triggering	7600/7700/ Storage	2	$910
7B53AN	70	No READOUT Dual Time Base with Mixed Sweep	7400/7600/ 7700/Storage	2	$750
7B53AN Opt. 5	70	7B53AN with TV Sync Triggering	7400/7600/ 7700/Storage	2	$810

All Time Bases (exc. 7B92) have EXT Amplifier

1 7313 limited to 20 ns/div

2 Usable up to 5 ns/div on 7700 Family

7000-SERIES STORAGE FAMILY

There are six models to choose from in the TEKTRONIX 7000-Series Storage FAMILY: three cabinet models and three 5¼-inch rackmount versions. Each mainframe has three-plug-in versatility and is compatible with the 26 TEKTRONIX 7000-Series plug-ins, available for making virtually any measurement.

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	192	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	74	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	76	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1050 $1410 $1225
Digital Multimeter	7D13	78	Digital Multimeter Plus a unique Temperature Probe	$ 560
Digital Counting	7D14	79	Directly Gated Counter to 525 MHz	$1400
Universal Counter/Timer	7D15	80	DC-225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	168	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	170	100 kHz to 1.8 GHz Spectrum Analyzer	$6500
Delay Line	7M11	80	High Quality Dual 50-Ω Delay Line	$ 325
Readout Unit	7M13	82	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	84	Accepts Plug-In Sampling Heads	$ 575
TDR and Sampling	7S12	84	TDR and Sampling Applications	$1200
Calibrated Delayed Sweep Sampler	7S14	88	General Purpose Dual-Channel Sampler	$1850
Sampling Sweep	7T11	89	Random or Sequential, Equivalent or Real-Time Sampling	$1625

- **200 cm/μs STORED WRITING SPEED**
- **LONG VIEW TIME**
- **MULTIMODE STORAGE**
- **DC-to-100 MHz BANDWIDTH**
- **EXTREMELY BURN RESISTANT CRT**
- **5¼-INCH RACKMOUNT**

The TEKTRONIX 7623 (Option 12) Storage Oscilloscope delivers 200 cm/μs Stored Writing Speed. The standard 7623 performs at 100 div/μs (0.9 cm/div). A new proprietary TEKTRONIX storage CRT is used to achieve these fast stored writing speeds. The CRT incorporates a special high-speed target and uses a unique mesh-to-mesh TRANSFER TECHNIQUE. This unparalleled design and operation provides the extremely fast writing speed without compromising viewing time. This means stored traces can be viewed for hours or even days, without fading. The CRT is extremely burn resistant. This means that there are no special operating precautions to be observed.

The instrument has four operating modes: Fast Bistable Storage, Bistable Storage, Variable Persistence Storage, and Conventional (nonstorage). Now, in just one oscilloscope, the operator can select the mode that best satisfies his measurement requirements.

Note—All 7000-Series plug-ins with lighted push buttons do not light in the vertical or horizontal compartments.

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 Storage FAMILY Vertical System Specification Chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

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 2° from DC to 35 kHz. Bandwidth is DC to at least 2 MHz.

CRT AND DISPLAY FEATURES

Standard Storage CRT—Internal 8 x 10-div (0.9 cm/div) graticule with variable illumination.

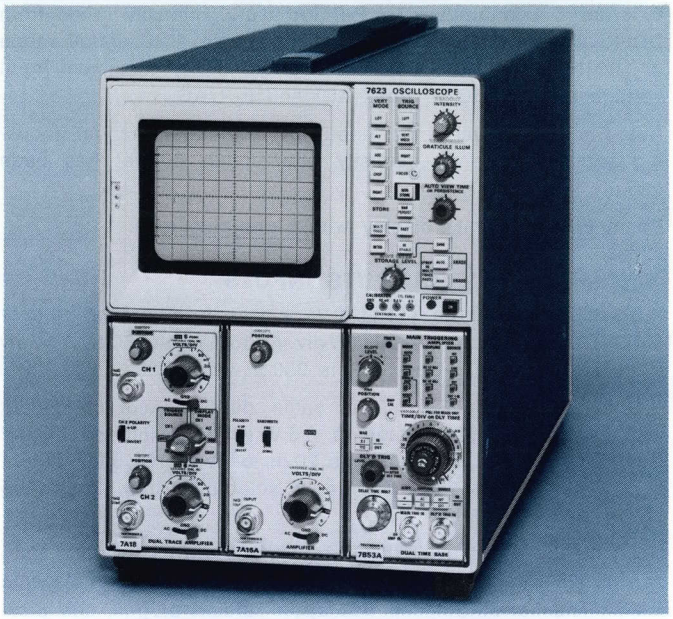
Option 1, Without CRT Readout—Deletes CRT READOUT.

Option 12, Fast Writing Speed CRT—Offers 200 cm/μs stored writing speed. Internal 8 x 10-div (0.9 cm/div) graticule with variable illumination.

Accelerating Potential— 8.5 kV.

Phosphor—P31.

Storage Display Modes—Nonstore, Fast, Variable Persistence, Bistable.



STORAGE WRITING SPEED

DISPLAY MODE	FAST	VARIABLE PERSISTENCE	BISTABLE
STORED WRITING SPEED	200 cm/μs - Opt 12* (220 div/μs) 100 div/μs - Std*	0.5 div/μs	30 div/ms
VIEW TIME	until erased	15 s at max writing speed** 1 minute at 100/div/ms**	until erased
ERASE TIME	1 s or less	1 s or less	1 s or less

*Measured over center 4 x 5 div area, derated toward display edges.
**May be extended by selecting SAVE mode.

The fast storage writing speed of 100 div/μs (200 cm/μs Opt 12) will allow the capture of a non-recurring (single shot) signal to be stored and held for examination with at least the following characteristics.

WRITING SPEED	APPROX SINEWAVE FREQUENCY (5 or more cycles/display)	STEP RESPONSE		
		Tr	P-P AMP.	SWEEP SPEED
222 div/μs	1.0 div at 60 MHz (10 ns/div)	5 ns	1.2 div	10 ns/div
	4.0 div at 15 MHz (50 ns/div)	20 ns	4.9 div	10 ns/div
100 div/μs	1.0 div at 30 MHz (20 ns/div)	10 ns	1.1 div	20 ns/div
	4.0 div at 7.5 MHz (50 ns/div)	50 ns	5.4 div	20 ns/div

Persistence—(Variable Persistence mode only) Continuously variable, persistence may be turned off when not needed to provide high contrast stored displays without the characteristic fading of variable persistence.

Auto Erase (Fast Mode only)—Viewing time continuously variable up to 12 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 is 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.

Save—Prevents erasing and storing additional displays, also extends viewing time in variable persistence mode.

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

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. Maximum input voltage is 10 V (DC + Peak AC) and P-P AC.

Auto-Focus—Reduces the need for additional manual focusing with changes in intensity after focus control has been initially 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. Risetime 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. The bandwidth depends upon vertical plug-in, see Storage Family 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.

Option 7 Without Signals Outputs/Inputs—Deletes previously described OUTPUTS/INPUTS.

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.

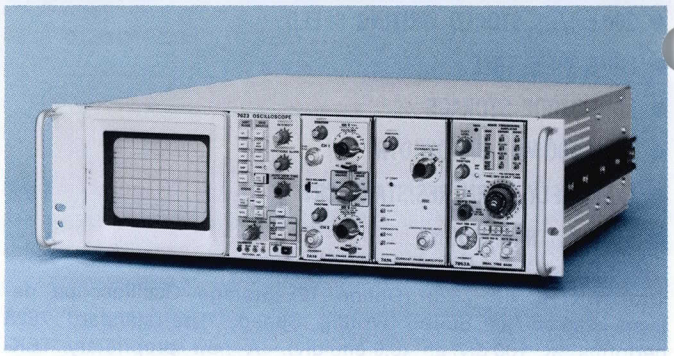
CALIBRATOR

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.

DIMENSIONS AND WEIGHTS

DIMENSIONS	HEIGHT		WIDTH		LENGTH	
	in	cm	in	cm	in	cm
7313, 7613, 7623	11.4	28.9	8.7	22.1	24.0	60.9
R7313, R7613, R7623	5.25	13.3	19.0	48.2	24.7	62.9
SINGLE-WIDTH PLUG-INS	5.0	12.7	2.8	7.1	14.5	36.9
DOUBLE-WIDTH PLUG-INS	5.0	12.7	5.5	14.0	14.5	36.9
WEIGHTS (Approx)	**NET**		**DOMESTIC SHIPPING**		**EXPORT PACKED**	
	lb	kg	lb	kg	lb	kg
7613, 7623 R7613, R7623	30.0	13.6	42.0	19.0	55.0	25.0
7313, R7313	32.0	14.5	44.0	20.0	57.0	25.8
SINGLE-WIDTH PLUG-INS	2.0	0.9	5.0	2.3	10.0	4.5
DOUBLE-WIDTH PLUG-INS	9.0	4.1	12.0	5.4	17.0	7.7



The R7623 requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

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 60 Hz.

Option 5, Line Frequency Change (50 - 400 Hz)—Converts the 7623 and R7623 to 50 - 400 Hz operation.

Max Power Consumption— 180 Watts, 2.0 Amps at 115 V line, 60 Hz. Cooling is provided by a fan for both models.

Included Accessories—(For 7623 and R7623) 20-inch cable (two-pin-to-BNC) (175-1178-00); CRT filter (Gray 378-0625-02). The R7623 includes rackmounting hardware.

ORDERING INFORMATION

(Plug-ins not included)

7623 STORAGE OSCILLOSCOPE	$2850
R7623 STORAGE OSCILLOSCOPE	$2950

7623 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $75
Option 5	LINE FREQ CHANGE (50 - 400 Hz)	Add $100
Option 7	W/O SIG OUT/IN	Sub $50
Option 12	FAST WRITING SPEED CRT	Add $500

R7623 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $50
Option 5	LINE FREQ CHANGE (50 - 400 Hz)	Add $100
Option 7	W/O SIG OUT/IN	Sub $50
Option 12	FAST WRITING SPEED CRT	Add $500

7623 CONVERSION KITS

040-0656-00	CRT READOUT	$400
040-0663-00	EMI MODIFICATION	$75
040-0629-00	SIG OUT/IN	$50

R7623 CONVERSION KITS

040-0676-00	CRT READOUT	$400
040-0678-00	EMI MODIFICATION	$75
040-0633-00	SIG OUT/IN	$50

- **VARIABLE PERSISTENCE STORAGE**
- **DC-to-100 MHz BANDWIDTH**
- **EXTREMELY BURN RESISTANT CRT**
- **5¼-INCH RACKMOUNT**

The TEKTRONIX 7613 Storage Oscilloscope offers Variable Persistence operation with a stored writing speed of 5 div/μs or conventional (nonstorage) operation. Stored traces can be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div). The 7613 CRT is extremely burn resistant and doesn't require any special operating precautions.

Note—All 7000-Series plug-ins with lighted push buttons do not light in the vertical or horizontal compartments.

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 Storage FAMILY Vertical System Specification Chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

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 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.

Option 1, Without CRT Readout—Deletes CRT READOUT.

Option 6, Special Internal Graticule (Spectrum Analyzer)—Internal 8 x 10 div (0.9 cm/div) with variable illumination including LIN, LOG and FREQUENCY markings.

Accelerating Potential— 8.5 kV.

Phosphor—P31.

Non-Store Mode—For displaying waveforms in the conventional (non-storage) mode.

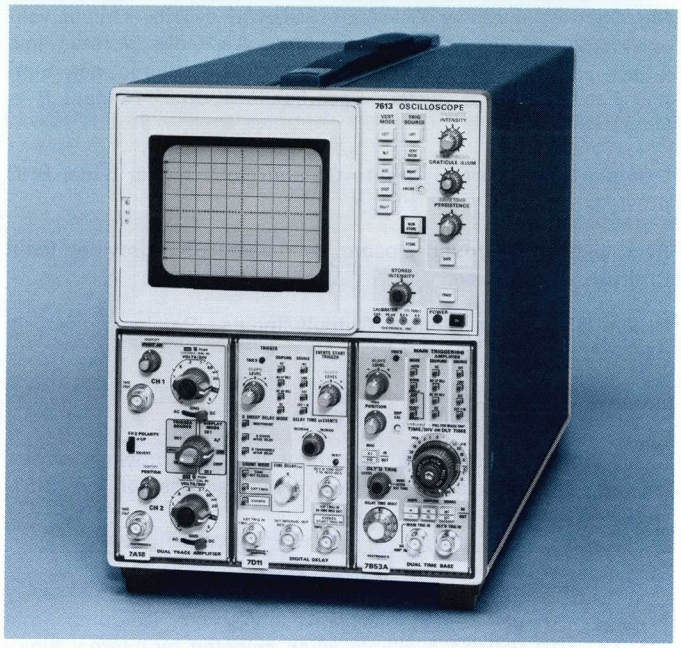
Store Mode—For displaying waveforms utilizing the variable persistence storage feature.

Maximum Stored Writing Speed—Greater than 5 div/μs.

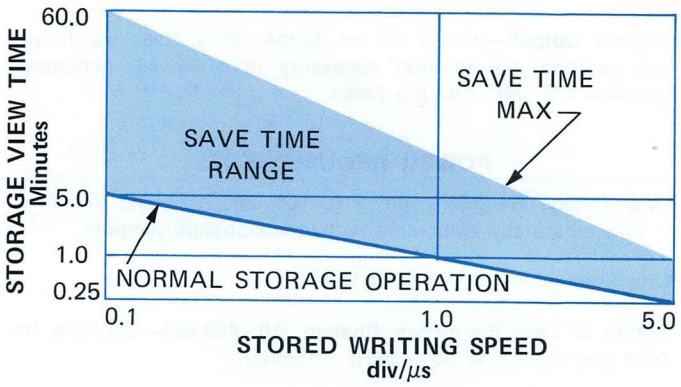
Storage View Time—(See chart) may be increased by selecting SAVE and adjusting for reduced viewing brightness with SAVE TIME control.

Erase Time— 0.5 s or less.

Persistence—Continuously variable, persistence may be turned off when not needed to provide high contrast stored displays without the characteristic fading of variable persistence.



Save—Prevents erasing and storing additional displays, also extends viewing time of stored displays.



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

Auto-Focus—Reduces the need for additional manual focusing with changes in intensity after focus control has been initially 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%) in 1 MΩ. Risetime 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. The bandwidth depends upon vertical plug-in, see Storage Family 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.

Option 7, Without Signals Outputs/Inputs—Deletes previously described OUTPUTS/INPUTS.

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.

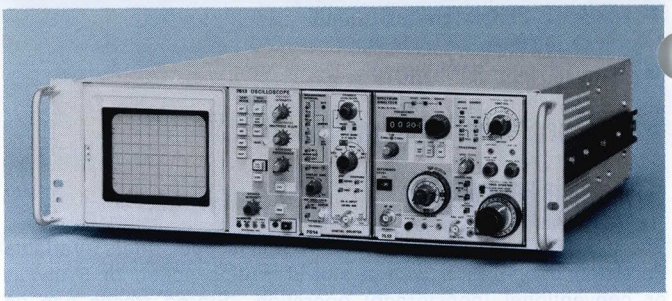
Line Frequency— 50 Hz to 60 Hz.

Option 5, Line Frequency Change (50 - 400 Hz)—Converts the 7613 and R7613 to 50 - 400 Hz operation.

Max Power Consumption— 180 Watts, 2.0 Amps at 115 V line, 60 Hz. Cooling is provided by a fan for both models.

DIMENSIONS AND WEIGHTS

Please refer to the 7623 dimensions and weights chart.



The R7613 requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

Included Accessories—(For 7613 and R7613) 20-inch cable (two-pin-to-BNC) (175-1178-00); CRT filter (Gray 378-0625-02). The R7613 includes rackmounting hardware.

ORDERING INFORMATION

(Plug-ins not included)

7613 STORAGE OSCILLOSCOPE	$2500
R7613 STORAGE OSCILLOSCOPE	$2600

7613 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $75
Option 5	LINE FREQ CHANGE (50 - 400 Hz)	Add $100
Option 6	SPECIAL INT GRATICULE (Spectrum Analyzer)	No Charge
Option 7	W/O SIG OUT/IN	Sub $50

R7613 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $50
Option 5	LINE FREQ CHANGE (50 - 400 Hz)	Add $100
Option 6	SPECIAL INT GRATICULE (Spectrum Analyzer)	No Charge
Option 7	W/O SIG OUT/IN	Sub $50

7613 CONVERSION KITS

040-0656-00	CRT READOUT	$400
040-0663-00	EMI MODIFICATION	$75
040-0629-00	SIG OUT/IN	$50

R7613 CONVERSION KITS

040-0676-00	CRT READOUT	$400
040-0678-00	EMI MODIFICATION	$75
040-0633-00	SIG OUT/IN	$50

- **SPLIT-SCREEN BISTABLE STORAGE**
- **DC-to-25 MHz BANDWIDTH**
- **EXTREMELY BURN RESISTANT CRT**
- **5¼-INCH RACKMOUNT**

The TEKTRONIX 7313 Storage Oscilloscope offers Split-Screen Bistable operation or conventional (nonstorage) operation. It has a stored writing speed of 5 div/μs. Stored traces can be viewed up to 4 hours on a display area of 8 x 10 div (0.98 cm/div). The 7313 CRT is extremely burn resistant and doesn't require any special operating precautions.

The split-screen storage CRT provides the convenience of storage and conventional displays on the same CRT at the same time. This capability is useful in many applications. For instance, the operator may wish to store a reference trace and then view the change in waveform characteristics as he varies circuit components. He does this easily by operating half of the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

Note—All 7000-Series plug-ins with lighted push buttons do not light in the vertical or horizontal compartments.

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 approximately 1 MHz.

Delay Line—Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

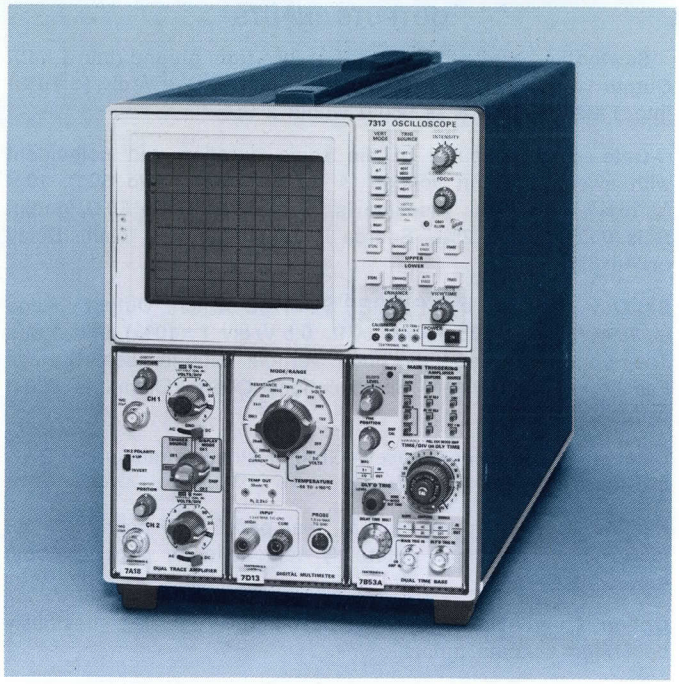
Fastest Calibrated Sweep Rate— 20 ns/div.

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

STORAGE CRT AND DISPLAY FEATURES

Bistable Split-Screen Storage CRT—Internal 8 x 10 div (0.98 cm/div) graticule with variable illumination. Store on either 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—Up to 4 hours.

Auto Erase 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.

Auto Erase 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 is 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.

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

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. Risetime 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. The bandwidth depends upon vertical plug-in, see Storage Family Vertical System Specifications Chart. Output 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.

Option 7, Without Signals Outputs/Inputs—Deletes previously described Outputs/Inputs.

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.

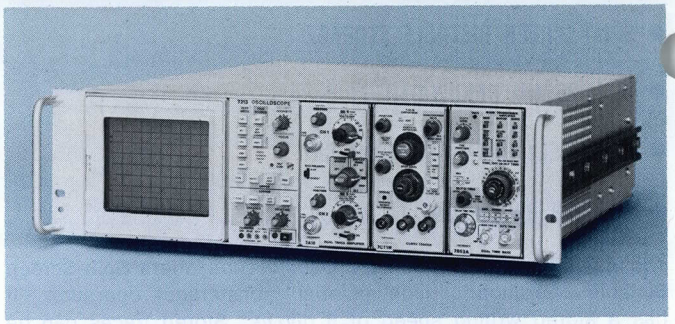
POWER REQUIREMENTS

Line Voltage Ranges—100, 110, 120, 200, 220 and 240 VAC ±10%; internally selectable with quick-change jumpers.

Line Frequency— 50 Hz to 400 Hz (7313), 50 Hz to 60 Hz (R7313).

Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7313 to 50 - 400 Hz operation (not required for 7313).

Max Power Consumption— 180 Watts, 2.0 Amps at 115 V line, 60 Hz. Cooling is provided by a fan for the R7313.



The R7313 requires only 5¼ inches of rack height in a standard 19-inch rack. It is fan-cooled and comes complete with slide-out chassis tracks.

DIMENSIONS AND WEIGHTS

Please refer to the 7623 dimensions and weights chart.

Included Accessories—(For 7313 and R7313) 20-inch cable (two-pin-to-BNC) (175-1178-00); CRT filter (Light Green 378-0625-08). The R7313 includes rackmounting hardware.

ORDERING INFORMATION
(Plug-ins not included)

7313 STORAGE OSCILLOSCOPE	$2000
R7313 STORAGE OSCILLOSCOPE	$2100

7313 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $75
Option 7	W/O SIG OUT/IN	Sub $50

R7313 OPTIONS

Option 1	W/O CRT READOUT	Sub $400
Option 3	EMI MODIFICATION	Add $50
Option 5	LINE FREQ CHANGE (50 - 400 Hz) (Not required for 7313)	Add $100
Option 7	W/O SIG OUT/IN	Sub $50

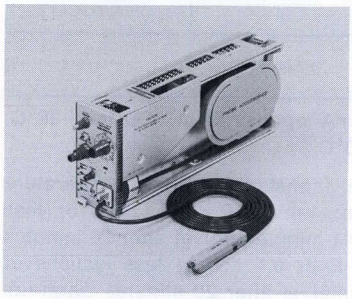
7313 CONVERSION KITS

040-0655-00	CRT READOUT	$400
040-0664-00	EMI MODIFICATION	$75
040-0629-00	SIG OUT/IN	$50

R7313 CONVERSION KITS

040-0675-00	CRT READOUT	$400
040-0678-00	EMI MODIFICATION	$75
040-0633-00	SIG OUT/IN	$50

- **BUILT-IN FET PROBE**
- **DC-to-250 MHz BANDWIDTH (7900 FAMILY)**
- **5 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS**
- **DC OFFSET**



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

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	250 MHz	1.4 ns
7700 FAMILY	7704A Opt 9	180 MHz*	2.0 ns
	7704A	170 MHz	2.1 ns
	R7704	150 MHz	2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
7500 FAMILY	7504	90 MHz	3.9 ns
	7503	90 MHz	3.9 ns
	7514	90 MHz	3.9 ns
7400 FAMILY	7403N/R7403N	60 MHz	5.9 ns
STORAGE FAMILY	7623/R7623	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

DC to 20 MHz within 2 MHz, 20 MHz bandwidth mode. 15 Hz or less, AC coupled (lower −3 dB).

*System bandwidth temperature range from +20°C to +30°C.

**Refer to Ruggedized Oscilloscope System.

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

Input R and C— 1 MΩ within 1%; ≈5.8 pF (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 20 MHz)	200 V (DC + Peak AC) (AC Component to 40 MHz)
MAX AC COUPLED INPUT (DC VOLTAGE)	±200 V		

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

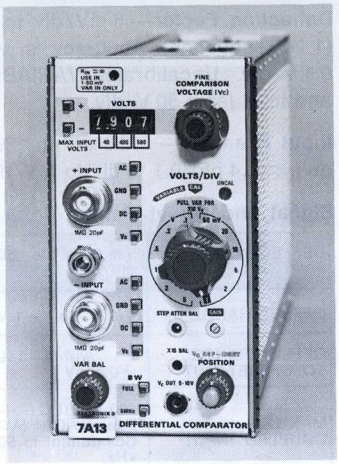
Displayed Noise— 0.5 mV or 0.1 div, whichever is greater, in FULL BANDWIDTH mode, measured tangentially.

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

Included Accessories—Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adapter (013-0085-00); 3-inch ground lead (nose) (175-0849-00); 3-inch ground lead (screw-in) (175-0848-00); 12-inch 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-inch cable (offset out) (175-1092-00).

Order 7A11 AMPLIFIER **$950**

- **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**



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

As a conventional amplifier the 7A13 has excellent and constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable either FULL or 5 MHz for best displayed noise conditions during low-frequency applications.

As a differential amplifier the 7A13 maintains its conventional features and provides a balanced (+ and —) input for applications requiring rejection of a common-mode signal. The CMRR is 20,000:1 from DC to 100 kHz, derating to 250:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100 V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div. As a comparator amplifier the 7A13 utilizes its differential capabilities, but provides an accurate (0.1%) positive or negative internal offsetting voltage covering the common-mode signal range of the unit. A signal of up to ±10 V may be applied to an input (+ or —) at a deflection factor setting of 1 mV/div and, with an opposing Vc (offset voltage), viewed in 10,000 segments of 1 mV. The offset voltage is also available as an output for external monitoring.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	105 MHz	3.4 ns
7700 FAMILY	7704A Opt 9	100 MHz	3.5 ns
	7704A	100 MHz	3.5 ns
	R7704	100 MHz	3.5 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	75 MHz	5.0 ns
7500 FAMILY	7504	75 MHz	4.7 ns
	7503	75 MHz	4.7 ns
	7514	75 MHz	4.7 ns
7400 FAMILY	7403N/R7403N	55 MHz	6.4 ns
STORAGE FAMILY	7623/R7623	75 MHz	5.0 ns
	7613/R7613	75 MHz	5.0 ns
	7313/R7313	25 MHz	14 ns

DC to 5 MHz within 500 kHz, 5 MHz bandwidth mode.
10 Hz or less, AC coupled (lower —3 dB).

*Refer to Ruggedized Oscilloscope System.

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 and to at least 12.5 V/div.

Signal Range

DEFLECTION FACTOR SETTINGS	1 mV to 50 mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
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.

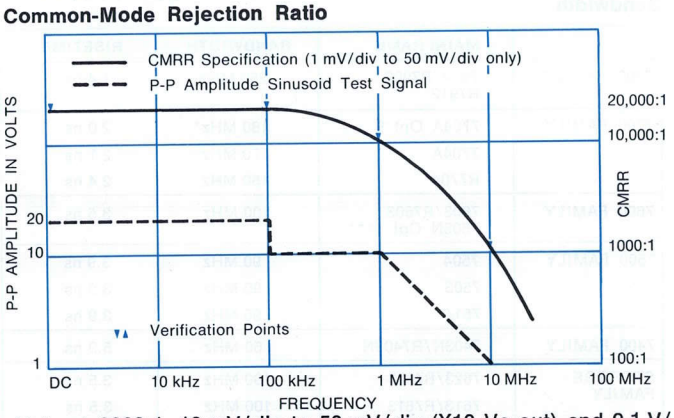
DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 1 mV P-P or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minutes warm-up. Long-Term; 1 mV P-P or 0.1 div, or less (whichever is greater) during any 1-hour interval after 20 minutes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

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

Overdrive Recovery— 1 μs to recover to within 1.5 mV and 0.1 ms to recover to within 0.5 mV after the removal of an overdrive signal that is 10 div or more off screen in either direction.

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

Common-Mode Rejection Ratio



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

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

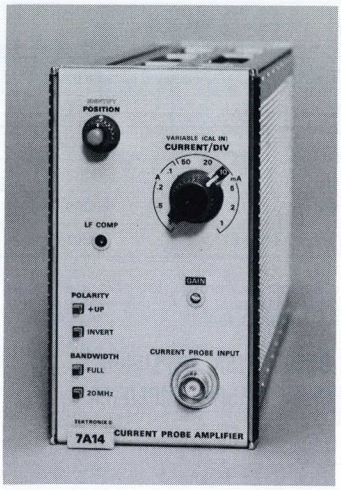
ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
1X	P6011	1.5%	All
10X	P6065A	1.5%	7313, 7400
	P6053B	1.5%	7600, 7700, 7900
	P6055	1.5%	All
100X	P6009	1.5%	All

*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A13 AMPLIFIER **$1250**

Current Probe Amplifier 7A14

- 25 Hz-to-120 MHz BANDWIDTH (7900 FAMILY)
- 1 mA/DIV to 1 A/DIV CALIBRATED DEFLECTION FACTORS



	MAINFRAME	BANDWIDTH (MHz)		RISETIME (ns)	
		P6021	P6022	P6021	P6022
7900 FAMILY	7904/R7903 R7912	55	120	6.4	2.9
7700 FAMILY	7704A Opt 9	50	105	7.0	3.4
	7704A	50	105	7.0	3.4
	R7704	50	105	7.0	3.4
7600 FAMILY	7603/R7603 7603N Opt 11*	50	80	7.0	4.4
7500 FAMILY	7504	45	75	7.8	4.7
	7503	45	75	7.8	4.7
	7514	40	75	7.8	4.7
7400 FAMILY	7403N/R7403N	40	55	8.8	6.4
STORAGE FAMILY	7623/R7623	50	80	7.0	4.4
	7313/R7313	50	80	7.0	4.4
	7613/R7613	24	25	15	14

20 MHz within 3 MHz 20 MHz bandwidth mode.

25 Hz or less (+20°C to +75°C) 30 Hz or less (0°C to +20°C) with P6021 (lower —3 dB). 250 Hz or less with P6022 (lower —3 dB).

*Refer to Ruggedized Oscilloscope System.

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

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

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

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application. The P6021 and P6022 AC current probes are recommended.

Input Characteristics

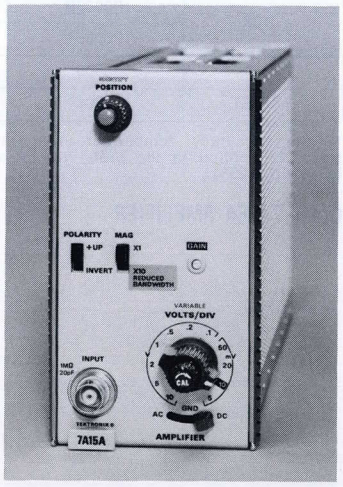
	WITH P6021	WITH P6022
MAX CW CURRENT	15 A P-P to 5 MHz, decreasing to 1 A P-P at 100 MHz.	6 A P-P to 10 MHz, decreasing to 2 A P-P at 150 MHz.
MAX PULSE CURRENT	25 A peak, limited to an Amp-second product of 2.0 A-ms or 5.3 A RMS.	25 A peak, limited to an Amp-second product of 30 A-μs or 2.1 A RMS.
MAX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

Order 7A14 AMPLIFIER **$700**

An optional current-loop adapter is available for the 7700-, 7600- and 7400-mainframe calibrator output.
Order 012-0259-00 ..... $11

Single-Trace Amplifiers 7A15A and 7A15AN

- 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 and 7A15AN are wideband plug-in amplifiers for all 7000-Series mainframes. They feature constant bandwidth over all the deflection factor settings. The two vertical mainframe channels allow the 7A15A/AN to be used alone, or with another vertical unit for dual-trace operation. Polarity of the display is selectable. The 7A15A/AN can also be used in the horizontal channels for X-Y operation. The 7A15AN does not incorporate CRT READOUT; all other specifications are identical.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	80 MHz	4.4 ns
7700 FAMILY	7704A Opt 9	75 MHz	4.7 ns
	7704A	75 MHz	4.7 ns
	R7704	75 MHz	4.7 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	65 MHz	5.4 ns
7500 FAMILY	7504	60 MHz	5.9 ns
	7503	60 MHz	5.9 ns
	7514	60 MHz	5.9 ns
7400 FAMILY	7403N/R7403N	50 MHz	7.0 ns
STORAGE FAMILY	7623/R7623	65 MHz	5.4 ns
	7613/R7613	65 MHz	5.4 ns
	7313/R7313	25 MHz	14 ns

10 Hz or less, AC coupled (lower —3 dB).

*Refer to Ruggedized Oscilloscope System.

7000-SERIES OSCILLOSCOPES
7A15A and 7A15AN *Single-Trace Amplifiers*

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 and 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.

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

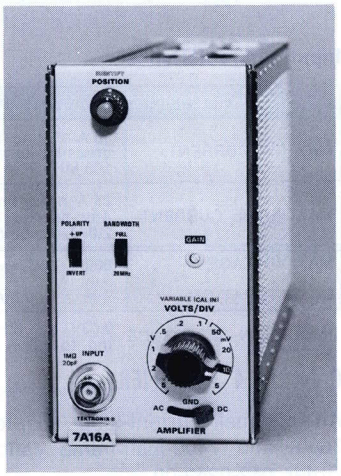
ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
10X	P6065A	3%	7313, 7400, 7600
	P6053B	3%	7700, 7900
100X	P6009	3%	All
1X FET	P6201	5%	7700, 7900

*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A15A AMPLIFIER **$280**
Order 7A15AN AMPLIFIER **$250**

7A16A *Single-Trace Amplifier*

- **DC-to-225 MHz BANDWIDTH (7900 FAMILY)**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**



The 7A16A is a wideband plug-in amplifier for all 7000-Series mainframes. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable, as is bandwidth, which can be either FULL or limited to 20 MHz for low frequency applications.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	225 MHz	1.6 ns
7700 FAMILY	7704A Opt 9	170 MHz*	2.1 ns
	7704A	160 MHz	2.2 ns
	R7704	150 MHz	2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
7500 FAMILY	7504	90 MHz	3.9 ns
	7503	90 MHz	3.9 ns
	7514	90 MHz	3.9 ns
7400 FAMILY	7403N/R7403N	60 MHz	5.9 ns
STORAGE FAMILY	7623/R7623	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

DC to 20 MHz within 3 MHz, 20 MHz bandwidth mode. 10 Hz or less, AC coupled (lower —3 dB).

*System bandwidth temperature range from +20°C to +30°C.

**Refer to Ruggedized Oscilloscope System.

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

Input R and C—1 MΩ within 2%; ≃20 pF.

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

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

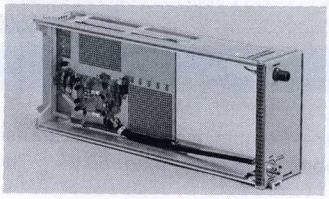
Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
10X	P6053B	3%	7600, 7700, 7900
	P6065A	3%	7313, 7400
100X	P6009	3%	All
1X FET	P6201	5%	7700, 7900

*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A16A AMPLIFIER **$475**

- **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 for all 7000-Series mainframes. It is optimized electrically and mechanically for "do it yourself" design and modification.

The layout of the circuit board assembly provides, in addition to that of the amplifier, a blank soldering pad matrix and a ground plane surface totaling approximately 40 square inches. This area may be used for installation of application-oriented circuits. Mainframe power is identified and available on the circuit board. The front subpanel is prepunched with various sizes and shapes of holes allowing additional mounting of connectors, switches, indicators, etc.

Deflection Factor—Adjustable to 50 mV/div. There is no step attenuation.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	150 MHz	2.4 ns
7700 FAMILY	7704A Opt 9	150 MHz	2.4 ns
	7704A	150 MHz	2.4 ns
	R7704	150 MHz	2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	100 MHz	3.5 ns
7500 FAMILY	7504	75 MHz	4.7 ns
	7503	75 MHz	4.7 ns
	7514	75 MHz	4.7 ns
7400 FAMILY	7403N/R7403N	50 MHz	7.0 ns
STORAGE FAMILY	7623/R7623	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

*Refer to Ruggedized Oscilloscope System.

Input Z—50 Ω.

Max Input Voltage—5 V RMS.

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

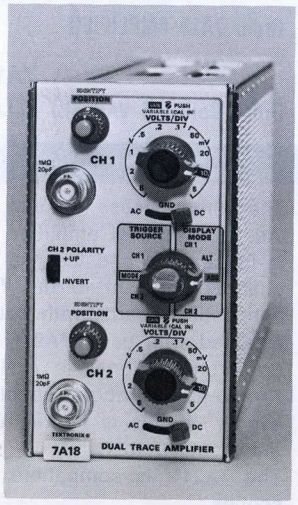
ATTENUATION*	RECOMMENDED TYPE	RECOMMENDED FAMILY
10X	P6056	All
100X	P6057	All
1X FET	P6201	7700, 7900

*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A17 AMPLIFIER **$95**

Dual-Trace Amplifiers 7A18 and 7A18N

- **DC-to-80 MHz BANDWIDTH (7900 FAMILY)**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**



The 7A18/7A18N are dual-trace plug-in amplifiers for use with the 7000-Series mainframes. They are the basic building block for 3- or 4-trace operation. They feature 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 trace IDENTIFY function is operative on 7A18 only. The 7A18N does not incorporate CRT READOUT, all other specifications are identical.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	75 MHz	4.7 ns
7700 FAMILY	7704A Opt 9	75 MHz	4.7 ns
	7704A	75 MHz	4.7 ns
	R7704	75 MHz	4.7 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	75 MHz	4.7 ns
7500 FAMILY	7504	60 MHz	5.9 ns
	7503	60 MHz	5.9 ns
	7514	60 MHz	5.9 ns
7400 FAMILY	7403N/R7403N	50 MHz	7.0 ns
STORAGE FAMILY	7623/R7623	75 MHz	4.7 ns
	7613/R7613	75 MHz	4.7 ns
	7313/R7313	25 MHz	14 ns

10 Hz or less, AC coupled (lower —3 dB).

*Refer to Ruggedized Oscilloscope System.

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

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

More →

7A18 and 7A18N *Dual-Trace Amplifiers*

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

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

Common-Mode Rejection Ratio—At least 10:1, DC to 50 MHz.

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
10X	P6065A	3%	7313, 7400
	P6053B	3%	7600, 7700, 7900
100X	P6009	3%	All
1X FET	P6201	5%	7700, 7900

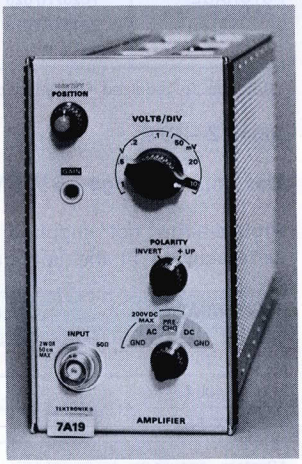
*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A18 AMPLIFIER **$535**

Order 7A18N AMPLIFIER **$500**

7A19 *Single-Trace Amplifier*

- **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 and 7700-FAMILY mainframes, but is compatible with all 7000-Series 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%.

Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
10X	P6056	4%	All
100X	P6057	4%	All
1X FET (450 MHz)	P6201	6%	7900
1X FET	P6201	6%	7700

*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Input R—50 Ω.

Option 4, Variable Signal Delay—Permits matching the transit time of two preamps and probes to better than 50 ps. The range is ±500 ps.

Max Input—2 watts RMS or 50 div Peak in both the AC and DC coupled mode. 200 V (DC + Peak AC) in the AC coupled mode.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	500 MHz*	0.8 ns
7700 FAMILY	7704A Opt 9	250 MHz*	1.5 ns
	7704A	200 MHz	1.8 ns
	R7704	175 MHz	2.0 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	105 MHz	3.4 ns
7500 FAMILY	7504	100 MHz	3.5 ns
	7503	100 MHz	3.5 ns
	7514	100 MHz	3.5 ns
7400 FAMILY	7403N/R7403N	65 MHz	5.4 ns
STORAGE FAMILY	7623/R7623	105 MHz	3.4 ns
	7613/R7613	105 MHz	3.4 ns
	7313/R7313	25 MHz	14 ns

1 kHz, AC coupled (lower —3 dB).

*System bandwidth temperature range from +20°C to +30°C.

**Refer to Ruggedized Oscilloscope System.

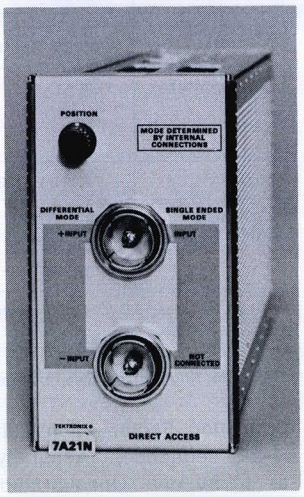
Order 7A19 AMPLIFIER **$700**

7A19 OPTION

Order Option 4 VAR SIG DELAY ..... **Add $200**

7A21N *Direct Access Unit*

- **BANDWIDTH to 1 GHz (7900 FAMILY ONLY)**
- **LESS THAN 4 V/DIV DEFLECTION FACTOR**
- **SINGLE and DIFF INPUTS**
- **POSITIONING CONTROL**



The 7A21N plug-in is designed specifically for the AC coupling of high-frequency or fast risetime signals directly into the wide-bandwidth CRT of the 7900-FAMILY Oscilloscopes. Two front-panel input connectors allow either single-ended or differential operation (internally selected). Vertical trace positioning is accomplished by a front-panel control.

The direct-access feature of this plug-in dictates by-passing the 7900 vertical amplifier. Hence the vertical mode switching is inoperative and the use of the other preamps in the vertical channel adjacent to the 7A21N is not possible. Small interconnection boards with coupling cables to accomplish this are supplied with each 7A21N CRT READOUT is inoperative, and no internal trigger is available when the 7A21N is installed. 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-FAMILY Oscilloscopes.

Bandwidth—20 kHz to 1 GHz.

Deflection Factor—Less than 4 V/div.

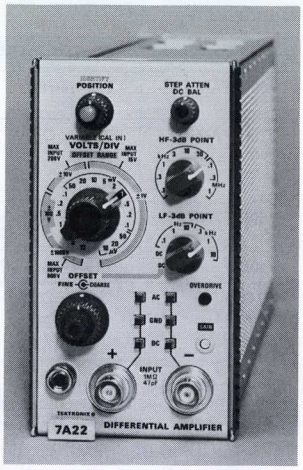
Input Z—50 Ω.

Max Input Voltage— 25 V DC, 100 V pulsed AC.

Included Accessories—Interconnecting board assembly.

Order 7A21N DIRECT ACCESS **$350**

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



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

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

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

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

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

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).

*With constant temperature. See DC STABILITY specifications.

Signal and Offset Range

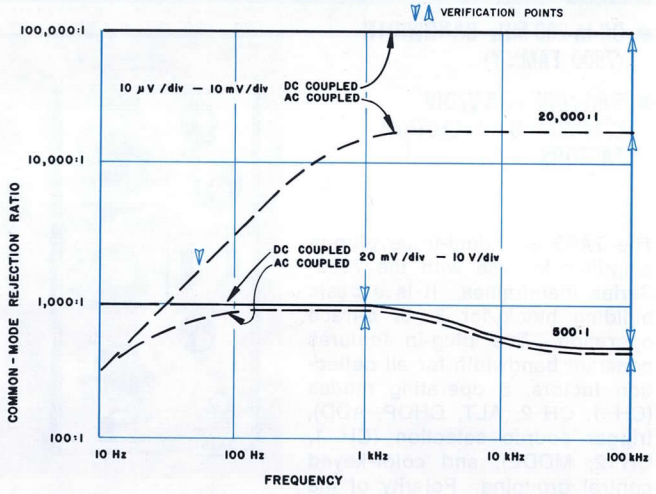
DEFLECTION FACTOR SETTINGS	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
COMMON-MODE SIGNAL RANGE	±10 V	±100 V	±500 V	
MAX DC COUPLED INPUT (DC + PEAK AC AT 1 kHz OR LESS)	±15 V	±200 V	±500 V	
MAX AC COUPLED INPUT (DC VOLTAGE)	±500 V DC rejection, at least 4 x 10^5:1			
DC OFFSET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

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

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

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

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



Probes—Are not supplied with the plug-in, and are ordered separately to fit the application.

ATTENUATION	RECOMMENDED TYPE	SYSTEM* ACCURACY	RECOMMENDED FAMILY
1X and 10X	P6052 (Selectable)	2%	All
10X	P6055	1%	All
100X	P6009	2%	All

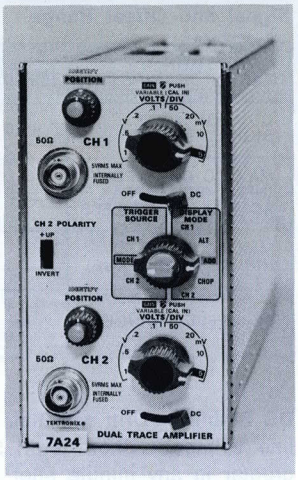
*System accuracy: temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A22 AMPLIFIER **$575**

7A24 *Dual Trace Amplifier* — New

- **DC-to-350 MHz BANDWIDTH (7900 FAMILY)**
- **5 mV/DIV to 1 V/DIV CALIBRATED DEFLECTION FACTORS**
- **50-Ω INPUT**

The 7A24 is a dual-trace plug-in amplifier for use with the 7000-Series mainframes. It is a basic building block for 3- or 4-trace operation. The plug-in 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 grouping. Polarity of the display is selectable.



7A24— 50-Ω INPUT

Deflection Factor— 5 mV/div to 1 V/div in 8 calibrated steps (1-2-5 sequence). Accuracy is within 2% with GAIN adjusted at 5 mV/div. Uncalibrated VARIABLE is continuous between steps and 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 350 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.

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	350 MHz	1.0 ns
7700 FAMILY	7704A Opt 9 7704A R7704	250 MHz 200 MHz 150 MHz	1.5 ns 1.8 ns 2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
7400 FAMILY	7403N/R7403N	60 MHz	5.9 ns
STORAGE FAMILY	7623/R7623 7613/R7613 7313/R7313	100 MHz 100 MHz 25 MHz	3.5 ns 3.5 ns 14 ns

10 Hz or less, AC coupled (lower —3 dB).
**Refer to Ruggedized Oscilloscope System.

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.

Probes—Are not supplied with the 7A24 and are ordered separately to fit the application.

ATTENUATION	RECOMMENDED TYPE	SYSTEM† ACCURACY	RECOMMENDED FAMILY
10X	P6056	4%	ALL
100X	P6057	4%	ALL
1X FET	P6201	5%	7700, 7900

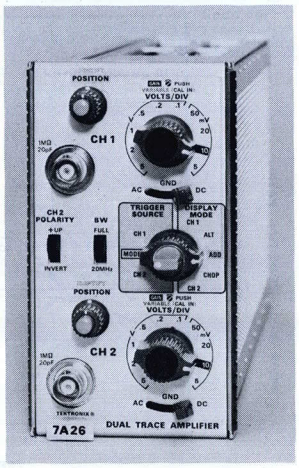
†System accuracy; temperature range is +20°C to +30°C; the calibration signal is applied to the probe tip by an external calibrator whose accuracy is within 0.25%.

Order 7A24 AMPLIFIER **$1050**

7A26 *Dual Trace Amplifier* — New

- **DC-to-200 MHz BANDWIDTH (7900 FAMILY)**
- **5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS**

The 7A26 is a dual-trace plug-in amplifier for use with the 7000-Series mainframes. It is a basic building block for 3- or 4-trace operation. The plug-in 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 grouping. Polarity of the display is selectable. Bandwidth can be either FULL or limited to 20 MHz for low frequency applications.



7A26— 1-MΩ INPUT

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

Input R and C— 1 MΩ within 2%; ≈20.0 pF.

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

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904/R7903 R7912	200 MHz	1.8 ns
7700 FAMILY	7704A Opt 9 7704A R7704	170 MHz* 150 MHz 140 MHz	2.1 ns 2.4 ns 2.5 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
7400 FAMILY	7403N/R7403N	60 MHz	5.9 ns
STORAGE FAMILY	7623/R7623 7613/R7613 7313/R7313	100 MHz 100 MHz 25 MHz	3.5 ns 3.5 ns 14 ns

DC to 20 MHz within 3 MHz, 20 MHz bandwidth mode. 10 Hz or less, AC coupled (lower —3 dB).

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.

Common-Mode Rejection Ratio—At least 10:1, DC to 50 MHz.

Probes—Are not supplied with the 7A26 and are ordered separately to fit the application.

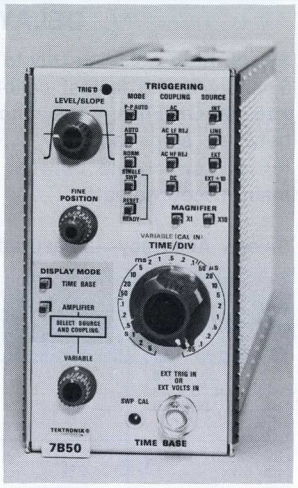
ATTENUATION	RECOMMENDED TYPE	SYSTEM† ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
10X	P6053A	3%	7600, 7700, 7900
	P6065	3%	7313, 7400
100X	P6009	3%	All
1X FET	P6201	5%	7700, 7900

Order 7A26 AMPLIFIER **$1050**

*System bandwidth temperature range from +20° C to +30° C.

**Refer to Ruggedized Oscilloscope System.

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



The 7B50 Time Base is recommended for use with the 7400, 7500, 7600 and Storage FAMILIES to provide bandwidth/sweep speed compatibility. However, it may be used in any 7000-Series mainframe. The 7B50 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source. The calibrated TIME/DIV range is from 5 ns/div. The 5 ns/div rate is obtained with the X10 MAGNIFIER.

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

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

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

Sweep Accuracy—Measured over the center 8 div.

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

TRIGGERING

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 150 mV 750 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	150 mV
DC	DC - 10MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

EXT HORIZONTAL INPUT

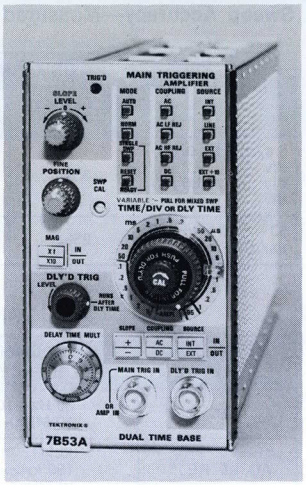
Deflection Factor—Minimum deflection factor is 90 mV/div within 10 mV/div when in EXT source with variable fully CW; minimum deflection factor is 900 mV/div within 110 mV/div when in Ext ÷ 10 source position with variable fully CW. The VARIABLE is continuous between steps and to at least 9 V.

Typical Frequency Response

COUPLING	LOWER —3 dB	UPPER —3 dB
AC	16 Hz	500 kHz
AC LF REJ	50 kHz	500 kHz
AC LF REJ ÷ 10	15 kHz	500 kHz
AC HF REJ ÷ 10	16 Hz	75 kHz
AC HF REJ	16 Hz	120 kHz
DC	DC	500 kHz

Order 7B50 TIME BASE **$450**

- 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 7B53A and 7B53AN Dual Time Bases are recommended for use with the 7400, 7500, 7600 and Storage FAMILIES to provide bandwidth/sweep speed compatibility. Both time bases have identical characteristics except the 7B53AN does not incorporate CRT READOUT.

These Dual Time Bases feature four sweep display modes: normal, intensified delaying, delayed and mixed.

Normal Sweep (nondelayed) is selected when the DLY'D TIME/DIV switch is pushed in and set to the same sweep rate as the TIME/DIV switch. The switches will latch in this mode.

Intensified Delaying Sweep is accomplished by pulling out the DELAYED SWEEP TIME/DIV knob. The delaying (main) sweep is intensified for a period of time determined by the delayed sweep setting. The intensified zone may be initiated at any point on the delaying sweep determined by the DELAY TIME MULT (DTM). The DELAYING and DELAYED TIME/DIV controls can be independently set. MAIN TRIGGERING controls are used to control the delaying sweep.

Delayed Sweep is selected by pushing in the DELAYED SWEEP TIME/DIV knob. The intensified segment of the delaying sweep is now displayed over the full 10 div of the CRT. The delayed sweep may be operated in either a "triggered" or "runs-after-delay" mode.

Mixed Sweep is accomplished by pulling the VARIABLE knob out, combining the slower and faster sweep speeds into one display. The main sweep is displayed at the slower speed from the sweep start to a selectable point on the main sweep. Past this point, the sweep is displayed at the faster of the two sweep speeds. The intensified zone, delayed sweep and mixed sweep may be initiated at any point on the main sweep determined by the DLY TIME MULT.

TV SYNC

Option 5, 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 can be displayed with the delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame color-burst observations in the PAL color system.

DELAYING SWEEP

Sweep Rate— 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div. The variable control is internally switchable between 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
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

Delay Time 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 major DTM divisions from +15°C to +35°C.

Jitter— 1 part or less in 20,000 of X10 the TIME/DIV setting.

Triggering

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED INT	MIN SIGNAL REQUIRED EXT
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 100 mV 500 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	100 mV
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter—1 ns or less at 75 MHz.

External Trigger Input—Max input voltage is 500 V (DC + peak AC), 500 V P-P AC at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT, at least +15 V to −15 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate— 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps to at least 1.25 s/div and is switchable between the main, 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 approximately +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Risetime 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

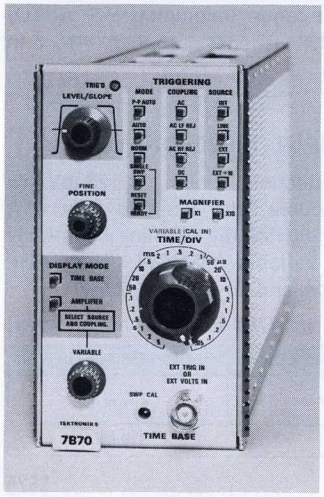
COUPLING	LOWER −3 dB	UPPER −3 dB
AC	40 Hz	2 MHz
AC LF REJ	16 kHz	2 MHz
AC HF REJ	40 Hz	100 kHz
DC	DC	2 MHz

Order 7B53A TIME BASE **$850**
Order 7B53AN TIME BASE **$750**

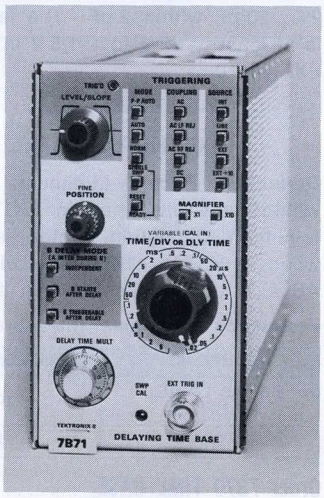
7B53A/AN OPTION

Order Option 5 TV TRIGGERING ..... **Add $60**

Time Bases 7B70 and 7B71



7B70



7B71

FEATURES OF BOTH TIME BASES

- 2 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- PEAK-TO-PEAK AUTO TRIGGERING
- TRIGGERING TO 200 MHz
- SINGLE-SWEEP OPERATION

The 7B70 and 7B71 are horizontal TIME-BASE units intended primarily for use with the 7700-FAMILY mainframes to provide bandwidth/sweep speed compatibility. However, the 7B70 and 7B71 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B71 being the DELAYING SWEEP and the 7B70 the DELAYED SWEEP. The 7B70 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

More →

The calibrated TIME/DIV range is from 2 ns/div to 5 s/div. The 2 ns/div rate, obtained with the X10 MAGNIFIER, complements the risetime capability of the 7700-FAMILY vertical systems.

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

The triggering frequency range is from DC to 200 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B71 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B70 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

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

Characteristics are common to both units unless otherwise noted.

Sweep Rate— 0.02 μs/div to 5 s/div in 26 steps (1-2-5 sequence). 2 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div, with the 7704A mainframe calibrator.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.02 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP CHARACTERISTICS (7B71 ONLY)

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy— 5 s/div to 1 s/div: ±(1.5% of measurment + 0.3% of full scale); 0.5 s/div to 1 μs/div: ±(1% of measurement + 0.3% of full scale). Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 major DTM divisions from +15°C to +35°C.

Jitter— 1 part or less in 50,000 of X10 the TIME/DIV setting.

TRIGGERING

COUPLING	TRIGGERING FREQUENCY RANGE	MIN SIGNAL REQUIRED	
		INT	EXT
AC	30 Hz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC LF REJ*	30 kHz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
AC HF REJ	30 Hz - 50 kHz	0.3 div	75 mV
DC	DC - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P Auto Operation— 0.5 div INT, 125 mV EXT from 200 Hz to 20 MHz; 1.5 div INT, 375 mV EXT from 20 MHz to 200 MHz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter— 1 ns or less at 150 MHz.

Ext Trigger Input—Max input voltage is 500 V (DC + Peak AC), 500 V (P-P AC) at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. The level range (excluding P-P AUTO) is at least +1.5 V to —1.5 V in EXT, at least +15 V to —15 V in EXT ÷ 10.

EXT HORIZONTAL INPUT (7B70 ONLY)

Deflection Factor—Minimum deflection factor is 25 mV/div within 5 mV/div when in EXT source with variable fully CW; minimum deflection factor is 250 mV/div within 50 mV/div when in EXT ÷ 10 source with variable fully CW. The VARIABLE is continuous between steps and to at least 2.5 V.

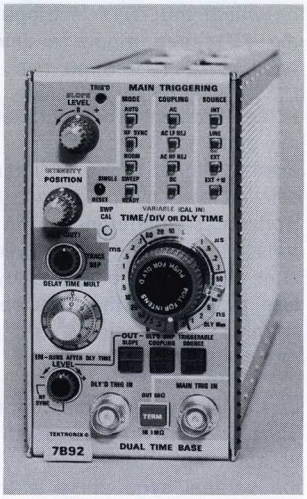
Frequency Response (measured in 7700-FAMILY mainframes)

COUPLING	LOWER —3 dB	UPPER —3 dB
AC, AC LF REJ, AC HF REJ	10 Hz	200 kHz
DC	DC	200 kHz

Order 7B70 TIME BASE **$625**

Order 7B71 TIME BASE **$725**

- **0.5 ns/DIV to 0.2 s/DIV CALIBRATED TIME BASE***
- **TRIGGERING to 500 MHz***
- **DISPLAY SWITCHING—ALTERNATE DISPLAY OF INTENSIFIED DELAYING & DELAYED SWEEPS**



The 7B92 is recommended for use with the 7700 and 7900 FAMILIES. Its exceptionally fast sweep (500 ps/div) ideally matches the ultra-high bandwidth of the 7900 FAMILY and provides full bandwidth triggering for the 7700 FAMILY. Since the 7B92 uses only one horizontal compartment it permits usage of the other horizontal compartment for specialized measurements.

The 7B92 features four display modes: normal, intensified delaying sweep (controlled contrast), delayed sweep and alternate.

DELAYING SWEEP

Sweep Rate—10 ns/div to 0.2 s/div in 23 steps (1-2-5 sequence). The uncalibrated VARIABLE is continuous between steps and to 0.5 s/div. Variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy—Measured over the center 8 div in the 7900-FAMILY Oscilloscope mainframe.

TIME/DIV	+15°C to +35°C	0°C to +50°C
0.2 s/div	within 4%	within 5%
All other sweep rates	within 3%	within 4%

Delay Time Multiplier Range— 0 to 9.9 times the TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.98 seconds).

Differential Delay Time Measurement Accuracy— 0.2 s/div: ±(1.4% of measurement + 0.3% of full scale); 0.1 s/div to 0.1 μs/div; ±(0.7% of measurement + 0.3% of full scale); 50 ns/div to 10 ns/div: ±(1.5% of measurement + 0.5% of full scale).

Absolute Time Measurement Accuracy—(Measurement from start of Delaying Sweep.) 0.2 s/div to 1 μs/div: Within 1% of full scale plus differential time measurement accuracy; 0.5 μs/div to 0.1 μs/div: Within 1% of full scale plus differential time measurement accuracy plus 0.1 μs; 50 ns/div to 10 ns/div: Within 1% of full scale plus differential time measurement accuracy plus 20 ns.

Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 major DTM divisions from +15°C to +35°C.

*The two fastest sweep speeds (0.5 ns/div and 1 ns/div) are not usable in the 7700-FAMILY mainframes, also internal triggering is limited to 250 MHz.

Jitter—1 part in 50,000 of maximum available delay time or 500 ps whichever is greater. (Not applicable for first 2% of available delay range.)

Triggering

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

HF Sync—Triggering frequency range is from 100 MHz to 500 MHz with increased sensitivity, this mode may be used with any coupling mode except AC HF REJ.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter— 50 ps or less at 500 MHz.

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (DC + peak AC) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +3.5 V to −3.5 V in EXT, at least +35 V to −35 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate— 0.5 ns/div to 0.2 s/div in 27 steps (1-2-5 sequence). The uncalibrated VARIABLE is continuous between steps to at least 0.5 seconds. Variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy—Measured over the center 8 div in the 7900-FAMILY Oscilloscope mainframe.

TIME/DIV	+15°C to +35°C	0°C to +50°C
0.1 s/div to 50 ns/div	within 3%	within 4%
0.2 s/div and 20 ns/div to 1 ns/div	within 4%	within 5%
0.5 ns/div	within 5%	within 6%

HF Sync—Triggering frequency range is from 100 MHz to 500 MHz with increased sensitivity.

Internal Trigger Jitter— 50 ps or less at 500 MHz.

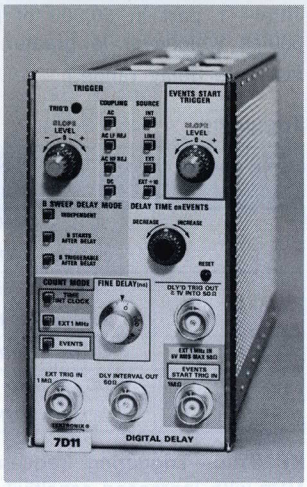
Triggering

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
DC	DC - 20 MHz	0.5 div	100 mV
	20 MHz - 500 MHz	1.0 div	500 mV

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (DC + peak AC) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +2.5 V to −2.5 V.

Order 7B92 TIME BASE **$1400**

- **DIGITAL DELAY READOUT TO 7½ DIGITS**
- **DELAY BY TIME OR EVENTS**
- **100 ns to 1 s DELAY TIME**
- **1 ns RESOLUTION**
- **LESS THAN 2.2 ns JITTER**
- **0.5 ppm (±2 ns) ACCURACY**
- **DELAY INTERVAL CRT DISPLAY**



The 7D11 Digital Delay plug-in provides a means of accurate and stable delayed triggers for measurements requiring low jitter and precision time delays. With the capability of being used in any compartment of a 7000-Series mainframe equipped with CRT READOUT, the 7D11 provides a variety of outputs. Upon the receipt of a trigger, the 7D11, in the Delay By Time mode, counts a highly accurate clock and at the selected delay time, delivers a delayed trigger to its front panel connector and to the mainframe in which it is installed. (See Fig 1.)

In the Delay By Events mode, the 7D11 will count arbitrary trigger events, periodic or aperiodic, and will deliver an output after the preselected count has been reached. In both modes, the delay time or the number of events to be counted is selected by a single front panel control.

The 7D11 generates signals which are applied to the vertical channel and Z-axis to aid in obtaining the proper delay. Installed in a vertical compartment, the CRT will display a waveform that lasts for the duration of the delay interval. This waveform can be displayed together with the signal waveform on which the 7D11 is triggered. From a vertical compartment, the 7D11 can trigger a timebase, such as a 7B70, 7B53A or another 7D11, through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 will generate a blanking pulse for the duration of the delay interval. This provides a display similar to the "A Intensified By B" mode of conventional delayed sweep operation. (See Fig 2.) When used in the A Horizontal compartment, the 7D11 B Sweep delay mode controls will permit the B Sweep to either run or be triggerable after the delay generated by the 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 the Delay By Events operation, 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 7D11 counts "n" number of horizontal sync pulses (Events) into the field or frame (See Fig 3). 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 requiring 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 can 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.

The 7D11 Digital Delay Unit is very helpful in making measurements under complex timing conditions such as those encountered in troubleshooting modern digital circuitry.

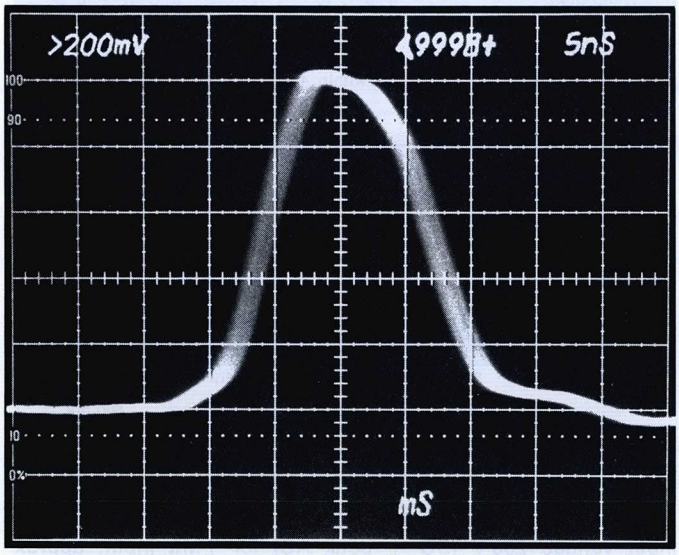


Fig. 1: 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

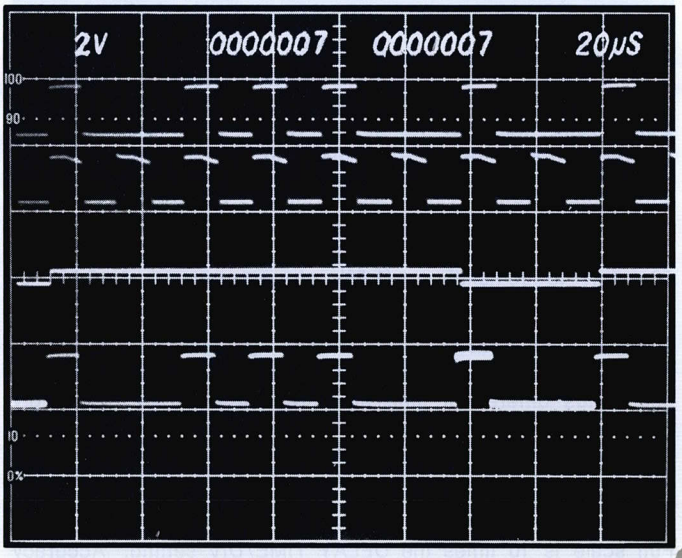


Fig. 2: Events Delay Mode (delay equals seven events). The top trace is a digital wavetrain and the second waveform is its clock. The third waveform represents the delay interval generated by the 7D11 in a vertical compartment; this began on the 1st clock pulse and ended on the 7th. The lower trace shows the display obtained with a 7D11 in a horizontal compartment (double exposure).

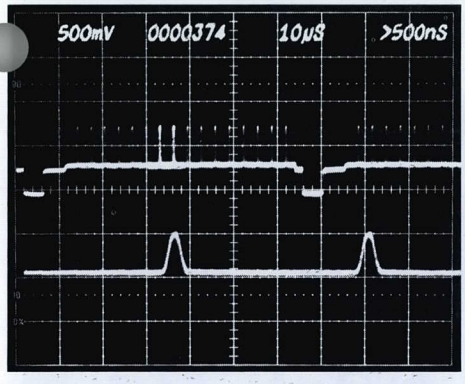


Fig. 3: Digital Delay Analog-Delay operation. The 7D11 triggers Time Base A at the beginning of the 374th line (upper trace). The 7th and 8th vertical bars are intensified by Time Base B set by the 7B71 delay time multiplier. The lower trace shows video information on the B delayed sweep.

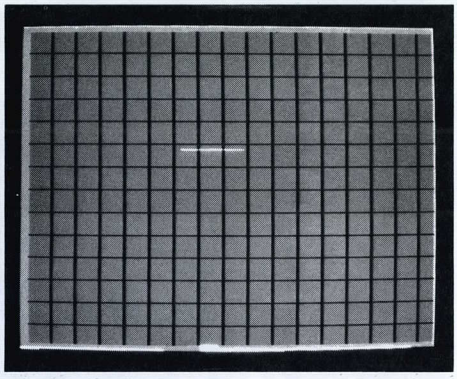


Fig. 4: The cross hatch signal seen on a Video Monitor. The B sweep gate of Fig. 3 applied to the monitor shows the 7th and 8th vertical bars unblanked at the 374th line.

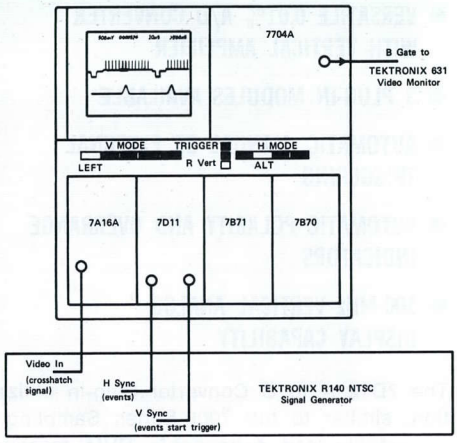


Fig. 5: Equipment set up for figures 3 and 4.

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.

Maximum 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	150 V DC + Peak AC			
LEVEL RANGE	±3.5 V in Ext ±35 V in Ext ÷ 10			
INPUT R and C	1 MΩ ±5%, 20 pF ±2 pF			
SENSITIVITY	COUPLING	FREQUENCY RANGE	MIN SIGNAL REQUIRED	
			INT	EXT
	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 sinewaves 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	40 mV minimum, 30 Hz to 4 MHz; increasing to 100 mV, 4 MHz to 20 MHz; increasing to 250 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 X 10^{-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 2%, AC coupled, 50 Ω.

OUTPUTS

Delayed Trigger Out—Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime into 50 Ω Load: 2 ns or less. Falltime 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. Risetime and Falltime: 5 ns or less. Accuracy: Equal to Delay Interval less 20 to 30 ns.

READOUT

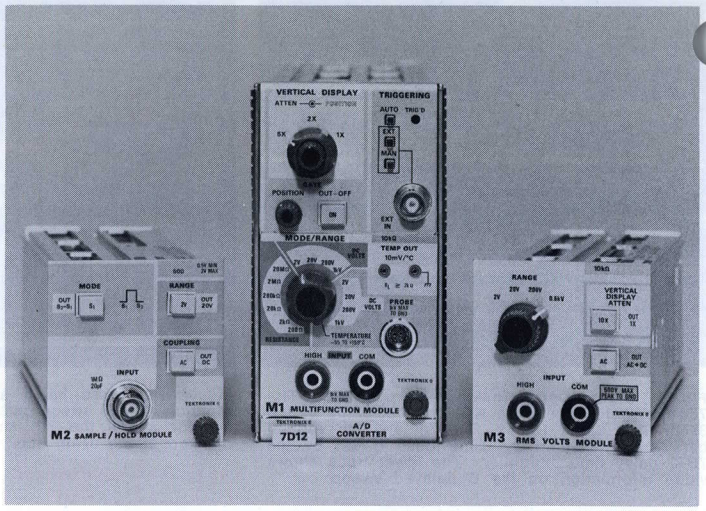
Display— 7½ digit with leading zero suppression. ms legend in Time Delay Mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

Order 7D11 DIGITAL DELAY UNIT $1475

Please use the return card, inside front cover, to write for application notes describing the use of the 7D11.

New

- **VERSATILE 0.01% A/D CONVERTER WITH VERTICAL AMPLIFIER**
- **3 PLUG-IN MODULES AVAILABLE**
- **AUTOMATIC, MANUAL OR EXTERNAL TRIGGERING**
- **AUTOMATIC POLARITY AND OVERRANGE INDICATORS**
- **100-MHz VERTICAL ANALOG-DISPLAY CAPABILITY**



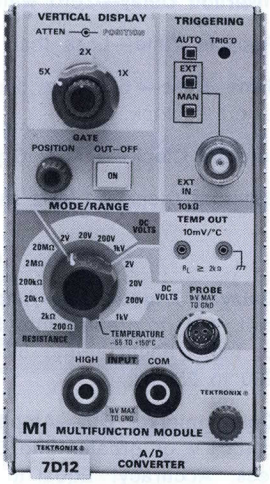
The 7D12 A to D Converter Plug-in utilizes modular construction, similar to the 7000-Series Sampling Plug-ins, to provide a versatile and expandable DVM measurement system. The 7D12 plug-in along with three interchangeable modules satisfies most DVM measurement applications including: DC volts, resistance, temperature, one- or two-point sample and hold, and true RMS volts.

The 7D12 is designed for use with all 7000-Series Oscilloscope mainframes except those without CRT READOUT.

There are three interchangeable modules available for the 7D12. Their description and specifications are described in combination with the 7D12 A/D Converter.

7D12/M1 MULTIFUNCTION MODULE

- **TEMPERATURE MODE**
- **4¼-DIGIT CRT READOUT**
- **100-μV RESOLUTION**
- **PROBE MEASURES TEMPERATURE OR VOLTAGE**



The M1 Multifunction Module in combination with the 7D12, measures DC volts, resistance, and temperature. The input can be elevated 1 kV above ground, with a 10-MΩ input impedance on the DC scale. When the temperature probe is used a front-panel analog output of 10 mV/°C (0°C = 0 volts), is available in addition to the CRT READOUT on the display.

DC Voltage Range— 0 to 1000 V in four ranges. 4½-digit presentation of 1.9999 V, 19.999 V, 199.99 V, 1.0000 kV. 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. Maximum 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. See P6058 voltage/temperature probe specifications included on 7D13 Digital Multimeter catalog page 78.

Settling Time— 2 s or less to within 1 count of final reading (voltage and resistance modes).

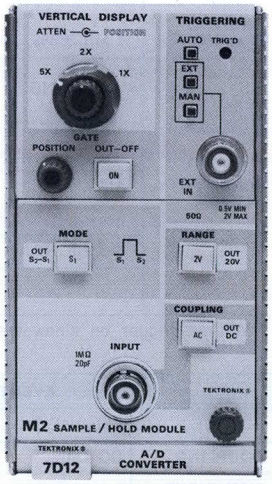
Measurement Rate— 4 measurements per second in AUTO triggering; 1 to 12 measurements per second in EXT triggering, internally adjustable.

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 (003-0120-00).

7D12/M2 SAMPLE/HOLD MODULE

- **OSCILLOSCOPE-CONTROLLED SAMPLING DVM**
- **10-ns APERTURE-SAMPLE TIME**
- **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 in combination with the 7D12 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) can be triggered automatically, manually, or externally from sources such as: the oscilloscopes Delayed B Gate, the 7D15 Universal Counter/Timers Pseudo Gate, 7D11 Delayed Trigger Out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and the 7D12/M2 gate are displayed together providing a visual indication of where the sample(s) are 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 zero volt 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 divisions, risetime and falltime 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 calibrated 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.

Maximum 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-Sample Time— 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— 1 to 12 measurements per second, internally adjustable (EXT triggering). 4 measurements per second (AUTO triggering S1 mode only).

Settling Time— 40 ns.

Accuracy Without Probe (40 ns after input signal step function)

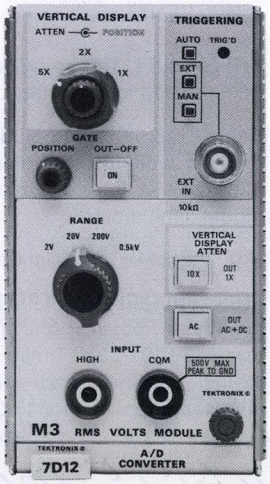
Temperature Range	S1 Mode	S2-S1 Mode
+ 20°C to + 30°C	± 0.15% of P-P input voltage, ± 0.1% of reading, ± 1 count, ± % of AC Decay*	± 0.25% of P-P input voltage, ± 0.15% of reading, ± 1 count, ± % of AC Decay*
+ 15°C to + 40°C	± 0.25% of P-P input voltage, ± 0.2% of reading, ± 2 counts, ± % of AC Decay*	± 0.35% of P-P input voltage, ± 0.25% of reading, ± 2 counts, ± % AC of Decay*

*Applicable when M2 is AC coupled.

Included Accessories— 3.5 ft P6055 Probe pack (010-6055-01).

7D12/M3 RMS VOLTS MODULE

- 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 MAXIMUM PEAK COMMON-MODE VOLTAGE



The M3 RMS Volts Module in combination with the 7D12 measures the true RMS voltage of signals from 40 Hz to 100 kHz. Voltages up to 1-kV peak can be measured while floating the input connectors.

Input R and C— 1 MΩ; ≃50 pF.

Maximum Crest Factor— 5, (crest factor = $\frac{E_{pk}}{E_{RMS}}$)

Maximum 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 V 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, .500 kV full scale.

Overrange Indication—When overrange occurs, a > symbol appears to the left of the reading.

Measurement Rate— 1 to 12 measurements per second internally adjustable (EXT triggering). 4 measurements per second (AUTO triggering).

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, maximum 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 calibrated 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).

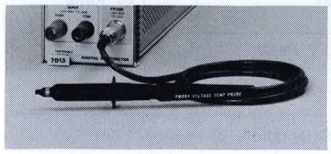
7D12/M1/M2/M3 ORDERING INFORMATION

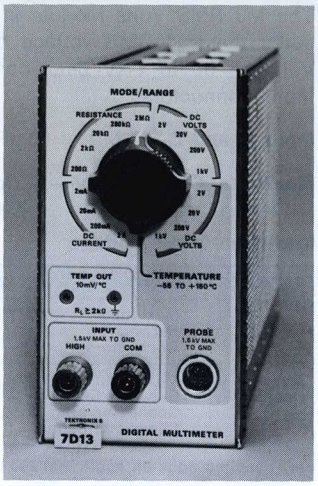
7D12 A/D CONVERTER (Modules Not Included)	$725
M1 MULTIFUNCTION MODULE	$325
Option 2 without P6058	Sub $65
M2 SAMPLE/HOLD MODULE	$685
Option 2 without P6055	Sub $85
M3 RMS VOLTS MODULE	$500

Please use the return card, inside front cover, to write for application notes describing the use of the 7D12.

7D13 *Digital Multimeter*

- TEMPERATURE MODE
- 1.5 kV MAXIMUM COMMON MODE VOLTAGE
- PROBE MEASURES TEMPERATURE OR VOLTAGE
- 3½-DIGIT CRT READOUT





The 7D13 is a Digital Multimeter plug-in designed for use in all 7000-Series Oscilloscope mainframes except those without CRT READOUT. The 7D13 will function in any plug-in compartment.

In addition to measuring DC volts, DC current and resistance, temperature measuring capability is also featured in the 7D13, provided by a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 volts). Thus, by using an external voltage indicator, temperature may be measured simultaneously along with any other function. Most any NPN transistor can 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 face of the CRT, along with a legend for units like kΩ, mA, C (temperature).

DC Voltage Range— 0 to 1000 V in four ranges. 3 1/2-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +40°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 megohms on all ranges. Maximum safe input is 1.5 kV Peak between either contact and ground, 1.0 kV Peak between voltage contacts.

DC Current Range— 0 to 2 A in four ranges. 3 1/2-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +40°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Maximum input is 3A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range— 0 to 2 megohms in five ranges. 3 1/2-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +40°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range— −55°C to +150°C in one range. 3 1/2-digit presentation to +150°C. Accuracy (+15°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Accuracy (0°C to +50°C ambient) is ±2°C from −55°C to +125°C, ±3°C above +125°C.

Settling Time— 1.5 s or less (voltage, current, and resistance modes).

Polarity—Automatic indication.

Maximum Common-Mode Voltage— 1.5 kV Peak between two terminals and ground.

Normal-Mode Rejection Ratio—At least 30 dB at 60 Hz increasing at 20 dB/decade.

Common-Mode Rejection Ratio—With a 1-kΩ imbalance it is at least 100 dB at DC; 80 dB at 60 Hz.

Overrange Indication—When overrange occurs, the readout goes into a "blinking" mode with the most significant digit displaying a 2.

Recycle Time— 5 measurements per second.

Temperature Out— 10 mV/°C into a load of at least 2 kΩ.

Included Accessories—P6058 Voltage/Temperature probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 DIGITAL MULTIMETER **$560**

7D13 OPTION

Order Option 2 without P6058 Probe ..... **Sub $65**

P6058 PROBE

The P6058 Probe is a combination 1X DC voltage and temperature measuring device. The temperature sensing element consists of a transistor installed in the nose tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and a five inch "common" (low) strap is provided, and is attached by threading into a hole in the side of the probe body. There is no external ground on the P6058 body, "ground" or the low potential point of the circuit under test is obtained via the common strap or connector, which is a floating common that has no tie to chassis ground. This lead may be floated at up to 1500 VDC away from chassis ground. The retractable hook-tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

DC Voltage Range— 0 to 1000 V. Accuracy is ±0.1% of reading ±1 count.

Maximum Safe Input— 1500 V peak between either voltage contact and chassis ground. 1000 V peak between voltage contacts.

Temperature Range—See the 7D13 for the accuracy of a P6058/7D13 combination.

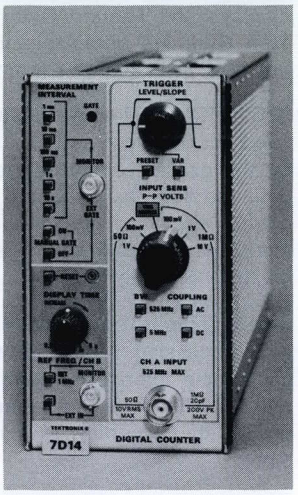
Cable— 46 inches including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight—Approximately 5 ounces.

P6058 VOLTAGE/TEMPERATURE PROBE, Order 010-0260-00 ..... **$65**
Includes: P6058 Probe (010-0259-00); probe retractable hook tip (013-0121-00); 5-inch ground lead (screw-in, 175-0848-01); 12-inch ground lead (screw-in, 175-0848-02); two miniature alligator clips (344-0046-00).

P6058 Temp probe specs have been derated in the Voltage mode. This affects the specs for 7D12/M, 7D13 + DM501. Max safe input is 500 V peak between input connectors, 40 V peak between probe's common connector + ground.

- **FREQUENCY MEASUREMENTS DIRECTLY TO 525 MHz**
- **TRIGGER INDICATOR DISPLAY**
- **NO-WARM-UP OSCILLATOR**
- **50-Ω and 1-MΩ INPUTS**
- **10 μV SENSITIVITY AT 1 MHz WITH 7A22**
- **FULL SIGNAL CONDITIONING TO 525 MHz**



The 7D14 is a directly gated digital counter plug-in unit designed for use in all 7000-Series Oscilloscope mainframes except those without 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 can be displayed on the screen with the ones being counted 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. Not only is general-purpose triggering made easier, selective triggering is now possible.

When the 7D14 is used in a horizontal plug-in compartment, a signal connected to a vertical plug-in can be internally routed to it by the trigger source switches. All the 7000-Series vertical plug-ins are available as signal conditioners for the counter. 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 can be restricted to 5 MHz to filter incoming high frequency noise.

Measurement Interval (Time Base)—1 ms to 10 s in five decade steps. Up to 0.1 Hz resolution can be obtained.

Accuracy—Within $\pm \frac{1}{\text{total count}} \pm$ time base.

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—Manual 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, the width is determined by the measurement interval.

REF FREQ/CH B Monitor—Provides a crystal-based, 1-MHz, +5 V output pulse. This connector functions as CH B input in the EXT IN mode.

READOUT

Display—8 digits with leading zero suppression, positioned decimal, MHz or kHz 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.

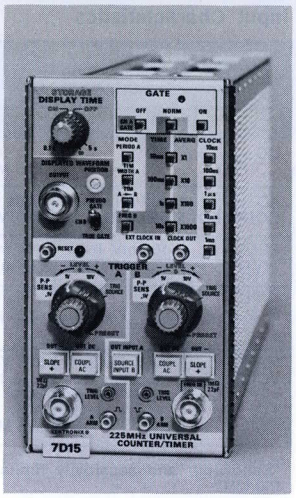
Displayed Trigger Indicator—Displayed amplitude of Schmitt trigger output is approximately 0.2 div.

Included Accessories—BSM male to BNC female adapter (103-0036-00).

Order 7D14 DIGITAL COUNTER $1400

Please use the return card, inside front cover, to write for application notes describing the use of the 7D14.

- **OSCILLOSCOPE CONTROLLED TIME and FREQUENCY MEASUREMENTS**
- **10 ns "SINGLE SHOT" TIME INTERVAL MEASUREMENT RESOLUTION**
- **TIME INTERVAL AVERAGING**
- **CRT DISPLAY OF COUNTING INTERVAL AND SCHMITT TRIGGER SIGNAL**
- **10 PICO SECOND PERIOD AVERAGING RESOLUTION**
- **SIGNAL CONDITIONING VIA MAINFRAME TRIGGER SOURCE**
- **FREQUENCY MEASUREMENTS DIRECTLY TO 225 MHz**
- **ACCURATE "TIME MARK" OUTPUTS**



The 7D15 is a Universal Counter/Timer Plug-In unit designed for use in all 7000-Series Oscilloscope mainframes except those without CRT READOUT.

The 7D15 offers all of the measurement capabilities known to the Counter/Timer world such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

The performance of the 7D15 is further enhanced by its ability to display the count interval or the output of the Channel B Schmitt trigger shaper on the CRT. By utilizing the 7000-Series mainframe Vertical Mode switching, these outputs from the 7D15 can be displayed simultaneously with the actual signal being measured. The Pseudo Gate, which is a high rep-rate replica of the actual gate (True Gate), is independent of the Display Time control and therefore a more useful display. Three displays, the Pseudo Gate, Ch B Schmitt Trigger Output and True Gate are obtainable from a 7D15 front panel switch and are also available at a front panel connector.

Another 7D15 feature useful in complex timing or burst related measurements is its ability to be completely controlled by the oscilloscope's delayed or B 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 desired point on the CRT display. See Fig. 1.

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 high resolution capabilities of the 7D15 are made possible by a 10-ns clock, one of five clock positions obtainable from the front panel. A front panel Clock Out connector makes the selected clock signal available at a front panel connector. This provides a "time mark" function that is TTL compatible, which will also 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 is compatible 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.

The measurement versatility, high degree of accuracy and resolution, that the 7D15 introduces to the 7000-Series Oscilloscopes, will contribute significantly to the higher performance measurement requirements of today's expanding technologies.

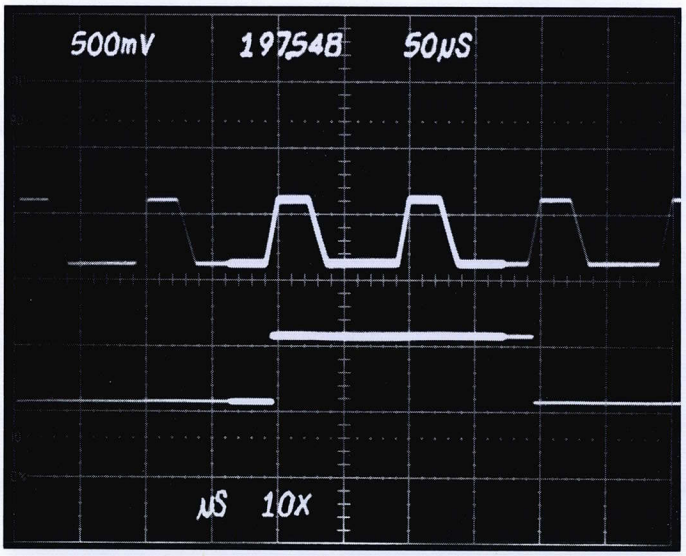


Fig 1: Oscilloscope controlled digital measurements using the delayed B Gate as the arming input logic allows user to make precise time measurement from third to fifth pulse on CRT display. Counter Ch A is "armed" with leading edge of B Gate while Ch B is "armed" with falling edge of B Gate Lower trace is Pseudo Gate of 7D15.

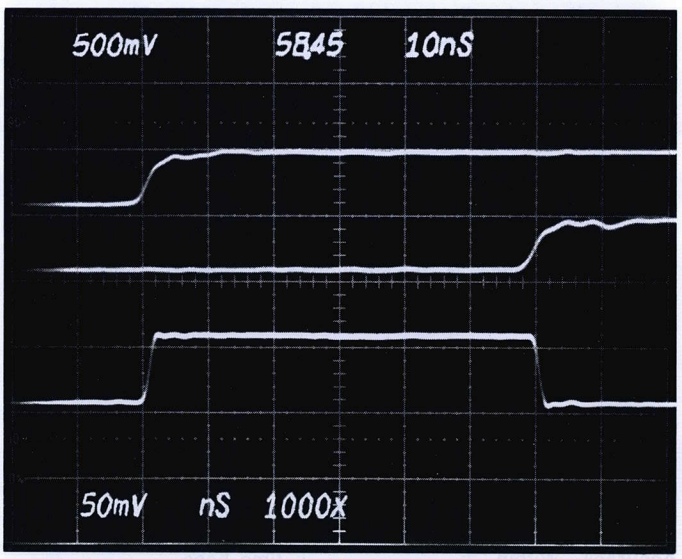


Fig 2: The delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 Pseudo Gate display.

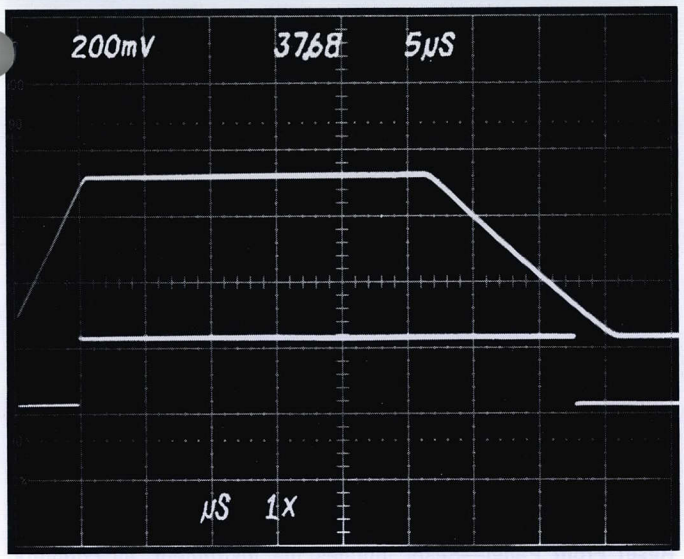


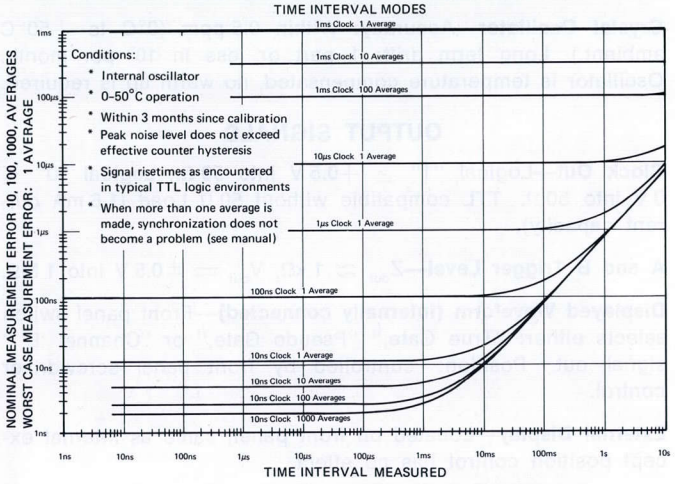
Fig 3: Independent Slope and Level control allows the user to select precise points on the waveform where the counter starts and stops.

MODES OF OPERATION		
FREQUENCY MODE	RANGE	DC to 225 MHz Resolution 0.1 Hz maximum
	ACCURACY	$\epsilon_{freq(Hz)} = \pm TB \cdot f_{in}$
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
	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 (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

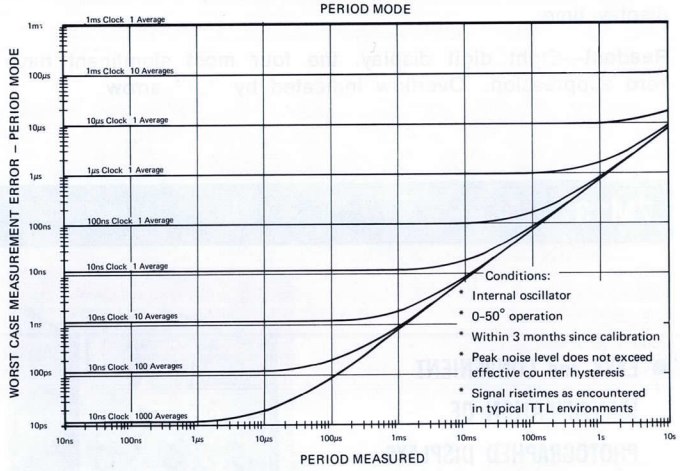
NOTE: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period or time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts/second).

ACCURACY

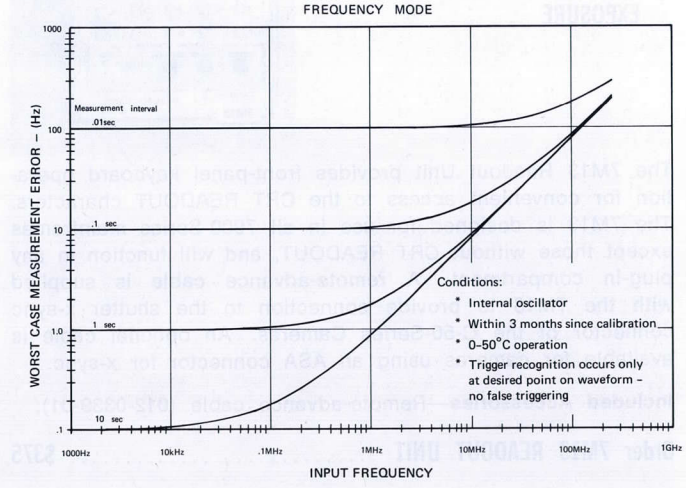
TIME INTERVAL MODES



PERIOD MODE



FREQUENCY MODE



More →

7000-SERIES OSCILLOSCOPES
7D15 *Universal Counter/Timer*

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 either: "True Gate," "Pseudo Gate," or "Channel 'B'" signal out. Position: controlled by front panel screwdriver control.

External Display—Located on front panel, same as internal except position control has no effect.

Display Mode Switch—Front panel 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 ">" arrow.

INPUT SIGNALS 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-to-p. Trigger Source: 0.5 divisions of vertical deflection.

Input R and C—1 MΩ and 22 pF.

Triggering—Preset Position: Automatically triggers at 0 volts.

Level Control Range (CH A and B Inputs)—100 mV Range: ±500 mV; 1 V Range: ±5 Volts; 10 V Range: ±50 Volts.

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 initiates the instrument, all counters are affected, including averaging circuits.

Included Accessories—Two Cables RF 44″ (012-0403-00), Sealectro to BNC connector).

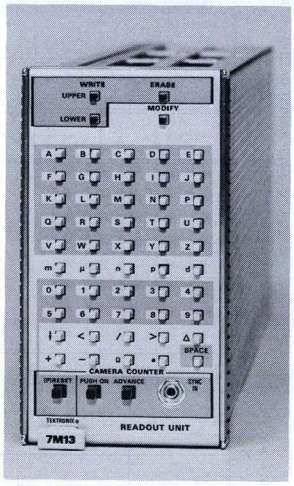
Order 7D15 UNIV. COUNTER TIMER **$1475**

Please use the return card, inside front cover, to write for application notes describing the use of the 7D15.

7M13 *Readout Unit*

New

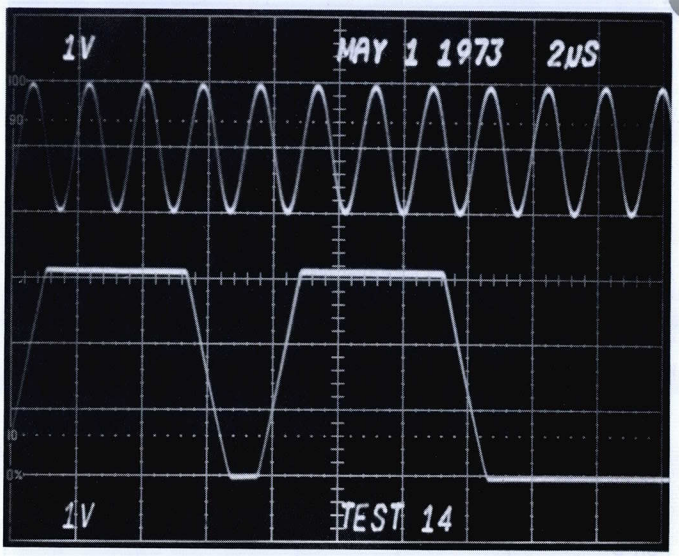
- **EASY and CONVENIENT IDENTIFICATION OF PHOTOGRAPHED DISPLAYS**
- **AUTOMATIC SEQUENCE ADVANCE WITH EACH CAMERA EXPOSURE**



The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the CRT READOUT characters. The 7M13 is designed for use in all 7000-Series mainframes except those without CRT READOUT, and will function in any plug-in compartment. A remote-advance cable is supplied with the 7M13 to provide connection 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 Accessories—Remote-advance cable (012-0339-01).

Order 7M13 READOUT UNIT **$375**



The photograph above was dated and identified as TEST 14 by using the 7M13 in a 7704A Oscilloscope.

Optional Accessory—Remote-advance cable with ASA connector for camera x-sync, **Order 012-0364-01** **$8.00**

7000-Series Sampling Plug-ins

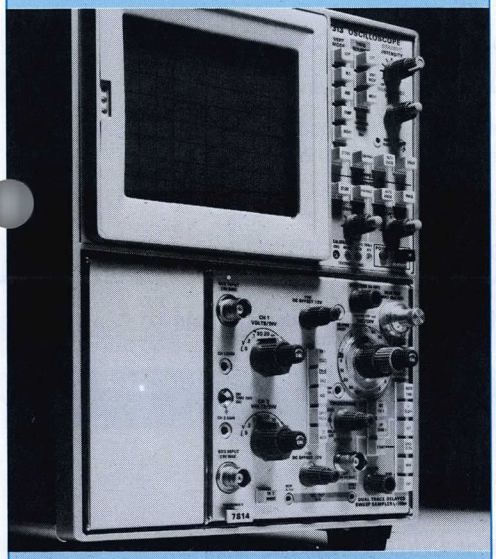
The following pages have detailed descriptions of the sampling units that will plug into any of the 7000-Series mainframes.

The sampling plug-ins for the 7000-Series mainframes will make any 7000-Series oscilloscope a useful sampler to suit varied applications because of the combination possibilities of the many mainframes, plug-ins, and sampling heads.

The 7S14 sampler is a totally-integrated sampling unit added to the line of 7000-Series samplers. It combines two vertical and horizontal functions in one double-width plug-in for lower cost and operating ease over existing configurations.

Plug-ins

- ***7S11*** ..... ***Sampler***
- ***7S12*** ..... ***Sampler/TDR***
- ***7S14*** ..... ***Sampler***
- ***7T11*** ..... ***Sampler Time Base***
- ***7M11*** ..... ***Dual Delay Line***



7S14 Sampler in 7313 Mainframe

Time Domain Reflectometry

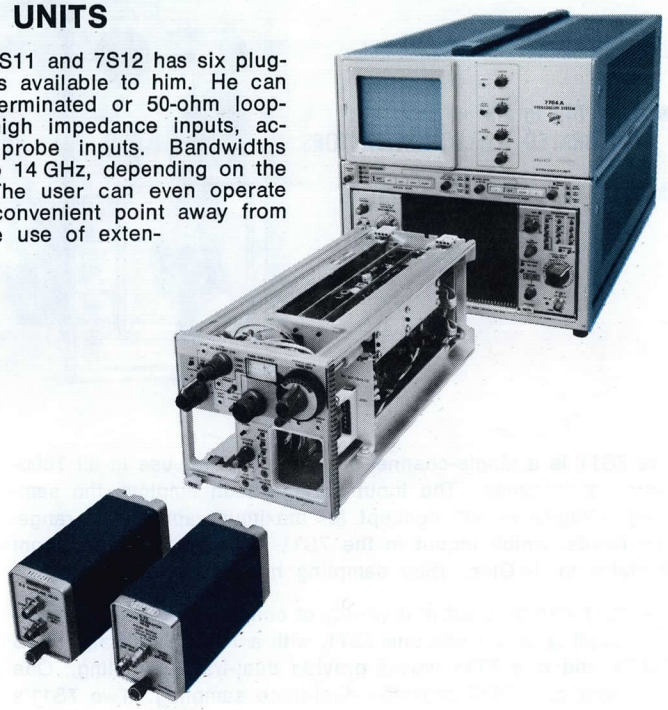
Time Domain Reflectometry or TDR is closely associated with sampling oscilloscopes because the risetimes achieved with sampling allow best resolution, location and measurement of impedance differences. Time Domain Reflectometry is possible with any sampling system or fast conventional oscilloscope, but is easiest and most precise in systems designed for TDR. Tektronix, Inc. offers two sampling systems designed specifically for TDR.

In the 7000 Series—The **7S12** with plug-in heads.

For use in **CATV, TV** and similar applications—the **1501,** with or without oscilloscope.

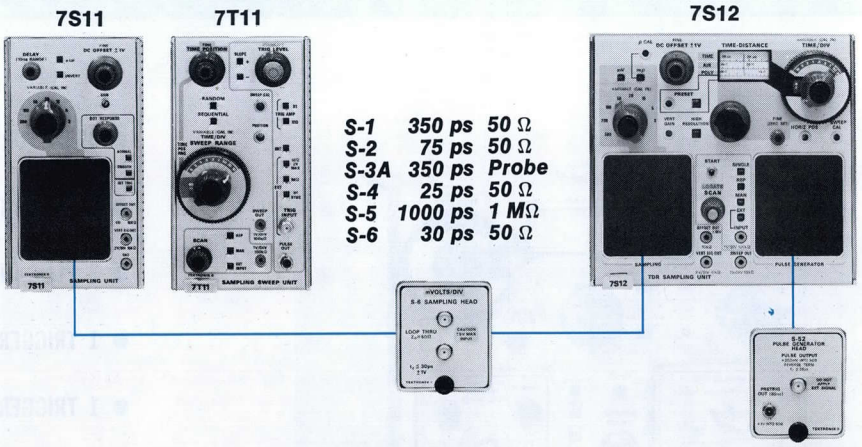
FOR VERSATILITY: PLUG-IN HEADS IN PLUG-IN UNITS

The user of the 7S11 and 7S12 has six plug-in sampling heads available to him. He can choose 50-ohm terminated or 50-ohm loop-through inputs, high impedance inputs, active or passive probe inputs. Bandwidths range from DC to 14 GHz, depending on the head selected. The user can even operate the heads at a convenient point away from the scope by the use of extension cables.



Time Bases and Other Considerations

The 7T11 Time Base is designed to be used with one or two 7S11 Sampling Units. The 7S12 includes a built-in time base that can also be used with a 7S11, eliminating the need for a time-base plug-in unit. For example, a 7S11 and a 7S12, with plug-in heads, will operate as a dual-trace sampling system with the time base of the 7S12 providing a common time-based sweep. If a delay line is required, the 7M11 delay line plug-in unit can be used in a vacant compartment or outside the mainframe. The 7M11 is a passive unit requiring no power.



7S12—This unit features the flexibility of two plug-in heads for time domain reflectometry or general-purpose sampling. For TDR a sampling head, usually the S-6 feedthrough head, is used in one compartment. A pulse generator head is used in the other compartment as a pulse source. When the 7S12 is to be used as a general-purpose sampler, a trigger recognizer head is substituted for the pulse generator head.

- ***S-50*** ***Pulser***
- ***S-51*** ***18 GHz Countdown***
- ***S-52*** ***Pulser***
- ***S-53*** ***General Purpose***
- ***S-54*** ***Pulser***

7S11 *Sampling Unit*

- **2 mV/DIV to 200 mV/DIV CALIBRATED DEFLECTION FACTORS**
- **PLUG-IN SAMPLING HEADS**

The 7S11 is a single-channel sampling unit for use in all 7000-Series mainframes. The input configuration employs the sampling "Plug-In Head" concept for maximum application range. The heads, which mount in the 7S11, cover a bandwidth from 350 MHz to 14 GHz. (See sampling head descriptions.)

The 7S11 can be used in a variety of combinations. Single channel sampling would use one 7S11, with a 7T11 Time Base. Two 7S11's and one 7T11 would provide dual-trace sampling. One 7S11 and one 7S12 provides dual-trace sampling. Two 7S11's can be used for X-Y operations.

An INTERNAL TRIGGER path is provided from the Plug-In Head (except for the S-3A) to the 7T11 Time Base when the INT TRIG mode is selected. When operating in dual-trace mode, either vertical channel may be used as the trigger source.

The 7S11 deflection factor is from 2 mV/div to 200 mV/div with a continuous VARIABLE control. The DOT RESPONSE control optimizes dot transient response in the NORMAL mode. The SMOOTH position reduces display noise at the more sensitive deflection factor settings.

The ±1 V DC OFFSET can be used as a vertical position control to view any segment of a signal within its range at any sensitivity, even when portions of the trace are off screen. The DC OFFSET voltage is available at the OFFSET OUT jack (X10) for external monitoring.

CHARACTERISTICS

Deflection Factor— 2 units/div to 200 units/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/div or less to at least 400 units/div). Deflection factor (i.e., mV/div) is determined by the plug-in sampling head.

Bandwidth—Determined by the sampling head.

Input 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 10 kΩ within 1%.

Delay Range—At least 10 ns (helps compare 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%.

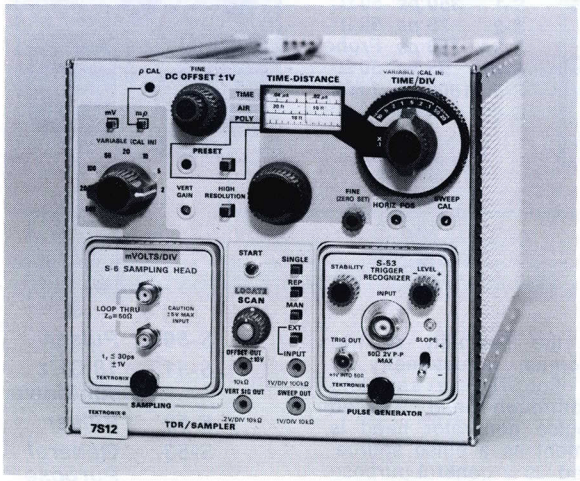
Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

Weights

Net weight	2 lb	0.9 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

Order 7S11 SAMPLING UNIT without sampling head $575

7S12 *TDR and General-Purpose Sampler*



- **45-ps TDR or 30-ps GENERAL PURPOSE SAMPLER**
- **6 PLUG-IN SAMPLING HEADS AVAILABLE**
- **3 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 unit, designed to operate in all 7000-Series mainframes. It permits high-resolution TDR or general-purpose sampling measurements. As a TDR, using the S-6 Sampling Head and S-5 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 32

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 (airline) and discontinuities to twice this distance may be viewed. System risetime 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 pretrigger signal is not available. Very fast triggering events will not be displayed at 20 ns/div or slower.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Risetime— 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distance to at least 49 ft (airline). Time range is at least .2 μs, round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude—At least +200 mV into 50 Ω.

Input Characteristics—Nominal, 50-Ω, feed-through signal channel (termination supplied). SMA (3-mm) connectors.

Jitter—Less than 10 ps (without signal averaging).

Aberrations— +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 Risetime— 1.5 ns or less, for the displayed reflection from a short-circuited test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distances to 4900 ft (airline, 3240 ft solid polyethelene). Time range is 20 μs, round trip.

Pulse Amplitude—At least +400 mV into 50 Ω.

Input Characteristics—Nominal, 50-Ω test-line connection (cable and T supplied). BNC connectors.

Jitter—Less than 20 ps (without signal averaging).

Aberrations— +4%, —6%, total of 10% P-P within first 17 ns of step; +1.5%, —1.5%, total of 3% thereafter.

OTHER 7S12 CHARACTERISTICS

Vertical Scale—Calibrated in mρ (reflection coefficient X10^{-3}) and mV from 2 to 500 units/div in 8 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

Resolution—Reflection coefficients as low as 0.001 can be observed. Signal averaging reduces test-line noise in display.

DC Offset Range— +1 V to —1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 actual DC offset through 10 kΩ.

Time/Distance—Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectrics having propagation factors from 0.6 to 1.0.

Time/Div— 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button—Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes—Repetitive or single sweep, manual or external scan.

Signal Outputs—Pin jacks provide both vertical signal and sweep outputs.

Weights

Net weight	≈5 lb	2.1 kg
Domestic shipping weight	≈8 lb	≈3.6 kg
Export-packed weight	≈13 lb	≈5.9 kg

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 $1200

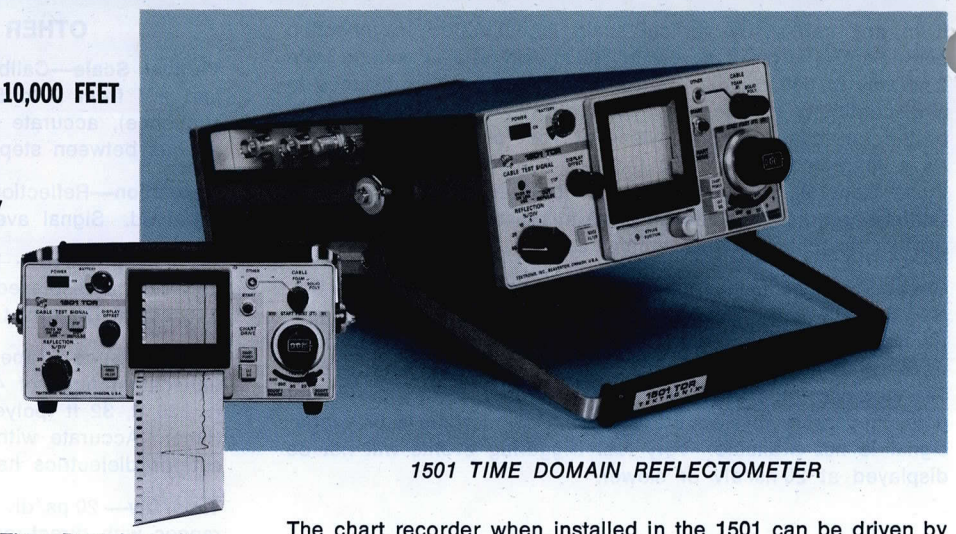
Order Option 3 TAPE DIAL CHANGE (meters) ..... No Charge

OPTIONAL ACCESSORIES

Patch Cords—are available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT and SWEEP OUT jacks of the 7S12. Pin-jack to pin-jack, 0.08 inch dia pin.

Red, 8 inch, **Order 012-0179-00** **$2.50**
Red, 18 inch, **Order 012-0180-00** **$2.50**
Black, 8 inch, **Order 012-0181-00** **$2.50**
Black, 18 inch, **Order 012-0182-00** **$2.50**
Tape Dial—calibrated in feet, **Order 331-0273-00** **$8.80**
Tape Dial—calibrated in meters, **Order 331-0276-00** **$8.80**

- **DETECTS and LOCATES CABLE FAULTS to 10,000 FEET or 3000 METERS**
- **ACCURATE to INCHES for SHORT RANGES**
- **SELF-CONTAINED RECHARGEABLE BATTERY**
- **AC OPERATED WHILE BATTERY CHARGES**
- **LESS THAN EIGHT POUNDS**
- **50-OHM or 75-OHM SOURCE IMPEDANCE**
- **PLUG-IN STRIP CHART RECORDER**
- **USE with OSCILLOSCOPE OPTIONAL**



1501 TIME DOMAIN REFLECTOMETER

The 1501 is a portable, battery-operated Time Domain Reflectometer (TDR) used to detect and locate faults and to measure impedance variations in transmission cables through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever communication or power transmission cable systems are used.

Two types of test signals and operating modes are provided . . . narrow pulses (IMPULSE mode) or fast rise long duration step signals (STEP mode). The step mode is usually preferred for analytical work; the impulse mode is especially for operating in the presence of noise signals or power voltage on the line. Test pulses are generated within the 1501 and drive the cable under test through a type "F" connector on the side panel. Adapters are available to mate with other connector types. Reflected signals return to the same connector and are terminated by the source impedance, either 50 ohms or 75 ohms—selectable with an internal switch. The input circuits are automatically protected from voltage on the line up to ±100 volts for frequencies up to 440 Hz. Voltages over 5 volts automatically AC couple the input, blocking DC and low frequency voltages, and causing a front panel light to indicate the presence of voltage on the line.

The 1501 is designed to be a complete measurement package when the Chart Recorder (016-0506-00) is plugged in. A strip chart 4 CM wide by 32.5 CM long can be made in about 20 seconds for about 10 cents per chart. For convenience in previewing each chart or as a substitute for graphic records a separate oscilloscope may be easily connected to the Vertical and Horizontal outputs of the 1501. The 323 or 324 SONY/TEKTRONIX Oscilloscopes are recommended for a size and style match with the 1501. The TEKTRONIX 211 Oscilloscope is also recommended. Most any oscilloscope with DC coupled vertical and horizontal amplifiers having a vertical sensitivity of 0.2 volts per division and a horizontal sensitivity of 0.5 volts per division is suitable.

The recorded portion of each chart has ten major horizontal divisions spaced 2.5 CM apart (about 1 inch) and eight major vertical divisions spaced 0.5 CM apart. The long (25 CM) horizontal scale provides distance resolution down to an inch or two for the 500 foot range at 2 feet per division. A direct reading, ten turn, start point delay dial provides the means for precise distance measurements using an oscilloscope display. Each chart is 7.5 centimeters longer than the recorded portion to provide space for handwritten data.

The chart recorder when installed in the 1501 can be driven by the 1401A or 1401A-1 Spectrum Analyzer, works especially well when coupled with a 323. The 1401A has a 50-Ω input and the 1401A-1 has a 75-Ω input especially suited for CATV.

CHARACTERISTICS

Test Signal Amplitudes—Step 1 V, Impulse 10 V.

Displayed Risetime—1.3 ns (from reflection).

Displayed Impulse Width—1.3 ns (at 50% amplitude).

Displayed Aberrations— +5%, −5%, total not to exceed 8% of test signal amplitude within first ten feet, much less thereafter.

Vertical Deflection Factors— 0.5, 1, 2, 5, 10, 20 and 50% (of test signal amplitude) per division. One division on scope is equal to one 0.5 centimeter division on chart. Accuracy is 3%.

Displayed Noise (Tangentially measured)—Less than 0.2% using noise filter mode, or recorded on chart.

Source Impedance—75 ohms within 2% or 50 ohms within 2 %. Selectable with internal slide switch.

Maximum Safe Input Voltage—±100 volts (DC + peak AC) for AC frequencies to 440 Hz.

Horizontal Scale Factors—2, 5, 20, 50, 200, 500 feet per division. Accuracy within 3%.

Start Point (Delay) Ranges—500 feet and 5000 feet, continuously variable. Direct distance readout on dial. Accuracy within 2% of dial setting.

Distance Ranges—0-520 feet at 2 feet/div
0-550 feet at 5 feet/div
0-5200 feet at 20 feet/div
0-5500 feet at 50 feet/div
0-7000 feet at 200 feet/div
0-10,000 feet at 500 feet/div

Metric Calibration (Option 2)—The metric 1501 Options 2 and 3 have scale factors of 0.5, 2, 5, 20, 50 and 200 meters with delay ranges of 100 and 1000 meters. This allows measurements to be made out to 3000 meters.

Cable Dielectric—Three choices. Either solid polyethylene, foam polyethylene with propagation velocity of 0.81, or one other, adjustable to your choice.

Sweep Rate—Changes from about 40 per second (flicker free) to 4 per second when noise filter mode is selected. Approximately 20 seconds when a chart recording is made. Front panel push button starts the recording. Paper automatically stops when record is complete.

Sweep Output—0 to +5 volt ramp within 2%.
Vertical Output—0.2 V per chart division. Range limited to +2 V to −2 V.

External Pen Drive Input—0.2 V per chart division, 1.6 V P-P.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Nonoperating: −55° to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock (operating and nonoperating)—30 g's ½ sine, 11 ms duration. Two guillotine-type shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

POWER SOURCES

External DC Source—Operates from an external DC source of 6 V to 16 V, requires 5 W.

External AC Source—Operates from an external AC source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 15 W maximum at 115 VAC.

Battery Operation—Removable power pack contains a battery of 6 size C NiCd cells providing at least 8 hours of operation with 30 recordings at 20° to 25°C. Power packs may be removed and plugged into AC to recharge the cells or may be left in the 1501 for recharge. The cells completely recharge in 16 hours. The 1501 may be operated from AC while the cells recharge or turned off except for recharge.

DIMENSIONS AND WEIGHTS

	1501	
	in	cm
Height	≈4	8.9
Width w/handle	≈9	21.6
Depth w/panel cover	≈11	27.0
Depth w/handle	13	33.0
	lb	kg
Weight w/Recorder and Accessories	≈8	≈3.6
Net weight w/o Recorder and Accessories	≈7	≈3
Domestic shipping weight w/Recorder	≈13	≈5.9
Export-packed weight w/Recorder	≈21	≈9.5

TIME DOMAIN REFLECTOMETER MODULE

1501 Included Accessories—Cover front (200-0812-00); chart recorder (016-0506-00); two rolls chart paper (006-1658-00); "F" male to male adapter (103-0157-00); "F" female to female adapter (103-0159-00); "F" male to BNC female adapter (103-0158-00); 8-ft power cable assembly (161-0043-02); cover plate, chart recorder blank (016-0509-00); TDR slide rule (003-0700-00): TDR Application Note #1 (062-1538-00); cable interconnector (012-0214-00).

ORDERING INFORMATION

1501 (with recorder) **$1900**
Option 1 (without recorder) ..... **Subtract $475**
Option 2 (Metric version) ..... **No Charge**
Option 3 (Metric version without recorder) ..... **Subtract $475**

OPTIONAL ACCESSORIES

Chart Recorder, Order 016-0506-00 ..... **$525**

323 Oscilloscope with P7 Phosphor—The 323 with high persistance P7 phosphor is highly recommended. **Order 323 Option 76** **$995**

1501 Convenience Accessory Group—Panel cover (200-0812-00); neck strap carrying assembly (346-0051-00); accessory pouch (016-0113-03); protective cover (016-0112-00);
Order 020-0053-00 ..... **$27.50**

Protective Cover—Waterproof blue vinyl,
Order 016-0112-00 ..... **$11.00**

Handle Conversion Kit (for two instruments)—For combining an existing 323 or 324 Oscilloscope with 1501 TDR.
Order 040-0563-00 ..... **$33.00**

Handle Conversion Kit (for three instruments)—For combining the 1501 with a 323 or 324/1401A or 1401A-1.
Order 040-0596-00 ..... **$55.00**

Chart Paper—One roll, **Order 006-1658-00** **$7.55**

Power Pack—Extra power pack, identical to the one supplied with the 1501, allows one power pack to charge while the other is powering the 1501. **Order 016-0119-02** **$110.00**

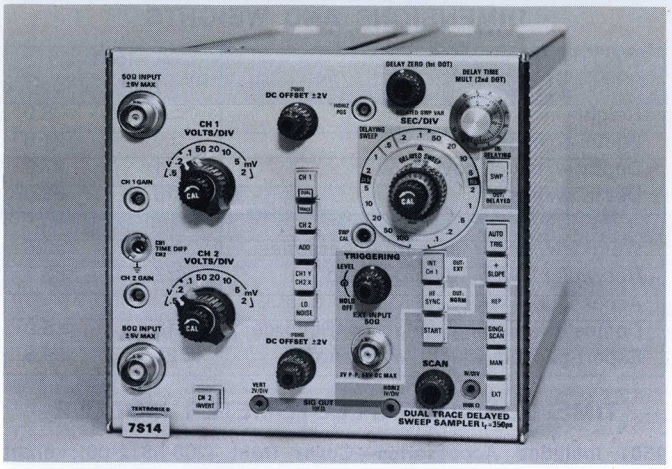
Battery Set—Set of 6 NiCd cells, **Order 146-0012-01** .. **$25.30**

Adapters
"F" male to BNC female, **Order 103-0158-00** **$6.90**
"F" female to BNC male, **Order 013-0126-00** **$6.90**
"F" female to GR 874*, **Order 017-0089-00** **$11.00**

*Registered Trademark General Radio Company

7S14 *Dual Trace Delayed Sweep Sampler*

New



- **CALIBRATED DELAYED SWEEP**
- **TWO-DOT TIME 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 unit designed to operate in all 7000-Series mainframes. Combining the Sampling vertical and time-base functions in one plug-in enables the 7S14 to provide new economy and ease of operation.

Two identical vertical channels provide dual-trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A new and 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 Mult Dial by the selected time per division.

Front-panel control grouping is identified by different shades of color on the panel and the control nomenclature relates closely to that encountered in conventional oscilloscopes. Learning to operate the 7S14 requires a minimum effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL 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.

Risetime— 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 .5 V/div in 8 calibrated steps (1, 2, 5 sequence). Continuously variable between steps b at least 2.5 to 1.

Accuracy—Within ±3%.

Maximum Input Voltage— ±5 V.

Input Signal Range— 2 V P-P maximum 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 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 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 trigge recognition or when the time must be 5 ns or less per divisio 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 CHARACTERISTICS

Range— 10 ns/div to 100 μs/div in 13 steps (1, 2, 5 sequence).

Accuracy—Within ±3%, excluding first ½ division of displayed sweep.

Delayed Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the Delaying Sweep selected.

Delay Time (2nd Dot)—Adjustable to any portion of the time interval represented by ten divisions of the Delaying Sweep selected.

Delay Accuracy—Within ±1% of ten divisions when measurement is made within the last 9.5 divisions.

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 division of displayed sweep.

Start Delay—Depends on the Delaying Sweep time selected ar the setting of the Delay Time Mult dial. Adjustable from Zer to any time interval up to that represented by ten divisions 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 one division of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

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 maximum. Trigger pulse amplitude 10 mV P-P or more with risetime of 1 μs or less. 10 Hz to 100-MHz. Sinewave amplitude 10 mV P-P or more from 150-kHz to 100-MHz.

Internal Triggering—Pulse amplitude 50 mV P-P or more with risetime of 1 μs or less. Sinewave 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 +.5 V and —.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 a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the peak-to-peak voltage of the signal.

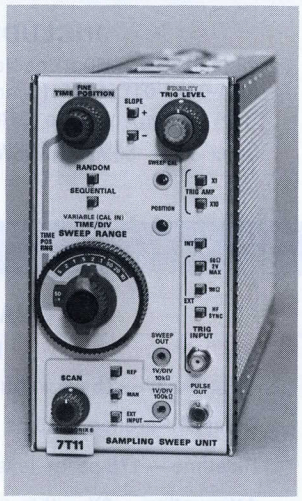
Holdoff—Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode—For sinewaves 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 $1850

Sampling Sweep Unit 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 in all 7000-Series Oscilloscopes. The TIME/DIV range is calibrated from 10 ps/div to 5 ms/div, selectable with the concentric TIME POSITION RANGE, TIME/DIV and VARIABLE control. Timing accuracy is within 3% (see characteristics) and nonlinearity is well below 1%, making specification unnecessary. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz. The following describes the modes of operation.

RANDOM SAMPLING—In this mode the triggering event may be displayed without the need of a pretrigger or signal delay line. The sampling process is controlled automatically by circuits which allow samples to be taken before, during and after the signal event of interest. The horizontal coordinate of each sample is then determined by a measurement of the time between the instant of sampling and the occurrence of a trigger. The random-sampling mode is most useful for displaying repetitive signals above 1 kHz.

SEQUENTIAL SAMPLING—When the signal repetition rate is between 10 Hz and 1 kHz, the most useful display is obtained in the sequential-sampling mode. In this mode, the sampling process is initiated by the trigger signal. As a result, either a pretrigger or signal delay line (such as the 7M11) is required to display the triggering event. Very fast triggering events will not be displayed at 100 ns/div or slower. For measurements which do not require display of the trigger-event (i.e., sinewaves) a pretrigger is not necessary and the decision to use random or sequential mode is based on repetition rate.

REAL-TIME SAMPLING—To provide a wide measurement range, the 7T11 automatically crosses from equivalent-time to real-time sampling for the three longest Time Position Ranges (50 ms, 5 ms, 0.5 ms). In this mode, sampling occurs at a free-running (50 kHz) rate with the horizontal coordinate determined in a manner similar to that described above for Random Sampling. Lead-time is fixed at about 3 μs for this mode but time-positioning is available as in equivalent-time sampling.

TIME-POSITION RANGE—Control selects the time window from 50 ms to 50 ns in 7 steps. The TIME/DIV controls can then select all or a portion of the time window for display. Each RANGE has 9 TIME/DIV steps (1-2-5 sequence) associated with it. The displayed portion of the time window is selectable with the TIME POSITION control.

TRIGGERING CONSIDERATIONS—The unit is capable of triggering on signals in the useful sampling range from 10 Hz to above 12.4 GHz. The EXT mode has 50 Ω, 1 MΩ, and HF SYNC positions, each with its special application advantage. The 50 Ω input complements sources requiring termination and provides an optimized signal path to the DC coupled trigger recognition circuit; operation extends to 1 GHz. The 1 MΩ input inserts a X1 FET amplifier in the 50 Ω path for minimum loading of the signal source at frequencies under 100 MHz. The HF SYNC position operates from 1 GHz to above 12.4 GHz as a trigger countdown device. An INT trigger source from the 7S11 is provided (except with the S-3A plug-in head) for frequencies up to 500 MHz.

CHARACTERISTICS

Time/Div Range— 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to TIME POSITION RANGES. Uncalibrated VARIABLE is continuous between steps and to at least 4 ps/div.

Time Position Range—Equivalent time is 50 ns to 50 μs in 4 steps, real time is 0.5 ms to 50 ms in 3 steps.

Time/Div Accuracy—Within 3% for all TIME/DIV settings over center 8 cm.

More →

7T11 *Sampling Sweep Unit*

TRIGGERING

Ext 50 Ω Input—Frequency range is DC to 1 GHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V P-P (DC to 1 GHz) in X1 TRIG AMP, 0.5 mV to 2 V P-P (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Max input voltage is 2 V (DC + peak AC).

Ext 1 MΩ Input—Frequency range is DC to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V P-P (DC to 100 MHz) in X1 TRIG AMP, 0.5 mV to 2 V P-P (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 MΩ within 5%. Max input voltage is 100 V P-P to 1 kHz, derating 6 dB/octave to a minimum 5 V P-P.

Ext HF Sync—Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV P-P. Input R is 1 MΩ. Max input voltage is 2 V P-P.

Sensitivity derated - 175 mV

Int Trigger Source (Sinewave Triggering)*—Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is ~~50~~ mV to 1 V P-P (referred to the vertical input) in X1 TRIG AMP; 5 mV to 1 V P-P (referred to the vertical input) in the X10 TRIG AMP.

Random Mode Trigger Rate— 100 Hz minimum.

Display Jitter—Measured under optimum trigger conditions TIME/DIV switch cw.

*NOTE: Trigger circuits will operate to DC with pulse triggering, except for HF Sync.

TIME POS RNG	SEQUENTIAL MODE	RANDOM MODE
50 μs to 500 ns	0.4 div at 10 ps/div	1 div at 10 ps/div
50 ns	10 ps	30 ps

Pulse Out—Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5-ns risetime or less.

Trigger Kickout— 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate—Continuously selectable from at least 40 sweeps/sec to less than 2 sweeps/sec.

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.

Weights

Net weight	2.8 lb	1.3 kg
Domestic shipping weight	≈ 6 lb	≈2.7 kg
Export-packed weight	≈11 lb	≈5.0 kg

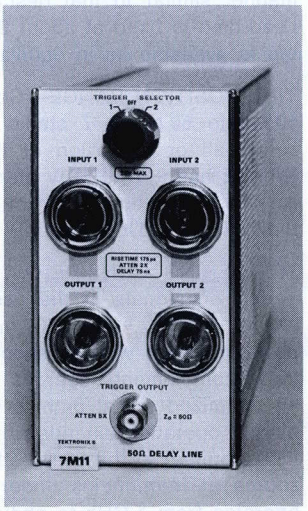
INCLUDED ACCESSORIES

42-inch BNC 50 Ω cable (012-0057-01); 10X, 50 Ω attenuator (011-0059-01); 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 $1625

7M11 *Dual Delay Line*

- 75 ns TIME DELAY
- SELECTABLE TRIGGER OUT
- 175 ps RISETIME



The 7M11 is a passive dual DELAY LINE unit for use with the 7000-Series sampling system. In low-repetition rate applications, requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at the faster time per division settings. Very fast triggering events will not be displayed at the slower time per division settings of most sampling sweep units.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50-Ω, 75-ns delay lines. The closely matched (30 ps) lines have GR874 INPUT-OUTPUT connectors, 175-ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay— 75 ns within 1 ns.

Delay Difference— 30 ps or less between channels.

Risetime— 175 ps or less.

Attenuation— 2X within 2% into 50 Ω.

Input Impedance— 50 Ω within 2%.

Maximum Input Voltage— ±5 V (DC + Peak AC).

TRIGGER OUTPUT

Risetime—600 ps or less.

Attenuation— 5X within 10% into 50 Ω (referred to INPUT).

Output Impedance— 50 Ω within 10%.

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

Weights

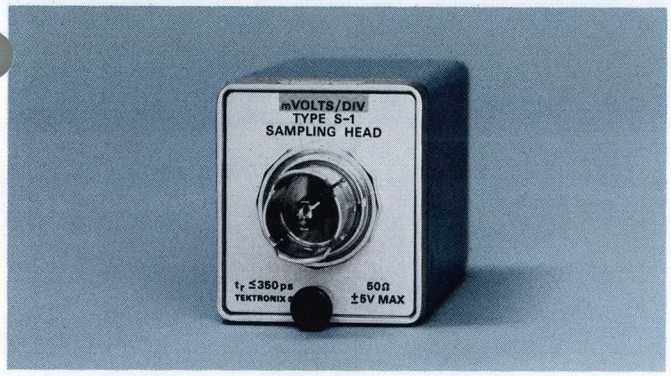
Net weight	5.8 lb	2.6 kg
Domestic shipping weight	≈9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.3 kg

INCLUDED ACCESSORIES

10-inch BNC cable (012-0208-00); two 2 ns GR cables (017-05[illegible]00).

Order 7M11 DELAY LINE UNIT $325

7M11 CARRYING CASE, Order 437-0106-00 ..... $33



- ***DC-TO-1 GHz BANDWIDTH***
- ***CLEAN TRANSIENT RESPONSE***

The S-1 Sampling Head is a low-noise, 350-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

RISETIME
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%, −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.

WEIGHTS

Net weight	≈1 lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

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 $375

- ***DC-TO-4.6 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 6 mV (unsmoothed)***

The S-2 Sampling Head is a 75-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

RISETIME
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.

WEIGHTS

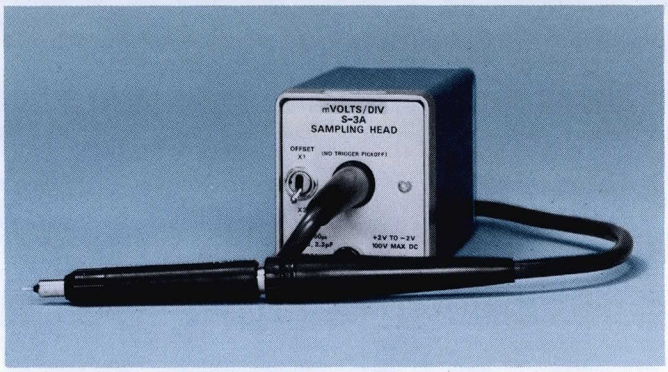
Net weight	≈1 lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

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 $430

OPTIONAL ACCESSORIES

6040/CT-1 Current Probe, order 015-0041-00 ..... $55
CT-3 Signal Pickoff, order 017-0061-00 ..... $41.80
P6056 10X Passive Probe, order 010-6056-03 ..... $50
P6057 100X Passive Probe, order 010-6057-03 ..... $50
Coupling Capacitor, GR874-K , order 017-0028-00 ..... $20
Power Divider GR874-TPD , order 017-0082-00 ..... $110
VP-1 Voltage Pickoff "T", order 017-0073-01 ..... $35
GR to BNC Adapter, order 017-0063-00 ..... $9



- ***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 volts of DC offset may be used while maintaining a 2-mV/div deflection factor. The S-3A can be plugged in or attached by an optional extender for remote use with 7S11, 7S12, 3S2, 3S5, 3S6 and the 286.

RISETIME
350 ps or less.

BANDWIDTH
Probe only is equivalent to DC-to-1 GHz at 3-dB down.

TRANSIENT RESPONSE (Probe Only)
Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less P-P, +1%, −1% or less, total of 2% or less P-P after 2 ns, with 284 pulse displayed.

DISPLAYED NOISE (Probe Only)
3 mV or less referred to probe tip (includes 90% of dots).

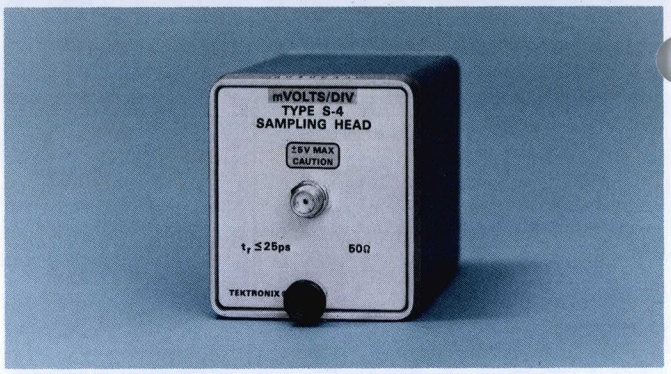
SIGNAL RANGE
Variable DC offset allows signals between +1 V and −1 V, X1 range; or +2 V and −2 V, X2 range to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the use of the probe attenuators.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	≈ 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

INCLUDED ACCESSORIES
10X attenuator head (010-0364-00); 100X attenuator head (010-0365-01); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½-inch ground lead (175-1017-00); 12½-inch ground lead (175-1018-00); 3-inch cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50-Ω voltage pickoff (017-0077-01); carrying case (016-0121-00); 3-inch elec lead (175-0849-00); 6-inch elec lead (175-0849-01).

Order S-3A SAMPLING HEAD $580



- ***25-ps SAMPLING HEAD***
- ***DC-to-14 GHz BANDWIDTH***
- ***DISPLAYED NOISE LESS THAN 5 mV (unsmoothed)***

The S-4 Sampling Head is a 25-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5, 3S6, 7S11, 7S12, and 286. The S-4 can be plugged into the sampling unit or attached by a Sampling-Head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

RISETIME
25 ps or less.

BANDWIDTH
Equivalent to DC-to-14 GHz at 3-dB down.

TRANSIENT RESPONSE
Aberrations in the first 400 ps following a step from a S-50 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.

WEIGHTS

Net weight	≈1 lb	≈0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

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-inch wrench (003-0247-00).

Order S-4 SAMPLING HEAD $875

- ***1-MΩ, 15-pF INPUT IMPEDANCE***
- ***PASSIVE PROBE***
- ***INTERNAL TRIGGER PICKOFF***

The S-5 Sampling Head is a low noise, 1-ns risetime sampling unit with a 1-MΩ, 15-pF input impedance. When used with the included P6010 passive probe the input impedance increases to 10 MΩ, 10 pF while maintaining the 1-ns risetime at the probe tip. A switch on the sampling head selects either AC or DC coupling of the input.

The S-5 Sampling Head is designed for use with the 7S11, 7S12, 3S2, 3S5, 3S6 and 286 and can be plugged in or attached by an optional Sampling-Head extender for remote use.

CHARACTERISTICS

RISETIME
S-5 only, 1 ns or less; with 3.5 foot P6010, 1 ns or less.

BANDWIDTH
Equivalent to DC-to-350 MHz at 3-dB down at input connector or probe tip.

TRANSIENT RESPONSE
S-5 only (driven with a 50-Ω source terminated in 50 Ω): aberrations +2.5%, —5% or less, total of 7.5% or less P-P within 17 ns after step +1%, —1% or less, total of 2% or less P-P thereafter.

S-5/P6010 (3.5-foot probe properly compensated): aberrations +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 coupled, DC voltage—100 V.

INPUT CHARACTERISTICS
S-5 only is 1 MΩ within 1% paralleled by 15 pF within 1 pF.
S-5/P6010 is 10 MΩ paralleled by approx 10 pF.

ATTENUATION ACCURACY
Probe attenuation is 10X within 3%.

WEIGHT

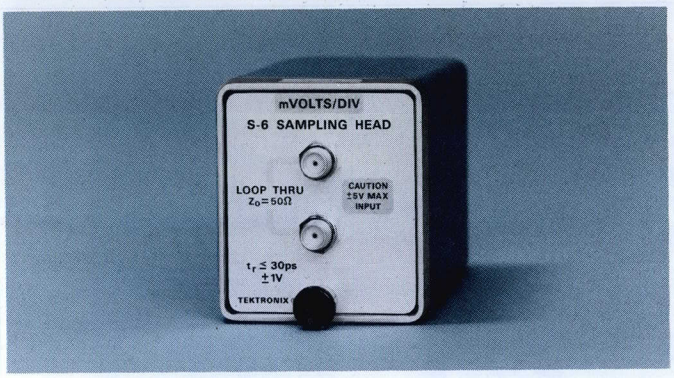
Net weight	≈9 oz	≈0.2 kg
Domestic shipping weight	≈3 lb	≈1.4 kg

INCLUDED ACCESSORIES
P6010 probe package (010-0188-00), 50-Ω termination (011-0049-01).

Order S-5 SAMPLING HEAD $375

OPTIONAL ACCESSORIES

P6010 passive 10X probe package, order 010-0188-00 ... $45
Probe tip-to-BNC adapter, order 013-0084-01 ..... $5.85
Probe tip-to-GR adapter, order 017-0076-00 ..... $12
Probe tip-to-GR terminated adapter, order 017-0088-00 . $27.50



- ***30-ps RISETIME***
- ***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 in the 7S11, 3S2, 3S5, 3S6 or 286, and TDR applications in the 7S12 Time Domain Reflectometer.

RISETIME
30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

BANDWIDTH
Equivalent to DC to 11.5 GHz at 3-dB down.

TRANSIENT RESPONSE
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.

DISPLAYED NOISE
5 mV or less, measured tangentially.

SIGNAL RANGE
+1 V to —1 V (DC plus 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. Maximum safe overload is ±5 V.

WEIGHTS

Net weight	≈1 lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

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); coaxial termination (015-1020-00).

Order S-6 SAMPLING HEAD $875

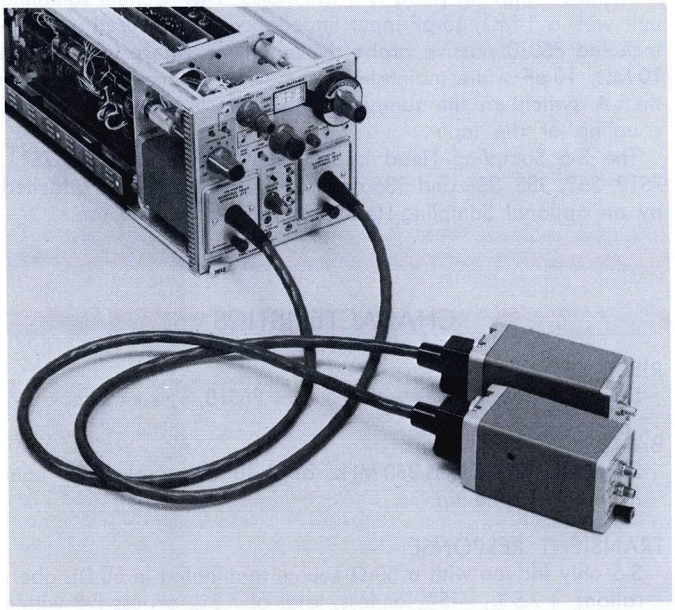
OPTIONAL ACCESSORIES FOR SAMPLING HEADS

With SMA (3-mm) Connectors

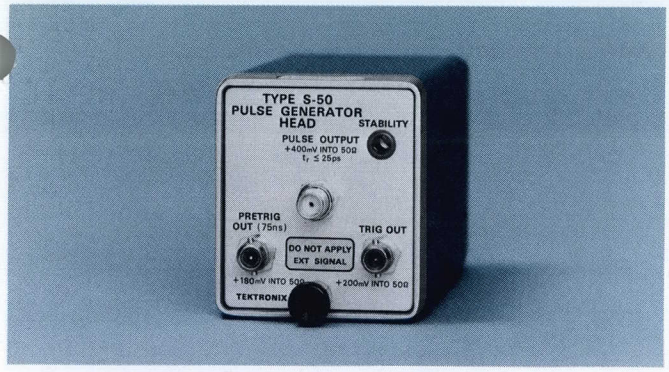
2X 50-Ω attenuator, order 015-1001-00	$ 90.00
5X 50-Ω attenuator, order 015-1002-00	120.00
10X 50-Ω attenuator, order 015-1003-00	80.00
50-Ω termination, order 015-1004-00	44.00
2-ns 50-Ω signal cable, order 015-1005-00	44.00
5-ns 50-Ω signal cable, order 015-1006-00	50.00
Male-to-GR874 adapter, order 015-1007-00	33.00
Female-to-GR874 adapter, order 015-1008-00	26.00
Male-to-N female adapter, order 015-1009-00	44.00
Male-to-7-mm adapter, order 015-1010-00	115.00
Male-to-male adapter, order 015-1011-00	9.00
Female-to-female adapter, order 015-1012-00	7.50
Coupling capacitor, order 015-1013-00	82.50
50-Ω power divider T, order 015-1014-00	115.00
500-ps 50-Ω semi-rigid cable, order 015-1015-00	26.40
SMA T adapter, order 015-1016-00	25.00
SMA male-to-BNC female adapter, order 015-1018-00	4.95
1-ns 50-Ω cable, order 015-1019-00	30.00
SMA male short-circuit termination, order 015-1020-00	7.25
SMA female short-circuit termination, order 015-1021-00	7.25
SMA male 50-Ω termination, order 015-1022-00	30.25

With BNC Connectors

50-Ω feedthrough termination, order 011-0049-01	15.00
50-Ω feedthrough (5 watt), order 011-0099-00	21.00
50-Ω 2X attenuator, order 011-0069-01	18.15
50-Ω 2.5X attenuator, order 011-0076-01	18.15
50-Ω 5X attenuator, order 011-0060-01	18.15
50-Ω 10X attenuator, order 011-0059-01	18.15
50-Ω, 18-in, coaxial cable, order 012-0076-00	6.60
50-Ω, 42-in, coaxial cable, order 012-0057-01	6.60



3-ft Sampling-Head extender, order 012-0124-00	$70.40
6-ft Sampling-Head extender, order 012-0125-00	$72.60



- ***25-ps PULSE RISETIME***
- ***400-mV INTO 50 Ω***
- ***PRETRIGGER OUT***

The S-50 Pulse Generator Head is a high-speed, tunnel-diode step generator designed for use in the 7S11, 7S12, 3S2, 3S5, 3S6, 285, and 286. The S-50 is also used for verification of sampling system risetimes. A pretrigger output allows operation with sequential sampling systems.

CHARACTERISTICS

PULSE OUTPUT

Risetime is 25 ps or less. Amplitude into 50 Ω is at least 400 mV, positive going. Pulse duration is 100 ns, pulse repetition rate is 25 kHz. Pulse aberrations following the step are: —10%, +10% with a total of 20% or less P-P in the first 400 ps, —5%, +5% with a total of 8% or less P-P from 400 ps to 5 ns; —4%, +1% with a total of 5% or less P-P after 5 ns.

PRETRIGGER OUTPUT

Risetime is 400 ps or less. Amplitude into 50 Ω is at least 180 mV, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 75 ns (±5 ns) before the pulse output. Pretrigger to pulse output jitter is 15 ps or less.

TRIGGER OUTPUT

Risetime is 200 ps or less. Amplitude into 50 Ω is at least 200 mV, positive going. Trigger pulse duration is 100 ns. The trigger output occurs in time coincidence with the pulse output.

POWER REQUIREMENTS

The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

OUTPUT CONNECTORS

Pulse output uses a SMA (3-mm) connector. Pretrigger output and trigger output use BSM connectors. A pretrigger output from the rear of the S-50 provides a pretrigger pulse for internal triggering of the sampling sweep unit.

WEIGHTS

Net weight	≈1 lb	0.3 kg
Domestic shipping weight	≈3 lb	≈1.4 kg

INCLUDED ACCESSORIES

500 ps 50 Ω semi-rigid coax (015-1015-00).

Order S-50 PULSE GENERATOR HEAD $525

- ***18 GHz COUNTDOWN***
- ***10 ps or less TRIGGER JITTER***

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 may be used with the 3S2, 3S5, 3S6, 7S11 Sampling Units and 7S12 TDR Unit or it may be operated separately with the 285 Power Supply or 286. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a 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.

CHARACTERISTICS

INPUT SIGNAL

Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV P-P, as measured separately into 50 Ω; 5 V, P-P maximum.

INPUT CHARACTERISTICS

50-Ω SMA (3-mm) connector. Open termination paralleled by 1 pF.

TRIGGER OUTPUT

Front panel trigger output is at least 200 mV into 50 Ω, Type BSM connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less, with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less, kickout occurs between successive samples.

POWER REQUIREMENTS

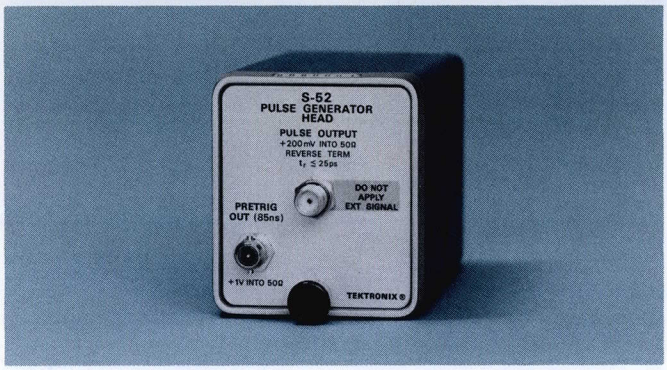
The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

WEIGHT

Net weight	≈1 lb	0.2 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

Order S-51 TRIGGER COUNTDOWN HEAD $500

S-52 *Pulse Generator Head*
S-53 *Trigger Recognizer Head*



- ***25-ps RISETIME***
- ***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. The S-52 may be powered by the 7S11, 3S2, 3S5, 3S6, 285, or 286 for use as a fast, clean step signal source.

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50-Ω reserve termination minimizes reflections. The pulse width is sufficient for distances up to 32 feet in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

PULSE OUTPUT

Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 350 ns, pulse period 8.3 μs within 0.8 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

Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive-going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

OUTPUT CONNECTORS

Pulse output uses a SMA (3-mm) connector. Pretrigger output uses a BSM connector.

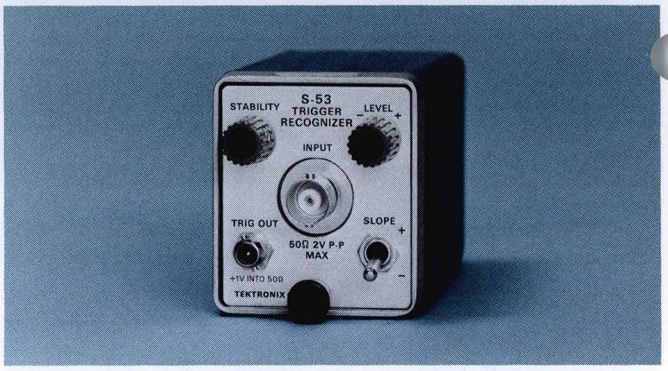
WEIGHTS

Net weight	≈1 lb	0.3 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED ACCESSORIES

500-ps, 50-Ω semi-rigid coax (015-1023-00).

Order S-52 PULSE GENERATOR HEAD $550



- ***DC-to-1 GHz OPERATION***
- ***10-mV SENSITIVITY***

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12 or for other applications. The S-53 can also be powered from the 7S11, 3S2, 3S5, 3S6, 285, or 286.

INPUT CHARACTERISTICS

Frequency range is DC to 1 GHz. Sensitivity range is 10 mV to 2 V P-P into 50 Ω. Kickout at input, ±5 mV or less.

OUTPUT CHARACTERISTICS

Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

CONNECTORS

Trigger input connector is BNC type. Front-panel, trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

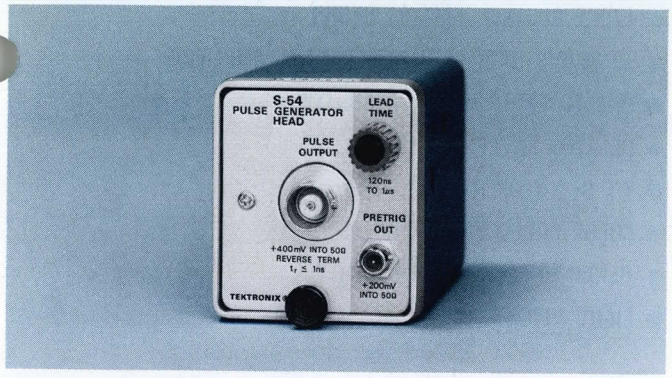
WEIGHTS

Net weight	≈1 lb	0.3 kg
Domestic shipping weight	≈2 lb	≈0.9 kg

INCLUDED ACCESSORIES

42-inch, 50-Ω cable (012-0057-01); 10X, 50-Ω attenuator (011-0059-01).

Order S-53 TRIGGER RECOGNIZER HEAD $425



- ***1-ns RISETIME***
- ***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. The S-54 is also useful as a clean step signal source in the 7S11, 3S2, 3S5, 3S6, 285, or 286.

Intended for TDR applications, the S-54 is 50-Ω reverse-terminated to minimize reflections and a zero-volt baseline to eliminate baseline shift with load changes. A front-panel continuously variable control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

PULSE OUTPUT

Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are: +1.5%, −1.5%, total of 1.5% P-P, as displayed with S-1 Sampling Head. Baseline level is 0 V within 20 mV, terminated in 50 Ω.

PRETRIGGER OUTPUT

Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front-panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger to pulse output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

OUTPUT CONNECTORS

Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

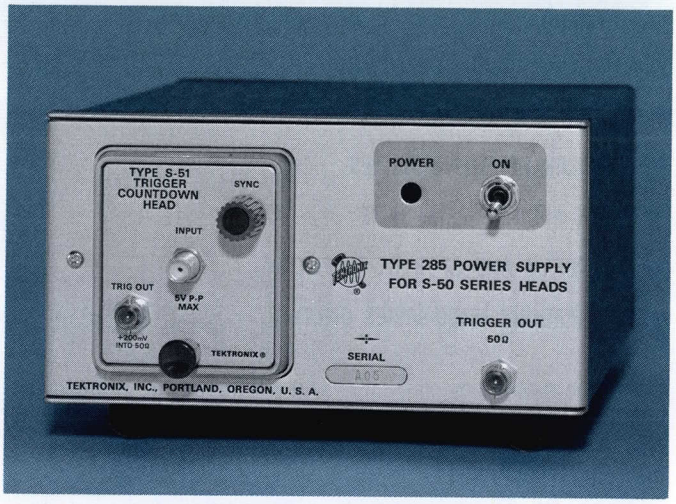
WEIGHTS

Net weight	≈1 lb	0.3 kg
Domestic shipping weight	2 lb	0.9 kg

INCLUDED ACCESSORIES

BNC T connector (103-0030-00); 8-inch, 50-Ω cable (012-0123-00).

Order S-54 PULSE GENERATOR HEAD $325



- ***ACCEPTS ONE S-50 SERIES HEAD***
- ***TRIGGER OUTPUT JACK***

The 285 Power Supply provides the regulated power supplies necessary to power one S-50 Series Head. It also has a front panel trigger output jack which delivers the trigger pulse from the plug-in Head to the front panel of the 285. It makes the S-50, S-52 or S-54 a complete pulse generator package.

CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, 50 Hz to 400 Hz, 8.5 watts at 115 V and 60 Hz. Slide switch on rear panel selects high or low voltage operation.

TRIGGER OUTPUT

BSM Connector provides internal trigger output of S-50 Series Heads to the front panel.

DIMENSIONS AND WEIGHTS

Height	≈3 in	5.1 cm
Width	5 in	12.7 cm
Depth	8 in	20.3 cm
Net weight	2 lb	0.9 kg
Domestic shipping weight	≈4 lb	≈2.8 kg

INCLUDED ACCESSORIES

18-inch trigger output cable (012-0127-00).

Order 285 POWER SUPPLY, without Heads $225

- LOW COST
- BANDWIDTH 2 MHz OR 60 MHz
- SAMPLING to 1 GHz
- MODULAR DISPLAY MODULES
- THREE PLUG-IN MAINFRAME
- DUAL-BEAM AND STORAGE DISPLAYS
- CRT READOUT (5400-SERIES ONLY)
- LARGE 6½-INCH CRT (8 x 10 DIV)
- 10 μV/DIV HIGH GAIN DIFFERENTIAL AMPLIFIER
- ONE TO EIGHT TRACE CAPABILITY
- DELAYED SWEEP TIME BASES
- Y-T Or X-Y OPERATION
- COLOR CODED FRONT PANELS
- BENCH-TO-RACK CONVERTIBILITY
- LIGHT WEIGHT

The 5000-Series Oscilloscope was designed to provide optimum versatility and performance at the lowest possible price. This was achieved with state-of-the-art technology and manufacturing techniques.

The 5100-Series was the first of the 5000-Series family providing for the first time plug-in versatility to the low frequency Oscilloscope user. Plug-in versatility means you can buy an Oscilloscope system that meets your present needs, then add plug-ins as your measurement needs change.

The 5100-Series features a 2-MHz mainframe, the 5103N, with a compartment typically accommodating two vertical and one horizontal plug-in. It has the ability to easily convert from a bench to a rackmount configuration.

To date, 15 plug-ins are available for use with the 5103N, with more to come. Among these plug-ins is the recently announced 5S14N, a general purpose, 1 GHz sampling plug-in. The 5S14N/5103N/D10 provides the lowest priced general purpose sampling system on the market.

The 5400-Series, the newest addition to the 5000-Series takes a giant step in bandwidth performance, by providing a 60-MHz bandwidth. With 60-MHz bandwidth, the 5400-Series is capable of satisfying a wide range of measurement needs. The 5400-Series features readout of plug-in scale factors on the CRT except with plug-ins having an N suffix such as 5A22N, 5B10N, etc. This feature, previously available only on expensive oscilloscopes, allows you to make measurements quicker and more conveniently. The CRT READOUT can also be externally accessed. No other oscilloscope has this feature.

Whether it's the low frequency 5100-Series or the 60-MHz 5400-Series, the TEKTRONIX 5000-Series Oscilloscopes always give you the most versatility and performance for your dollar.

DISPLAY MODULES

Five 5100-Series display modules are available. They include single beam, dual beam, and storage displays. The storage display modules feature bistable, split-screen storage with burn resistant phosphor. The dual beam display modules have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drive both beams.

One 5400-Series display module is presently available, a single-beam, non-storage display. It features CRT readout of plug-in scale factors. Additional display modules will become available.

Each display module features a 6½-inch CRT with an internal graticule, a voltage-current-time calibrator, and a beam finder. The modules bolt onto the mainframe, either in the bench or rackmount configuration, and are powered by the mainframe.

MAINFRAME AND INTERCHANGEABLE DISPLAY UNITS

PRODUCT	PAGE	FEATURES		
5103N MAINFRAME	104	Power Supply/Amplifier Unit compatible with each of five interchangeable display units		
5403 MAINFRAME	100	Power Supply/Amplifier Module compatible with D40 Display Module		
INTERCHANGEABLE DISPLAY UNITS		BEAMS	BISTABLE STORAGE	DISPLAY SIZE
D10	104	Single		8 x 10 div (½ in/div)
D11	104	Single	Yes	8 x 10 div (½ in/div)
D12	104	Dual		8 x 10 div (½ in/div)
D13	104	Dual	Yes	8 x 10 div (½ in/div)
D15	104	Single	Yes	8 x 10 div (½ in/div)
D40	100	Single		8 x 10 div (½ in/div)

PLUG-IN VERSATILITY

Presently 17 plug-ins are available in the 5000-Series family. All these plug-ins are compatibe with the 5400-Series, and all but two (the 5A48 and the 5B42) are compatible with the 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 both single sweep, dual and delayed sweep units. All 5000-Series time bases are compatible* with the 60-MHz 5403 mainframe.

Two special purpose plug-ins are also available. 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 sampler, extends the bandwidth of either the 5100 or the 5400-Series to 1 GHz @ 2 mV sensitivity.

*Only the 5B42 permits viewing the leading edge of a triggered waveform when used in the 5403.

More plug-ins are planned for the 5000-Series, so that even greater measurement capability will be available to you.

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.

AMPLIFIER PLUG-INS

PRODUCT	PAGE	TRACES	MINIMUM DEFLECTION FACTOR	BANDWIDTH —3 dB	CMRR
5A13N	106	Single	1 mV	2 MHz	10,000:1
5A14N	107	Four	1 mV	1 MHz	
5A15N	107	Single	1 mV	2 MHz	
5A18N	107	Dual	1 mV	2 MHz	
5A19N	110	Single	1 mV	2 MHz	1,000:1
5A20N	108	Single	50 μV	1 MHz	100,000:1
5A21N	108	Single (Voltage and Current)	50 μV 0.5 mA	1 MHz	100,000:1
5A22N	109	Single	10 μV	1 MHz	100,000:1
5A23N	110	Single	10 mV/div	1.5 MHz	
5A24N	110	Single	50 mV/div	2 MHz	
5A48	102	Dual	1 mV/div	60 MHz	

TIME BASE PLUG-INS

PRODUCT	PAGE	DUAL and DELAYED SWEEP	SWEEP RATE	MAG	SINGLE SWEEP	VOLTS/DIV EXT MODE
5B10N	111		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	112	Yes	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B13N	113		1 μs to 100 ms			50 mV
5B42	103	Yes	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes	50 mV

SPECIAL PURPOSE PLUG-INS

PRODUCT	PAGE	DESCRIPTION
5CT1N	113	Semiconductor Curve Tracer
5S14N	114	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	12.5	2.6	6.7	12.0	30.5
Double Width	5.0	12.5	5.2	13.4	12.0	30.5
Weights (Approx)	**Net**		**Domestic Shipping**		**Export Packed**	
	lb.	kg.	lb.	kg.	lb.	kg.
Single Width	2.8	1.2	10.0	4.5	15.0	6.9
Double Width	5.8	2.6	10.8	4.9	17.9	8.2

5103N DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	11.5	29.5	5.3	13.5
Width	8.5	21.5	19.0	48.0
Length	20.0	50.9	19.0	48.3
Weights (approx)	lb	kg	lb	kg
Net	23.0	10.5	23.0	10.5
Domestic Shipping	32.0	14.5	42.0	19.0
Export Packed	44.0	20.0	59.0	24.5

5403 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	10.5	26.6	5.25	13.5
Width	8.4	21.3	19.0	48.0
Length	20.4	51.9	20.4	51.9
Weight (Approx)	lb	kg	lb	kg
Net	25.0	11.0	25.0	11.0
Domestic Shipping	32.0	14.5	42.0	19.0
Export Packed	44.0	20.0	59.0	24.5

5000-SERIES ACCESSORIES

PROBES	Voltage	Current
5103N	P6060 10X	P6021
5403	P6065A 10X	P6021
	P6011 1X	

SCOPE-MOBILE® CART
5103N, 5403 — 203 or 203 Option 1

CAMERAS
5103N — C-5
5403 — C-59-R or C-50-R

BLANK PANEL
5103N, 5403 — 016-0195-00

VIEWING HOODS
5103N, 5403 — 016-0260-00 (folding), 016-0154-00

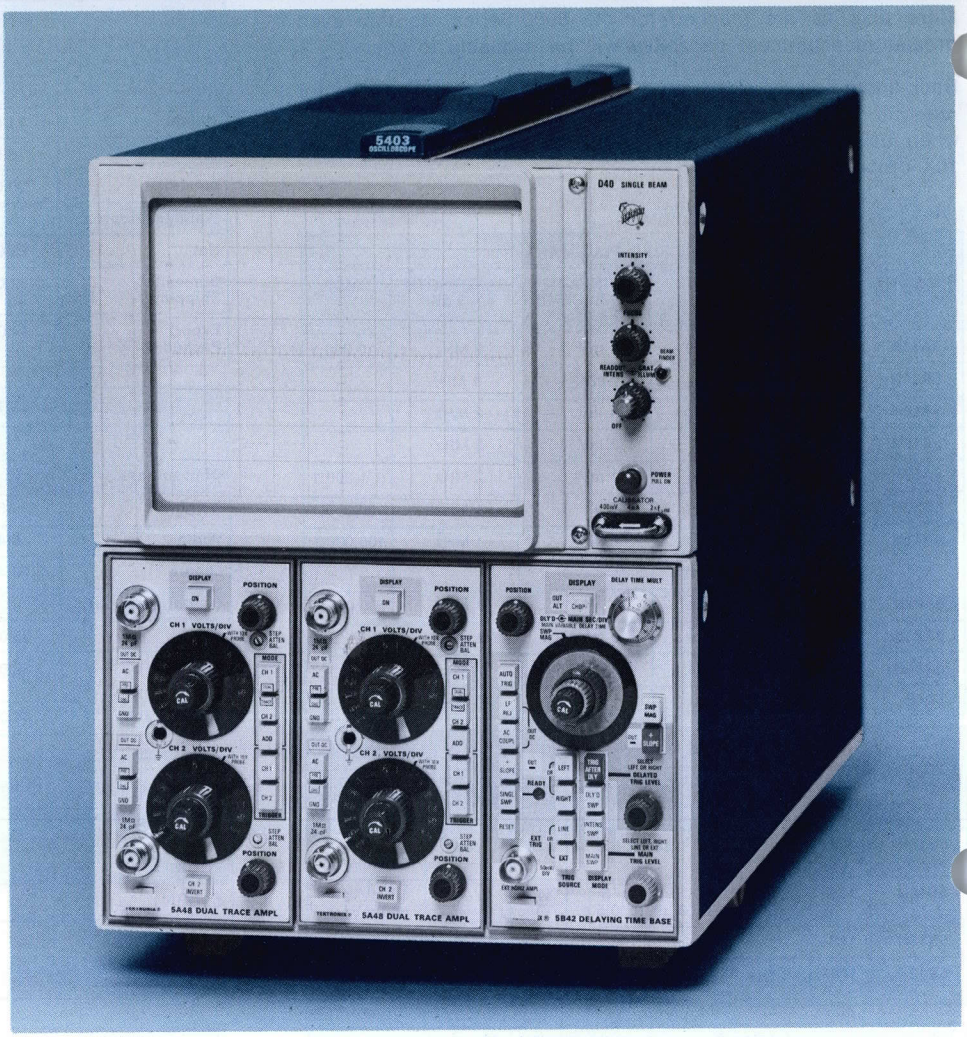
RAIN COVER
5103N, 5403 — 016-0544-00

See accessories section for complete information.

5400-SERIES OSCILLOSCOPES
5403 *60-MHz Oscilloscope*

New

- **LOW COST**
- **DC to 60 MHz SAMPLING to 1 GHz**
- **CRT READOUT**
- **THREE-PLUG-IN FLEXIBILITY**
- **CHOOSE from 17 PLUG-INS**
- **BENCH-to-RACK CONVERTIBILITY**



The new 5400-Series combines outstanding versatility and low cost in a 60-MHz, general-purpose, plug-in oscilloscope system. It features CRT READOUT of plug-in scale factors, a three plug-in mainframe, a choice of *17 plug-ins, and easy bench-to-rackmount convertability.

CRT READOUT is a feature previously found only on more expensive oscilloscopes. With the plug-in scale factors displayed on the CRT, measurement time is reduced, because the operator can concentrate on the CRT display rather than having to look down at the plug-in knobs. The CRT READOUT reduces operator errors by taking into account magnifiers and probe attenuators. The CRT READOUT can also be accessed externally, a feature found on no other oscilloscope. This unique ability can be used to readout dates, picture numbers, digital clock times, etc.

*Plug-ins with an N suffix, such as 5A13N, 5B12N, etc., do not provide CRT READOUT.

All the plug-ins in the 5000-Series are compatible** with the 5400-Series mainframe. Thus, although the 5400-Series is new, it already has a wide range of measurement capability. The available plug-ins provide multi-trace (up to four) amplifiers, differential amplifiers, a differential comparator amplifier, transistor curve tracer, a 1-GHz sampler and delayed sweep time-bases. More plug-ins utilizing the additional mainframe bandwidth will be available soon.

The 5403/5A48/5B42 provides 5 mV sensitivity at 60 MHz and 1 mV/division sensitivity at 25 MHz. This 1 mV/division sensitivity for example, allows you to look at the heads of tape drive and disc drive units. Problems in these units are often the causes of computer system malfunctions.

If you're looking for a 60-MHz general purpose oscilloscope, the 5400-Series provides you with the most versatility and performance at the lowest price.

**Only the 5B42 permits viewing the leading edge of a triggered waveform when used in the 5403.

5403 MAINFRAME

VERTICAL SYSTEM

Channels—Two plug-in compartments (left and center) compatible with all 5400-Series plug-ins and 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 maximum, determined by plug-in.

Chopped Mode—The 5403 will chop between channels at an approx 25-kHz to 100-kHz rate, depending on plug-ins used and operating modes.

Alternate Mode—In this 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 5403 switches to the second amplifier.

HORIZONTAL SYSTEM

Channels—One plug-in compartment (right) compatible with all 5400 and 5000 Series plug-ins. CRT READOUT is not available with plug-ins having a suffix N (5A13N, 5B10N, etc.).

Internal Trigger Mode—LEFT VERT, RIGHT VERT.

Fastest Calibrated Sweep Rate— 10 ns/div, determined by plug-in.

X-Y Mode—The phase shift is within 1° from DC to 20-kHz, checked with two amplifiers of the same type.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C, unless otherwise specified.

Power Requirements—100, 110, 120, 200, 220 and 240 VAC ±10%; internally selected with quick change jumpers. Line frequency range; 48 to 440 Hz.

D40 SINGLE-BEAM DISPLAY UNIT

The D40 provides a single-beam conventional display for the 5403 Mainframe. The CRT has an 8 x 10 division (1.22 cm/div) display area with internal parallax-free edge-lit graticule. A bright display is provided by a 15-kV accelerating potential. P31 phosphor standard; P7 or P11 optional without extra charge.

CRT READOUT labels the CRT with: deflection factors; sweep speeds; invert and uncalibrated symbols; and identifies the trace and its data. The readout is automatically corrected when magnified sweeps and recommended 10X or 100X probes are used.

Beam Finder—Brings trace within viewing area and intensifies trace.

External Intensity Input— +5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 2 MHz. Input R and C is approx 10 kΩ, paralleled by approx 40 pF. Maximum input is ±50 V (DC + peak AC).

Calibrator—Voltage amplitude is 400 mA within 1%. Current Maximum input is ±50 V (DC + peak AC).

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information).

MAINFRAME	WRITING SPEED cm/μs				CAMERA	LENS
	P31		P11			
	10,000 ASA	3,000 ASA	10,000 ASA	3,000 ASA		
5403/D40	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 5403.

Option 1—The 5403 may be ordered without CRT READOUT. This feature may easily be added by installing a conversion kit.

Option 3—User Addressable CRT READOUT. An additional CRT READOUT access is available for the operator to program two 10-digit words such as: time; operator name or test number. The additional display is useful for photographic records and is accomplished by external resistor and switches.

Option 4—Protective Panel Cover (cabinet model only). The 5403 may be ordered with a protective front panel cover. The cover protects the front panel and knobs for transportation and storage.

ORDERING INFORMATION

The 5403 mainframe unit and display unit may be ordered as a cabinet model oscilloscope equipped with a tilt bail or it may be ordered as a 5¼-inch rackmount oscilloscope equipped with a slide-out assembly.

Cabinet (without plug-ins)—
5403/D40 OSCILLOSCOPE, Order 5440 ..... $1175

Rackmount (without plug-ins)—
R5403/D40 OSCILLOSCOPE, Order R5440 ..... $1175

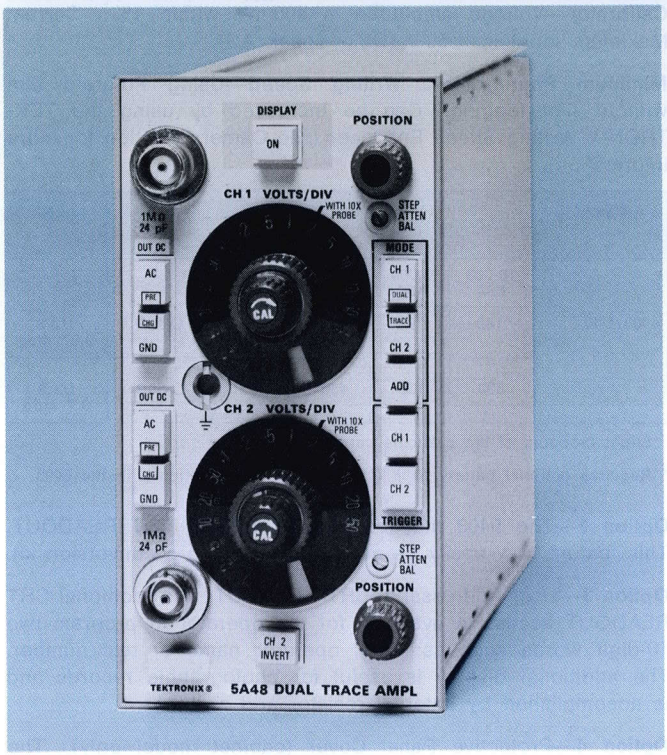
OPTIONS

Option 1	WITHOUT CRT READOUT	Sub $350
Option 3	USER ADDRESSABLE CRT READOUT	Add $60
Option 4	PROTECTIVE PANEL COVER (cabinet model only)	Add $15
Option 76	P7 PHOSPHOR	No Charge
Option 78	P11 PHOSPHOR	No Charge

CONVERSION KITS

Cabinet-to-rackmount, Order 040-0583-01 ..... $33
Rackmount-to-cabinet, Order 040-0584-01 ..... $33
CRT READOUT, Order 040-0691-00 ..... $350

New



- **DC-to-60 MHz BANDWIDTH**
- **1 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS**

The 5A48 is a dual-trace 60 MHz plug-in amplifier for use with the 5403 mainframe. 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).

Risetime— 5.8 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

Deflection Factor—1 mV/div and 2 mV/div accurate within 5%, and 5 mV/div to 10 V/div, accurate within: 3% 15° to 35°C; 4% 0° to 50°C; (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes—Channel 1 only, Channel 2 only (normal or inverted), Dual Trace, Added, Alternate, Chopped (determined by time-base plug-in in horizontal compartment). Internal trigger source is selectable from channel one or channel two.

Input R & C— 1 MΩ within 1%, approx 24 pF.

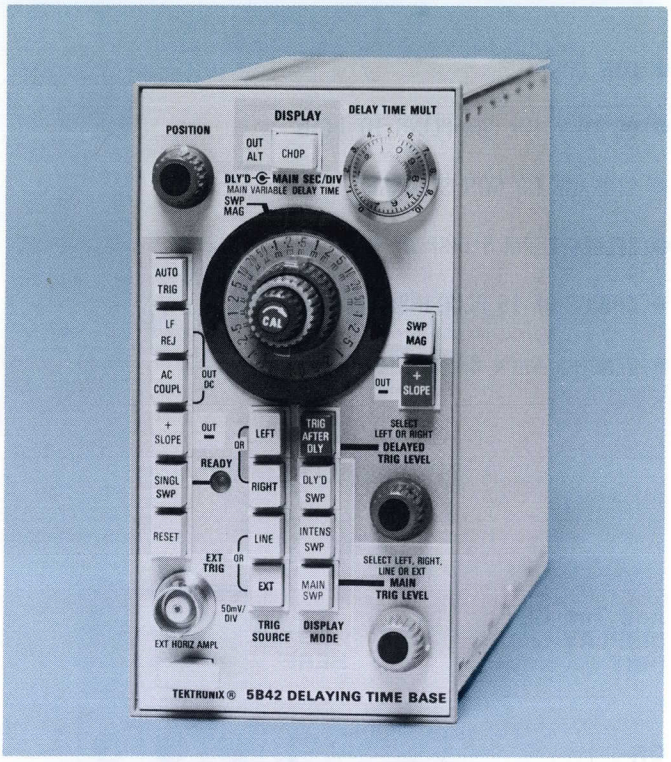
Maximum Input Volts—DC coupled, 250 V (DC + peak AC); AC coupled, 500 V (DC + peak AC). AC component 500 V P-P maximum, 1 kHz or less.

Common Mode Rejection Ratio—At least 10:1 up to at least 40 MHz.

DC Stability—Drift with Time (constant ambient temperature and line voltage) 0.3 mV or less over any 1 minute after 1 hour warmup. Drift with Ambient Temperature (constant line voltage) 0.2 mV/°C or less.

5A48 DUAL-TRACE AMPLIFIER **$450**

- **10 ns/DIV to 5 s/DIV CALIBRATED TIME BASE**
- **SINGLE-SWEEP OPERATION**
- **TRIGGERING to 60 MHz**



The 5B42 dual time base is designed specifically for use with the 5403 mainframe. The 5B42 is designed so that the user may easily operate the time base in the many applications where delayed sweep and increased measurement capability is mandatory.

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		TRIGGERING	MINIMUM SIGNAL REQUIRED	
		FREQUENCY RANGE	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	200 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 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— 1 part or less in 20,000 of X10 TIME/DIV setting.

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		TRIGGERING	MINIMUM SIGNAL REQUIRED
		FREQUENCY RANGE	INT
DC	5400 AMPL	DC to 10 MHz	0.4 div
	5400 AMPL	10 MHz to 60 MHz	1.0 div
	5100 AMPL	DC to 2 MHz	0.4 div

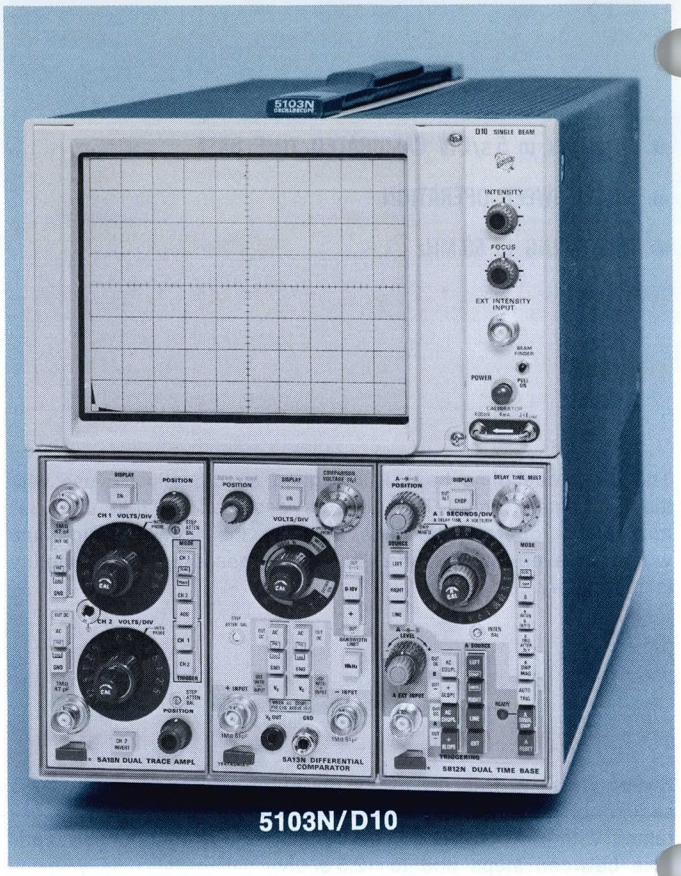
EXTERNAL HORIZONTAL INPUT

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.

5B42 DUAL TIME BASE **$575**

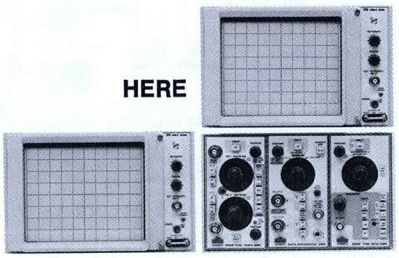
- LOW COST
- DC TO 2 MHz, SAMPLING TO 1 GHz
- STORAGE OR NON STORAGE
- SELECT FROM 5 DISPLAY UNITS
- CHOICE OF 15 PLUG-INS
- BENCH-to-RACK CONVERTIBILITY



5103N/D10

Add The CRT DISPLAY UNIT HERE

OR HERE



5103N MAINFRAME

VERTICAL SYSTEM

Channels—Two plug-in compartments (left and center) compatible with all 5000-Series Plug-Ins, except 5A48 and 5B42.

Deflection Factor—Determined by plug-in unit.

Bandwidth— 2 MHz maximum.

Chopped Mode—The 5103N will chop between two amplifiers, at an approx 25-kHz to 100-kHz rate, depending on plug-ins used and operating modes. The chop mode is selected from the time base unit.

Alternate Mode—In this 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 5103N switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—One right-hand plug-in compartment compatible with all 5000-Series Plug-Ins, except 5A48 and 5B42.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—PHASE SHIFT is within 1° from DC to 100 kHz.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

Power Requirements— 100, 110, 120, 200, 220 and 240 VAC ±10%; internally selected with quick change jumpers. Line frequency range; 48 to 440 Hz.

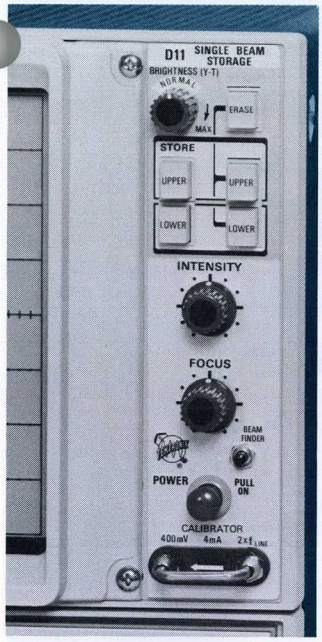
D10 SINGLE BEAM DISPLAY UNIT

The D10 provides a single beam conventional display for the 5103N Mainframe. The electrostatic-deflection cathode-ray tube has an 8 x 10 division (1/2 in/div) display area with internal graticule. A bright display is provided by a 3.5 kV accelerating potential. P31 phosphor is standard; P7 or P11 optional without extra charge.

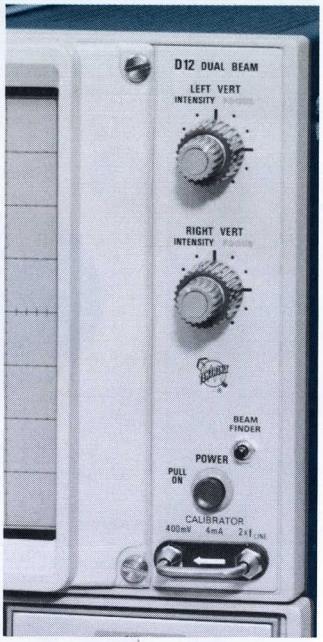
D11 and D15 SINGLE BEAM STORAGE DISPLAY UNITS

The D11 and D15 provide storage displays for the 5103N Mainframe. Each unit features a single-beam, 6½-inch 8 x 10-div (½ in/div) CRT with bistable, split-screen storage and an internal graticule. Accelerating potential is 3.5 kV and the phosphor is similar to P1. The D11 has a brighter stored display. The D15 has the higher stored writing speed (center 6 x 8 div).

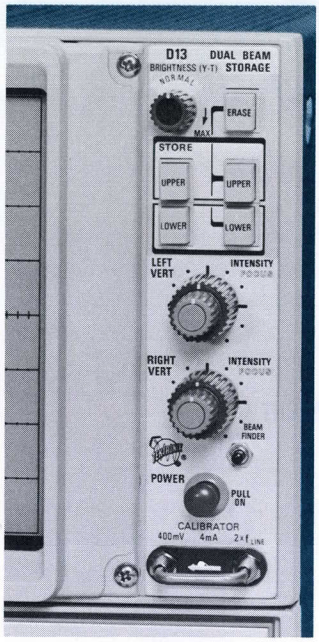
D11 writing speed is at least 20 div/ms (Normal mode only). D15 writing speed is at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage viewing time is at least one hour at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hours at reduced intensity, after which time the intensity may be increased to its original level. Variable brightness also permits optimum photographic results, and integration of multiple traces. Erase time is ≈250 ms.



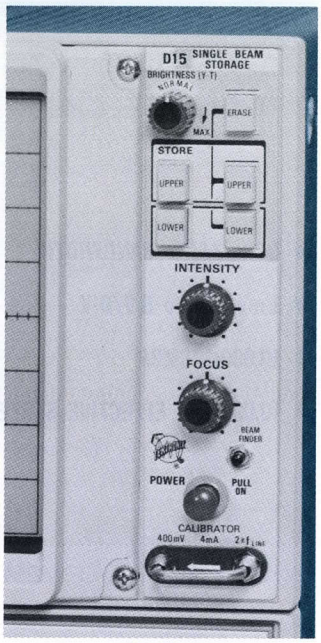
D11



D12



D13



D15

D12 DUAL BEAM DISPLAY UNIT

The D12 provides a dual beam display for the 5103N Mainframe. Dual beam oscilloscopes are essential to the many applications where two transient events must be compared simultaneously. Application areas include stimulation and reaction events in areas such as medicine, biology, chemistry, engineering mechanics and many other electronic and scientific measurement areas. Both beams of the D12 are driven by one set of horizontal deflection plates. When using a dual time base plug-in in the dual sweep mode, both beams will be deflected by both sweeps and with two single trace plug-ins four traces will be displayed. Other characteristics are the same as the D10 Single Beam Display Unit.

D13 DUAL BEAM STORAGE DISPLAY UNIT

The D13 provides a dual beam, bistable, split-screen storage display for the 5103N Mainframe. The storage display characteristics and operation are the same as the D11 Storage Display Unit. Other characteristics are the same as the D12. New measurement problems are continuously developing which can only be solved with a dual beam storage oscilloscope. Experimenters and researchers in areas such as electronics, mechanics and bio-medicine recognize the expediency and thoroughness of dual beam storage for retaining two related transients.

Writing speed is at least 20 div/ms. (Option 3, 200 div/ms, center 6 x 8 div). Storage time is at least one hour at normal intensity increasing to 10 hours at reduced intensity. Erase time is ≈250 ms.

DISPLAY UNIT COMMON CHARACTERISTICS

External Intensity Input—+5 V will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (DC + peak AC).

Calibrator—Voltage output is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, the beam is positioned on screen, regardless of vertical and horizontal position control settings.

Option 2—Protective Panel Cover. The 5103N may be ordered with a protective front panel cover. The cover protects the front panel and knobs for transportation and storage.

Option 3—(D13 Only) Fast writing speed CRT. Increases stored writing speed to 200 div/ms (center 6 x 8 divisions).

ORDERING INFORMATION

Cabinet (without plug-ins)—

5103N/D10 OSCILLOSCOPE, Order 5110	$ 540
5103N/D11 STORAGE OSCILLOSCOPE, Order 5111	$1020
5103N/D12 OSCILLOSCOPE, Order 5112	$ 870
5103N/D13 STORAGE OSCILLOSCOPE, Order 5113	$1370
5103N/D15 STORAGE OSCILLOSCOPE, Order 5115	$1095

Rackmount (without plug-ins)—

R5103N/D10 OSCILLOSCOPE, Order R5110	$ 540
R5103N/D11 STORAGE OSCILLOSCOPE, Order R5111	$1020
R5103N/D12 OSCILLOSCOPE, Order R5112	$ 870
R5103N/D13 STORAGE OSCILLOSCOPE, Order R5113	$1370
R5103N/D15 STORAGE OSCILLOSCOPE, Order R5115	$1095

OPTIONS

Option 2—PROTECTIVE PANEL COVER (cabinet model only)	Add $15
Option 3—(D13 ONLY) FAST WRITING SPEED CRT	Add $25
Option 76—(D10 AND D12 ONLY) P7 PHOSPHOR	No Charge
Option 78—(D10 AND D12 ONLY) P11 PHOSPHOR	No Charge

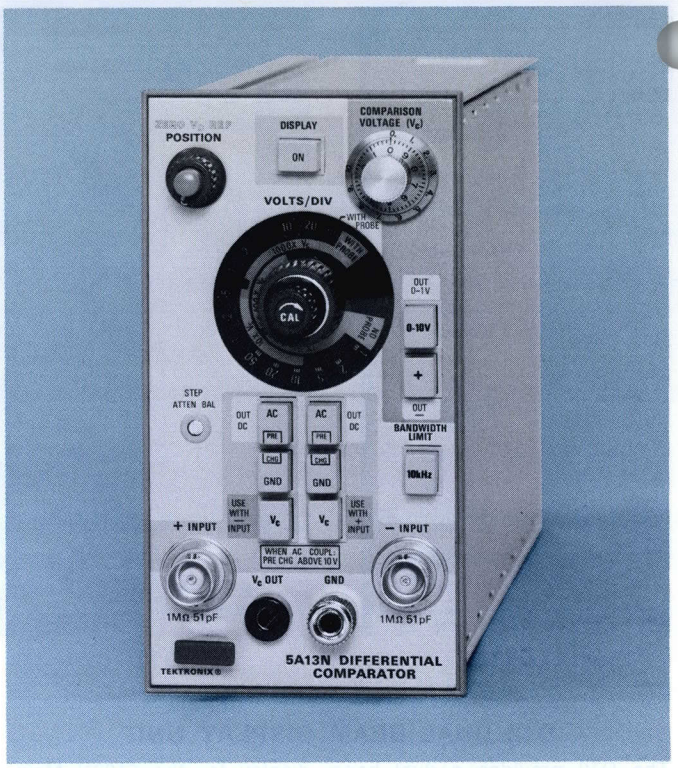
CONVERSION KITS

These oscilloscopes may be converted from one configuration to the other as applications change.

Cabinet-to-rackmount conversion kit order 040-0583-01	$33
Rackmount-to-cabinet conversion kit order 040-0584-01	$33

5A13N *Differential Comparator Amplifier*

- **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 which make it particularly versatile, especially in multi-trace combination with other 5000-Series verticial 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 utilizes 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 divisions by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for application requiring maximum 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	±15 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	

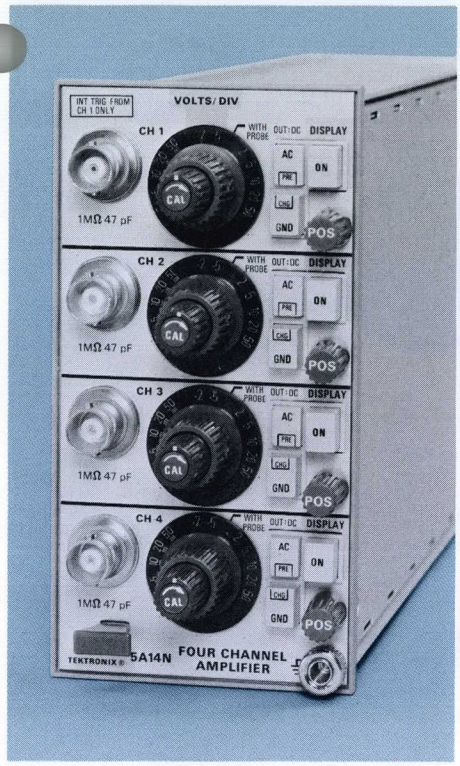
Max Input Gate Current— 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Overdrive Recovery— 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after the removal of an overdrive signal between +15 V and —15 V, regardless of overdrive signal duration.

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-volt peak-to-peak 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-volt peak-to-peak 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.

Order 5A13N DIFFERENTIAL COMPARATOR AMPLIFIER $550



● 1 mV/DIV to 5 V/DIV

The 5A15N (single channel), 5A18N (two identical channels) and 5A14N (four identical channels) are amplifiers with solid-state circuits. Each features simplified front panel controls and is used in the 5000-Series mainframes. These plug-ins may be used in combination for displaying up to eight traces. For instance, two 5A14N amplifiers provide eight traces; one each 5A14N and 5A15N amplifiers provide five traces. Each amplifier may be used in the 5000-Series horizontal plug-in compartments for X-Y operation.

5A18N operating modes include channel one or two only, channels one and two added, and channel one alternate or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

5A14N operating modes are each channel separately, and alternate or chop between any combination of channels. Internal trigger is available from channel one only.

CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 2 MHz (5A14N, 1 MHz) at all deflection factors. AC coupled, 2 Hz or less to at least 2 MHz (5A14N, 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.

Maximum Input—DC coupled, 350 V (DC + peak AC). AC coupled, 350 VDC.

Chopping Rate (5A18N and 5A14N)— 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

ORDERING INFORMATION

5A14N FOUR-TRACE AMPLIFIER	**$575**
5A15N SINGLE-TRACE AMPLIFIER	**$115**
5A18N DUAL-TRACE AMPLIFIER	**$265**

5000-SERIES OSCILLOSCOPES
5A20N *Differential Amplifier*
5A21N *Differential Amplifier (Current Input)*

- **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 (5A21N)**

The 5A20N and 5A21N are 50 μV/div, DC coupled differential amplifiers for the 5000-Series. The units are identical except that the 5A12N has a current probe input.

5A20N AND 5A21N VOLTAGE CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 2 Hz or less to at least 1 MHz. Bandwidth 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.

Maximum Input Voltage

	DC COUPLED	AC COUPLED
50 μV/div to 50 mV/div	10 V (DC + peak AC)	350 VDC (Coupling cap pre-charged), 10 V peak AC
100 mV/div to 5 V/div	350 V (DC + peak AC)	350 V (DC + peak AC)

Input Gate Current— 100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Displayed Noise— 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio—AC coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. DC coupled, at least 100,000:1, DC to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V P-P sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V P-P sinewave. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

5A21N CURRENT PROBE INPUT CHARACTERISTICS (WITH P6021 CURRENT PROBE)

Bandwidth— 15 Hz or less, to at least 1 MHz. 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.

Maximum Input Current— 4 A P-P (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise— 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A20N and 5A21N from 0°C to +50°C.

ORDERING INFORMATION

5A20N DIFFERENTIAL AMPLIFIER **$165**
5A21N DIFFERENTIAL AMPLIFIER **$185**
P6021 5-FT Current Probe, order 010-0237-02 ..... **$10**
P6021 9-FT Current Probe, order 010-0244-02 ..... **$100**

- **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**

There are many factors which contribute to the usability and performance of this high-gain, wideband differential amplifier. Displayed noise (grounded inputs) is held to 20 μV or less at 10 μV/div, tangentially measured at full bandwidth. Since noise is related to bandwidth, the displayed noise can be greatly reduced with the HF —3 dB point selector. Low amplitude signals often ride a small DC component, perhaps a few millivolts, which would place a DC-coupled display offscreen at 10 μV/div. Or, DC drift may be present in the signal to be measured. Low frequency drift is minimized by using AC coupled inputs for frequencies above 2 Hz or by using DC coupled inputs and low frequency limits selectable by a front panel switch. The same techniques are used to cancel a DC component from the signal being measured. Adding a DC voltage opposite in polarity to the polarity of the disturbing DC component is a third method. This is done by using the plug-in's variable DC offset. Full bandwidth is retained in this mode of operation. These and other factors 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 within 20% of selected frequency and 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 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.

Input R and C— 1 MΩ within 0.15%, approx 47 pF.

Drift With Temperature— 100 μV/°C or less.

Max Input Gate Current— 200 pA or less.

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 x 10^5:1	
DC OFFSET RANGE	+0.5 V to −0.5 V	+50 V to −50 V

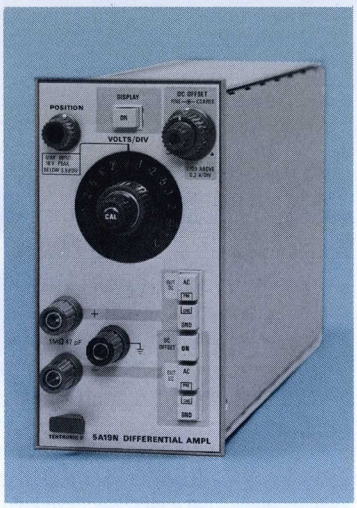
Displayed Noise— 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

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.

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 sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V P-P sinewave. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

Order 5A22N DIFFERENTIAL AMPLIFIER **$425**

5A19N DIFFERENTIAL AMPLIFIER



- 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 and 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 Factors—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

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.

Order 5A19N DIFFERENTIAL AMPLIFIER **$150**

5A23N AMPLIFIER

- 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.

Maximum Input—350 volts (DC + peak AC).

Order 5A23N SINGLE-TRACE AMPLIFIER **$65**

5A24N AMPLIFIER

- 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-inch 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.

Maximum Input—50 volts (DC + peak AC).

Order 5A24N SINGLE-TRACE AMPLIFIER **$25**

- **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 CALIBRATED 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 push button selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

The 5B10N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartments as well.

CHARACTERISTICS

Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div, and within 4% at 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

COUPLING		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—Maximum input voltage is 350 V (DC + peak AC). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div, accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

Maximum Input Voltage— 350 V (DC + peak AC).

Order 5B10N TIME BASE/AMPLIFIER **$175**

- **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 the 5000-Series Oscilloscopes. The 5B12N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartments as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by push-button switches. Triggering sources for A and B sweep include left and right plug-in, line and display 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 together with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers, therefore 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 together 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 push button 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 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

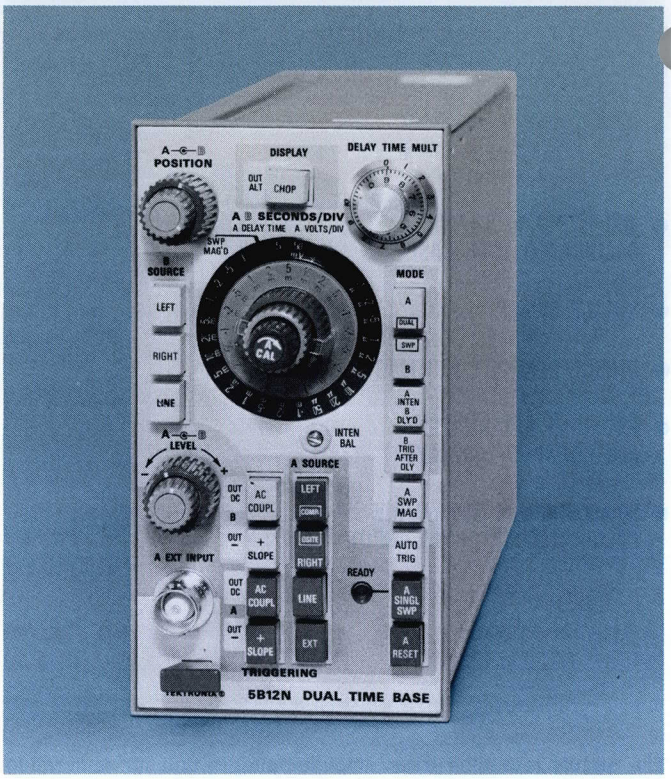
The following applies to the A and B trigger except as noted.

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—Maximum input voltage is 350 V (DC + peak AC). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Accuracy— 1 μs/div to 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% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5 s delay times.

Jitter— 1 part or less in 20,000 of 10X the A Time/Div setting.

EXTERNAL HORIZONTAL MODE

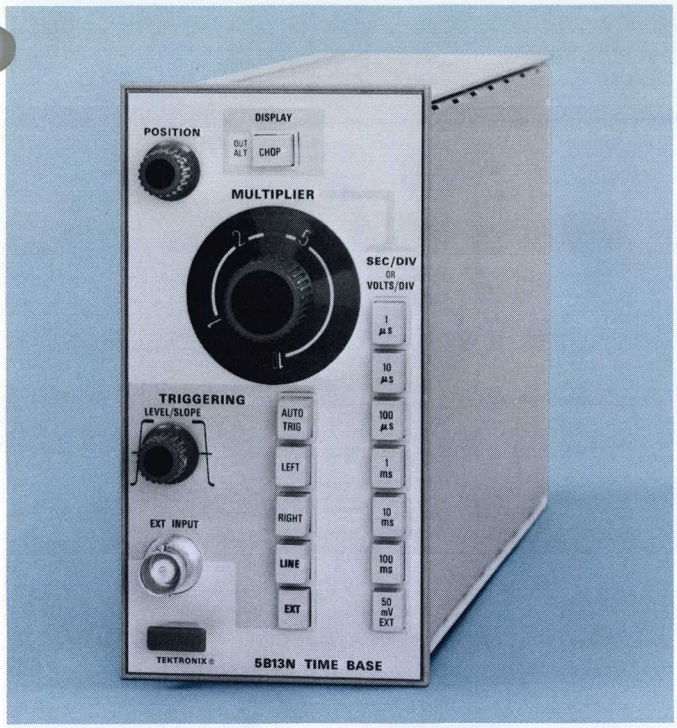
Deflection Factor— 50 mV/div and 500 mV/div accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

Maximum Input Voltage— 350 V (DC + peak AC).

Order 5B12N DUAL TIME BASE **$450**



- **1 µs/DIV to 100 ms/DIV CALIBRATED TIME BASE**
- **EXTERNAL HORIZONTAL INPUT**

The 5B13N is a low-cost, general-purpose time base for the 5000-Series Oscilloscopes. Sweep rates are selected by push button. The 5B13N is for applications such as basic laboratory use by students, production testing, scientific research and other areas where 100 ms/div to 1 µs/div sweep rates are needed.

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 push-button selected rate to at least 1 s/div.

TRIGGERING

COUPLING	SENSITIVITY AND FREQUENCY RANGE
AC	0.4 div from 50 Hz to 100 kHz, increasing to 1 div at 1 MHz
Preselected	200 mV from 50 Hz to 1 MHz

External Trigger Input—Maximum 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 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, approx 1000 pF.

Maximum Input Voltage—200 V (DC + peak AC).

Order 5B13N TIME BASE **$85**

- **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**

The 5CT1N Curve Tracer is a plug-in unit used in TEKTRONIX 5000-Series Oscilloscope systems for displaying characteristic curves of semiconductor devices to power levels up to 0.5 watts. The plug-in operates in either vertical compartment of the mainframe. Horizontal deflection is achieved through a front panel source which drives the external input of either a vertical or horizontal plug-in unit installed in the mainframe's horizontal compartment.

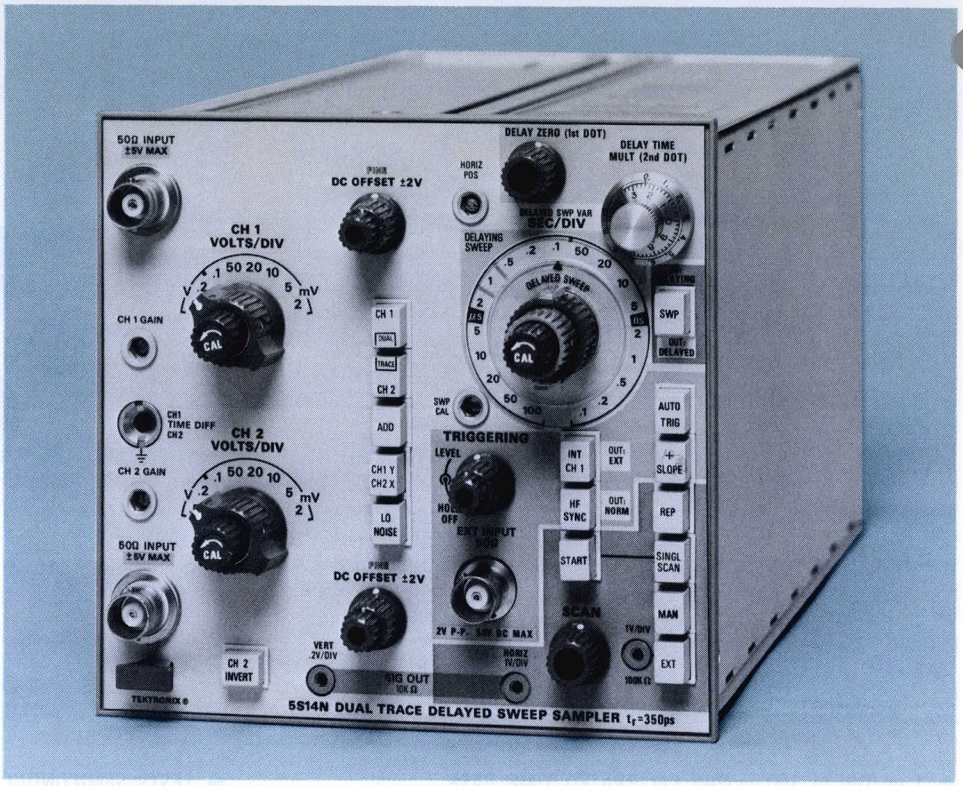
A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are 1 µA/step to 1 mA/step for current and 1 mV/step to 1 V/step for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.

Order 5CT1N CURVE TRACER **$350**

See complete description page 192-193.

5S14N *Dual Trace Delayed Sweep Sampler* New

- DC-to-1 GHz BANDWIDTH
- DUAL TRACE, 2 mV SENSITIVITY
- CALIBRATED DELAYED SWEEP
- SIMPLIFIED TRIGGERING
- OPERATIONAL EASE OF A CONVENTIONAL OSCILLOSCOPE
- TWO DOT TIME MEASUREMENTS



The 5S14N Sampling Unit combines vertical and time-base functions in one double width plug-in unit designed to operate in all 5000-Series mainframes. Combining the Sampling vertical and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical vertical channels provide dual trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A new and 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 Mult Dial by the selected time per division.

Front-panel control grouping is identified by different shades of color on the panel and the control nomenclature relates closely to that encountered in conventional oscilloscopes. Learning to operate the 5S14N requires a minimum effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL 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.

Risetime—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 .5 V/div in 8 calibrated steps (1, 2, 5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy—Within ±3%.

Maximum Input Voltage— ±5 V.

Input Signal Range— 2 V P-P maximum 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 push button 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 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 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 division. 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 CHARACTERISTICS

Range—10 ns/div to 100 μs/div in 13 steps (1, 2, 5 sequence).

Accuracy—Within ±3%, excluding first ½ division of displayed sweep.

Delay Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the Delaying Sweep selected.

Delay Time (2nd Dot)—Adjustable to any portion of the time interval represented by ten divisions of the Delaying Sweep selected.

Delay Accuracy—Within ±1% of ten divisions when measurement is made within the last 9.5 divisions.

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 division 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 ten divisions 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 one division of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

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 maximum. Trigger pulse amplitude 10 mV P-P or more with risetime of 1 μs or less, 10 Hz to 100 MHz. Sinewave amplitude 10 mV P-P or more from 150 kHz to 100 MHz.

Internal Triggering—Pulse amplitude 50 mV P-P or more with risetime of 1 μs or less. Sinewave 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 +.5 V and —.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 approximately the peak-to-peak 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 sinewaves 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 5S14N DUAL TRACE DELAYED SWEEP SAMPLER $1750
5103N/D10 OSCILLOSCOPE, Order 5110 ..... $ 540
5103N/D11 STORAGE OSCILLOSCOPE, Order 5111 ..... $1020

OSCILLOSCOPES		
PRODUCT	**PAGE**	**DESCRIPTION**
561B	117	Plug-in oscilloscope
564B	118	Plug-in oscilloscope with storage
564B MOD 121N	118	Plug-in oscilloscope with storage and auto-erase
565	120	Dual-beam oscilloscope with built-in time bases
POWER SUPPLY		
285	97	Powers one S-Series head

PLUG-IN UNITS

PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R
MULTIPLE TRACE				
3A3 Dual-Trace	122	100 μV/div	DC to 500 kHz	0.7 μs
3A6 Dual-Trace	123	10 mV/div	DC to 10 MHz	35 ns
3A74 Four-Trace	128	20 mV/div	DC to 2 MHz	0.18 μs
DIFFERENTIAL				
3A3	122	100 μV/div	DC to 500 kHz	0.7 μs
3A7 Comparator	124	1 mV/div	DC to 10 MHz	35 ns
3A9	125	10 μV/div	DC to 1 MHz	350 ns
SPECTRUM ANALYZER				
3L5	177	10 μV/div	10 Hz to 1 MHz	

PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T_R
SPECIAL PURPOSE				
3A10 Transducer	127	10 μV/div	DC to 1 MHz	350 ns
2B67 3A74	131	Engine Analyzer Plug-ins		

TIME-BASE UNITS

PLUG-IN UNIT	PAGE	FASTEST TIME-BASE RATE	MAGNIFIER	FEATURES
2B67	128	1 μs/div	X5	single sweep
3B3	129	0.5 μs/div	X5	calib delayed sweep; single sweep
3B4	130	0.2 μs/div	X1 to X50	single sweep

SAMPLING

3S2 Dual Trace	286	2 mV/div	Used with S-Series Heads	
3S5 Programmable	285	2 mV/div	Used with S-Series Heads	
SAMPLING HEADS				
S-1	91	50 Ω	DC to 1 GHz	350 ps
S-2	91	50 Ω	DC to 4.5 GHz	75 ps
S-3A	92	100 kΩ	DC to 1 GHz	350 ps
S-4	92	50 Ω	DC to 14 GHz	25 ps
S-5	93	1 MΩ	DC to 350 MHz	1 ns
S-6	94	50 Ω	DC to 11.5 GHz	30 ps
S-50	95	25-ps Pulse Generator Head		
S-51	95	1-to-18 GHz Trigger Countdown Head		
S-52	96	25-ps Pulse Generator Head		
S-53	96	DC-to-1 GHz Trigger Recognizer Head		
S-54	97	1-ns Pulse Generator Head		

3T2	286	0.2 ns/div	X10	random sampling
3T5 Programmable	285	0.1 ns/div		calib digital sweep delay

The 560 Series offers 17 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical and horizontal deflection systems (565), a bistable storage oscilloscope with auto-erase (564B MOD 121N) and without auto-erase (564B), and a conventional oscilloscope (561B). The dual plug-in unit feature of the 564B and 561B allows conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling displays, as well as spectrum analysis and raster generation are also available.

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

The 568 is described in the Automated Test Equipment Section, but can be used with any of the 560-Series plug-ins when digital readout is not required. The 3S6 and 3T6 Programmable Plug-Ins are described in the systems section.

- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***X-Y DISPLAYS***
- ***SOLID-STATE MAINFRAME***

The TEKTRONIX Type 561B and Type R561B Oscilloscope have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. They accept all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3S6 and Type 3T6 Plug-Ins. See plug-in reference chart.

TEKTRONIX CRT

Flat-faced rectangular 5-inch tube with 3.5-kV monoaccelerator and beam deflection unblanking. The edge lighted graticule is marked in 8 vertical and 10 horizontal cm divisions. The centerlines are marked every 2 mm. Illumination is controlled by a front-panel knob. A P31 phosphor is normally supplied; P2, P7 or P11 are optional without extra charge.

Z-AXIS INPUT

A BNC connector at the rear of the instrument permits external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals. Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2 mV, 20 mV or 200 mV ground-to-peak squarewave into 50.0 Ω. Current—Current loop of 10 mA DC or 10 mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C.

Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

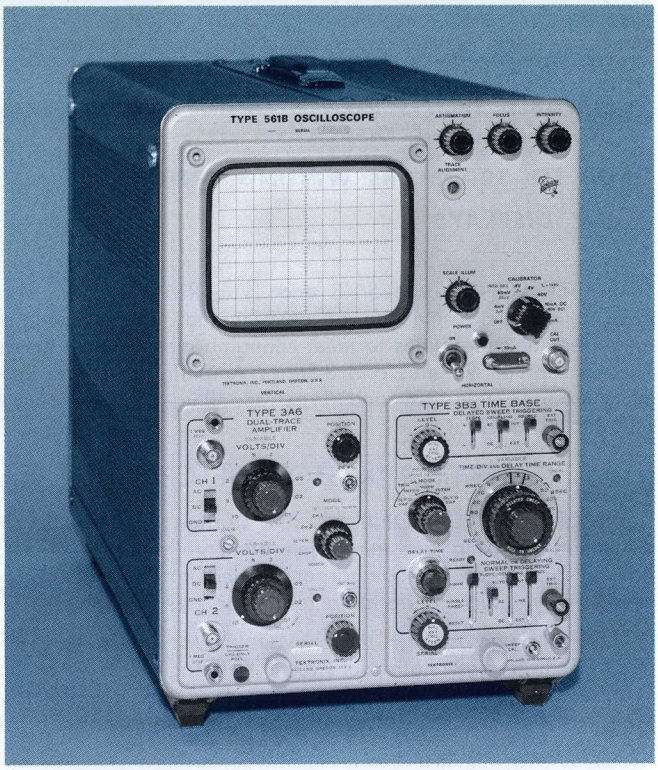
ENVIRONMENTAL CHARACTERISTICS

Operating temperature 0°C to 50°C, operating altitude to 15,000 feet.

POWER REQUIREMENTS

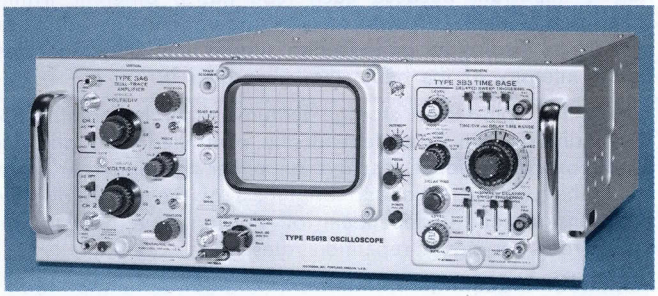
Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 561B will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 178 watts at 115 VAC, 60 Hz. The Type R561B will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 186 watts at 115 VAC, 60 Hz.

	561B		R561B	
DIMENSIONS	in	cm	in	cm
Height	14¾	37.5	7	17.8
Width	9¾	24.8	19	48.3
Depth	21½	54.7	20½	52.1
WEIGHTS	lb	kg	lb	kg
Net	32	14.6	31¼	14.2
Domestic shipping	≈41	≈18.6	≈56	≈25.4
Export-packed	≈53	≈24	≈76	≈34.4



INCLUDED ACCESSORIES FOR TYPE 561B

BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).



INCLUDED ACCESSORIES FOR TYPE R561B

Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

Order TYPE 561B OSCILLOSCOPE,
without plug-in units $695

Order TYPE R561B OSCILLOSCOPE,
without plug-in units $745

Option 2 SLIDE-OUT TRACKS ..... Add $50

Slide out tracks that allow the R561B to be pulled out from a standard 19-inch rack, tilted and locked in any of 7 positions for convenient servicing.

Option 72 P2 PHOSPHOR ..... No Charge

Option 76 P7 PHOSPHOR ..... No Charge

Option 78 P11 PHOSPHOR ..... No Charge

564B MOD 121N *Auto-Erase Storage Oscilloscope*

- ***DC-to-10 MHz BANDWIDTH***
- ***BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS***
- ***UP TO 500 cm/ms WRITING SPEED***
- ***X-Y DISPLAYS***

The TEKTRONIX Type 564B and Type R564B Oscilloscopes have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. They accept all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6 Plug-Ins. See plug-in reference chart.

TEKTRONIX STORAGE CRTS

The CRT is a TEKTRONIX bistable storage tube with beam-deflection blanking and an accelerating voltage of 3.5 kV. It has an 8 x 10-cm storage target divided into two 4 x 10-cm areas, individually controllable for storage and erasure.

There are two storage tubes available for use in the Type 564B Oscilloscopes. Both tubes exhibit characteristics of a conventional CRT when used in the non-stored mode. The standard tube has the brighter stored display. The optional tube has the faster writing speed.

By selecting the proper tube, you can obtain optimum oscilloscope performance for your particular application. Such selection is important because each tube has a different writing speed and brightness for stored-mode operation. The brightness of a stored display for an individual tube is one value regardless of the intensity of the beam that generated it.

With the split-screen storage feature, either half of the 8 x 10-cm display can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. The contrast ratio and brightness of the stored displays are constant and independent of viewing time, writing and sweep rates, or signal repetition rates.

WRITING SPEED

Initially, at least 25 cm/ms for the standard CRT. At least 100 cm/ms when option 8 is specified.

VIEWING TIME

Displays can be stored and viewed up to 1 hour.

ERASURE TIME

Approx 0.25 second.

STORED WRITING-SPEED ENHANCEMENT

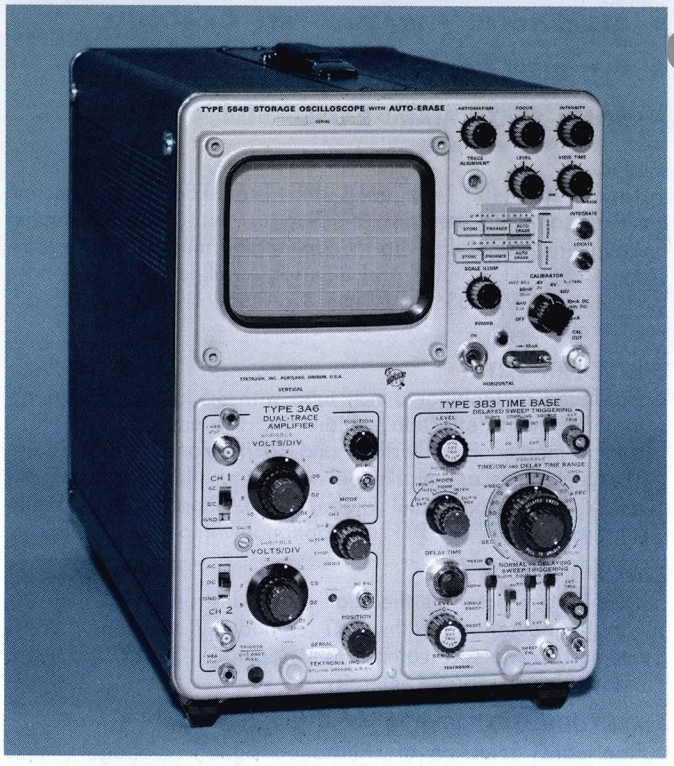
This feature controls the single-sweep storage capabilities of the storage CRT. Through adjustment of the front-panel Level control, single-trace spot velocities up to 250 cm/ms using the standard CRT; up to 500 cm/ms using the fast CRT can be stored with minimal loss of resolution and contrast in the center 7 x 9 cm.

SINGLE-SHOT SIGNALS

At slow or medium speeds, single-shot signals are easily stored for extended viewing time (within writing-speed capabilities of CRT selected).

INTEGRATE MODE

Increases the effective writing speed for repetitive fast signals with repetition rates that are too low for effective storage, but which may be too fast for satisfactory single-shot storage with enhancement.



REMOTE CONTROL OPERATION

A rear-panel connector permits erasing of upper and/or lower half of split screen from a remote location and permits remote operation of the Save Mode.

Erasure can be initiated in either of two ways:

1. Pulse initiated—Requires a negative pulse of 5 V to 100 V. Rate of change at least 0.1 V/μs.
2. Impedance change initiated—Requires a change from at least 1 MΩ to 50 kΩ or less in 10 μs or less.

AUTO ERASE (MOD 121N only)

In the Auto Erase Mode there is a continuous sequence of storing, viewing time and erasure of either upper screen, lower screen or entire screen. A rear-panel switch provides two modes of operation, either Signal Triggered Sweep or Erase Triggered Sweep.

In the Signal Triggered Sweep Mode, the input Signal initiates a sweep and the viewing time begins as the sweep ends. At the end of the variable viewing time, the selected portion of the screen is automatically erased and the cathode-ray tube is unblanked after the next sweep retrace. This cycle will automatically repeat itself as long as an input signal triggers the sweep.

The Erase Triggered Sweep Mode is primarily useful with sweep rates of 0.1 s/div and slower. In this mode of operation, the CRT is not blanked during the variable viewing time. The sweep unit can be triggered either by the input signal or by the erase pulse output located on the rear of the oscilloscope.

VARIABLE VIEWING TIME (MOD 121N only)

1 s to at least 12 s. SAVE position disables automatic erasure.

EXTERNAL GRATICULE

The graticule is edge lighted and is marked in 8 vertical and 10 horizontal cm divisions. The centerline is marked every 2 mm. Illumination is controlled by a front-panel knob.

Z-AXIS INPUT

Accessible through a BNC connector at the rear of the instrument permitting external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals.

Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 MΩ or greater; 40 V DC into 1 MΩ or greater; 2-mV 20-mV or 200-mV ground-to-peak squarewave into 50.0 Ω.

Current—Current loop of 10 mA DC or 10-mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 1½% from +20°C to +30°C; within 2% from 0°C to +50°C. Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μs or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μs or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS

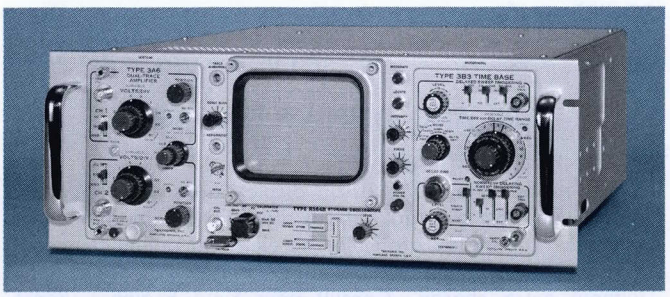
Operating temperature 0°C to 50°C, operating altitude to 15,0000 feet.

POWER REQUIREMENTS

Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 564B MOD 121N will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 196 watts at 115 VAC, 60 Hz. The Type R564B MOD 121N will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 204 watts at 115 VAC, 60 Hz.

TYPE 564B

The auto erase and variable viewing time features of the Type 564B MOD 121N are deleted in the Type 564B and Type R564B. A cost savings is thus realized. All other storage characteristics, electrical characteristics and mechanical characteristics remain the same.



TYPE R564B

The Type R564B is a rackmount version of the 564B that is also available with or without auto-erase (MOD 121N).

DIMENSIONS	564B		R564B	
	in	cm	in	cm
Height	14¾	37.5	7	17.9
Width	9¾	24.9	19	48.4
Depth	21½	54.7	20½	52.2
WEIGHTS	**lb**	**kg**	**lb**	**kg**
Net	36	16.3	37	16.7
Domestic shipping	≈45	≈20.4	≈58	≈26.3
Export-packed	≈55	≈25	≈80	≈36.3

INCLUDED ACCESSORIES FOR TYPE 564B MOD 121N
BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00).

INCLUDED ACCESSORIES FOR TYPE R564B MOD 121N
Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 50-Ω BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00).

INCLUDED ACCESSORIES FOR TYPE 564B
BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

INCLUDED ACCESSORIES FOR TYPE R564B
Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

ORDERING INFORMATION

Plug-ins not included

TYPE 564B OSCILLOSCOPE **$1195**
(with CRT for brightest stored display)

TYPE R564B OSCILLOSCOPE **$1245**
(with CRT for brightest stored display)

564B OPTIONS

Option 1 MOD 121N FEATURES ..... **Add $155**

Option 8 MAX WRITING SPEED CRT .... **No Charge**

R564B OPTIONS

Option 1 MOD 121N FEATURES ..... **Add $155**

Option 2 SLIDE-OUT TRACKS ..... **Add $ 50**
For mounting the R564B in a standard 19-inch rack. Allows instrument to be pulled out, tilted and locked in any of 7 positions for convenient servicing.

Option 8 MAX WRITING SPEED CRT .... **No Charge**

OPTIONAL ACCESSORIES

SLIDE-OUT ASSEMBLY

Converts standard Type R564B or R561B for easy withdrawal and tilt of instrument. Order 351-0050-00 ..... $55

CRADLE ASSEMBLY

Provides rear slide support when R564B or R561B with slide-out tracks is mounted in a backless rack. Order 040-0344-00 $11

REMOTE-ERASE CONNECTOR

Mates with 9-pin connector on the rear panel of Type 564B or R564B. Supplied without cable. Order 134-0049-00 .. $6.60

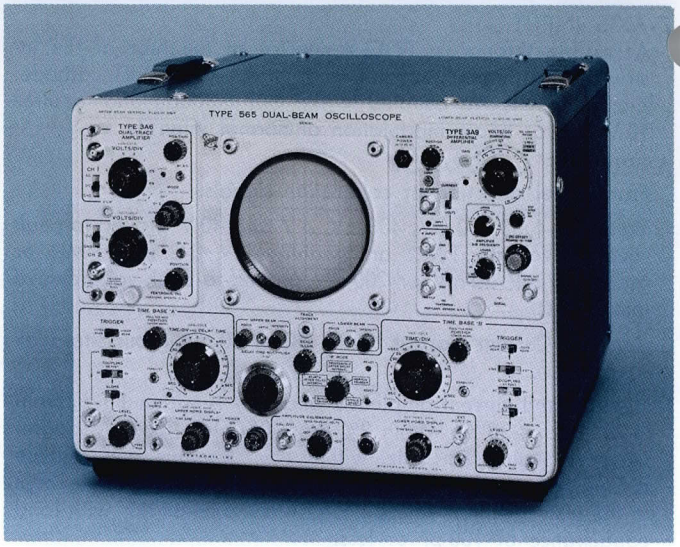
CAMERAS

The C-12 and C-27 Cameras are recommended for the 564B and R564B, see camera section of catalog for more details. Other accessories are available, see catalog accessory pages.

565 *10-MHz Dual-Beam Oscilloscope*

- ***TWO VERTICAL AND HORIZONTAL SYSTEMS***
- ***8 x 10-cm DISPLAY PER BEAM***
- ***CALIBRATED DELAYED SWEEP***

A Type 565, or rackmount counterpart Type RM565, is essentially two single-beam oscilloscopes sharing a common cathode-ray tube and power supply. Each beam has separate vertical and horizontal deflection systems, focus, and intensity controls.



VERTICAL DEFLECTION

2 identical systems

The vertical amplifiers can be any of 2-Series or 3-Series Plug-In Units, except Spectrum Analyzer and Sampling Units. See plug-in reference chart.

HORIZONTAL DEFLECTION

2 identical systems

The horizontal amplifiers are built-in and can be driven by either of two sweep systems, simultaneously or independently, or from their external inputs. Front-panel controls permit using "A" sweep as a delaying sweep and "B" as the delayed sweep. In this mode of operation the upper beam is intensified for the duration of the "B" sweep. "B" sweep may also be used for single-sweep operation.

TIME BASE A AND B

1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable and to approx 12 s/div. A warning light indicates when the variable control is in the uncalibrated position. Either time base can be operated independently, or Time Base B can be delayed by Time Base A. In delayed-sweep operation, Time Base A display is intensified for the duration of the "B" sweep.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 0.1 μs/div. Magnified time base accurate within 5%.

OPERATING MODES

Time Base A—Normal Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY-TIME MULTIPLIER. DELAY TIME control selects 10 μs to 5 s delay time in a 1-2-5 sequence, accurate to within 3% (5, 2, and 1 μs delay time, accuracies not specified). DELAY-TIME MULTIPLIER accurate within 0.5% of full scale. Provides continuously calibrated time intervals from 0.50 to 10.00 times the DELAY TIME. Dial is divided into 1000 parts.

DIFFERENTIAL TIME-MEASUREMENT ACCURACY

Within 3% and 10 minor divisions. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY RANGE

5 μs to 50 s after start of delaying sweep. Inherent delay to start of delayed sweep is 1.5 μs or less.

EXTERNAL INPUT

Upper and Lower Horizontal Display Switches select Time Base A, Time Base B, or Ext. In the External position, the gain is continuously variable from approx 100 mV/div to 30 V/div, DC to 350 kHz. Maximum input voltage is 300-V RMS. Input RC is approx 100 kilohms paralleled by 30-55 pF depending on gain setting.

TRIGGER

2 identical systems

MODES

Manual, Automatic, Free-run. In Automatic mode, sweep free-runs at approx 50 Hz in the absence of a triggering signal.

COUPLING

AC, AC Fast, DC.

SOURCES

Internal from Upper Beam or Lower Beam, External, or Line.

REQUIREMENTS

0.2 divisions of deflection internal or 0.5 V external up to 50 kHz, increasing to 1 div or 1 V at 2 MHz.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 10 x 10-cm display area; 8 x 10 cm per beam with 6-cm overlap. Tube is aluminized with illuminated, internal, no-parallax graticule. Accelerating potential is 4 kV. P2 phosphor is normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, intensity contrast between A sweep and non-intensified B-zone of A sweep (internal screwdriver adjustment), trace rotation.

Z-AXIS MODULATION

AC-coupled to both CRT grids via rear panel input connectors. Time constant is 3.5 ms nominally, CRT modulation requires approx 10 V at normal intensity.

OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

1-kHz squarewave output, calibrated in 6 steps from 1 mV to 100 V. Accurate within 3%.

REAR-PANEL OUTPUTS

VERTICAL SIGNAL OUT (both upper and lower)—Signal amplitude, DC level, and transient response depend on the vertical plug-in unit used. Typical signal amplitude: 2 V/div to 4 V/div of display; DC level ±20 V. Output impedance: approx 500 ohms; maximum load current 2 mA.

HORIZONTAL OUTPUTS (both upper and lower)—Signal amplitude, at least 50 mV/div of display in External position and 0.5 V/div of display in Sweep position. DC level 0 to +5 volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

A AND B +GATES—Pulse height 20 V minimum; DC level zero volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

DELAYED TRIGGER—Fast-rise pulse amplitude +8 V minimum; DC level zero volts. Output impedance: approx 50 ohms; maximum load current 2 mA.

POWER REQUIREMENTS

600 watts maximum, 50 to 60 Hz. Instrument factory wired for 105-V to 125-V (117 V nominal) operation, or 210 V to 250 V (234 V nominal) upon request. Transformer taps permit operation at nominal voltages ranging from 99 V to 132 V or 198 V to 265 V.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	13¾ in	34.9 cm
Width	16⅞ in	42.8 cm
Depth	23⁹⁄₁₆ in	59.8 cm
Net weight	67 lb	30.5 kg
Domestic shipping weight	≈95 lb	≈43.2 kg
Export-packed weight	≈117 lb	≈53.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	12¼ in	31.1 cm
Width	19 in	48.3 cm
Rack depth	22³⁄₁₆ in	56.4 cm
Net weight	80 lb	36.3 kg
Domestic shipping weight	≈104 lb	≈47.3 kg
Export-packed weight	≈124 lb	≈56.4 kg

INCLUDED ACCESSORIES

3-conductor power cable (161-0010-03); smoke-gray light filter (installed) (378-0567-00); clear CRT protection plate (387-0918-00); two patch cords, BNC-to-BNC 18-inch (012-0087-00); post jack, BNC (012-0092-00); Type RM565 also includes slide-out assembly (351-0086-00); power cable (161-0024-03).

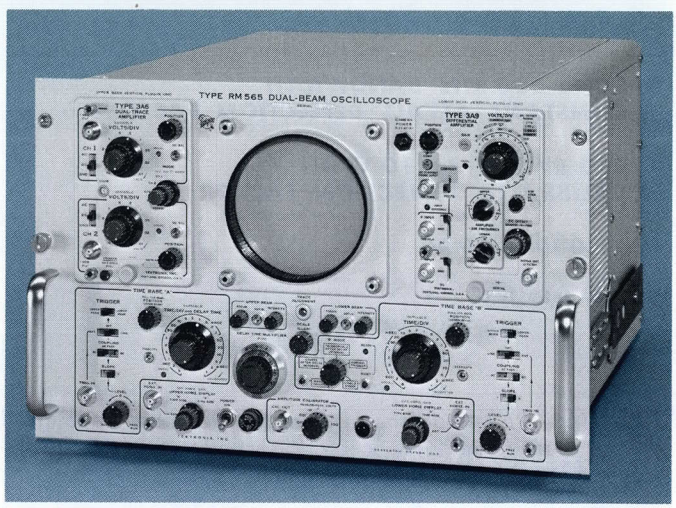
Order TYPE 565 OSCILLOSCOPE,
without plug-in units $2100

Order TYPE RM565 OSCILLOSCOPE
without plug-in units $2200

Option 76 P7 PHOSPHOR ..... No Charge

Option 78 P11 PHOSPHOR ..... No Charge

Option 80 P31 PHOSPHOR ..... No Charge



RACKMOUNTING

Type RM565 mounts on tilting slide-out tracks to standard 19-inch rack. Additional mounting information on catalog instrument dimension page.

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The probes recommended for use with these instruments are covered on the 2- and 3-Series Plug-In Unit pages. Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERA

C-59-P: f/2.8—0.67 mag lens, Polaroid Land Pack-Film back provides 10.2 x 12.7 cm coverage on 4 x 5-inch film.
Order C-59-P $450

Type 565, RM 565 to C-59 Camera adapter.
Order 016-0225-03 ..... $20

SCOPE-MOBILE® CART

Model 205: has 9-position tilt-lock oscilloscope tray.
Order 205 ..... $190

CRADLE ASSEMBLY

Provides rear slide support when RM565 is mounted in backless rack. Order 040-0346-00 ..... $11

- ***DC-to-500 kHz BANDWIDTH CONSTANT AT ALL DEFLECTION FACTORS***
- ***100 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTOR***
- ***50,000:1 CMRR***
- ***FET INPUTS***

The Type 3A3 Dual-Trace Differential Amplifier is designed for use in the Type 561B, 564B, 565, or in the 568/230 Oscilloscope, but without digital presentation of the measurement.

BANDWIDTH

DC-to-500 kHz or 5 kHz (switch selectable). Selected bandwidth is constant at all volts/div settings. Low frequency —3 dB point when AC coupled is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

100 μV/div to 10 V/div in 16 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

MAXIMUM INPUT VOLTAGE

350 V (DC + peak AC, DC to 1 kHz) 0.1 mV/div to 10 mV/div; 350 V (DC + peak AC, DC to 500 kHz) 20 mV/div to 10 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF. Input R can be disconnected by removing internal wire link.

PHASE SHIFT (0.1 mV to 10 mV)

Less than 2° from DC to 100 kHz between two Type 3A3 Amplifiers used in X-Y operation. Phase shift can be adjusted to 0° at any particular deflection factor setting.

NOISE

Displayed noise, tangentially measured, is less than 15 μV in the 500 kHz bandwidth position.

DC STABILITY

Drift with ambient temperature (constant line voltage) less than 50 μV/°C.

INTERCHANNEL ISOLATION

Electrostatic Isolation is 10^6:1 or better referred to input signal levels. Dual-Trace Isolation in alternate or chopped operation is 100:1 or better referred to divisions of display. Example: 5 divisions displayed on Channel 1 will cause no more than 0.05 divisions of deflection on Channel 2.

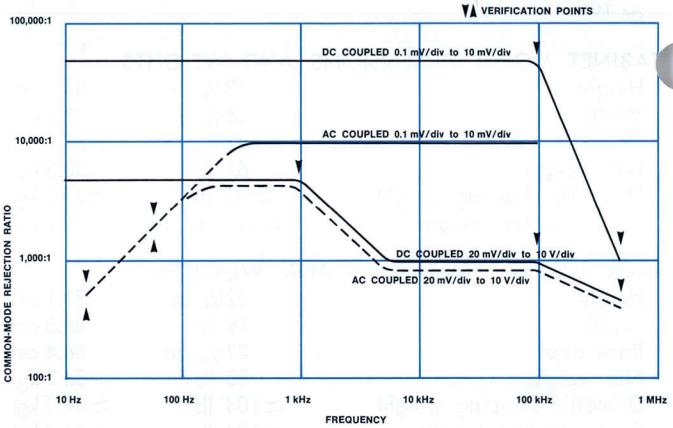
TRIGGER PICKOFF

Internally coupled. Can be selected from Channel 1, Channel 2 or the composite signal after switching.

DIFFERENTIAL CF OUTPUTS

Output is available from two of the connector pins at the rear of the plug-in for use in driving recorders or other equipment. Output amplitude is a ground-reference, differential, ≈5-volt signal for each division of displayed signal. Front-panel TRIGGER SWITCH allows signal out selection of CH 1, CH 2 or composite. Bandwidth is DC to ≈400 kHz with a non-capacitive load. Jacks can be easily installed at the rear of the oscilloscope to provide access to the CF outputs.

COMMON-MODE REJECTION RATIO



WEIGHTS

Net weight	5¼ lb	2.4 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED ACCESSORIES

Four BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00).

Order TYPE 3A3 DUAL-TRACE DIFFERENTIAL AMPLIFIER $950

OPTIONAL ACCESSORIES

P6028 1X Probe Package. Order 010-0074-00 ..... $22

P6055 10X Probe Package, adjustable attenuation helps maintain common-mode rejection. Order 010-6055-01 .... $85

P6007 100X Probe Package. Order 010-0150-00 ..... $3

P6006 10X Probe Package. Order 010-0127-00 ..... $32

- ***10 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***35-ns RISETIME***

The Type 3A6 Amplifier is a general-purpose, dual-trace plug-in unit designed for use in the Types 561B, 564B and 565 Oscilloscopes. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The Type 3A6 features two separate channels with identical characteristics. It can be operated in any one of five modes for a variety of single and dual-trace displays. Two Type 3A6's can be used for X-Y curve tracing, but without synchronized switching or channel pairing.

BANDWIDTH
DC to 10 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 35 ns.

DEFLECTION FACTOR
10 mV/div to 10 V/div in 10 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Includes Channel 1 only (polarity of Channel 1 can be changed to provide 180° inversion); Channel 2 only; alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 4 μs (approx) segments of each channel are displayed at an approx 125-kHz rate per channel (chopped transient blanking is provided); Added—outputs of Channel 1 and 2 added algebraically.

INTERNAL TRIGGER SIGNAL
Selectable from the output of Channel 1 only or from the combined output of the unit. Triggering from Channel 1 only permits viewing the true relationship between two signals when operating the unit in either alternate or chopped mode.

SIGNAL DELAY
Permits viewing of leading edge of fast-rise waveforms.*

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

Order TYPE 3A6 DUAL-TRACE AMPLIFIER $600

OPTIONAL ACCESSORIES

The probes recommended for use with these instruments satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package. Order 010-0074-00 ..... $22
P6006 10X Probe Package. Order 010-0127-00 ..... $32
P6007 100X Probe Package. Order 010-0150-00 ..... $38

**The Type 3A6 can be used with a Type 2B67 or Type 3B2 Time-Base Unit, but it will not usually be possible to view the entire leading edge of the triggering waveform. Same applies when the unit is used with Types 565 and RM565 Oscilloscopes.*

- ***DC-to-10 MHz BANDWIDTH***
- ***1 mV/DIV to 50 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***20,000:1 CMRR***
- ***±11,000-cm EFFECTIVE SCREEN HEIGHT***

The Type 3A7 High-Gain Differential Comparator adds to the measurement capabilities of Type 561B, 564B, and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required.

As a differential input amplifier, the dynamic range of the 3A7 Unit permits common-mode signals up to ±15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of about 20,000 to 1 for DC or low-frequency signals, differential signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using the slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage, added differentially to the input signal, makes precise voltage measurements possible. Using this mode of operation, the 3A7 Unit has an effective screen height of ±11,000 cm. This is equivalent to a ±11-volt dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated ±DC comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 μV per mm to be resolved.

CALIBRATED DEFLECTION FACTOR

1 mV/div to 50 V/div, depending on millivolts/div and attenuator settings. Accuracy of millivolts/div positions is within 3%. Uncalibrated, continuous variation between steps and to approx 125 V/div.

BANDWIDTH (—3 dB)†		
mV/DIV	FREQUENCY	RISETIME
50 mV to 10 mV/div	DC to ≥10 MHz	≤35 ns
5 mV/div	DC to ≥ 8 MHz	≤44 ns
2 mV/div	DC to ≥ 6 MHz	≤58 ns
1 mV/div	DC to ≥ 4 MHz	≤88 ns

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

INPUT CHARACTERISTICS		
INPUT ATTEN	MAX PEAK INPUT VOLTS Common or Differential Mode	MAX INPUT ATTEN ERROR
R ≈ ∞	±15 V	*
1X	±15 V	**
10X	±150 V	±0.05%
100X	±500 V	±0.15%
1000X	±500 V	±3%

*Input R ≈ 10,000 to 50,000 MΩ.

**1X input R within ±0.1% of 10X input R.

INPUT RC

1 megohm paralleled by approx 20 pF.

COMMON-MODE REJECTION RATIO AT 1 mV/div	
DC COUPLED	≥20,000:1 with ±11 VDC or 30 V P to P AC, DC to 20 kHz
AC COUPLED	≥1000:1 with 30 V P to P at 60 Hz, to ≥20,000:1 at 20 kHz
HF (AC OR DC COUPLED)	≥500:1 with 30 V P to P at 500 kHz, to ≥20,000:1 at 20 kHz

COMPARISON VOLTAGE

0 to ±1.1 V, or 0 to ±11 V. Accuracy: ± (0.15% of indicated value plus 0.05% of V_c Range). V_c OUT jack on front panel.

OVERDRIVE RECOVERY

Recovers to within 10 mV of reference signal within 300 ns after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to 5 mV in the reference level.

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈14 lb	≈6.3 kg

Order TYPE 3A7 DIFFERENTIAL COMPARATOR . . . $750

OPTIONAL ACCESSORIES

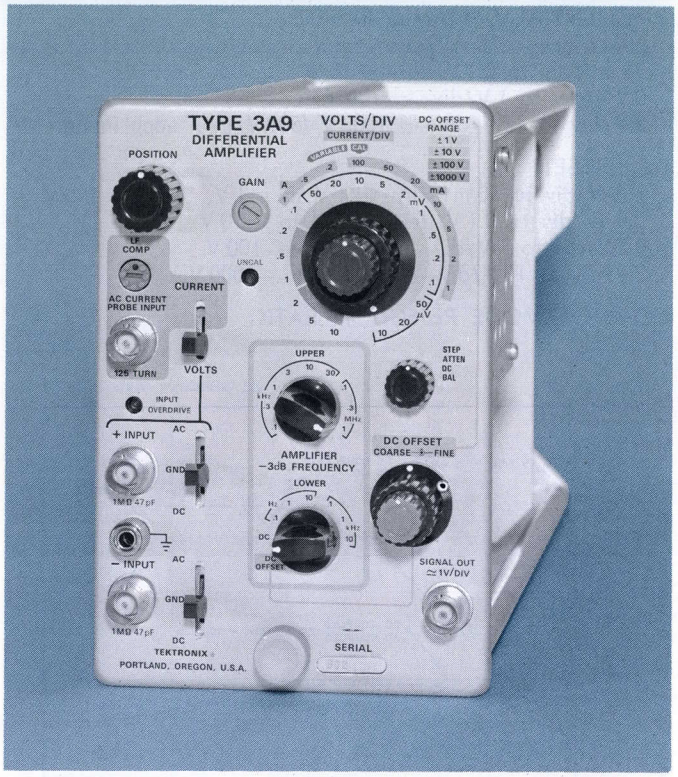
P6028 1X Probe Package. Order 010-0074-00 ..... $22

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection. Order 010-6055-01 .. $85

P6006 10X Probe Package. Order 010-0127-00 ..... $3

P6007 100X Probe Package. Order 010-0150-00 ..... $38

- ***VOLTAGE MEASUREMENTS***
  10 μV/div to 10 V/div
  DC-to-1 MHz BANDWIDTH
- ***CURRENT MEASUREMENTS (with optional current probe)***
  1 mA/div to 1 A/div
  10 Hz-to-1 MHz BANDWIDTH
- ***SELECTABLE UPPER AND LOWER 3-dB POINTS***
- ***100,000:1 CMRR***
- ***INTERNAL DIFFERENTIAL DC OFFSET***
- ***10 μV/hour DC DRIFT***



The Type 3A9 is a DC-coupled differential amplifier designed for use in Tektronix 561B, 564B and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required.

Bandwidth is maintained at DC-to-1 MHz throughout the deflection factor range of 10 μV/div to 10 V/div. CMRR is at least 100,000:1 from DC-to-100 kHz from 10 μV/div to 10 mV/div. DC differential offset provides an internal voltage to cancel signal DC levels or to inspect signal components over a full differential dynamic range. Bandwidth is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequencies (0.1 Hz).

In addition, the Tektronix P6021 (125-turn) AC current probe provides the convenience of current readings from 1 mA/div to 1 A/div with the AC current probe input. The bandwidth when using the optional current probe is from 10 Hz to 1 MHz.

VOLTAGE CHARACTERISTICS

BANDWIDTH
DC-to-1 MHz independent of deflection factor setting.

FREQUENCY LIMITS— 3-dB POINTS
Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz. A DC offset position provides DC low frequency response and turns on the DC offset control.

INPUT RC
1 megohm, paralleled by 47 pF.

DEFLECTION FACTOR
10 μV/div to 10 V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuously variable between steps and to approximately 25 V/div.

INPUT COUPLING
May be switched to AC, GND or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower —3-dB point is approximately 1.6 Hz when AC coupled at input.

INPUT GATE CURRENT
From 10 μV/div to 10 mV/div, maximum input gate current is ±20 pA at +25°C and ±100 pA at +50°C; 20 mV/div to 10 V/div, maximum input gate current is ±10 pA at +25°C and ±10 pA at +50°C. Display shift at 10 μV/div (+25°C, AC coupled) is ±2 div.

DISPLAYED NOISE
≤12 μV or 0.1 div, whichever is greater, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less.

DC STABILITY
Drift with time (constant ambient temperature and line voltage; DC to 100 Hz bandwidth).

Short term: ≤5 μV/min (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

Long term: ≤10 μV/h (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

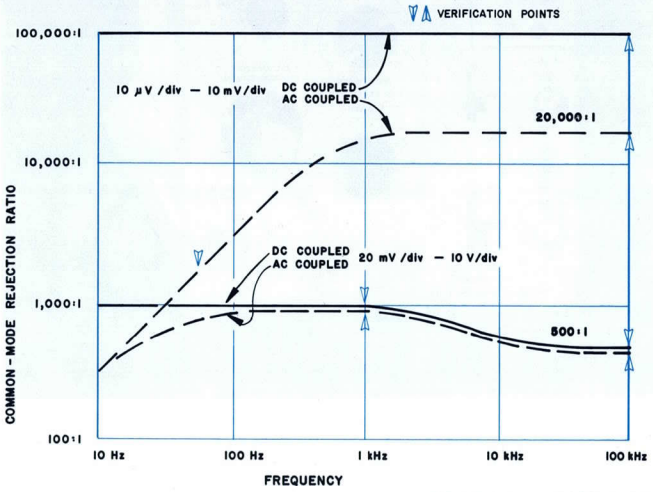
DIFFERENTIAL DYNAMIC RANGE

10 μV/div to 10 mV/div—±1 V.
20 mV/div to 0.1 V/div—±10 V.
0.2 V/div to 1 V/div—±100 V.
2 V/div to 10 V/div—±1000 V (500 V max each input).

DC OFFSET

10 μV/div to 10 mV/div—+1 V to —1 V.
20 mV/div to 0.1 V/div—+10 V to —10 V.
0.2 V/div to 1 V/div—+100 V to —100 V.
2 V/div to 10 V/div—+1000 V to —1000 V.

COMMON-MODE REJECTION RATIO



COMMON-MODE DYNAMIC RANGE

10 μV/div to 10 mV/div—±10 V.
20 mV/div to 0.1 V/div—±100 V.
0.2 V/div to 10 V/div—±500 V.

MAXIMUM INPUT VOLTAGE

DC Coupled: 10 μV/div to 10 mV/div—±15 V (DC + peak AC);
20 mV/div to 10 V/div—±500 V (DC + peak AC).

AC-Coupled Input DC Voltage: ±500 V, each input.

OVERDRIVE RECOVERY

≤10 μs to recover to within 0.5% of zero level after removal of a + or — voltage applied for 1 s. Voltage not to exceed differential dynamic range.

INPUT OVERDRIVE LIGHT

Indicates differential overload is being approached.

AC CURRENT CHARACTERISTICS WITH OPTIONAL CURRENT PROBE

BANDWIDTH

10 Hz to 1 MHz with optional AC current probe.

FREQUENCY LIMITS—3-dB POINTS

Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 1 kHz, 300 Hz, 100 Hz.
Lower—10 kHz, 1 kHz, 100 Hz. Not calibrated from 10 Hz to DC.

INPUT

Accepts Tektronix P6021 (125-turn) AC current probe.

DEFLECTION FACTOR

1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence accurate within 3%. Uncalibrated continuously variable between steps and to approximately 2.5 A/div.

MAXIMUM INPUT CURRENT

10 A P-P.

FRONT-PANEL SIGNAL OUTPUT

1 V (±20%) per displayed division. DC coupled, internally adjustable to ground reference. Dynamic range is at least +5 V to —5 V. Bandwidth is DC to at least 500 kHz. Output resistance is 100 Ω or less. Minimum load resistance, 10 kΩ.

WEIGHTS

Net weight	4¾ lb	2.2 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

Order TYPE 3A9 PLUG-IN UNIT $600

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available. See the Tektronix Catalog accessory pages for additional information on these and other items.

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection. Order 010-6055-01 . $85
P6028 1X Probe Package. Order 010-0074-00 . . . . . $22
P6007 100X Probe Package. Order 010-0150-00 . . . . . $38
P6021 Current Probe. Order 010-0237-02 . . . . . $100

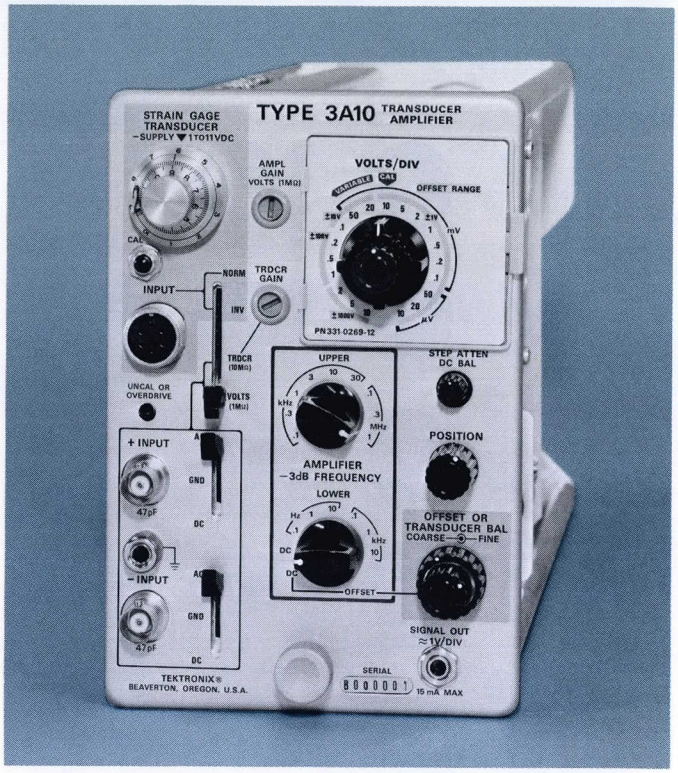
- ***DC to 1 MHz BANDWIDTH***
- ***10 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***
- ***100,000:1 CMRR***
- ***DC VOLTAGE SUPPLY FOR TRANSDUCERS***
- ***SELECTABLE UPPER AND LOWER —3 dB POINTS***
- ***SPECIALLY TAILORED TRANSDUCER ACCESSORIES***

The Type 3A10 is especially designed for transducer measurements and can be used with standard voltage probes. As a transducer amplifier, its inputs are designed to accommodate piezoelectric and other self-generating transducers, or strain gage and other voltage-excited transducers, using the built-in calibrated variable DC voltage supply.

A wide range of mechanical quantities, such as pressure, force, acceleration, vibration, displacement, strain, and temperature can be measured with optional transducer accessories adapted especially for use with the 3A10. Accessory transducer packages include a snap-in, scale-factor plate to permit direct reading of units being measured without computation.

TRANSDUCER PACKAGES

TYPE	ORDER PACKAGE NO.	PRICE	RECOMMENDED ACCESSORY
Pressure 3000 psig	015-0161-00	$250	20 ft cable 012-0209-00
Pressure 300 psig	015-0162-00	$250	20 ft cable 012-0209-00
Force 3000 Lbsf	015-0163-00	$450	20 ft cable 012-0209-00
Force 50 gram f; 50 lb f with adapter	015-0164-00	$450	
Acceleration 10,000 g	015-0165-00	$225	20 ft cable 012-0211-00
Vibration ±0.025 inch Vertical	015-0166-00	$105	20 ft cable 012-0136-00
Vibration ±0.025 inch Horizontal	015-0167-00	$120	20 ft cable 012-0136-00
Displacement ±0.2 inch	015-0168-00	$220	20 ft cable 012-0209-00
Strain 30,000 μstrain package of 5	015-0171-00	$ 15	
Temperature Thermocouples package of 3 +105°C Max +480°C Max +480°C Max With magnet mounting	015-0173-00	$ 33	



The 3A10 can be used with any 560-Series oscilloscope.

STRAIN GAGE/TRANSDUCER POWER SUPPLY
Voltage range is —1 V to —11 V, ±1%. Current range is 0 to at least 60 mA. Maximum (short circuit) current is 90 mA.

3A10 TRANSDUCER AMPLIFIER $800

For complete specifications see 3A9 description.

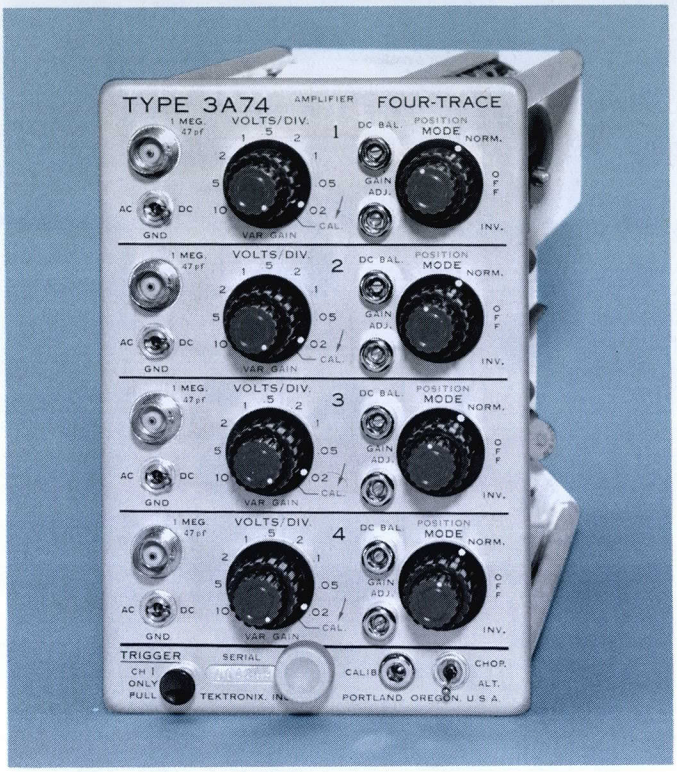
The 3A10 is specifically designed for transducer-aided measurements. However, many other TEKTRONIX instruments are ideally suited for mechanical measurement applications. For complete details and specifications on Tektronix mechanical measurement instrumentation, as well as application notes and other supporting literature, contact a Tektronix Field Office or use the reply card at the front of the catalog.

STRAIN GAGE ADAPTER—Provides means of connecting four arms of a wheatstone bridge to Type 3A10.
Order 015-0169-00 ..... $75

20 ft Cable Order 012-0136-00 ..... $15.40

20 ft Cable Order 012-0209-00 ..... $40.00

20 ft Cable Order 012-0211-00 ..... $22.00



- ***20 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS***

The Type 3A74 is a general purpose plug-in unit for use in the Type 561B, 564B or 565 Oscilloscpe. The 3A74 can also be used in the Type 568 Oscilloscope when digital readout is not required.

3A74 CHARACTERISTICS

BANDWIDTH
DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME
Approximately 0.17 μs.

DEFLECTION FACTOR
20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC
1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈15 lb	≈6.8 kg

INCLUDED ACCESSORIES
Four BNC to binding-post adapters (103-0033-00).

Order TYPE 3A74 AMPLIFIER $900

The Type 2B67 is recommended for use with 2 and 3 Series vertical plug-in units with bandwidth to 2 MHz.

TIME BASE
1 μs/div to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/div.

5X MAGNIFIER
Operates over full time base, increases the fastest rate to 0.2 μs/div. Magnified display accurate within 5%.

SINGLE SWEEP
For one-shot waveform photography and storage applications.

EXTERNAL HORIZONTAL INPUT
Approx 1 V/div, DC to 750 kHz at —3 dB.

TRIGGER

MODES
Manual, automatic, or free-run.

COUPLING
AC slow, AC fast, or DC.

SOURCES
Internal, external, or line.

REQUIREMENTS
Internal Triggering—0.4 divisions of display, DC to 2 MHz.
External Triggering—0.5 V at DC increasing to 2 V at 2 MHz.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈12 lb	≈5.4 kg

Order TYPE 2B67 TIME BASE $300

- ***500 ns/DIV TO 1 s/DIV CALIBRATED TIME BASE***
- ***CALIBRATED DELAYED SWEEP***
- ***TRIGGERING TO 10 MHz***
- ***SINGLE SWEEP OPERATION***

The Type 3B3 Time-Base Unit is used to generate normal and delayed sweeps. Flexible triggering facilities are similar for both the normal sweep and delayed sweep. Calibrated sweep delay enables accurate delay intervals to be set and measured. The unit can be used with the Type 561B or Type 564B Oscilloscopes. It can also be used with the Type 568 Oscilloscope when digital readout is not required.

DISPLAY MODES

NORMAL SWEEP

The normal sweep generator operates as the display time base in (1) the NORMAL position, (2) the INTENSIFIED position—where the delayed-sweep generator intensifies a portion of the normal sweep trace, indicating the time during which the delayed sweep operates—and (3) the TRIGGERED, INTENSIFIED position—where the delayed sweep is armed at the end of the delay time and starts by the delayed sweep trigger . . . intensifying a segment of the normal sweep trace as above.

DELAYED SWEEP

The delayed-sweep generator operates as the display time base in (1) the DELAYED SWEEP position—displaying the portion of the trace which was intensified in the INTENSIFIED position . . . with time-jitter less than 1 part in 20,000 of the maximum available delay interval—and (2) the jitter-free TRIGGERED, DELAYED SWEEP position—displaying the portion of the trace which was intensified in the TRIGGERED, INTENSIFIED position.

Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER.

CHARACTERISTICS

TIME BASE

(Both normal and delayed sweeps.) 0.5 μs/div to 1 s/div in 20 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 2.5 s/div. The Variable control operates with the normal sweep in the normal display mode, and with delayed sweep in all other display modes. Coupled time/div controls may be unlocked for independent setting of delayed sweep time.

5X MAGNIFIER

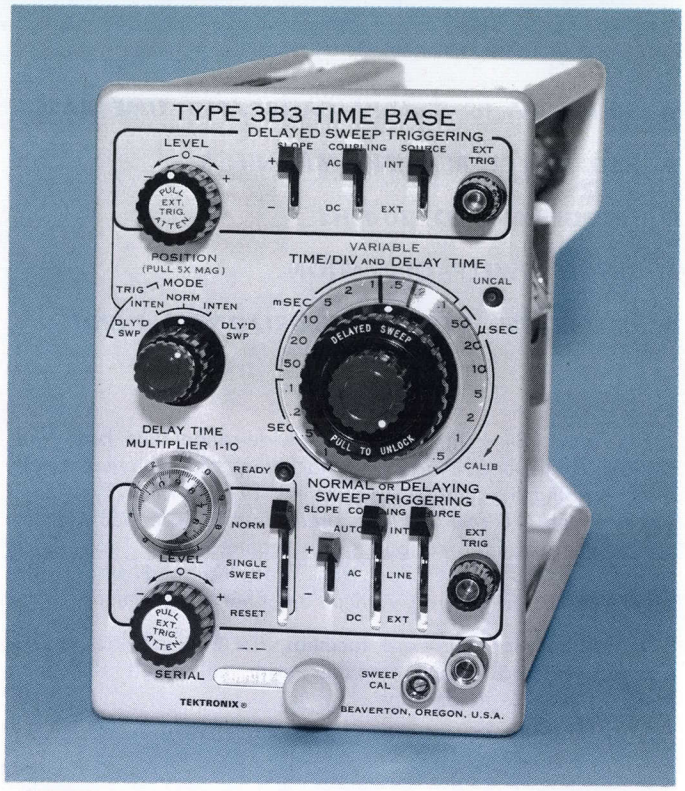
Expands the fastest sweep rate to 0.1 μs/div. Magnified sweep accurate within 5%.

DELAY TIME (OR TIME/DIV)

0.5 μs to 1s, 20 calibrated steps, 1-2-5 sequence; accurate within 1% of indicated delay from 0.5 μs to 0.2 s.

DELAY TIME MULTIPLIER

Continuously calibrated time interval from 0.50 to 10.00 times the Delay Time (dial divided into 1000 parts); accurate within 0.2% of maximum delay (DELAY TIME X10.00).



DELAY RANGE

2.5 μs to 2 s after delaying sweep start with 1% accuracy; to 10 s total. Inherent delay to start of delayed sweep 500 ns or less.

DIFFERENTIAL TIME

Measurement accuracy within 1% and 3 minor divisions.

SINGLE SWEEP

Facilitates photographic recordings of waveforms.

TRIGGER MODES

Normal-Sweep Trigger—manual or automatic.
Delayed-Sweep Trigger—manual only.
Coupling—AC or DC.

SOURCES

Internal or External. Line triggering in normal or delaying sweep operation only.
External trigger facility has two ranges: 0.5 to 15 V and 5 to 150 V, plus or minus polarity.

REQUIREMENTS

Internal Triggering—0.4 major graticule divisions from DC to 5 MHz, increasing to 1 major division at 10 MHz.
External Triggering—0.5 V from DC to 5 MHz, increasing to 1.25 V at 10 MHz. Requirements increase below 6 Hz with AC-coupling.

WEIGHTS

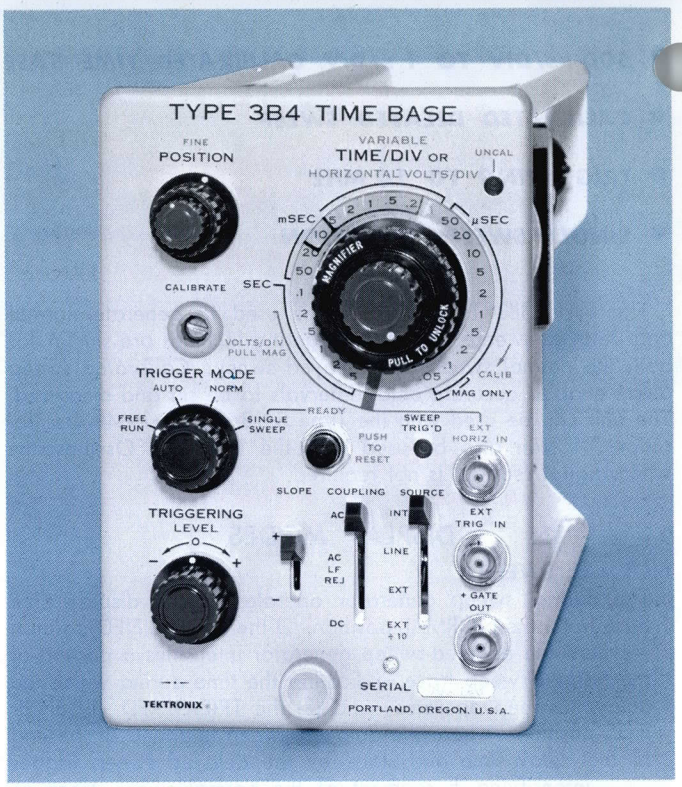
Net weight	6 lb	2.7 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈14 lb	≈6.3 kg

Order TYPE 3B3 TIME-BASE $680

- ***50 ns/DIV to 5 s/DIV CALIBRATED TIME BASE***
- ***X50 DIRECT READING MAGNIFIER***
- ***TRIGGERING TO 20 MHz***
- ***SINGLE SWEEP OPERATION***
- ***CALIBRATED EXTERNAL HORIZONTAL INPUT***

The Type 3B4 Plug-In Unit is a wide-range time base with flexible, high-speed triggering facilities, and a wide-range, direct-reading magnifier for use in the Type 561B or Type 564B Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required. The Type 3B4 is recommended for operation with Type 3A6 and other wide-band (2 MHz or greater) vertical amplifier plug-in units.

In addition to time base facilities, the 3B4 provides a DC-coupled external input amplifier with calibrated deflection factors from 0.2 to 5 V/div.



TIME BASE

0.2 µs/div to 5 s/div in 23 calibrated steps, 1-2-5 sequence; accuracy within 3% from 0.2 µs/div to 2 s/div, within 5% at 5 s/div. Uncalibrated, continuously variable between steps and to 12.5 s/div.

DIRECT READING MAGNIFIER

Provides sweep expansion up to X50 and extends the fastest sweep rate to 50 ns/div. The MAGNIFIER control is concentric with the TIME/DIV control, providing a direct indication of both the sweep rate being magnified and the magnified time/div rate. Up to 5 magnification steps are provided, to X40, or X50, depending on the TIME/DIV control setting before magnification. Magnified sweep rates are confined to the time/div steps on the panel, so there are no "forbidden" (uncalibrated) combinations. Magnified sweep accurate within 5%.

The MAGNIFIER control is also used to set the external input deflection factor when the TIME/DIV control is in the "Ext Input" position.

EXTERNAL HORIZONTAL INPUT

0.2 V/div to 5 V/div in 5 calibrated steps (max input ±20 V); accuracy, when plug-in unit is matched to oscilloscope, is within 3%. The External Input Amplifier is DC-coupled.

SINGLE SWEEP

Facilitates waveform photography and operation in the Type 561B or 564B Oscilloscope.

TRIGGER

MODES

Manual, free-run, automatic (with bright base-line in the absence of a trigger).

COUPLING

AC, AC LF-Reject, DC.

SOURCES

Internal, Line, External, External ÷ 10. A front-panel light indicates when the sweep is receiving a triggering signal—especially convenient when using an external trigger.

REQUIREMENTS

Internal Triggering—1 minor graticule division from DC to 20 MHz, with additional deflection required above 20 MHz. External Triggering—0.5 V to 15 V (EXT) or 5 V to 150 V (EXT ÷ 10) from DC to 20 MHz, with additional signal required above 20 MHz. Requirements increase below 30 Hz with AC-coupling.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 8 lb	≈3.6 kg
Export-packed weight	≈14 lb	≈6.3 kg

Order TYPE 3B4 TIME BASE $495

- ***REDUCES MAINTENANCE COSTS***
- ***DETECTS ENGINE MALFUNCTIONS***
- ***MEASURES AND DISPLAYS***
  - ***PRESSURE VS VOLUME***
  - ***PRESSURE VS CRANK ANGLE***
  - ***PRESSURE VS TIME***
  - ***ENGINE VIBRATION***
  - ***ENGINE IGNITION***

The TEKTRONIX Engine Analyzer is designed to locate and identify engine malfunctions by displaying engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer detects and locates malfunctions such as faulty ignition, timing, faulty valves, blowby, and broken or frozen piston rings. Damaged bearings, low compression pressures and other failures that impair the performance of the engine are also indicated on the oscilloscope. With the use of the Rotational Function Generator and pressure transducer, the engine horsepower can be calculated.

The TEKTRONIX Engine Analyzer consists of a Type 561B Oscilloscope or Type 564B Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crank-shaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Polaroid Trace-Recording Camera, SCOPE-MOBILE® Cart and a tripod for easy mounting of the Rotational Function Generator.

VIBRATION MEASUREMENTS

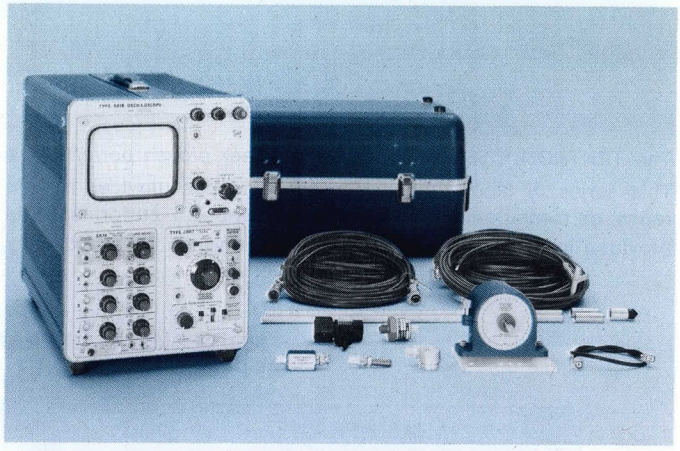
Vibration measurements are useful in detecting leaking valves, destructive detonation, excessive cylinder wear, blowby, worn bearings, broken compression rings, valve flutter and many other signs of wear and malfunction. The vibration pickup is a piezoelectric crystal mounted in a magnetic head that can be placed anywhere on the engine or compressor.

IGNITION MEASUREMENTS

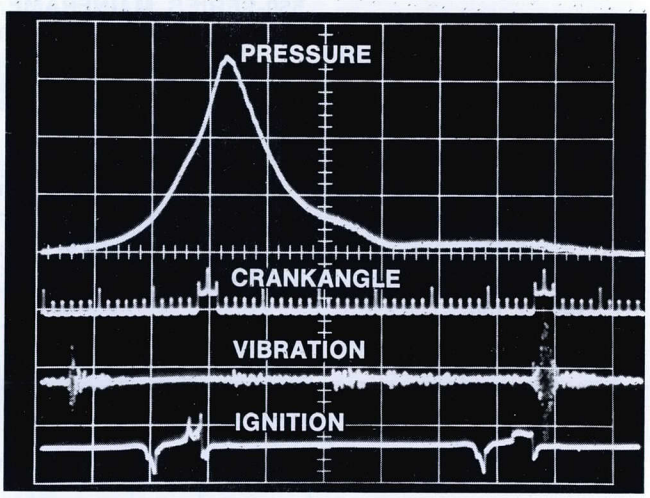
Ignition measurements are used for proper timing of the engine and can detect bad spark plugs, pulse generator problems, point problems, bad condensers, and coil condition. Ignition measurements can also be used to calculate RPM. Ignition measurements are made using a 1000:1 capacitive attenuator that clamps on the secondary coil and spark-plug wire.

PRESSURE MEASUREMENTS

Pressure measurements detect peak firing pressures, compression, early and late cylinder firing, and pre-ignition of the engine under test. Three displays of cylinder pressure are easily and quickly obtained: pressure vs crank angle, pressure vs cylinder volume and pressure vs time.



FOUR SIMULTANEOUS DISPLAYS



Simultaneous displays of four engine parameters provide the operator with one comprehensive picture of the total engine performance and make identification of malfunctions easy.

SELECT THE ANALYZER TO MEET YOUR NEEDS

Example 1 — Based on the 561B Oscilloscope, with special time base and amplifier. Prices start at $2095.

Example 2 — All the features of example 1, but with the added capability of the 564B Storage Oscilloscope, special time base and amplifier. Prices start at $2595.

A complete accessory package including a rotational function generator, transducers, adapters, and cable is available. Price is $1000.

The Engine Analyzer system is specifically designed to locate and identify engine malfunctions. However, many other TEKTRONIX instruments are ideally suited for mechanical measurement applications. For complete details and specifications on TEKTRONIX mechanical measurement instrumentation, as well as application notes and other supporting literature, contact a Tektronix Field Office or use the reply card at the front of the catalog.

The TEKTRONIX 550-Series offers the user *proven performance*. This series of laboratory plug-in oscilloscopes provides a wide range of measurement capabilities. Dual-beam performance is provided in the 556. With its many operating modes and display features it is one of today's most versatile oscilloscopes.

The plug-ins that are available for this series are briefly described in the plug-in chart below. More details are given on their respective page.

550-SERIES MAINFRAME PERFORMANCE CHART
APPLIES TO CABINET AND RACKMOUNT MODELS

MAINFRAME	PAGE	BANDWIDTH
556 Dual Beam/Delayed Sweep	**133**	DC to 50 MHz

550-SERIES MAINFRAME/PLUG-IN PERFORMANCE CHARTS

Bandwidth is in MHz unless noted otherwise. Risetime is in ns unless noted otherwise.

MULTI-TRACE

PLUG-IN	PAGE	NUMBER OF TRACES	MINIMUM DEFLECTION FACTOR	DC to 50 MHz MAINFRAME 556	
				BW	T_R
1A1	**135**	TWO	50 mV/cm 5 mV/cm ≃500 μV/cm	DC to 50 DC to 28 2 Hz to 15	7 13 24
1A4	**136**	FOUR	10 mV/cm	DC to 50	7

DIFFERENTIAL AND COMPARATOR

PLUG-IN	PAGE	MINIMUM DEFLECTION FACTOR	MAXIMUM CMRR	DC to 50 MHz MAINFRAME 556	
				BW	T_R
1A5	**137**	5 mV/cm 2 mV/cm 1 mV/cm	20,000:1	DC - 50 DC - 45 DC - 40	7 8 9
1A7A	**139**	10 μV/cm	100,000:1	DC - 1	350

SPECTRUM ANALYZERS

PLUG-IN	PAGE	MAXIMUM SENS	CENTER FREQUENCY RANGE	CAL. DISPERSION PER CM	RESOLUTION
1L5	**176**	10 μV/cm	50 Hz-990 kHz	10 Hz - 100 kHz	10 Hz - 500 Hz
1L20	**178**	—100 dBm	10 MHz-4.2 GHz	1 kHz - 10 MHz	1 kHz - 100 kHz

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. The following describes some of the accessories commonly used with these instruments. The accessory section of the catalog contains a complete description of all accessories.

CAMERAS

C-12 has beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back accepts 3000-speed film. Projected graticule eliminates parallax in oscilloscopes having external graticules.

C-27 provides direct viewing and maximum transmission of light to film, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back accepts 3000-speed film.

Bezels for adapting Cameras to Oscilloscopes are listed in the Camera accessory section.

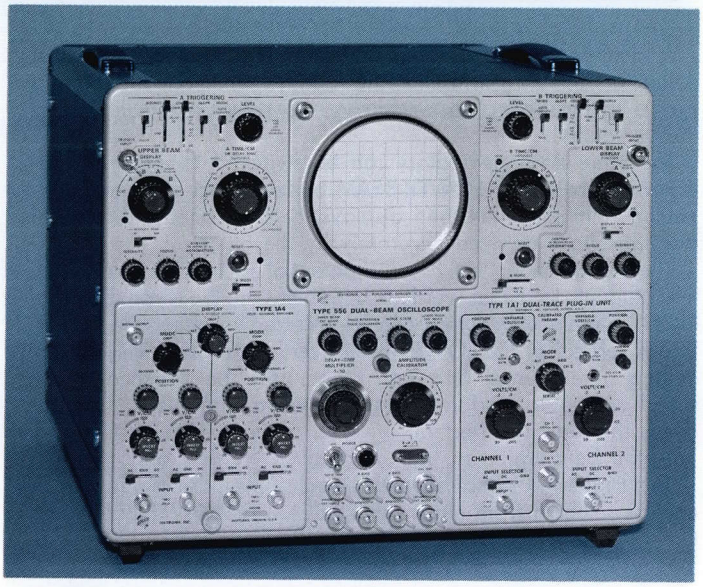
PROBES

The standard 10X probes supplied with the instrument satisfy most measurement requirements; however, optional probes (recommended on plug-in unit pages) may be better suited for particular applications.

SCOPE-MOBILE® CART

Model 205: storage drawer, 9 position tilt-lock oscilloscope tray.

- ***TWO VERTICAL AND HORIZONTAL SYSTEMS***
- ***OVER 50 DISPLAY MODES INCLUDING DUAL-BEAM DISPLAY WITH ONE INPUT***
- ***CALIBRATED DELAYED SWEEP***
- ***EMI SUPPRESSION***
- ***6 x 10-cm DISPLAY PER BEAM***
- ***ILLUMINATED PARALLAX-FREE GRATICULE***
- ***FULL-BANDWIDTH TRIGGERING***



The Type 556 and R556 are dual-beam laboratory instruments for accurate measurement in the DC to 50 MHz range. Features include independent vertical and horizontal deflection systems, trigger selectability for cross triggering, and uniform-focus CRT with 6 x 10-cm scan per beam.

Unique display capability allows simultaneous display of one signal at two different sweep times, using only one probe for minimum circuit loading.

VERTICAL DEFLECTION

2 identical systems

BANDWIDTH
DC to ≥50 MHz at 3-dB down, depending on plug-in unit.

RISETIME
≤7 ns, depending on plug-in unit.

DELAY LINE
Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B
0.1 μs/cm to 5 s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5 s/cm. Warning light indicates uncalibrated setting.

X10 MAGNIFIER
Operates over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μs to 5 s delay time in a 1, 2, 5 sequence. Accurate within 1%. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.20 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts. Accuracy within 0.2% of full scale from 1 μs to 5 s and within 0.5% of full scale from 0.1 μs to 0.5 μs. Inherent delay to start of delayed sweep 150 ns or less.

DELAY RANGE
0.1 μs to 50 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY
Within 1% and ±2 minor divisions from 1 μs to 5 s and within 1% and ±5 minor divisions from 0.1 μs to 0.5 μs. Jitter ≤1 part in 20,000 of 10 times DELAY TIME.

DELAY MODES
Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

OPERATING MODES
Time Base A—Normal and Single Sweep.
Time Base B—Normal, B delayed by A, and Single Sweep.

EXTERNAL INPUT
≤0.1 V/cm with X10 Display Mag, ≤1 V/cm with X1 Display Mag, continuously variable from ≤0.1 V/cm to approx 10 V/cm. DC to ≥400 kHz at 3-dB down. 50 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by ≈65 pF.

SIGNAL OUTPUTS
Gates from both time bases (≥ +9 V), sawtooths from both time bases (≥9 V/cm), delayed trigger pulse (≥7 V).

TRIGGER

(2 identical systems)

MODES
Triggered and Auto Stability. Latter mode free runs sweep in absence of triggering signal, triggers on signals ≥30 Hz.

COUPLING
AC, DC, AC LF reject, AC HF reject.

SOURCES
Internal from left or right vertical amplifier, left or right plug-in, external, or line. External trigger input RC approx 1 megohm paralleled by approx 35 pF. 50-V maximum external input (DC + peak AC). External trigger signals that have an amplitude greater than 2 V and a rate of rise exceeding 1/3 V/ns may cause erratic triggering. Internal source selectable from the oscilloscope vertical amplifier, or direct from a single channel of Type 1A1, 1A2, and 1A4 Plug-In Units. The latter mode displays the true time relationship between signals when plug-ins are in chopped or alternate operation.

REQUIREMENTS

AC INTERNAL—0.2-cm, 60 Hz to 10 MHz; 1 cm to 50 MHz.

AC EXTERNAL—0.2 V, 60 Hz to 10 MHz; 0.4 V at 50 MHz.

AC LF REJECT—INT or EXT requirement increases below 2.5 kHz.

AC HF REJECT—INT or EXT requirement increases above 60 kHz (≥2-cm deflection or ≥2 V at 2 MHz).

DC INTERNAL—0.35-cm, DC-to-10 MHz; 2 cm at 50 MHz.

DC EXTERNAL—0.2 V, DC-to-10 MHz; 0.4 V at 50 MHz.

DISPLAY LOGIC

A dual-beam oscilloscope, with two horizontal and vertical deflection systems, presents the ability to select the driving source to the deflection systems . . . thereby greatly increasing the versatility.

The Time Base generators can be switched to either UPPER-BEAM horizontal or LOWER-BEAM horizontal to give independent or identical time-based displays, or simultaneous display of one time base delayed accurately by the other.

The signal under test has the potential to be channeled from the plug-ins to either vertical amplifier. In the Type 556, the RIGHT plug-in unit output can be directed to either the UPPER-BEAM vertical or the LOWER-BEAM vertical or both. This means, among other things, only one probe need be attached to the signal source to perform delaying sweep operations. This reduces the loading effect on sensitive circuitry. The LEFT plug-in unit can be coupled to the UPPER-BEAM vertical only.

The triggering signal source to each Time Base trigger circuit can be selected from either UPPER-BEAM or LOWER-BEAM vertical (NORM), RIGHT or LEFT plug-in unit (necessary only in 1-series multi-trace plug-ins), or EXTERNAL.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 8 x 10-cm display area; ≥6 x 10 cm per beam with 4-cm overlap. Spot size, focus uniformity and geometry equivalent to our finest single-beam tubes. Aluminized construction, helical post acceleration. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires 10 V peak to peak for CRT modulation at normal intensity.

INTERNAL GRATICULE

Variable edge lighting. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, upper and lower beam intensity contrast controls between A sweep and nonintensified-B-zone of A sweep, trace rotation (screwdriver adjustment), and trace separation. BEAM FINDER button functions in both X-Y systems, indicates direction of off-screen signals.

OTHER CHARACTERISTICS

ELECTROMAGNETIC INTERFERENCE

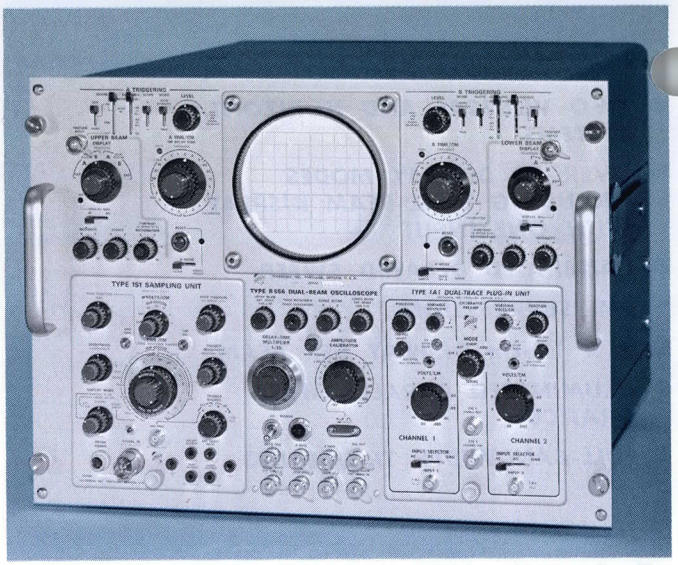
Oscilloscopes meet interference specifications of MIL-I-6181 D over the following frequency ranges: Radiated (with CRT mesh filter and BNC connector covers installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), accuracy within ±2%. 50-Ω source resistance from 0.2 mV to 0.2 V. ≤1.5-μs risetime; 1-kHz ±25% repetition rate; 45% to 55% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA ±2%, squarewave or DC.

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz source with less than 2% harmonic distortion; approx 840 W maximum, approx 1 kVA maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.



RACKMOUNTING

Type R556 mounts on tilting slide-out tracks to standard 19-inch rack. Further mounting information on catalog instrument dimension page.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	15 3/16 in	38.6 cm
Width	16 15/16 in	43.0 cm
Depth	24 in	61.0 cm
Net weight	83 lb	37.7 kg
Domestic shipping weight	≈135 lb	≈61.5 kg
Export-packed weight	≈148 lb	≈67.3 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	22 13/16 in	57.9 cm
Net weight	87 3/4 lb	39.9 kg
Domestic shipping weight	≈151 lb	≈68.6 kg
Export-packed weight	≈162 lb	≈73.6 kg

INCLUDED ACCESSORIES

Four P6008 10X probe package (010-0129-00); eighteen BNC covers, ten installed (016-0088-00); 3-conductor power cable (161-0030-01); smoke-gray light filter (378-0567-00); clear CRT protector plate (387-0918-00); graticule cover (200-0382-00); CRT mesh filter, installed (378-0572-00). Type R556 also includes slideout assembly (351-0086-00) and mounting hardware.

ORDERING INFORMATION

556 OSCILLOSCOPE, without plug-ins **$4100**
R556 OSCILLOSCOPE, without plug-ins **$4200**

INSTRUMENT OPTIONS

Option 72, P2 PHOSPHOR . . . . . **No Charge**
Option 76, P7 PHOSPHOR . . . . . **No Charge**
Option 78, P11 PHOSPHOR . . . . . **No Charge**

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. See page 132 for some of the accessories commonly used with this instrument.

- ***5 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***≈500-μV/cm SINGLE CHANNEL***
- ***CHANNEL 1 SIGNAL & TRIGGER OUTPUTS***
- ***1-MHz CHOPPING RATE***
- ***FET INPUTS***

Type 1A1 provides dual-trace displays in Type 530, 540, 550 and 580* Series Oscilloscopes. Maximum bandwidth is achieved in Type 544, 546, 547, 556, and 585A Oscilloscopes. Input channels are identical with separate controls for coupling, attenuating, inverting and positioning the signal.

Used with the Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscilloscope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

Solid state components are used throughout except for the output stage.

TYPE 1A1 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
535A	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 15 MHz DC to 14 MHz 2 Hz to 10 MHz	24 ns 25 ns 35 ns
545B	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 33 MHz DC to 23 MHz 2 Hz to 14 MHz	11 ns 16 ns 25 ns
544, 546, 547, 556, 585A*	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 50 MHz DC to 28 MHz 2 Hz to 15 MHz	7 ns 13 ns 24 ns
549	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 30 MHz DC to 23 MHz 2 Hz to 14 MHz	12 ns 16 ns 25 ns
551	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 27 MHz DC to 21 MHz 2 Hz to 13 MHz	13 ns 17 ns 27 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR
5 mV/cm to 20 V/cm in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE
600 V combined DC + peak AC.

OPERATING MODES
Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 500-ns segments of each channel displayed at an approx 1-MHz rate per channel. Chopped transient blanking except in Type 551 and 585A Oscilloscopes.

SIGNAL OUTPUT
Channel 1 Output provides up to X10 gain, can be AC coupled into Channel 2 for approx 500-μV/cm deflection factor. Noise or frequency filters can be inserted between channels if desired. Output impedance is approx 50 Ω. Maximum bandwidth of output alone is DC to 35 MHz; see chart for bandwidths at 500 μV/cm.

TRIGGER OUTPUT
Channel 1 output for external triggering permits viewing true time relationship between signals in alternate or chopped operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. Approx 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	6 lb	2.6 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈14 lb	≈6.4 kg

INCLUDED ACCESSORIES
BNC-to-BNC 50-Ω cable (012-0076-00).

Order TYPE 1A1 PLUG-IN UNIT **$725**

OPTIONAL ACCESSORIES

See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package. Order 010-0129-00 ..... $60
P6009 100X Probe Package. Order 010-0170-00 ..... $72
P6028 1X Probe Package. Order 010-0074-00 ..... $22

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

- ***10 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS***
- ***FOUR-CHANNEL ADDING (±1±2) + (±3±4)***
- ***SIGNAL OUTPUT***
- ***FET INPUTS***

This plug-in unit for Type 530, 540, 550, and (with adapter) 580*-Series Oscilloscopes through versatile switching logic provides the equivalent of two wide-band, dual-trace units connected to a third wide-band, dual-trace unit. Maximum bandwidth of DC to 50 MHz is achieved with Type 544, 546, 547 and 556 Oscilloscopes. The Type 1A4 provides a new standard of multi-channel versatility in all TEKTRONIX Oscilloscopes that accept Letter-Series or 1-Series Plug-In Units.

CHARACTERISTICS

TYPE 1A4 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
544, 546, 547, 556, 585A	DC to 50 MHz	7 ns
545B	DC to 33 MHz	11 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns
535A	DC to 15 MHz	24 ns

*A Type 81A Adapter is required.
†Low-frequency 3-dB point, AC coupled: ≤2 Hz, ≤0.2 Hz with 10X probe.

DEFLECTION FACTOR
10 mV/cm to 20 V/cm in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC
1 megohm (±1%) paralleled by approx 20 pF.

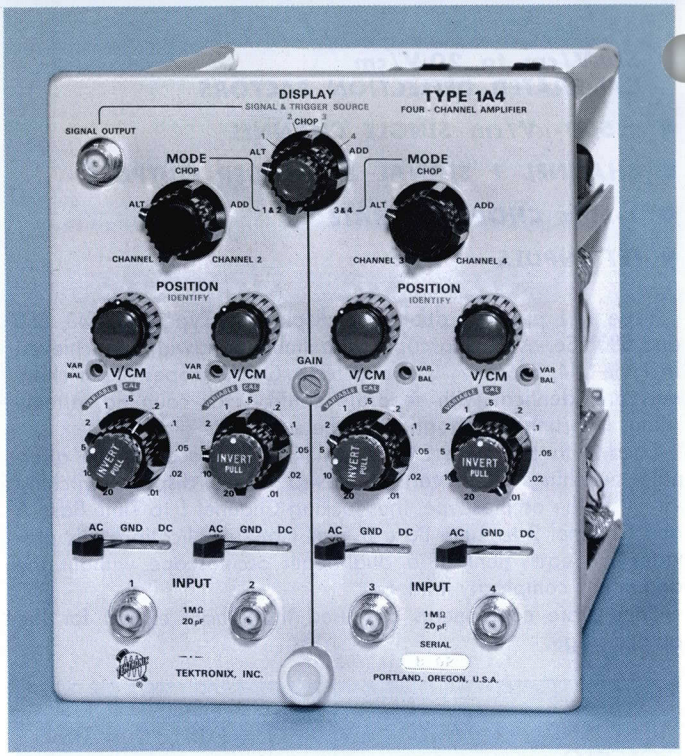
MAXIMUM INPUT VOLTAGE
600 V DC + peak AC.

COMMON-MODE REJECTION
At least 20:1, DC to 10 MHz common-mode signals up to 10 cm in amplitude.

CHANNEL ISOLATION
At least 50:1 for signals from DC to 20 MHz.

DISPLAY MODES
Any single-channel; any two channels (alternated, chopped, or added); three channels (alternated, chopped, or added in any combination); and four channels (Channels 1 and 2 alternated, chopped, or added with Channels 3 and 4). Four channel addition is useful in single-shot displays of four different signals, as in delay and coincidence studies.
Channels are always displayed in numerical sequence in chopped and alternate modes. One channel will run twice when only three are turned on. In chopped operation, successive 2.5-μs (approx) segments of each channel are displayed. Chopping rate is approx 400 kHz. Chopped transient blanking with all oscilloscopes except Type 551, and 585A.

SIGNAL OUTPUT AND TRIGGER SOURCE
Signal from any channel can be used to externally trigger the oscilloscope, thus indicating the true time relationship between signals displayed in alternate and chopped mode. Selected output also applied internally to Type 544, 546, 547, 549 and 556 Oscilloscopes. The front-panel output can also be cascaded with another channel, providing additional gain useful in many applications. Signal output amplitude is >0.5 V/cm of display signal, unterminated at 1 kHz. Bandwidth is ≤20 Hz to ≥10 MHz (to approx 500 kHz with any channel operated in chopped mode). Approx 50-Ω output impedance.



WEIGHTS

Net weight	6½ lb	3.1 kg
Domestic shipping weight	≈10 lb	≈4.5 kg
Export-packed weight	≈16 lb	≈7.3 kg

INCLUDED ACCESSORIES
BNC-to-BNC 18-inch cable (012-0076-00).

Order TYPE 1A4 PLUG-IN UNIT $1150

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package. Order 010-0129-00 . . . . . $60

P6009 100X Probe Package. Order 010-0170-00 . . . . . $72

P6028 1X Probe Package. Order 010-0074-00 . . . . . $22

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 MΩ and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

- ***1 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTOR***
- ***20,000:1 CMRR***
- ***±5-V COMPARISON VOLTAGE***
- ***FET INPUTS***

This wide-band differential unit for Type 530, 540, 550, and 580*-Series Oscilloscopes achieves a new high in common-mode rejection. Solid state design, with FET inputs provides low drift and eliminates microphonics.

CHARACTERISTICS

TYPE 1A5 UNIT AND OSCILLOSCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE-TIME
544, 546, 547, 556, 585A*	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 50 MHz DC to 45 MHz DC to 40 MHz	7 ns 8 ns 9 ns
545B	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 33 MHz DC to 31 MHz DC to 30 MHz	11 ns 12 ns 12 ns
549	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 30 MHz DC to 29 MHz DC to 28 MHz	12 ns 13 ns 13 ns
551	5 mV/cm to 20 V/cm 2 mV/cm 1 mV/cm	DC to 27 MHz DC to 26 MHz DC to 25 MHz	13 ns 14 ns 14 ns
535A	5 mV/cm to 20 V/cm 2 and 1 mV/cm	DC to 15 MHz DC to 14 MHz	24 ns 25 ns

†Low-frequency 3-dB point, AC coupled: ≤10 Hz.

*A Type 81A Adapter is required.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 2.5% (within 2% from 1 mV/cm to 20 mV/cm). Uncalibrated, continuously variable between steps and to ≥ 50 V/cm.

INPUT RC

1 megohm paralleled by approx 20 pF.

INPUT COUPLING

May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.

MAXIMUM INPUT VOLTAGE

±400 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ±500 V (DC + peak AC) from 10 mV/cm to 20 V/cm.

COMMON-MODE DYNAMIC RANGE

≥±5 V (DC + peak AC) from 1 mV/cm to 20 mV/cm, ≥±50 V from 50 mV/cm to 0.2 V/cm, ≥±500 V from 0.5 V/cm to 20 V/cm. The ±50 V range can be extended from 50 mV/cm to 10 mV/cm, and the ±500 V range can be extended from 0.5 V/cm to 0.1 V/cm by pulling and turning the VOLTS/CM control.

COMMON-MODE REJECTION RATIOS*

FREQUENCY	REJECTION RATIO	SINEWAVE AMPLITUDE	DEFLECTION FACTOR
DC to 100 kHz	≥20,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
100 kHz to 1 MHz	≥10,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
1 MHz to 10 MHz	≥10,000:1 divided by freq. in MHz	±5 V P to P divided by freq. in MHz	1 mV/cm to 20 mV/cm
DC to 10 kHz	≥2,000:1	±50 V P to P	10 mV/cm to 2 V/cm
DC to 10 kHz	≥100:1	±50 V P to P	5 V/cm to 20 V/cm
60 Hz (AC coupled)	≥1,000:1	±5 V P to P	1 mV/cm to 20 mV/cm

*At 0°C to 50°C

More →

1A5 *Differential Comparator Amplifier*

DC STABILITY
Drift with time: ≤200 μV/h at 25°C. With temperature: ≤200 μV/°C. With line voltage change: ≤300 μV from 105 to 125 VAC.

NOISE
≤50 μV RMS.

DC SHIFT DUE TO OVERDRIVE
Within 1% of ± overdrive signal, but not exceeding 10 mV in the 5 V input signal range, 0.1 V in the 50 V input signal range, or 1.0 V in the 500 V input signal range.

OVERDRIVE RECOVERY
Recovers to within 10 mV of DC-shifted level after 0.15 μs in the 5 V input signal range.

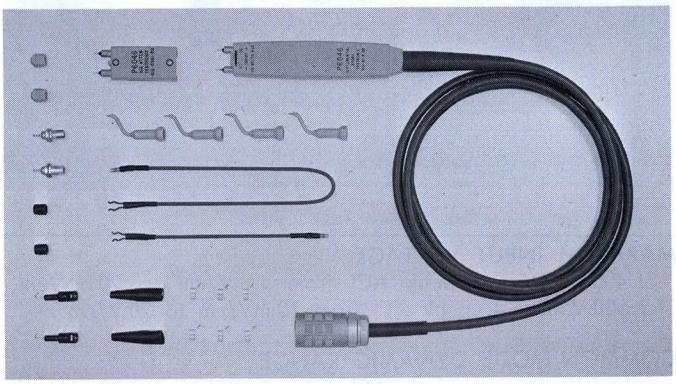
COMPARISON VOLTAGE
0 to ±5 V, internally applied to + input or — input, monitorable at front panel. Accuracy within 7 mV or 0.5% of comparison voltage, whichever is greater.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	≈ 7 lb	≈3.2 kg
Export-packed weight	≈13 lb	≈5.9 kg

Order TYPE 1A5 PLUG-IN UNIT $750

P6046 *Differential Probe*



The P6046 expands the differential measurement capabilities of the Type 1A5 Plug-In Unit. With this probe, the differential-signal-adding takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. This differential probe-tip performance minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 assures DC-to-45 MHz performance at the probe tip where the measurements are made.

CHARACTERISTICS

Probe with Type 1A5 Plug-In Unit

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, ±1%.

INPUT CAPACITANCE is approx 10 pF.

COMMON-MODE LINEAR DYNAMIC RANGE is ±5 V (DC + peak AC), ±50 V with 10X attenuator.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/cm to 20 mV/cm are 10,000:1 at DC, 1,000:1 at 45 MHz. Min AC-coupled CMRR from 1 mV/cm to 20 mV/cm is 1000:1 at 20 MHz decreasing to 500:1 from 40 MHz to 45 MHz.

BANDWIDTH/RISETIME

TYPE 1A5 DEFLECTION FACTOR	BANDWIDTH*	RISETIME*
200 mV/cm to 5 mV/cm	DC to 45 MHz	7.8 ns
2 mV/cm	DC to 43 MHz	8.1 ns
1 mV/cm	DC to 38 MHz	9.2 ns

*With Oscilloscope Types 544, 546, 547, 556, or 585A with Type 81A Adapter.

MAXIMUM INPUT VOLTAGE is ±25 V (DC + peak AC), ±250 V with 10X attenuator.

NOISE (periodic and random deviation) is 200 μV or less.

THERMAL DRIFT at the probe head is 250 μV/°C or less.

PROBE CABLE is 6 feet long, terminated with a special nine-pin connector.

P6046 PROBE PACKAGE. Order 010-0213-00 . . . . $470

- ***DC-to-1 MHz BANDWIDTH***
- ***10 μV/cm to 10 V/cm CALIBRATED DEFLECTION FACTORS***
- ***SELECTABLE UPPER AND LOWER —3-dB POINTS***
- ***100,000:1 CMRR***
- ***DC OFFSET***
- ***FET INPUTS***
- ***10-μV/HOUR DC DRIFT****

Designed for use with any TEKTRONIX 530, 540, 550, or (with Type 81A Adapter) 580-Series Oscilloscopes. Used with Type 132 Power Supply, the Type 1A7A can drive recording equipment, X-Y plotters, oscilloscopes or other indicators.

DEFLECTION FACTOR

10 μV/cm to 10 V/cm in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuous variation between steps and to approx 25 V/cm.

INPUT RC

1 megohm, paralleled by 47 pF.

MAXIMUM INPUT CURRENT

DEFLECTION FACTOR	INPUT	at 25°C	at 50°C
10 μV/cm to 10 mV/cm	each input	±20 pA	±100 pA
	both inputs	±40 pA	±200 pA
20 mV/cm to 10 V/cm	each input	±10 pA	±10 pA
Display shift at 10 μV/cm (AC coupled)	each input	±2 cm	±10 cm

MAXIMUM INPUT VOLTAGE

DC Coupled: 10 μV/cm to 10 mV/cm — ±20 V (DC + peak AC)
20 mV/cm to 10 V/cm — ±500 V (DC + peak AC)

AC Coupled Input DC Voltage:
10 μV/cm to 10 V/cm — ±500 V

OVERDRIVE RECOVERY

≤10 μs to recover within 0.5% of zero level after removal of a + or — voltage applied for 1 s, applied voltage within the differential dynamic range.

DISPLAYED NOISE

≤16 μV or 0.1 cm, whichever is greater, measured tangentially at full bandwidth (DC to 1 MHz), source resistance 25 Ω or less. See catalog glossary for definition of "tangential noise measurement".

DC STABILITY

Drift with time (ambient temperature and line voltage constant).

Short term: 5 μV/minute (P-P) after 1 hour warm up.
Long term: 10 μV/hour (P-P) after 1 hour warm up.

Drift with ambient temperature (line voltage constant): 50 μV/°C.

FRONT-PANEL SIGNAL OUTPUT

0.25 V per displayed cm, ±10%. Output is DC coupled, output impedance ≤750 Ω. Minimum load resistance, 10 kΩ.

*With constant temperature. See DC STABILITY specifications.

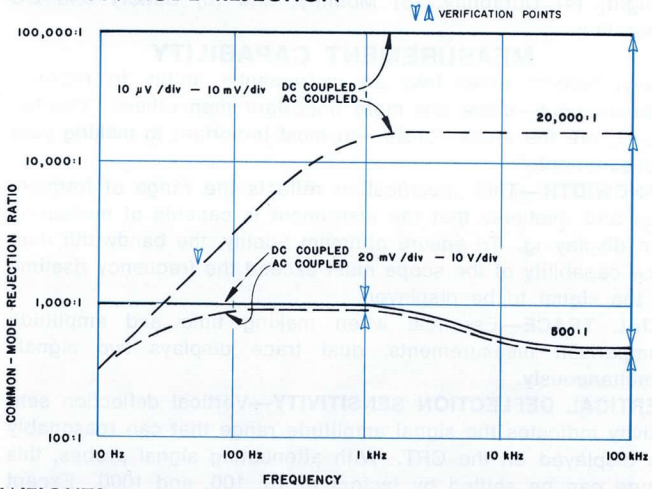
COMMON-MODE DYNAMIC RANGE

10 μV/cm to 10 mV/cm — ±10 V (DC + peak AC).
20 mV/cm to 0.1 V/cm — ±100 V (DC + peak AC).
0.2 V/cm to 10 V/cm — ±500 V (DC + peak AC).

DC OFFSET (within ±10%)

±400 mV from 10 μV/cm to 10 mV/cm; ±4 V from 20 mV/cm to 0.1 V/cm; ±40 V from 0.2 V/cm to 1 V/cm; ±400 V from 2 V/cm to 10 V/cm.

COMMON-MODE REJECTION



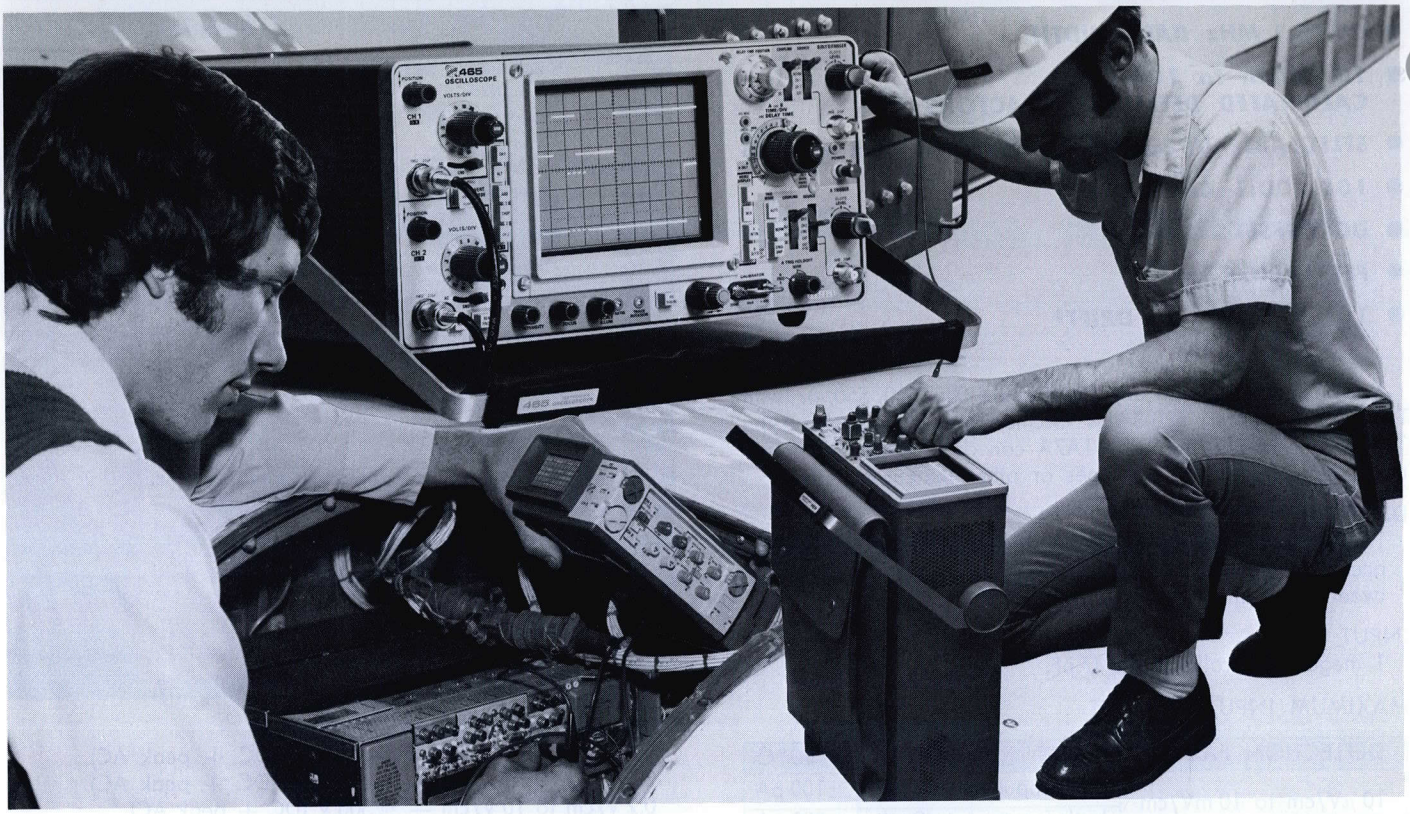
WEIGHTS

Net weight	4¾ lb	2.1 kg
Domestic shipping weight	≈ 9 lb	≈4.1 kg
Export-packed weight	≈13 lb	≈5.9 kg

Order TYPE 1A7A PLUG-IN UNIT $575

OPTIONAL ACCESSORIES

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection. Order 010-6055-01 $85.00



The purchase of a high-quality portable oscilloscope is an important investment. Thus, careful consideration must be given to your application or range of applications—present and future. The following are some areas to be considered when selecting a portable: (1) Measurement Capability; (2) Cost; (3) Size and Weight; (4) Durability; (5) Mobility; and (6) Battery and DC Operation.

MEASUREMENT CAPABILITY

Many aspects enter into an instrument's ability to make a measurement—some are more important than others. The following are the areas considered most important to making your measurement:

BANDWIDTH—This specification reflects the range of frequencies and risetimes that the instrument is capable of measuring and displaying. To ensure optimum fidelity, the bandwidth risetime capability of the scope must exceed the frequency risetime of the signal to be displayed.

DUAL TRACE—Essential when making time and amplitude comparison measurements, dual trace displays two signals simultaneously.

VERTICAL DEFLECTION SENSITIVITY—Vertical deflection sensitivity indicates the signal amplitude range that can reasonably be displayed on the CRT. With attenuating signal probes, this range can be shifted by factors of 10, 100, and 1000. Except for the 485, all current Tektronix portables have probes as an integral part of the scope or as a part of the included accessories package.

HORIZONTAL DEFLECTION SWEEP SPEEDS—This is an indication of the speeds at which the CRT beam is deflected. Instruments with very high bandwidth must be capable of moving the beam horizontally with sufficient velocity to permit detailed viewing of the signal.

CRT STORAGE—Storage retains a non-repetitive or slow-moving event in the CRT phosphor providing time for inspection. This capability, together with single sweep, allows you to arm the scope, then have it automatically wait for and capture a single event. The display is held until removed by the operator. This feature is especially useful in—but not limited to—such areas as industrial control, electro-optical and electro-mechanical. Tektronix has two portables with storage, the 434 and 214 (see specific instrument sections for details).

COST

Careful consideration must be given to the cost of an instrument. Foremost, it must be capable of making present and future measurements. Warranty and service-after-sale policies should ensure lasting performance. Tektronix instruments are warranted against defective materials and workmanship for one year. To assist you if service is required, Tektronix has 53 service centers located world-wide. Many years of satisfactory performance can be gained by conducting a thorough value analysis of the product prior to purchase.

SIZE & WEIGHT

The accessibility of the equipment to be repaired dictates size and weight requirements. Some applications require that the scope be used in and around heavy equipment; that it be carried on catwalks, cranes, trucks etc. Other situations require transport over great distances. The Tektronix 200 and 300 series have a convenient neck strap which frees both hands. The 200 series are small, light-weight and easily fit into a toolkit, briefcase or glove compartment. At 25 pounds, the 465, 475 and 485 offer unequalled performance for their size.

DURABILITY

Before an instrument can be considered portable, it must be designed and constructed to withstand the extremes associated with mobility—it must be rugged.

Vibration and shock tolerance are important parameters. Tektronix portables withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles while operating. They also withstand shock of 30 g's, half sine, 11 ms duration, (200 series is 150 g's, half sine, 2 ms)

two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Selectively, they are humidity tested using MIL-E-16400 F as a guide. The test consists of subjecting the instrument to relative humidities between 90 and 95% while varying the temperature over a 25°C to 60°C range. Five cycles of this rising and lowering temperature (each cycle covering 24 hours) are performed.

These instruments are tested to operate at an altitude up to 15,000 feet and they can be carried, non-operating to 50,000 feet.

Tektronix portables operate over a temperature range of —15°C to +55°C and can be stored for long periods from —55°C to +75°C. For those instruments with internal batteries, the storage temperatures are —40°C to +60°C.

Some portables (400 Series) are available which comply with the electromagnetic interference specifications described in MIL-I-6181D. This specification limits the radiated interference between 150 kHz to 1 GHz, and it limits the interference conducted through the power cord between 150 kHz to 25 MHz.

Consistent with quality, Tektronix portables are tested to meet all of these rigid physical and electrical requirements.

MOBILITY

Beyond size and weight, a portable oscilloscope should be equipped for convenient carrying and viewing. All Tektronix portables are designed to be carried comfortably in a position that places the front panel in the horizontal plane. This allows the unit to be placed on the floor with the CRT in a position for convenient viewing.

Many portables use their handles as tilt stands for bench-top use. These handles should have sufficient positions to permit convenient viewing and they should lock firmly into the desired position. The Tektronix 300 Series friction lock to the desired position. The 400 Series have 13 convenient self-locking positions; and in all cases, the handles swing out of the way when not in use. The 200 Series have a special flip stand to tilt the instruments upward.

BATTERY AND DC OPERATION

Whether battery operation is required depends upon the availability of commercial power, or whether operation while isolated from the line or ground is desired. All of Tektronix portables can be battery powered. Some have internal batteries while others are operated from the free-standing 1105 Battery Power Supply. The 1105 offers the convenience of providing battery capability only when required.

In some applications only DC power is available. The 465 and 475 Option 7 can be operated from 12 or 24 VDC in addition to operating from a detachable battery pack. All of the 300 series have internal batteries and can be powered from external DC sources ranging from 6 to 32 VDC (See specific instrument for details). The 432 and 434 operate from external DC sources ranging from 105 to 250 VDC. All of these scopes operate from conventional AC sources of 115 and 230 VAC, 50 and 60 Hz (most will operate to 440 Hz).

Discussion of many innovative features has been deferred to specific instrument sections. Some are: trigger view, alternate sweep switching, delayed and mixed sweep, deflection factor readout, automatic deflection factor readout adjustment with attenuating probes, automatic focus, adjustable trigger hold-off and more. A broad range of flexibility equips these scopes for any portable application.

The following chart is provided as a quick reference to finding the instrument which best fits your needs.

PRODUCT	PAGE	STORAGE	BW	DEFLECTION FACTOR	DUAL TRACE	DELAYED SWEEP	SWEEP RATE (WITH MAG)	MAG	BATTERY POWER	DISPLAY SIZE
211	155		500 kHz	10 mV/div @ BW 1 mV/div Min			1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
212	155		500 kHz	10 mV/div @ BW 1 mV/div Min	Yes		1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
214	155	Yes	500 kHz	10 mV/div @ BW 1 mV/div Min	Yes		1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
323	161		4 MHz	10 mV/div @ BW 1 mV/div Min			0.5 μs/div	X10	Yes Int.	6 x 10 div ¼ in/div
324	159		10 MHz	10 mV/div @ BW 2 mV/div Min			0.2 μs/div	X5	Yes Int.	6 x 10 div ¼ in/div
326	157		10 MHz	10 mV/div @ BW 1 mV/div Min	Yes		0.1 μs/div	X10	Yes Int.	8 x 10 div ¼ in/div
422/ R422	153		15 MHz	10 mV/div @ BW 1 mV/div Min	Yes		50 ns/div	X10	Yes Int.	8 x 10 div 0.8 cm/div
432/ R432	150		25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50	Yes w/1105	8 x 10 cm 1.0 cm/div
434/ R434	150	Yes	25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50	Yes w/1105	8 x 10 div 0.98 cm/div
465 R465	146		100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes w/1106	8 x 10 div 1 cm/div
475/ R475	146		200 MHz	2 mV/div @ BW 2 mV/div Min	Yes	Yes	1 ns/div	X10	Yes w/1106	8 x 10 div 1 cm/div
485/ R485	142		350 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	1 ns/div		Yes w/1105	8 x 10 div 0.8 cm/div
1105	163	Battery Power Supply								
1106	149	Battery Pack for 465 and 475								

485 *350-MHz Dual-Trace Oscilloscope*

- 350 MHz at 5 mV/DIV
- 1 ns/DIV SWEEP RATE
- 6.0 DIV/ns WRITING SPEED
- ALTERNATE SWITCHING BETWEEN INTENSIFIED and DELAYED SWEEPS
- 1-MΩ and 50-Ω INPUT IMPEDANCES
- 50-Ω INTERNAL INPUT PROTECTION
- AUTOMATIC DEFLECTION FACTOR READOUT
- AUTO FOCUS
- VARIABLE TRIGGER HOLDOFF
- PUSH BUTTON EXT TRIGGER VIEW
- 21 LB

The 485 is a 350 MHz, 1 ns/div portable dual-trace oscilloscope weighing 21 lbs, the lightest weight wide-band portable oscilloscope on the market today. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, adjustable trigger holdoff, EXT TRIG display, alternate delayed sweep, with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control. Single-function push buttons and automatic vertical scale-factor indication increase operator convenience.

The 485 vertical system provides wide bandwidth at full sensitivity with selectable input impedances. At 5 mV/div sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ), the 485 offers more gain bandwidth than any other oscilloscope available today. 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 5 V RMS .

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 volts/div even when the recommended 10X or 100X probes are used. The operator no longer has to mentally compensate for attenuating probes.

To complement the higher bandwidth, the 485 has a 1 ns/div sweep. A new alternate sweep mode expands the delayed sweep concept in portables. This feature allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, the operator sees the intensified zone and delayed display at the same time. He always knows exactly where in a pulse train he is making a delayed sweep measurement.

The external trigger signal may be easily viewed on the 485 without disconnecting leads and resetting controls. A front panel push button 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.

Full bandwidth triggering and "Variable Trigger Holdoff" provide stable presentation of repetitive complex waveforms.

An auto-focus circuit makes it unnecessary to readjust the focus each time the intensity is changed. The focus will always be correct in single shot photography. A beam current limit circuit protects the CRT phosphor from high intensity burns.

A new approach to battery operation is offered with the 1105 Battery Power Supply. The 485 can be powered for over 2 hours with this stand-alone power supply. Internal batteries add weight and are not required when commercial power is available. With the 1105, batteries are carried only when necessary.

VERTICAL DEFLECTION
(2 Identical Channels)

Selectable Input Impedance—50-Ω and 1-MΩ impedance are available at a single BNC connector by push button selection.

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 5 V/div to 350 MHz.

1 MΩ within 1% paralleled by approx 20 pF.

Bandwidth* and Risetime 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. Lower −3 dB point, AC coupled from 50 Ω source, is 1 kHz or less for 50 Ω and 10 Hz or less for 1 MΩ. 20 MHz bandwidth limit selection is provided.

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Probe Power—Two 4-pin connectors at the rear of the instrument provide power suitable for optional active probes.

Display Modes—Channel 1; Channel 2 (Normal and Inverted); Alternate; Chopped (Approx 1-MHz rate); Added; X-Y (Channel 1-Y and Channel 2-X).

Automatic Scale Factor—Probe tip deflection factors for 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.

50-Ω Protection—Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 volts. The "disconnected" condition is indicated, and has manual reset.

Maximum Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approximately: 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.

Internal Trigger Source—Normal (displayed signals), Channel 1 or Channel 2 signal.

HORIZONTAL DEFLECTION

Time Base A and B—Calibrated sweep range; 1 ns/div to 0.5 s/div in 27 calibrated steps (1-2-5 sequence). Uncalibrated A is continuously variable between steps and to at least 1.25 s/div.

Time Base A and B Sweep Accuracy

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%

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 sweeps faster than 0.2 s/div.

B Ends A—The A sweep is reset at the end of the B sweep to allow the fastest possible sweep repetition rate for increased trace intensity in the delayed sweep mode.

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.

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 10 times 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 10X 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.

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.

Time Base A & B Trigger Sensitivity

Trigger Mode		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	

A External Trigger Display—A momentary push button selector overrides other vertical controls and displays the external signal being 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 approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive and 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— 1 MΩ paralleled by approx 20 pF. Maximum input voltage; 500 V (DC + peak AC), 500 V P-P to 1 kHz.

Jitter—0.1 ns or less at 350 MHz and 1 ns/div.

X-Y OPERATION

Full Sensitivity X-Y (CH 1-Y, CH 2-X)— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 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.

CRT

TEKTRONIX CRT— 4-inch rectangular tube; 8 x 10-div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P11 optional without extra charge; 21-kV accelerating potential.

Photographic Writing Speed—At least 3 div/ns with standard P31 phosphor and at least 6 div/ns with optional P11 phosphor using the TEKTRONIX C-31-R Camera and Polaroid* 10,000 ASA film.

Auto Focus—Automatically maintains beam focus for all intensity settings.

Graticule—Internal, no parallax; variable edge lighting; markings for measurement of risetime. Graticule is dark with illumination off.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

External Z-Axis—Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (DC to 20 MHz) blanks trace of average intensity. +2 V (DC to 2 MHz) blanks maximum intensity trace.

Beam Current Limit—Automatically limits the average beam current to protect the CRT phosphor.

*Registered Trademark Polaroid Corporation

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Filtered forced air ventilation is provided. Storage: −35°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator—Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω or 1 ns or less. 1-kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V within 0.5% into 1 MΩ and 0.5 V within 1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA within 1%. Selectable repetition rates are 1 kHz and 1 MHz within 0.25%. Specifications apply over +15°C to +35°C range.

A Sweep Output—Open circuit, approximately 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs—Open circuit, approximately 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 watts maximum power consumption at 115 V. Line frequency 48 to 440 Hz.

Dimensions	Cabinet		Rackmount	
	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**
with accessories	24	10.9		
w/o accessories	21	9.5	26.2	11.9
Domestic Shipping	31	14	43.2	19.6
Export Packed	42	19	62.2	28.2

Included Accessories— 50-Ω 18-inch BNC cable (012-0076-00); two BNC jack posts (012-0092-00); 50-Ω termination (011-0049-01); accessory pouch (016-0535-00). Rack models also include mounting hardware and slide out assembly (351-0101-00).

ORDERING INFORMATION

485 OSCILLOSCOPE **$4200**

R485 OSCILLOSCOPE, 7-in rack model **$4240**

485-1 or R485-1 OSCILLOSCOPE, without A EXT TRIG Display ..... **Sub $100**

485-2 or R485-2 OSCILLOSCOPE, without A EXT TRIG Display and with 50-Ω input only instead of selectable input impedance ..... **Sub $350**

INSTRUMENT OPTIONS

Option 4, EMI MODIFICATION ..... **Add $20**

The 485 may be ordered to meet the interference specification of MIL-I-6181D over the following frequency ranges: Radiated from the instrument under test (with included CRT mesh filter installed) —150 kHz to 1 GHz; conducted through the power cord —150 kHz to 25 MHz.

EMI modified instruments include the standard accessories plus the following: BNC covers and retainers (200-0678-00 and 346-0045-00); mesh filter (378-0648-00).

Option 78, P11 PHOSPHOR ..... **No Charge**

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability and provide added convenience.

Current Loop Adapter—The adapter provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is approximately 25 ns.
Order 012-0341-00 ..... $17.60

50-Ω 5X Pad—Provides reverse termination for the calibrator.
Order 011-0060-01 ..... $18.15

Folding Viewing Hoods—Improves viewing in high ambient light conditions.
Folds to 7/16 x 4-1/4 x 7-1/2 inches.
Order 016-0274-00 ..... $6.60

Folds to 9/16 x 6-3/4 x 13-3/4 inches.
Order 016-0082-00 ..... $9.90

C-30A-P Option 1 Compact Camera—f/1.9 lens, 0.8 magnification, Polaroid Land Pack Film back for 3000-speed film (includes Adapter Frame/Corrector Lens 016-0301-00).
Order C-30A-P Option 1 ..... $535

C-31-R High Speed Camera—f/1.2, 1:0.5 lens with Roll-Film back for 10,000 or 3000-speed film.
Order C-31-R $675

C-32-P High Speed Camera—f/1.4 lens, magnification variable from 1.2 to 0.85, Polaroid Land Pack-Film back for 3000-speed film. Order C-32-P $715

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base.
Order 200 ..... $120

1105 Battery Power Supply—Provides 2.3 hours of battery operation. See Page 163 for complete description.
Order 1105 Battery Power Supply $475

PROBES

Probes are not supplied with the 485. Probes should be ordered separately according to the application.

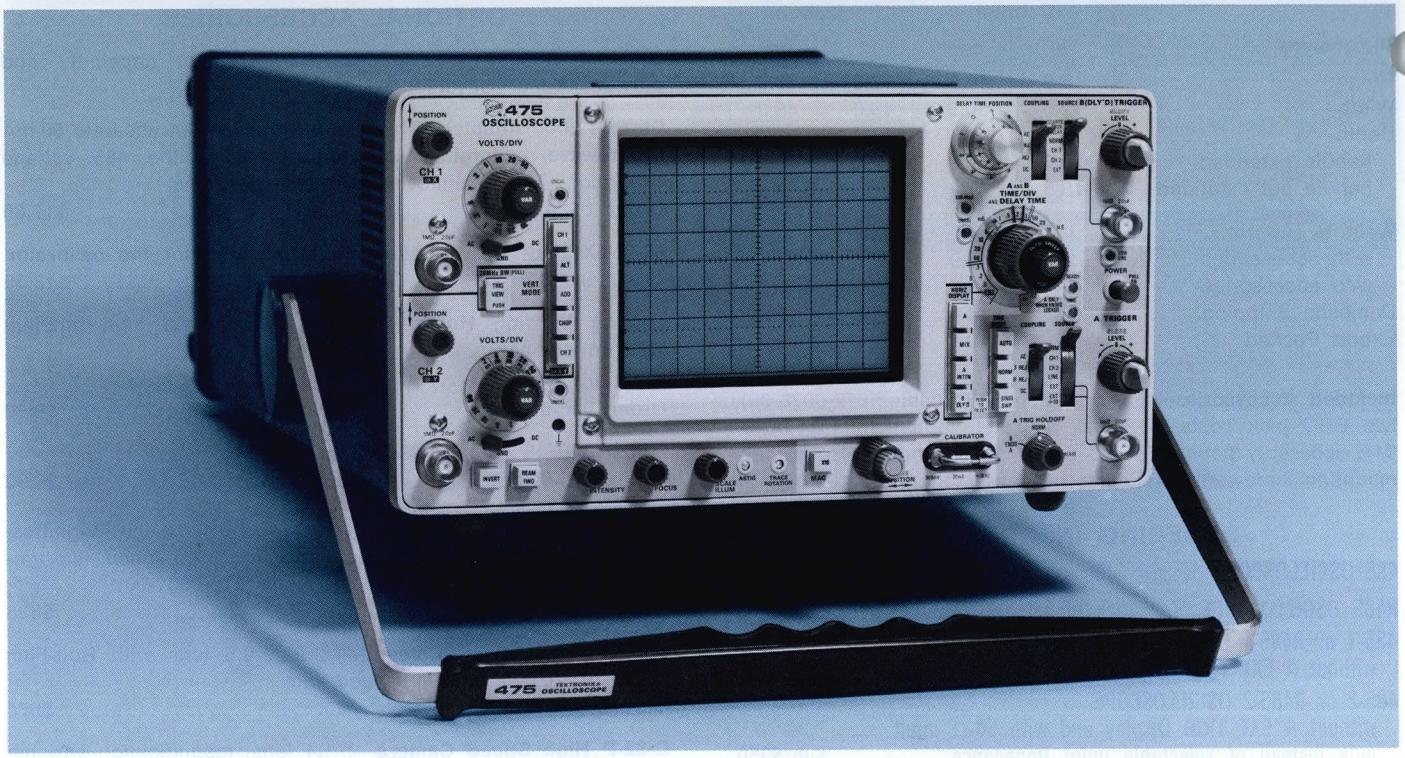
	Probe Type	Attenuation	Input Impedance	Lower —3 dB Point AC Coupled	Bandwidth with 485	Order	Price
	P6056	10X	500 Ω 1 pF	200 Hz	350 MHz	010-6056-03 — 6 ft 010-6056-05 — 9 ft	**$50**
50-Ω Input	P6057	100X	5000 Ω 1 pF	20 Hz	350 MHz	010-6057-03 — 6 ft 010-6057-05 — 9 ft	**$50**
	P6201 (FET Probe)	1X 10X } Plug-on 100X } Plug-on	100 kΩ 3 pF 1 MΩ <1.5 pF 1 MΩ <1.5 pF	10 Hz 1 Hz 10 Hz	330 MHz	010-6201-01 — 6 ft	**$395**
1-MΩ Input	P6053B	10X	10 MΩ 9.5 pF 12 pF 13.5 pF	1 Hz	250 MHz 250 MHz 200 MHz	010-6053-01 — 3.5 ft 010-6053-03 — 6 ft 010-6053-05 — 9 ft	**$60**

Refer to probe section of catalog for more detailed specifications.

PORTABLE OSCILLOCOPES

475 *200-MHz Dual-Trace Oscilloscope*

465 *100-MHz Dual-Trace Oscilloscope*



475 pictured above is identical in appearance to the 465 (not shown) except the 465 deletes the 0.01 and 0.02 μs TIME/DIV and 2 mV VOLTS/DIV switch positions.

- **200 MHz at 2 mV/DIV (475)**
- **1 nsec/DIV SWEEP RATE (475)**
- **100 MHz at 5 mV/DIV (465)**
- **5 nsec/DIV SWEEP RATE (465)**
- **8 x 10-cm CALIBRATED DISPLAY**
- **EASY-TO-OPERATE**
- **TRIGGER VIEW**
- **AUTOMATIC VOLTS/DIV READOUT**
- **BANDWIDTH LIMITING**
- **VERSATILE TRIGGER SELECTION**
- **BATTERY OPERATION**
- **DELAYED SWEEP**

The need to view and accurately measure complex nanosecond signals on customer locations or in a "field" environment is commonplace and expected. The new 465 and 475 have been specifically designed to be easy to use and meet the high performance and portable demands of these applications.

The exceptionally low-cost of the 465 with 100 MHz at 5 mV/cm and the 475 with 200 MHz at 2 mV/cm represents a price/performance breakthrough for portables and insures top value for the future.

At less than 23 lb the new 465 and 475 portables are light, short and easy to carry (25.3 lb with panel cover and accessories). They use less travel space and are approx 20% lighter than the TEKTRONIX 453A, and 454A, the world's most widely used portables.

Although light weight, small and rugged, the 465 and 475 contain a big, bright, high-resolution CRT. Even in adverse ambient light conditions low rep-rate pulses are easily viewed. With 8 cm vertically and 10 cm horizontally the CRT display covers ⅓ of the entire front panel. Though the front panel is small in area and dominated by the larger CRT, these versatile portables are easy to use. Operation has been simplified by single-function push buttons, control knob design, layout and color-coordinated front panels.

Troubleshooting circuits and equipment is often more effectively accomplished when using external trigger sources. It is essential that the timing, amplitude and other characteristics of the external trigger waveforms are known. By simply pressing a front panel push button on the 465 or 475, any waveform applied at the A trigger input is instantly displayed, thus eliminating resetting controls and disconnecting leads. This can be a real time saver and convenience when external trigger signals are frequently being used as timing references.

In the past, multi-trace applications or measurements requiring frequent attenuation or probe changes necessitated bothersome and error-prone deflection factor determination. With the 465 and 475, probe tip deflection factors for recommended 1X and 10X probes are automatically indicated by readout lights behind the knob skirts.

Measuring with respect to ground is important in many applications. This is easily accomplished at the probe when DC coupled by simply pressing the small ground reference push button on the probes recommended for 465 and 475 use.

The 465 and 475 can be operated from either a free-standing battery pack or one which attaches directly to the oscilloscope. Both are small and light weight, providing a handy solution for making accurate measurements in difficult environments such as conducted EMI, ground loops, power line fluctuations, or in the absence of line power.

CHARACTERISTICS

All characteristics apply to both the 465 and 475 except where indicated.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Risetime 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, 4.12 ns
475	DC to 200 MHz, 1.75 ns	175 MHz, 2.0 ns

*Measured at −3 dB down. Bandwidth may be limited to approximately 20 MHz by bandwidth limit switch.

Lower −3 dB point, AC coupling from 50-Ω source

465/475	X1 Probe	10 Hz or less
	X10 Probe	1 Hz or less

Deflection Factor

465—5 mV/div to 5 V/div in 10 calibrated steps**
475—2 mV/div to 5 V/div in 11 calibrated steps**

**1, 2, 5 sequence, accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Display Modes—Channel 1; Channel 2 (normal and inverted); Alternate; Chopped (465—approx 250-kHz rate, 475—approx 1-MHz rate); Added; X-Y (selected by Time/div, CH 1-X, CH 2-Y)

Automatic Scale Factor Readout—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 megohm within 2% paralleled by approx 20 pF.

Maximum 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

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) 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.

Delay Line—Permits viewing leading edge of displayed waveform.

Probe Power (for 475 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 in 22 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

Time Base B—0.05 μs/div to 50 ms/div in 19 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

475

Time Base A and B—0.01 μs/div to 0.5 s/div in 24 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 1 ns/div.

Variable Time Control; Time Base A (465/475)—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 +20°C +30°C to +55°C	
	465	475	465	475
Unmagnified	±2%	±1%	±3%	±2%
Magnified	±3%	±2%	±4%	±3%

Horizontal Display Modes—A only, Mixed Sweep, A Intensified, B Delayed.

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal), Normal Trigger, Single Sweep. Lights indicate when sweep is triggered and when single sweep is ready.

Time Base B Sweep Modes—B Starts After Delay Time; B Triggerable after Delay Time from selected source.

Calibrated Mixed Sweep—Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep. Mixed sweep measurements utilize portions of the A and B sweeps. The 465 is accurate to within 2% plus measured A sweep accuracy for the A portion of the display and to within the B accuracy for the B portion of the display. The 475 has a cumulative accuracy of within 3%.

CALIBRATED SWEEP DELAY

Delay Time Range

465—0.2 to 10X Delay Time/Div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

475—0 to 10X 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° to +35°C
over one or more major dial divisions	within 1%
less than one major dial division	within 0.01 major dial divisions

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).

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.

Time Base A and B Trigger Sensitivity

Trigger Mode		465		475	
		To 25 MHz	At 100 MHz	To 40 MHz	At 200 MHz
DC	Internal	0.3 cm deflection	1.5 cm deflection	0.3 cm deflection	1.5 cm deflection
DC	External	50 mV	150 mV	50 mV	250 mV
DC	External ÷ 10	500 mV	1.5 V	500 mV	2.5 V
AC		Requirements increase below 60 Hz			
AC LF Reject		0.5 cm with requirements increasing below 50 kHz			
AC HF Reject		0.5 cm with requirements increasing below 60 Hz and above 50 kHz			

465 Jitter— 0.5 ns or less at 100 MHz and 5 ns/div. (X10 Mag)

475 Jitter— 0.2 ns or less at 200 MHz and 1 ns/div. (X10 Mag)

A Trigger View—A momentary push button selector overrides other vertical controls and displays the signal being 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 approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform.

Time Base Trigger Sources—A: Norm, Channel 1, Channel 2, Line, External and External ÷ 10. B: Starts After Delay, Norm, CH 1, CH 2, and External. Level adjustment through at least ±2 Volts in External, through at least ±20 Volts in External ÷ 10.

External Inputs—R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (DC + peak AC) maximum input.

X-Y OPERATION

465

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—5 mV/div to 5 V/div in 10 calibrated steps, accurate within 4%. Bandwidth is DC to at least 4 MHz. Phase difference between amplifiers is 3° or less from DC to 50 kHz.

475

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—2 mV/div to 5 V/div in 11 calibrated steps, accurate within 3%. Bandwidth is DC to at least 1 MHz. Phase difference between amplifiers is 1° or less from DC to 1 MHz.

CRT

TEKTRONIX CRT—5 inch rectangular tube; 8 x 10 cm display area. Horizontal and vertical centerlines further marked in 0.2-cm increments. P31 phosphor normally supplied; P11 optional without extra charge. 18-kV accelerating potential.

Z-axis input—DC-coupled to CRT cathode; noticeable modulation at normal intensity witn 5 V or more peak-to-peak signal; DC to 50 MHz usable frequency range.

Graticule—Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: —15°C to +55°C. Storage: —55°C to +75°C. Filtered forced air ventilation is provided.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes. 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (OPTION 4 only)—Meets interference requirements of MIL-I-6181D, power line conducted, 150 kHz to 25 MHz. Radiated (with included mesh filter installed), 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-F-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 Volts	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Signal Outputs—Positive gates from both time bases (approx 5 V), and a vertical signal output from one channel.

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) maximum at 115 V and 60 Hz. Operation from 12 or 24 V DC is available with Option 7.

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	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 (w/o panel cover)	22.8	10.3	29.4	13.3
Net (with panel cover) and accessories)	25.3	11.5		
Domestic Shipping	32.7	14.8	46.4	21.1
Export Packed	48.0	21.8	65.4	29.7

465

Included Accessories—Two 6-ft P6065A Probes with accessories (010-6065-03); accessory pouch (016-0535-02); blue CRT light filter (337-1674-00); clear CRT light filter (337-1674-01); ground post (134-0016-01).

475

Included Accessories—Two 6-ft P6075A Probes with accessories (010-6075-03); accessory pouch (016-0535-02); blue CRT light filter (337-1674-00); clear CRT light filter (337-1674-01); ground post (134-0016-01).

INSTRUMENT OPTIONS

EMI Environmentalized, Option 4—Includes the features of the 465 and 475; in addition meets electromagnetic interference requirements of MIL-I-6181D over the following frequencies. Power line conducted: 150 kHz to 25 MHz: Radiated (with included mesh filter installed): 150 kHz to 1 GHz.

TV Sync Separator, Option 5 (465 only)—Option 5 adds a TV sync separator, providing stable sweep triggering from composite video waveforms. With sync separator mode selected, A sweep is automatically triggered at the field rate and TV line rate triggering is added to the signal source selection for sweep B. The sync separator accepts sync-positive or sync-negative video, from Channel 1, Channel 2 or external input. Video signal requirement is 2 divisions internal display or 100 mV external input. Recognition circuits are optimized for 405-525-625 line or 50 or 60 Hz field rate broadcast systems, and are compatible with closed circuit systems up to 1201 line 60 Hz field rate.

Included Accessories—Two 6-32 adapters (103-0051-01); interchangeable light filter/TV graticule (NTSC) (337-1674-02); interchangeable light filter/TV graticule (CCIR) (337-1674-03); OPTION 5 instruction book insert.

External DC Operation, Option 7—In addition to the standard AC line operation, Option 7 permits the 465 and 475 to be powered from a 12 VDC or a 24 VDC source. For battery operation, Option 7 makes these scopes compatible with the 1106 Battery Pack.

ORDERING INFORMATION

465 OSCILLOSCOPE	**$1725**
475 OSCILLOSCOPE	**$2500**
R465 OSCILLOSCOPE	**$1800**
R475 OSCILLOSCOPE	**$2575**

INSTRUMENT OPTIONS

Option 4, EMI ENVIRONMENTAL	**Add $75**
Option 5, TV SYNC SEPARATOR (465 only)	**Add $100**
Option 7, EXT DC OPERATION	**Add $75**
Option 78, P11 PHOSPHOR	**No Charge**

OPTIONAL ACCESSORIES

Probes

P6201 1X FET Probe Package (for 475 only), order 010-6201-01 ..... $395

P6048 10X Probe Package, order 010-0215-00 ..... $75

C-30A-P Option 1 Compact Camera—f/1.9 lens, 0.8 magnification, Polaroid Land Pack Film back for 3000-speed film (includes Adapter Frame/Corrector Lens 016-0301-00), order C-30A-P Option 1 ..... $535

Camera Adapter and Corrector Lens—Adapts C-30A to 465 or 475, order 016-0301-00 ..... $35

1105 Battery Power Supply—Provides 1.8 hour (465) or 1.4 hour (475) of battery operation. See Page 163 for complete description, order 1105 Battery Power Supply $475

Option 7 Modification Kit—Converts existing 465 or 475's to the Option 7 version. For 465's with serial No. below B042244, order 040-0650-00 ..... $125

For 475's with serial No. below B061174, order 040-0665-00 ..... $125

For 465's or 475's with serial No. above those listed, order 040-0666-00 ..... $125

Protective Cover—Waterproof, blue vinyl, order 016-0554-00 ..... $11

Folding Polarized Viewing Hood—Order 016-0180-00 .... $12

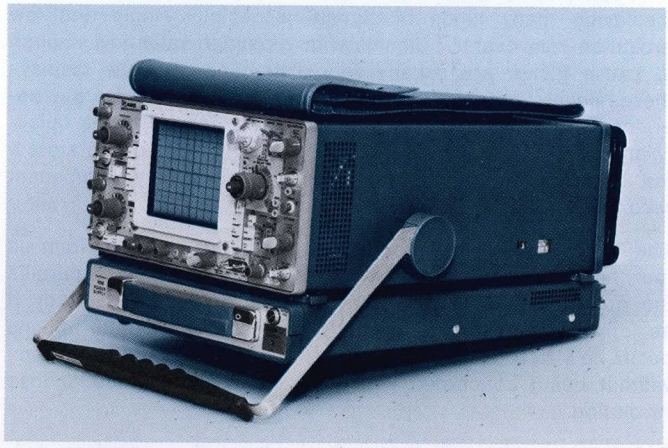
Mesh Filter—Improves contrast and EMI filtering, order 378-0726-01 ..... $15

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base, order 200 ..... $120

*Registered Trademark Polaroid Corporation

New — Battery Pack 1106

The 1106 Battery Pack permits freedom to operate your Tektronix 465 or 475 Option 7 oscilloscope at remote locations or when isolation from the line or ground is required. It supplies 24 V DC at a 140 watt hour capacity. The 1106 connected to the scope is pictured here. As an alternative, the scope and battery pack can be carried or operated separately. For carrying ease this provides two packages of almost equal weight, each with its own handle. Because the 1106 can easily be disconnected from the scope and has an internal battery charger, the scope can be operated on external AC or DC or from a second 1106 while the batteries are being recharged.



SPECIFICATIONS

POWER OUTPUT

Output— 22 to 24 volts DC

Battery Operating Time— 140 watt hours from fully charged internal batteries.

POWER SOURCE (Charging)

AC Requirements— 90 to 132 VAC, 50 to 400 Hz or 180 to 264 VAC, 50 to 400 Hz.

Power Consumption— 60 watts maximum.

Battery Charging Time— 14 to 16 hours.

ENVIRONMENTAL CAPABILITIES

Temperature—Operating, 0°C to +40°C. Non-operating, with batteries, —40°C to +60°C; without batteries, —55°C to +75°C.

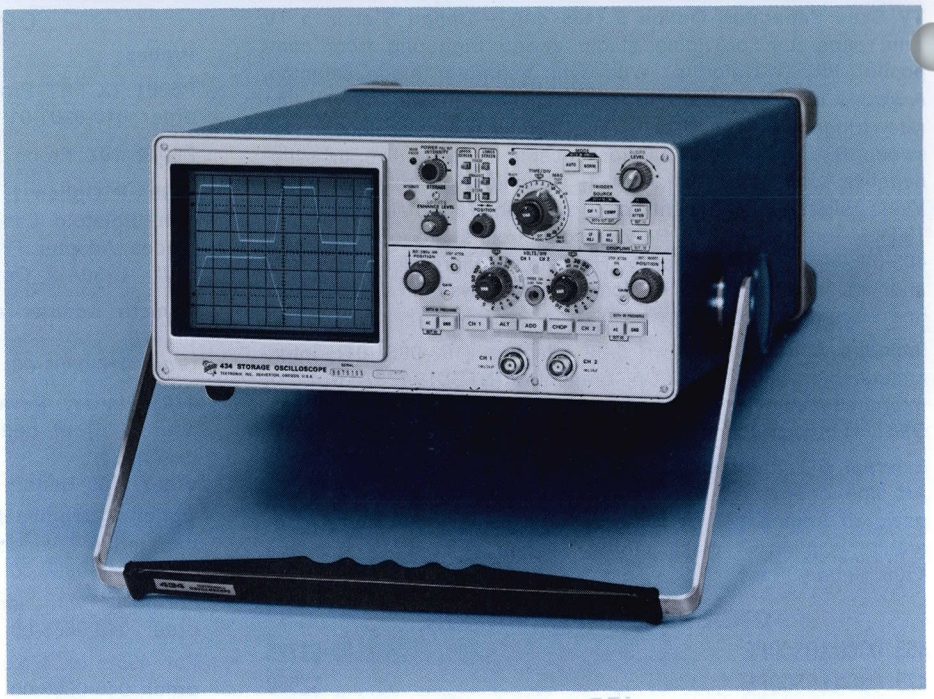
Dimensions and Weights

Height	2.3 in	5.8 cm
Width	12.9 in	32.7 cm
Depth	17.0 in	43.2 cm
Net Weight	16.4 lb	7.4 kg
Domestic Shipping Weight	≈19.4 lb	≈8.8 kg
Export-packed Weight	≈26.4 lb	≈12.0 kg

Included Accessory—Power Cord (IEC female, NEC male) 161-0066-00.

Order 1106 BATTERY PACK **$250**

PORTABLE OSCILLOSCOPES
432 *25-MHz Dual-Trace Oscilloscope*
434 *25-MHz Dual-Trace Bistable Storage Oscilloscope*



- **DEFLECTION FACTORS to 1 mV/DIV**
- **AUTOMATIC VOLTS/DIV READOUT**
- **DIRECT-READING WIDE-RANGE MAGNIFIER**
- **20¾ LB**
- **5¼-INCH RACKMOUNT**

The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div and deflection factors to 1 mV/div cover a wide range of laboratory and field applications. Both instruments are small and light. Cabinet height is 5¾ inches including the feet, (rackmount height is 5¼ inches) and weight is 20¾ pounds. Applications include field maintenance areas where conventional AND storage capability are needed.

The retention feature of the 434 storage CRT is useful for displaying many kinds of signals, especially single and low repetition rate events. Signals with repetition rates low enough to cause flicker are usually very distracting. Storage displays these signals at a constant light level. With storage, the operator can obtain displays of aperiodic or random events quickly and easily. Once the signal of interest is located and stored, the display can be photographed for high quality, permanent records.

The 434 displays stored events in a view mode for as long as four hours at constant intensity and resolution. This permits the operator to view the event as it's displayed, and study it as long as necessary at his convenience. When interruptions occur he's free to leave the stored display for extended periods without being concerned that the trace might degrade or lose resolution.

Split-screen storage operates in each of three modes: full-screen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the other half of the CRT.

The split-screen storage CRT provides the convenience of storage and conventional displays on the same CRT at the same time. This capability is useful in many applications. For instance, the operator may wish to store a reference trace and then view the change in waveform characteristics as he varies circuit components. He does this easily by operating half of the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

Comparison of changing phenomena is easily made using the TEKTRONIX unique split-screen storage CRT. In measurement of pulse response as a function of temperature, for example, a reference display can be stored on the upper screen area, then compared with subsequent displays stored on the lower screen area. The effect of the temperature change is easily seen. After studying the pulse changes, the user can erase either half of the screen and store a third display under still different conditions. This procedure can be repeated as often as needed. The operator presses one button to erase the upper half of the CRT and a second button to erase the lower half. Pressing both buttons simultaneously erases the full screen.

The writing speed of the bistable storage CRT is variable from 100 div/ms to 400 div/ms on the 434. Option 1 increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation. This allows the user to choose the writing rate best suited for his requirements.

The design of the TEKTRONIX storage CRT makes it highly resistant to burns. It requires only the same operating care as a conventional CRT.

Vertical scale-factor readout is provided by lighted knob skirts which automatically indicate the correct reading, even when using the recommended 10X probes. This feature saves time and reduces errors by freeing the user from having to calculate the scale factor each time a measurement is made with the 10X probes.

A new approach to battery operation is offered with the 1105 Battery Power Supply. The 432 and 434 can be powered fo 2.5 and 1.8 hours respectively with this stand-alone power supply. Internal batteries add weight and are not required when commercial power is available. With the 1105, batteries are carried only when necessary.

434 STORAGE

TEKTRONIX Storage CRT— 5-inch rectangular tube, 8 x 10 div (1 div = 0.98 cm) display area. Phosphor is similar to P1. 4-kV accelerating potential.

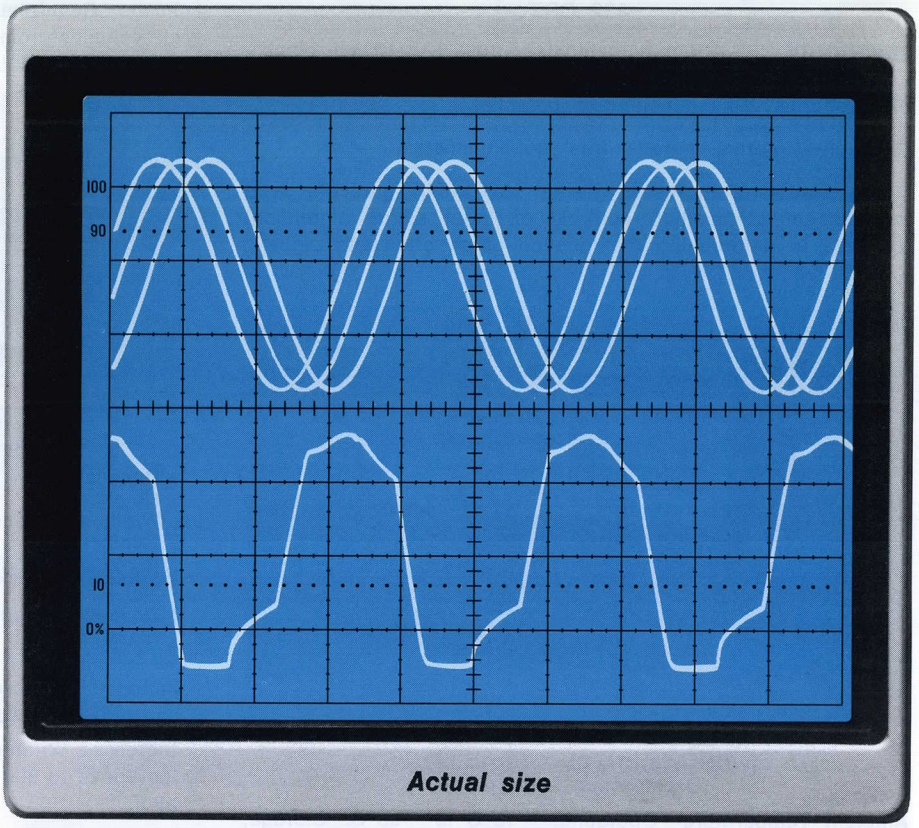
Graticule—Internal, parallax-free, nonilluminated.

Split-Screen Storage— 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.

Writing Speed (Center 8 div)—Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 1, 500 div/ms, normal; to 5000 div/ms, enhanced).

Storage Viewing Time—Up to four hours.

Erase Time— 300 ms or less.



Actual size

CHARACTERISTICS

The following characteristics apply to both the 432 Oscilloscope and 434 Storage Oscilloscope, except where noted:

VERTICAL DEFLECTION
(2 Identical Channels)

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 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.

Bandwidth and Risetime—(from 50-Ω 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).

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approximately 100 kHz); Added.

Input R and C— 1 megohm ±2% paralleled by approx 24 pF.

Maximum Input Voltage—DC coupled: 250 V (DC plus peak AC), AC coupled: 500 V (DC plus peak AC). In either mode the maximum AC is 500 V P-P at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

Internal Trigger Source—Composite (displayed signals) or channel 1 signal only.

*Bandwidth derating to 22 MHz at temperatures above +30°C.

HORIZONTAL DEFLECTION

Time Base— 0.2 μs/div to 5 s/div in 23 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to 12.5 s/div. Accurate within 3% unmagnified and 4% magnified from +20°C to +30°C, within 4% unmagnified and 5% magnified from −15°C to +55°C.

Direct Reading Magnifier—Six-position, push-to-turn, 50X maximum. Extends fastest sweep rate to 20 ns/div.

Time Base Sweep Modes—Auto Trigger, (sweep free runs in absence of triggering signal and provides bright baseline at all sweep rates), Normal Trigger, Single Sweep.

External Horizontal Input—Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

COUPLING		TO 5 MHz	AT 25 MHz
DC	INTERNAL	0.3 div deflection	1 div deflection
	EXTERNAL	50 mV	175 mV
AC		Same as DC at 20 Hz and above, requirements increase below 20 Hz	
AC LF REJECT		Same as AC at 50 kHz and above, requirements increase below 50 kHz	
AC HF REJECT		Same as AC at 50 kHz and below, requirements increase above 50 kHz	

Sources—Channel 1 only, composite, line, external and external ÷ 10. Input R approximately 1 megohm. Maximum external input, 250 Volts (DC + peak AC). External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

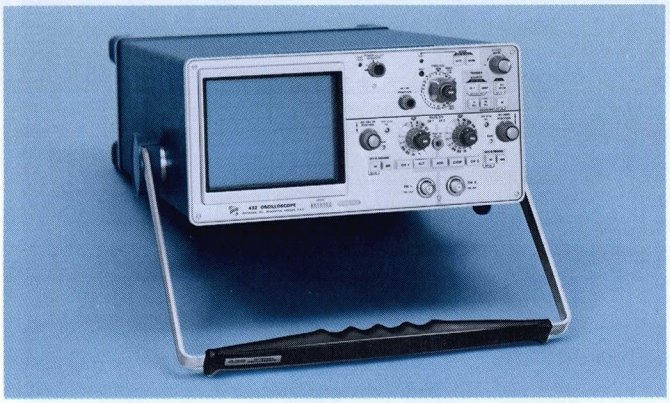
PORTABLE OSCILLOSCOPES
432 25-MHz Dual-Trace Oscilloscope
434 25-MHz Dual-Trace Bistable Storage Oscilloscope

432 CRT

TEKTRONIX CRT— 5-inch rectangular tube, 8 x 10 cm display area. P31 phosphor normally supplied. P7 is optional without extra charge. 4-kV accelerating potential.

Graticule—Internal, parallax-free, nonilluminated.

Beam Finder—Compresses display to within graticule area independent of position controls or input signal amplitude, for ease in determining the location of an off-screen signal.



ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating, −15°C to +55°C. Storage, −55°C to +75°C.

Altitude—Operating, 15,000 feet. Maximum allowable operating temperature decreases 1°C/1000 feet from 5,000 to 15,000 feet.

Vibration—Operating and non-operating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating. 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—With the optional mesh filter (378-0682-00) installed the 432 and 434 meet interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

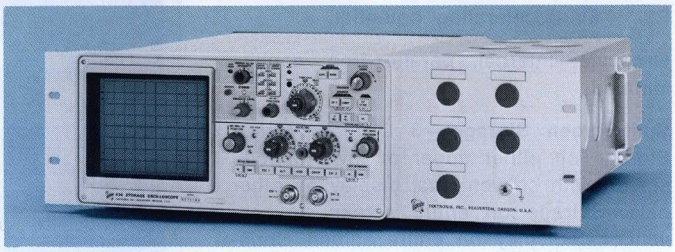
OTHER CHARACTERISTICS

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.

Z Axis—Input DC coupled to CRT, noticeable modulation at normal intensity with 5 volts or more P-P, DC to at least 20 MHz.

Amplitude and Time Calibrator—0.6 V adjustable within 1.0%. Repetition rate is adjustable to 1 kHz within 1.0% (+20°C to +30°C). Output resistance is 575 ohms.

Power Requirements—Operates without range switching on all voltages from 100 V to 240 V, 50 to 400 Hz, 90 VA (55 w) max (432), 120 VA (75 w) max (434). Also operates from 105 VDC to 250 VDC.



Dimensions	Cabinet in	Cabinet cm	Rackmount in	Rackmount cm
Height	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
Weight (approx)	lb	kg	lb	kg
Net weight	20.8	9.4	23.1	10.5
Domestic shipping	30.0	13.6	42.6	19.4
Export-packed	35.0	15.9	62.6	28.4

Included Accessories—Two ~~P6061~~ P6054A 3.5-ft probes with accessories (~~010-6061-01~~); accessory pouch (016-0165-00).

Increased Writing Speed, Option 1—Increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation.

ORDERING INFORMATION

432 OSCILLOSCOPE	$1585
434 STORAGE OSCILLOSCOPE	$2150
R432 OSCILLOSCOPE (Rackmount model)	$1625
R434 STORAGE OSCILLOSCOPE (Rackmount model)	$2190

INSTRUMENT OPTIONS

Option 1 INCREASED WRITING SPEED (434/R434)	Add $25
Option 76 P7 PHOSPHOR (432/R432)	No Charge

OPTIONAL ACCESSORIES

1105 Battery Power Supply—Provides 2.5 hours (432) or 1.8 hour (434) of battery operation. See Page 163 for complete description.
Order 1105 Battery Power Supply $475

Mesh Filter—Improves contrast and EMI filtering.
Order 378-0682-00 ..... $16.50

Portable to Rackmount Assembly—Includes hardware for converting standard 432 and 434 to 19-inch rack installation.
Order 016-0272-00 ..... $66

Folding Polarized Viewing Hood—Order 016-0180-00 ... $12

Clear Plastic CRT Filter—Order 378-0677-00 ..... $1.75

C-30A-P Option 1 Compact Camera—f/1.9 lens, 0.8 magnification, Polaroid Land Pack Film back for 3000-speed film (includes Adapter Frame/Corrector Lens 016-0301-00).
Order C-30A-P Option 1 ..... $535

Camera Adapter—Mounts C-30A Series Camera to the 432 & 434 Oscilloscope. Order 016-0301-00 ..... $35

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base. Order 200 ..... $120

- 1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC and AC/DC VERSIONS
- DUAL TRACE, FET INPUTS
- DESIGNED for SEVERE ENVIRONMENTS
- UP to 5 HOURS OPERATION from INTERNAL BATTERY PACK (AC/DC VERSION)
- ILLUMINATED PARALLAX-FREE GRATICULE

The 422 is a portable dual-trace oscilloscope that combines small size and light weight with the ability to make precise waveform measurements. It weighs under 22 pounds and is ruggedly constructed to withstand shock, vibration, and other extremes of environment. Solid-state design, using FET input circuitry, provides minimum drift and fast stabilization time. No longer need measurements be compromised due to adverse field conditions; the 422 brings the precision of the laboratory to the field.

Two models are available. One operates on AC; the other on AC or DC, with an optional battery pack providing up to 5 hours operating time for completely portable operation. The AC model is also available as an R422, arranged in a rackmount panel assembly with a hinged-door compartment for storing accessories. The hinged door can be removed to allow the installation of a second 422 for applications that require two instruments. The entire assembly is mounted to the rack with slide-out tracks.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth—DC to 15 MHz at 3-dB down (each channel); 5 Hz to 5 MHz at 3-dB down, on X10 gain (channel 2). Low-frequency 3-dB-down point is 2 Hz or less with AC coupling (each channel), 0.2 Hz or less with included 10X probe.

Risetime— 24 ns each channel; 70 ns at X10 gain (channel 2).

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence (each channel). Deflection factor extended to 1 mV/div in X10 position (channel 2). All steps accurate within 3%; 7.5% on X10 GAIN (channel 2). Uncalibrated, continuously variable between steps and to approx 50 V/div. Warning light indicates uncalibrated setting.

Display Modes—Channel 1 only; Channel 2 only; Channels 1 and 2 added algebraically; dual-trace chopped; dual-trace alternate. In chopped mode, successive segments of each channel are displayed at an approx 150-kHz rate. Channel 2 has polarity inversion.

Input R and C— 1 megohm ±2% paralleled by approx 33 pF.

Maximum Input Voltage— 300 V (DC plus peak AC), AC not to exceed 300 V P-P at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

Time Base— 0.5 μs/div to 0.5 s/div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 div. Uncalibrated, continuously variable between steps and to approx 1.25 s/div. Warning light indicates uncalibrated vernier settings.

X10 Magnifier—Operates over full time base, increases fastest rate to 50 ns/div. Accuracy of magnified time base is within 5% over center 8 div.

External Input—Variable between approx 1 V/div to 100 V/div. DC to at least 500 kHz at 3-dB down. Input R 300 kΩ ±10% paralleled by approx 35 pF.

Other—Gate output (on front panel) is a negative-going rectangular pulse with same duration as time base; approx 0.5-V; approx 620-ohm output resistance.

TRIGGER

Modes—Automatic or Normal. Automatic operation useful between 20 Hz and 15 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates.

Coupling—DC; AC; AC LOW FREQ REJECT.

Sources—Internal: Channels 1 and 2, Channel 1 only. External: Input RC is 100 kΩ ±3% paralleled by approx 33 pF. Positive or Negative slope. Trigger level range at least +10 V to −10 V. Maximum input voltage 250 V (DC plus peak AC).

Requirements—DC: 0.2-div deflection or 125 mV ext up to 5 MHz, increasing to 1 div or 0.6 V at 15 MHz. AC: Same as DC above 50 Hz. AC LOW FREQ REJECT: Same as DC above 50 kHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature

	AC Model	AC/DC Model
Operating	−15°C to +55°C	0°C to +40°C*
Storage	−55°C to +75°C	−40°C to +60°C

*charging

Vibration—Operating and nonoperating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles.

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.

Electromagnetic Interference—With the optional mesh filter installed, the 422 meets interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator— 1-kHz squarewave, negative-going. Provides 0.2 V, internally, ±1.5% (+20°C to +30°C), and 2 V, ±0.5% (+20°C to +30°C), at Probe Cal jack on front panel.

Power Options—AC Model: 90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz, 34 watts at 115 VAC.

AC/DC Model: AC mode: 92 to 137 VAC or 184 to 274 VAC, 48 to 440 Hz, 25 W maximum. DC mode: 11.5 to 33 VDC, 23 W maximum. 24-V battery pack (part number 016-0066-02) provides up to 5 hours continuous operation.

TEKTRONIX CRT—Rectangular, 4-inch, with 0.8-cm divisions; 8 x 10-div display area. Illuminated internal graticule. 6-kV accelerating potential. External blanking, DC-coupled +2 V and greater will completely blank trace. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

Dimensions and Weights (R422)

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth behind front panel	12.5 in	31.8 cm
Net weight	23.3 lb	10.6 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈73 lb	≈33.2 kg

Dimensions and Weights (422)

Height	6.9 in	17.7 cm
Width with handle	9.4 in	23.8 cm
Depth, handle not extended	15.8 in	40.0 cm
Depth, handle extended	17.8 in	45.3 cm
Weight with accessories	21.3 lb	9.7 kg
Domestic shipping weight	≈30.0 lb	≈13.6 kg
Export-packed weight	≈44.0 lb	≈20.0 kg

Included Accessories—Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00); both installed; clear, CRT protector plate (386-0118-00); AC power supply (016-0072-00); power cord, 117 V, 3-conductor right-angle, female with straight male plug (161-0024-03). R422 also includes slide-out assembly (351-0100-00); and mounting hardware.

INSTRUMENT OPTIONS

Option 1, AC/DC Powered Portable (Mod 125B)—Includes: two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00), both installed; clear, CRT protector plate (386-0118-00); AC/DC power supply (016-0073-00); 3-wire AC with female connector and male plug power cord (161-0015-01); 3-wire DC with female connector power cord (161-0016-01).

Option 2, Oscilloscopes Side by Side—Two 422's mounted in a rackmount panel include two sets of accessories listed for the 422 above plus slide-out assembly (351-0100-00); and mounting hardware.

Option 3, Oscilloscope Without Cabinet—422 Oscilloscope without cabinet for rackmount conversion. Includes accessories listed for the 422.

ORDERING INFORMATION

422 OSCILLOSCOPE **$1600**
R422 OSCILLOSCOPE **$1675**

INSTRUMENT OPTIONS

Option 1, AC/DC POWERED 422 (Mod 125B), without battery pack ..... **Add $170**
Option 2, SIDE BY SIDE R422's ..... **Add $1575**
Option 3, 422 WITHOUT CABINET ..... **Sub $25**
Option 72, P2 PHOSPHOR ..... **No Charge**
Option 76, P7 PHOSPHOR ..... **No Charge**
Option 78, P11 PHOSPHOR ..... **No Charge**

OPTIONAL ACCESSORIES

Battery Pack for 422 Option 1, Mod 125B
Order 016-0066-02 ..... $110

AC/DC Power Supply Without Battery Pack—Converts the 422 Portable Oscilloscope for DC or (with battery pack) battery operation. Domestic shipping weight is 10¼ lb.
Includes: power cord, 3-wire AC w/female connector and male plug (161-0015-01); power cord, 3-wire DC w/female connector (161-0016-01).
Order 016-0073-00 ..... $660

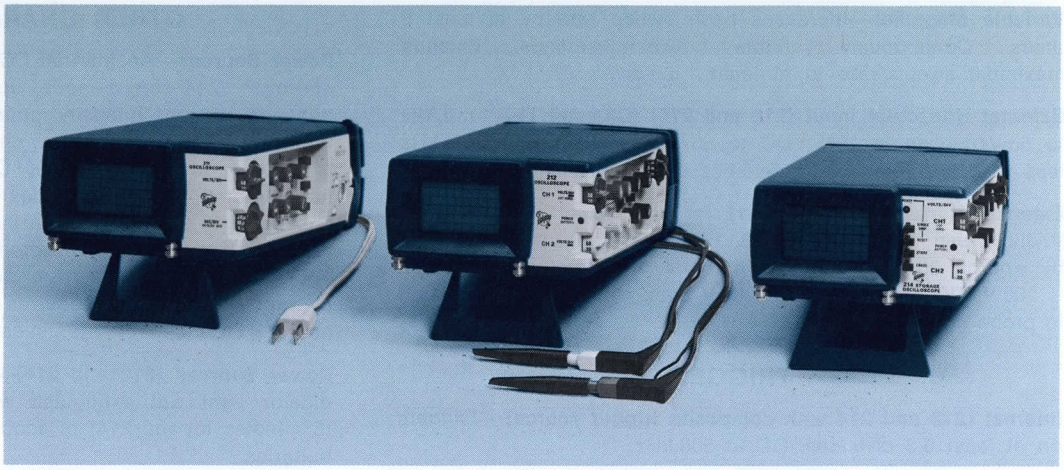
1105 Battery Power Supply—The AC versions of the 422 can be powered for over 4 hours with this stand-alone power supply. See Page 163 for complete description.
Order 1105 Battery Power Supply $475

Portable to Rackmount Conversion Kit—This mounting kit includes hardware and instructions to convert existing 422 Oscilloscopes (AC version) for rackmount installation.
Order 040-0419-00 ..... $105.00

Rackmount to Portable Conversion Kit—This kit includes the cabinet and necessary hardware to convert existing R422 Oscilloscopes for portable operation. Order 040-0421-00 .. $72.60

C-30A-P Option 1 Compact Camera—f/1.9 lens, 0.8 magnification, Polaroid Land Pack Film back for 3000-speed film (includes Adapter Frame/Corrector Lens 016-0301-00).
Order C-30A-P Option 1 ..... $535

- 3.5 LB, 3 x 5¼ x 9.5 INCHES
- INTERNAL BATTERY PACK
- 1 mV/DIV to 50 V/DIV
- INTEGRAL 1 MΩ PROBE
- DUAL TRACE (212 & 214)
- STORAGE (214)



The growing 200 series of miniscopes represent a breakthrough in portable oscilloscope design. Fully self-contained, these miniature size, ultra light-weight portables are double-insulated, permitting safer high-voltage measurements. They are built of impact-resistant plastic for applications in severe environments. When not in use, the integral 1 MΩ probes are stored in specially designed compartments. The 212 and 214 probes are color-matched with the vertical deflection controls to minimize measurement error. Clip-on 10X attenuators are available for higher-amplitude applications. A convenient neck strap, which is an included accessory, frees both hands. These miniscopes represent an unequalled value.

Trigger level and slope functions are simplified to one rotary control. With no signal input, an automatic trigger mode provides a bright baseline at all sweep speeds. In the auto mode, when a signal is received, these scopes trigger on the signal. Some applications require an adjustable trigger level. Turning the trigger control clockwise from the auto position allows the user to select any combination of trigger slope and trigger point.

The battery operation, rugged case, and extreme light weight and small size of these scopes make them suitable for a wide range of installation and service applications: Machine and motor controls, audio communication systems, mobile electronics, data transmission systems, office and industrial equipment, frequency translators, computer peripherals, hospital equipment and many others.

In many industrial applications, it is necessary to "float" the oscilloscope. These scopes can be elevated to 700 volts (DC + peak AC) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point. They meet or exceed IEC recommendations for class II instruments.

With the 214, storage is introduced in a miniscope. Storage retains a nonrepetitive or slow moving signal. This allows closer inspection of these signals. In the single sweep mode, the 214 waits for, then records 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 and then waits for a manual reset. When combined with storage, this provides the unique capability of automatically waiting for an event and then storing it for subsequent viewing. The 214 is especially suited for such applications as telephone line signals, electromechanical information, industrial controls and more.

CHARACTERISTICS

Except where indicated, all characteristics apply to all three scopes.

VERTICAL SYSTEM

Deflection Factor— 1 mV/div to 50 V/div in 15 calibrated steps (1-2-5 sequence), accurate within 5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

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 down point AC coupled is less than 2 Hz.

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, via attached signal acquisition probes. With optional X10 attenuator adapter, input R is 4.4 MΩ and input C is approx 20 pF.

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.

Display Modes (212 and 214)—Channel 1 only, Channel 2 only, or Channel 1 and Channel 2 chopped from 500 ms/div to 2 ms/div of time base, (chopped frequency approx 50 kHz for the 212 and approx 40 kHz for the 214) and alternate from 1 ms/div to 5 μs/div of time base.

Maximum Input Voltage (X1 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 volts (DC + peak AC), 600 volts peak-to-peak AC, 5 MHz or less.

Maximum Input Voltage Using Optional 10X Attenuator—1000 volts (DC + peak AC).

Channel 1-Channel 2 Isolation (212 and 214)— 1000:1 (Signals less than 6 divisions).

HORIZONTAL SYSTEM

Time Base (212 and 214)— 5 μs/div to 500 ms/div in 16 calibrated steps (1-2-5 sequence); accurate to within 5%.

Time Base (211)— 5 μs/div to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate to within 5%.

New

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable between settings. Extends maximum sweep rate to at least 1 μs/div.

External Horizontal Input (212 and 214) (Channel 1)—1 mV/div to 50 V/div within 10%; DC to 50 kHz; X-Y phasing to 5 kHz less than 3°. Input characteristics same as Channel 1.

External Horizontal Input (211) (at side panel)—1 V and 10 V/div within 10%; DC to 75 kHz. Approx 0.5 MΩ paralleled by approx 30 pF. Maximum external horizontal input voltage is 200 V (DC + peak AC) or 200 V peak-to-peak AC, referenced to probe common.

TRIGGER

Internal (212 and 214 with composite trigger source)—Triggers on at least 0.2 divisions, DC to 500 kHz.

Internal (212 and 214 with channel 2 trigger source)—Triggers on 0.2 division from 2 Hz (3-dB down) to 500 kHz.

External—1 V to 16 V peak-to-peak to 500 kHz. Input R and C, 1 MΩ paralleled by approx 30 pF.

Single Sweep (214)—Sweep generator produces one sweep when trigger is received.

CRT

CRT (211 and 212)—6 x 10-division display area, each division is approx 0.2 inch. P31 phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

CRT (214)—Bistable storage. 6 x 10-division display area, each division is approx 0.2 inch.

Graticule—Internal, black line, nonilluminated.

Stored Luminance (214)—At least 8 foot lamberts.

Writing Speed (214)—Normal, at least 100 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.

Storage Viewing Time—Approx 1 hr.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating (battery only), −15°C to +55°C; Charging or operating from AC line, 0°C to +40°; nonoperating −40°C to +60°C.

Altitude—Operating, 25,000 feet, maximum operating temperature decreased by 1°C/1000 feet above 15,000 feet. Nonoperating, 50,000 feet.

Vibration—Operating and nonoperating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one-minute sweeps. Held for three minutes at 55 Hz. All major resonances must be above 55 Hz.

Shock—Operating and nonoperating; 150 g's; ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

Humidity—Operating and nonoperating; 5 cycles (120 hours) to 95% relative humidity, referenced to MIL-E-16400F.

OTHER CHARACTERISTICS

Power Sources—An internal DC source provides up to 5 hours operation (214 stored mode, up to 3.5 hours). Operating time depends on trace intensity, operating temperature and temperature during previous battery charge. Maximum operating time is achieved at +20°C to +30°C charge and operating temperature. Internal charger provides for charging the batteries when connected to an AC line with instruments turned off. DC operation is automatically interrupted when battery charge drops to approximately 10 volts to protect batteries against deep discharge. Full recharge requires approximately 16 hours (214, 8 hours). Extended charge times will not damage the batteries.

Power Sources (212 and 214)—A pilot light battery-charge indicator light will extinguish when approximately 10 minutes (5 minutes for the 214) of scope operating time remains in the batteries.

Power Source (211)—A battery meter indicates full charge at 15 volts and discharged at 10 volts.

External AC Source—110 to 126 volts, 58 to 62 Hz, (212 and 214, 3 W; 211, 2 W or less at 126 volts). Can be operated at 104 to 110 volts with resulting slow discharge of internal batteries. Power options are shown below.

	212 and 214		211	
Dimensions	**in**	**cm**	**in**	**cm**
Height	3.0	7.6	3.0	7.6
Width	5.3	13.3	5.3	13.3
Depth	9.5	24.1	8.9	22.6
Weight (approx)	**lb**	**kg**	**lb**	**kg**
w/o Accessories	3.5	1.6	3.0	1.4
Domestic Shipping	8.0	3.6	7.5	3.4
Export Packed	12.5	5.7	12.0	5.4

Included Accessories—Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); (212 and 214) 2 fuses (159-0121-00).

ORDERING INFORMATION

211 OSCILLOSCOPE, including batteries **$545**
212 DUAL-TRACE OSCILLOSCOPE, including batteries **$725**
214 DUAL-TRACE STORAGE OSCILLOSCOPE, including batteries **$985**

50 Hz POWER OPTIONS

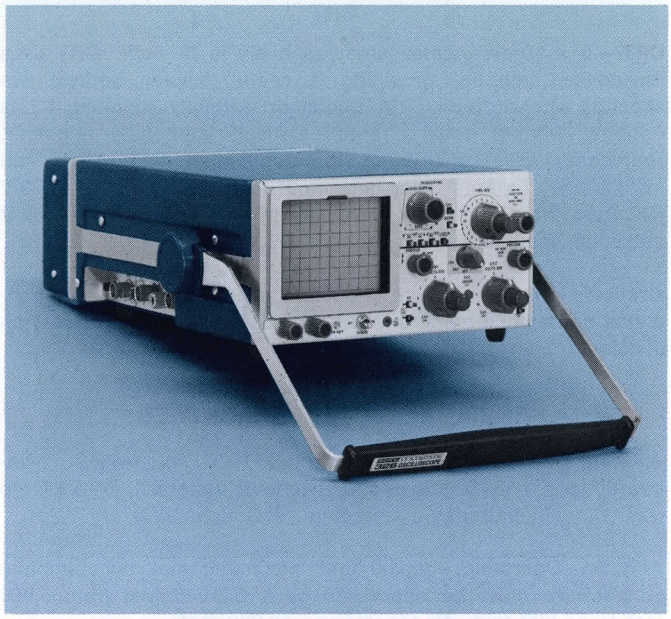
Option 1 for 220 to 250 V, includes batteries ..... **No Charge**
Option 2 for 90 to 110 V, includes batteries ..... **No Charge**

OPTIONAL ACCESSORIES

10X Attenuator Package—Includes: 10X attenuator (010-0378-00); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 ..... $27

Alligator Clip Kit—Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-00).
Order 015-0231-00 ..... $3.20

- **1 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS**
- **AC, DC or BATTERY POWERED**
- **COMPACT SIZE—WEIGHT <13 LB**
- **5-MHz BANDWIDTH at 1 mV/DIV**
- **DESIGNED for SEVERE ENVIRONMENTS**
- **CONVENIENT ACCESSORY STORAGE**



The 326 is an all solid-state, dual channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 326 features small size and light weight, together with low power consumption. Depth is 15 inches, width is 8.7 inches, height is 4.0 inches, and weight is less than 13 pounds. Power consumption is only 12 watts from an external DC source and 35 watts when powered from the AC line. Internal rechargeable batteries will provide up to 4 hours continuous operation. The portability/performance provided by the 326 Oscilloscope makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 5 MHz at 3-dB down using X10 gain. Low-frequency 3-dB-down point with AC coupling is 10 Hz or less, extending to 1 Hz or less with the included 10X probes.

Risetime— 36 ns or less; 72 ns or less using X10 gain.

Deflection Factor— 10 mV/div to 10 V/div in 10 calibrated steps (1-2-5 sequence), 1 mV/div to 1 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 110-kHz rate); Added.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage— 500 V (DC + peak AC).

Delay Line— Permits viewing leading edge of displayed waveform.

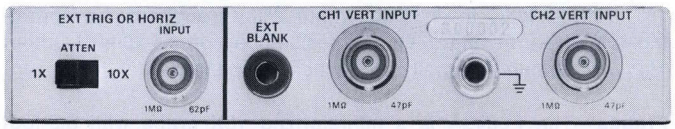
Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base— 1 μs/div to 1 s/div in 19 calibrated steps (1-2-5 sequence); accurate within 3% over the center 8 divisions from 1 μs/div to 0.2 s/div; accurate within 4% at 0.5 s/div and 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.1 μs/div. Accuracy of magnified display is within 4% over the center 8 divisions from 0.5 μs/div to 20 ms/div, within 5% at 0.1 μs/ div, 0.2 μs/div, 50 ms/div and 0.1 s/div.

External Input—Continuously variable from approx 25 mV/div to approx 1.5 V/div. AC or DC coupled. DC to at least 200 kHz at 3-dB down.



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements—0.3-div deflection or 150 mV external to 1 MHz, increasing to 1.0-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 50 kHz with AC LF REJ coupling.

CRT

CRT— 8 x 10-div display area; each div is ¼ inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your field engineer, representative or distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 50 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, nonilluminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum; maximum ambient temperature must be decreased by 1°C/1000 feet from 5,000 feet to 15,000 feet. Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

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.

Humidity—Nonoperating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probes—The P6049A is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 9 size "C" NiCd cells providing 1.5 to 4 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Charger provides for charging the internal batteries when connected to the AC line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 9 V to 32 V, requires up to 12 W.

External AC source: Operates from an external AC source of 90 V to 136 V or 180 V to 272 V. 48 to 440 Hz, 35 W maximum at 115 VAC.

Dimensions and Weights		
Height	4.0 in	10.2 cm
Width with handle	8.7 in	22.2 cm
Depth, handle not extended		
With charger	15.0 in	38.1 cm
Without charger	12.2 in	31.0 cm
Depth, handle extended		
With charger	18.2 in	46.2 cm
Without charger	15.8 in	40.1 cm
Net weight without accessories		
With charger	≈13 lb	≈5.9 kg
Without charger	≈10 lb	≈4.5 kg
Domestic shipping weight	≈21 lb	≈9.5 kg
Export-packed weight	≈29 lb	≈13.1 kg

Included Accessories—Two P6049A 10X probes (010-6049-01); carrying case (016-0532-00); strap assembly (346-0098-00); viewing hood (016-0297-00); blue light filter (426-0871-00); external DC cable assembly (012-0406-00).

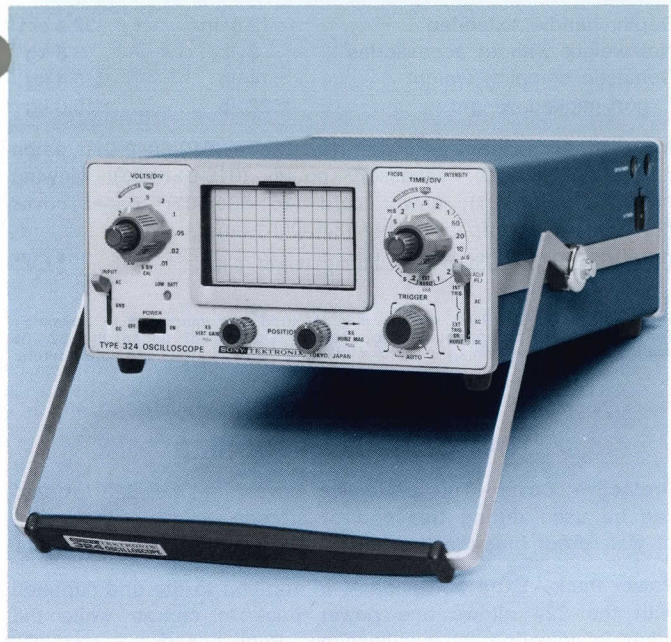
Order 326 OSCILLOSCOPE, including power pack **$1725**

The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Battery Set—Set of 9 NiCd cells, order 146-0018-00 ..... $44

Battery Pack—Includes 146-0018-00 in battery housing, order 016-0296-00 ..... $55



- **2 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS**
- **AC, DC or BATTERY POWERED**
- **COMPACT SIZE—WEIGHT ≈8 lb**
- **8-MHz BANDWIDTH at 2 mV/DIV**
- **DESIGNED for SEVERE ENVIRONMENTS**
- **CONVENIENT ACCESSORY STORAGE**

The 324 is an all solid-state, single-channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 324 features small size and light weight, together with low power consumption. Depth is 10.6 inches, width— 8.5 inches, height— 4.3 inches, weight— ≈8 pounds. Power consumption is only 8.5 watts from an external DC source and 20 watts when powered from the AC line. Internal rechargeable batteries will provide up to 3 hours continuous operation. The portability/performance provided by the 324 Oscilloscope makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 8 MHz at 3-dB down using X5 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime— 36 ns or less; 45 ns or less using X5 gain.

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 2 mV/div to 4 V/div using X5 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage— 500 V (DC + peak AC).

HORIZONTAL DEFLECTION

Time Base—1 μs/div to 0.2 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.1 s/div; accurate within 4% at 1 μs/div, 2 μs/div and 0.2 s/div. Uncalibrated, continuously variable between steps and to approx 0.5 s/div.

X5 Magnifier—Operates over full time base, increases fastest sweep rate to 0.2 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 1 μs/div to 20 ms/div, within 5% at 0.2 μs/div, 0.4 μs/div, and 40 ms/div.

External Input—Continuously variable from approx 25 mV/div to approx 2.5 V/div, AC or DC coupled. DC to at least 200 kHz at 3-dB down.

Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements— 0.3-div deflection or 100 mV external to 1.5 MHz, increasing to 1-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 15 kHz with AC LF REJ coupling.

CRT

CRT— 6 x 10-div display area; each div is 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4 inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The P6049A is a miniaturized 10X probe with 3.5 foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 6 size "C" NiCd cells providing 1 to 3 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 6.5 V to 16 V, requires up to 8.5 W.

External AC source: Operates from an external AC source of 115 V ±10%, or 230 V ±10%. 48 to 440 Hz, 20 W maximum at 126 VAC.

Dimensions and Weights—

Height with accessory pouch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with AC power cord	9.3 in	23.5 cm
Depth, handle not extended	10.6 in	27.0 cm
Depth, handle extended	12.8 in	32.4 cm
Net weight without accessories	8 lb	3.6 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈22 lb	≈10.0 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-02); panel cover (200-0812-00); strap assembly (346-0051-00).

Order 324 OSCILLOSCOPE, including power pack $1325

The SONY®/TEKTRONIX® 324 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 324 is available from Tektronix,Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $11

Power Pack—Extra power pack, in addition to the one supplied with the 324 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0160-02 ..... $110

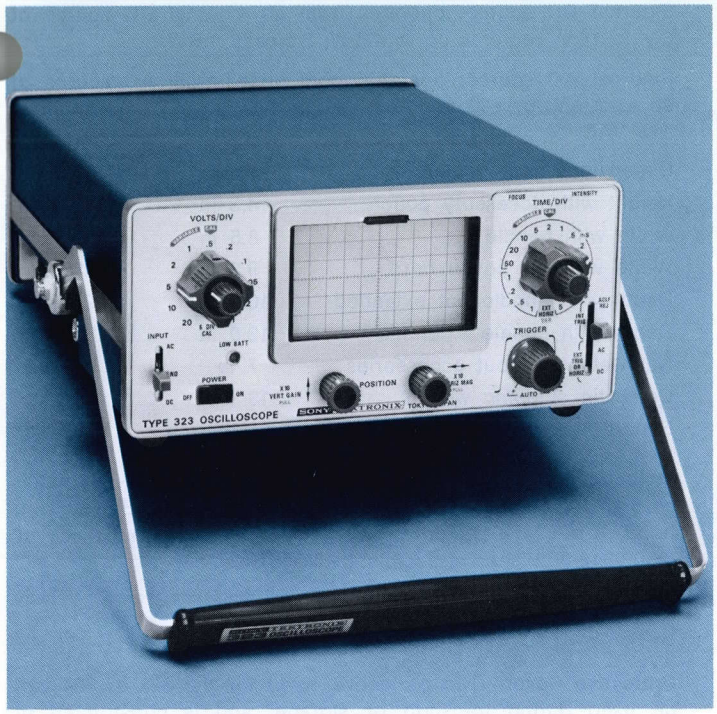
Battery Set—Set of 6 NiCd cells, order 146-0012-01 .. $25.30

PORTABLE TIME DOMAIN REFLECTOMETER

The 324, when packaged with a 1501 Time Domain Reflectometer (TDR), becomes a portable unit used to detect and locate faults and to measure impedance variations in transmission cables out to 10,000 feet through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever transmission or power cable systems are used, whether it be in-plant, or in the field, above or below ground.

The 1501 is especially designed for use with a 324 battery-powered oscilloscope, but other oscilloscopes can be used. The 1501 can be used without an oscilloscope if a strip chart recorder is plugged into a center compartment in the 1501. Each strip chart is four centimeters wide by 32.5 centimeters long to allow permanent, inexpensive, high-resolution TDR plots of entire cables, or any particular portion of a cable. Notes may be handwritten on each chart.

The chart recorder in the 1501 can also be driven by the 1401A or 1401A-1 Spectrum Analyzer. Refer to the Spectrum Analyzer section of this catalog for complete specifications and ordering information for the 1501, 1401A, and 1401A-1.



- **1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS**
- **AC, DC or BATTERY POWERED**
- **COMPACT SIZE—Weight ≈7 lb**
- **UP to 7 HOURS OPERATION from INTERNAL BATTERY PACK**
- **DESIGNED for SEVERE ENVIRONMENTS**
- **CONVENIENT ACCESSORY STORAGE**

The 323 is an all solid-state, single-channel, 4-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 323 features small size and light weight, together with extremely low power consumption. Depth is 10.6 inches, width— 8.5 inches, height— 4.3 inches, weight— ≈7 pounds. Power consumption is up to 4.5 watts (typically 1.6 watts) from an external DC source, and 14 watts when powered from the AC line. Internal rechargeable batteries will provide up to 7 hours continuous operation, sufficient for a full working day. The portability/performance provided by the 323 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications; for example, industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 4 MHz at 3-dB down. DC to at least 2.75 MHz at 3-dB down using X10 gain. Low-frequency 3-db-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime—90 ns or less; 130 ns or less using X10 gain.

Deflection Factor—10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 1 mV/div to 2 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/div.

Input R and C—1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage—500 V (DC + peak AC).

Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

HORIZONTAL DEFLECTION

Time Base—5 μs/div to 1 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.2 s/div; accurate within 4% from 0.5 s/div to 1 s/div. Uncalibrated, continuously variable between steps and to at least 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.5 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/div, 50 ms/div, and 0.1 s/div.

External Input—Continuously variable from approx 20 mV/div to approx 30 V/div, AC or DC coupled. DC to at least 10 kHz at 3-dB down.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300 V maximum input voltage (combined DC + peak AC).

Amplitude Requirements—0.3-div deflection or 75 mV external to 400 kHz, increasing to 0.75-div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 30 kHz with AC LF REJ coupling.

The SONY®/TEKTRONIX® 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

CRT

CRT—6 x 10-div display area; each div is ¼ inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of Mil-Std-202C. Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity.

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The P6049 is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: removable power pack contains 6 size "C" NiCd cells providing 3- to 7-hours of operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Front-panel light indicates when internal batteries are low, or when external DC source is low. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: operates from an external DC source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.

External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 VAC.

Dimensions and Weights—

Height with accessory pouch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with AC power cord	9.3 in	23.5 cm
Depth with handle not extended	10.6 in	27.0 cm
Depth with handle extended	13.0 in	33.0 cm
Net weight without accessories	7 lb	3.2 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-02); panel cover (200-0812-00); strap assembly (346-0051-00).

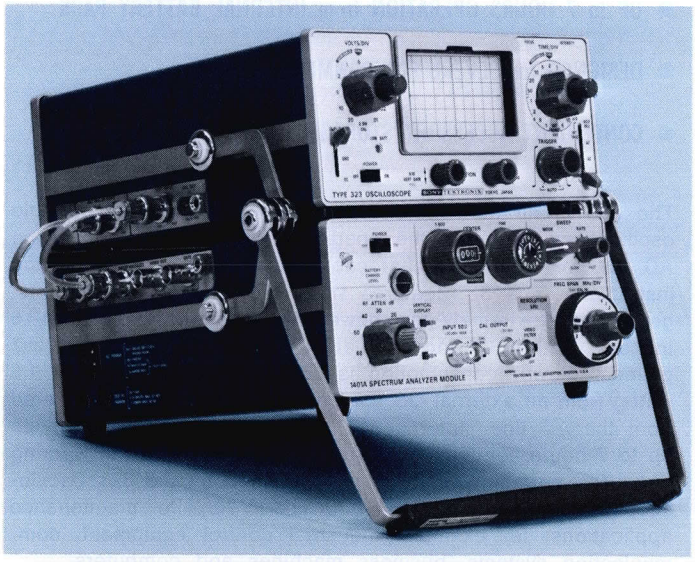
Order 323 OSCILLOSCOPE (includes power pack) $995

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $11

Power Pack—Extra power pack, in addition to the one supplied with the 323 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0119-02 ..... $110

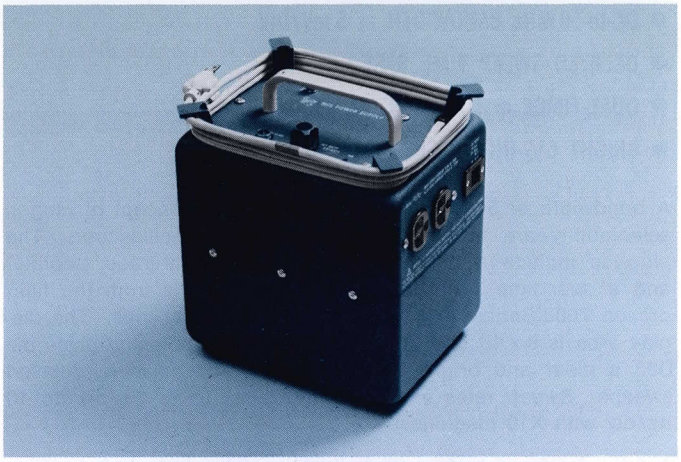
Battery Set—Set of 6 NiCd cells, order 146-0012-01 .. $25.30



PORTABLE SPECTRUM ANALYZER SYSTEM

The 323 Oscilloscope becomes a frequency domain measurement tool when used with the Tektronix 1401A 1-to-500 MHz Spectrum Analyzer Module. AC, DC, or battery power may be used for this 15-pound system. A complete description of the 1401A and the 1401A/323 System is found in the Spectrum Analyzer section.

- PORTABLE POWER SOURCE
- 115-230 VAC OUTPUT
- INTERNAL NiCd BATTERIES



The 1105 is a rechargeable battery power supply. It furnishes 108 to 137.5 VAC, 60 Hz squarewave at a 140 watt hour rate. The 20 Type F nickel cadmium cells are rechargeable from 90 to 132 VAC (220 VAC with Option 1), 50 to 60 Hz and 24 to 30 VDC. Internal sensing circuitry automatically switches the charge rate to trickle charge when the batteries are fully charged and reduces the possibility of battery damage by preventing deep discharge.

The application possibilities of the 1105 are not confined to scopes. It can be used to power any device or combination of devices that will operate from a 115 VAC, 60 Hz squarewave at up to 140 watts. With the 1105 Battery Power Supply, the necessity to carry the dead weight of an instrument's internal power pack to locations where ample commercial power is available is eliminated. Noisy or poorly regulated commercial power can be avoided. It is no longer necessary to make the portable/non-portable decision at initial purchase.

POWER OUTPUT

Output Waveform—Squarewave

Frequency— 60 Hz within 10%

Amplitude— 0 volts to approximately 108 volts when operating from a 24 VDC external source or 22 volts internal charge, with a 0.9 A load. 0 volts to 137.5 volts when operating from a 28 VDC external source or 30 volts internal charge, with a 0.9 A load.

Battery Operating Time—Approximately 140 watt/hours from fully charged internal batteries.

Recommended Max Output Current (0°C to +40°C)— 0.9 amp.

POWER SOURCE (Charging)

AC Requirements— 100 to 132 VAC, 48 to 440 Hz, 90 to 120 VAC, 180 to 240 VAC or 200 to 264 VAC with internal connection change.

Power Source (External DC Operating)— 24 to 30 volts. Maximum elevation for + or — power lead is 60 V with respect to chassis ground.

Power Consumption—Approximately 35 watts

Battery Charging Time— 14 to 16 hours

ENVIRONMENTAL CAPABILITIES

Temperature—Operating (0°C to +40°C). Nonoperating, with batteries, (—40°C to +60°C); without batteries, (—55°C to +75°C).

1105 OPTION 1 (220 V)

1105 Option 1 specifications are the same as above except as follows:

POWER OUTPUT

Amplitude—Approximately 216 volts 0 to peak from 22 volts internal battery charge or 24 volts external DC source, with 0.45 A load. Approximately 275 volts 0 to peak from 28 volts internal battery charge or 30 volts external DC source, with 0.45 A load.

POWER SOURCE (Charging)

AC Requirements— 200 to 264 VAC, 48 to 440 Hz. 180 to 240 with internal connection change. The 1105 Option 1 is supplied with an IEC power cord and output connector.

OTHER CHARACTERISTICS

Dimensions and Weights

Height	9.8 in	24.9 cm
Width	6.5 in	16.5 cm
Depth	8.3 in	21.0 cm
Weight	19.4 lb	8.8 kg
Domestic Shipping Weight	≈21.4 lb	≈9.7 kg
Export Packed Weight	≈28.4 lb	≈12.9 kg

Included Accessory—Power cord, external DC (161-0094-00).

ORDERING INFORMATION

1105 BATTERY POWER SUPPLY **$475**

INSTRUMENT OPTION

Option 1, 230 V OPERATION ..... **No Charge**

TELEQUIPMENT PRODUCTS
D83 *50-MHz Dual-Trace Oscilloscope*

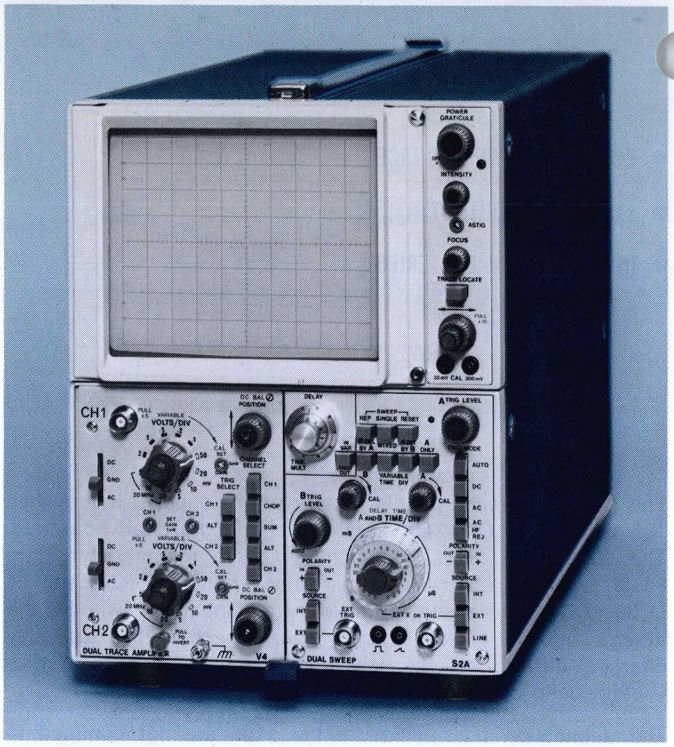
TELEQUIPMENT

- **DC-to-50 MHz BANDWIDTH at 5 mV/DIV**
- **DELAYED SWEEP TIME BASE**
- **DUAL-TRACE or DIFFERENTIAL AMPLIFIER**
- **BRIGHT 6½-INCH DISPLAYS**

A bandwidth of 50 MHz at 5 mV/div and the concept of plug-in selectability are the main features of this oscilloscope. The plug-ins include a differential amplifier, a dual-trace amplifier and a dual time base. The CRT in the D83 is from the field proven 7000-Series TEKTRONIX line of oscilloscopes. The display area is 8 x 10 div. A 15-kV accelerating potential gives the D83 a clear and bright display to view and measure delayed sweeps. Sweep rates extend from 100 ns/div to 2 s/div (to 10 ns/div with X10 magnifier).

A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 350-kHz rate), alternate and added. Signal delay permits viewing the leading edge of the waveform.

D83 OSCILLOSCOPE **$800**
V4 DUAL-TRACE AMPLIFIER **$295**
V3 DIFFERENTIAL AMPLIFIER **$295**
S2A DUAL TIME BASE **$400**



DM64 *Dual-Trace Bistable Storage Oscilloscope*

- **DC-to-10 MHz BANDWIDTH at 1 mV/CM**
- **BISTABLE STORAGE and CONVENTIONAL DISPLAYS**
- **CONVENIENT X-Y OPERATION**
- **DUAL TRACE**
- **8 x 10-cm VIEWING AREA**

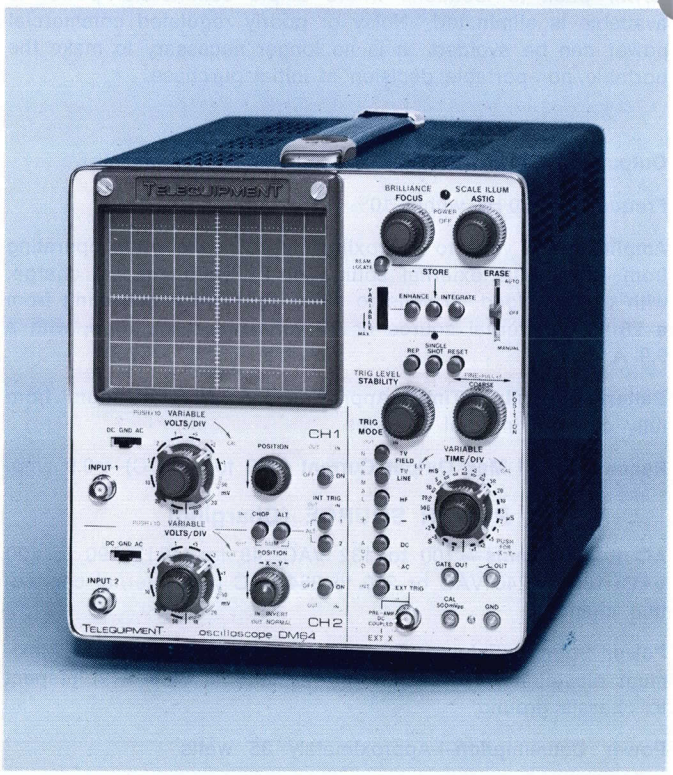
The world's least expensive bistable storage oscilloscope is now here in the TELEQUIPMENT product line. The heart of this oscilloscope is the proven CRT from the TEKTRONIX 560-Series Oscilloscope storage line. The CRT is the single screen version of the 564 and utilizes an 8 x 10-cm display area.

The normal stored writing speed is at least 25 cm/ms but the writing speed can be increased to at least 250 cm/ms by implementing the Enhanced Mode. The storage view time is one hour or less. Coupled with this storage CRT is the ability to measure X-Y relationships with the same ease as measuring Y-T.

The bandwidth of the DM64 is 10 MHz with a deflection factor of 10 mV/cm, using the X10 gain will extend the sensitivity to 1 mV/cm. Sweep rates extend from 100 ns/div to 2 sec/div. A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 150 kHz rate), alternate and added.

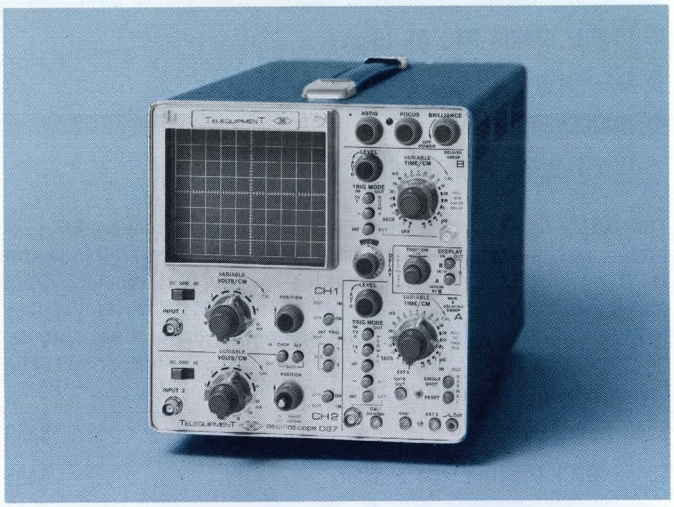
DM64 OSCILLOSCOPE **$1095**

The products on these three pages are manufactured and marketed in the United Kingdom by Telequipment, London, England. Outside the United Kingdom they are available from Tektronix, Inc., its marketing subsidiaries and distributors. Warranty, sales and service are the same as for other TEKTRONIX products.



For complete information on these and other TELEQUIPMENT products just check and return the reply card at the front of this catalog.

25-MHz Dual-Trace Oscilloscope D67

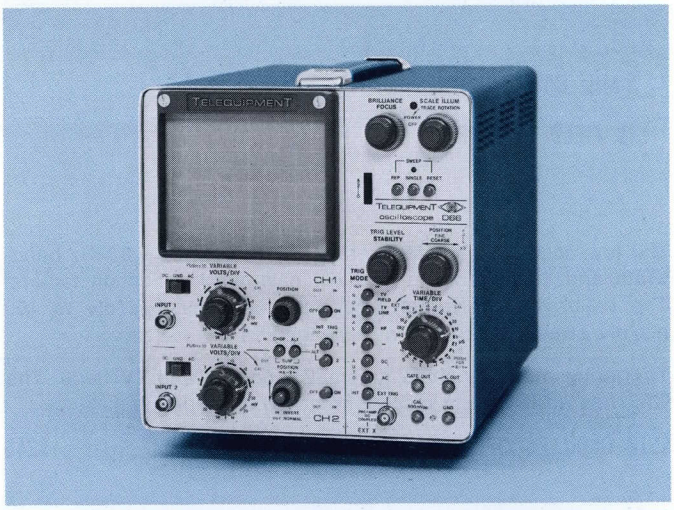


- 25-MHz BANDWIDTH at 10 mV/CM
- 3% MEASURING ACCURACY
- DELAYED SWEEP TIME BASE
- ALL SOLID-STATE DESIGN
- LARGE, BRIGHT 8 x 10-CM DISPLAY

The D67 offers an impressive array of specifications normally found only in high-priced oscilloscopes. Features include • 25-MHz bandwidth • delaying sweep • 3% accuracy • 10 mV sensitivity • sweep rates from 200 ns/cm to 2 s/cm • dual trace with signal delay line • FET inputs • all solid-state design.

D67 OSCILLOSCOPE **$975**

25-MHz Dual-Trace Oscilloscope D66



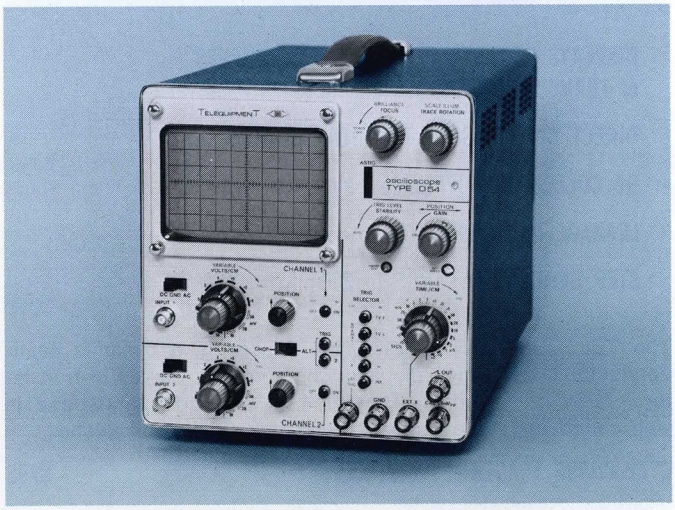
- 25-MHz BANDWIDTH at 10 mV/CM
- MINIMUM DEFLECTION FACTOR 1 mV/CM
- SWITCHED X-Y OPERATION
- LARGE, BRIGHT 8 x 10-CM DISPLAY

The D66 provides 25 MHz bandwidth at 10 mV/cm. X10 gain expands the sensitivity to 1 mV/cm at 15 MHz bandwidth. Sweep rates extend from 2 sec/cm to 100 ns/cm (to 20 ns/cm with X5 Magnifier).

An X-Y function on the D66 projects the TELEQUIPMENT product line into areas recently held only by higher priced oscilloscopes. Bandwidth is DC to 1 MHz and phase error is less than 1° at 25 kHz. A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 80-kHz rate), alternate and added. Signal delay allows viewing the leading edge of the display.

D66 OSCILLOSCOPE **$795**

10-MHz Oscilloscopes D54



- 10-MHz BANDWIDTH at 10 mV/CM
- ALL SOLID-STATE DESIGN
- TRIGGERED SWEEP
- 6 x 10-cm VIEWING AREA

Represents a new standard of performance for low-priced oscilloscopes. Features include: • 10-MHz bandwidth • 10-mV sensitivity • sweep rates from 200 ns/cm to 2 s/cm • FET inputs • bright trace • all solid-state design. Other features such as variable controls, probe calibration outputs, illuminated graticule and television field or line triggering make the instrument easy to use and versatile.

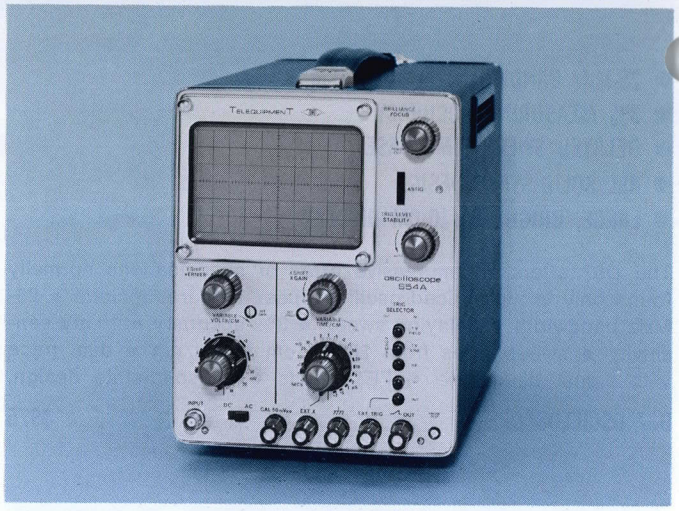
D54 OSCILLOSCOPE **$595**

D54R OSCILLOSCOPE (Rackmount) **$640**

TELEQUIPMENT PRODUCTS
S54A *10-MHz Oscilloscopes*

TELEQUIPMENT

- 10-MHz BANDWIDTH AT 10 mV/cm
- ALL SOLID-STATE
- TRIGGERED SWEEP
- TV FIELD OR LINE TRIGGERING



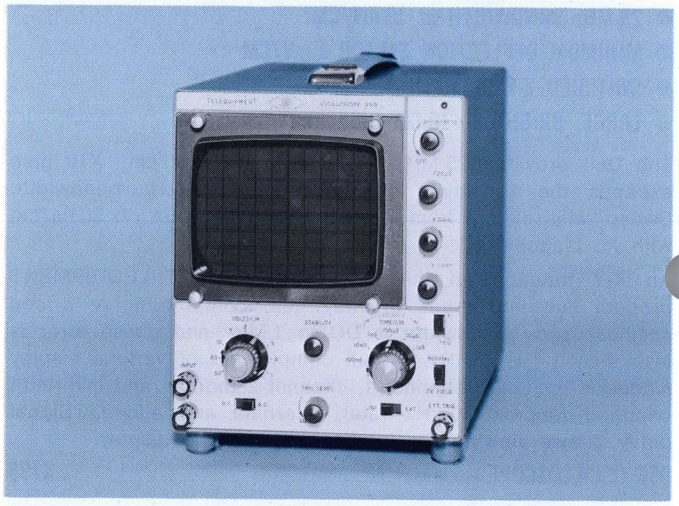
The S54A represents a new standard of performance for low-priced oscilloscopes. Features include: ● 10-MHz bandwidth ● 10-mV sensitivity ● sweep rates from 200 ns/cm to 2 s/cm ● FET inputs ● bright trace ● all solid-state design. Other features such as variable controls, probe calibration outputs, illuminated graticule and television field or line triggering make the instrument easy to use and versatile.

S54A OSCILLOSCOPE **$450**

S54AR OSCILLOSCOPE (Rackmount) **$495**

S51B *3-MHz Oscilloscope*

- 3-MHz BANDWIDTH
- TV FIELD TRIGGERING



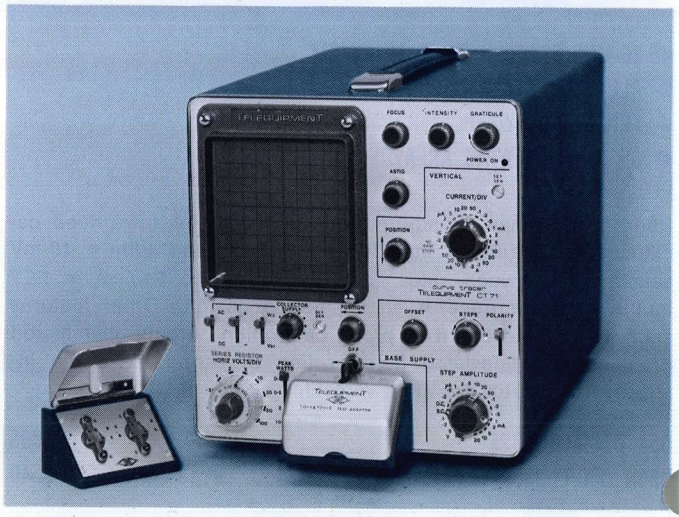
The low cost and easy to operate, S51B features a 3 MHz bandwidth and 100 mV/div to 50 v/div calibrated deflection factors. The calibrated horizontal time base provides 1 μs/div to 100 ms/div sweep rates, and a x2 magnifier.

Triggering modes include automatic, normal and TV field. The CRT has an 8 x 10 cm display area and a Z-axis input.

S51B OSCILLOSCOPE **$245**

CT71 *Curve Tracer*

- DISPLAYS DYNAMIC CHARACTERISTIC CURVES of TRANSISTORS, DIODES and FETS
- DIRECT COMPARISON of SIMILAR DEVICES
- DC COLLECTOR SUPPLY to 1 kV
- LEAKAGE MEASUREMENTS to 5 nA
- STEP GENERATOR RANGE to 200 mA or 20 V



The TELEQUIPMENT CT71 Curve Tracer is a dynamic semiconductor tester which displays characteristic curves of transistors, FETs and diodes. The CT71 is easy to operate and is well suited for student lab use and industrial applications.

CT71 CURVE TRACER **$795**

Added Dimensions in Spectrum Analysis

The increasingly crowded spectrum requires the resolution, stability and spurious-free performance of the 7000-Series Analyzers. These analyzers are superior in their frequency range, giving you the added dimensions of the 7000 Series, providing you with more information from your simplest, or most complex applications. 7000-Series Analyzers are also easier to use. Simply stated, we believe they're a good buy.

The TEKTRONIX **7L12** and **7L13** Spectrum Analyzers are both built to make exacting measurements of signals ranging up to 1800 MHz, using swept front-end techniques. The units are similar in function and application, except that the 7L13 has the additional features of 30-Hz resolution bandwidth and less than 10 Hz of internal FM'ing (phase locked). The units provide both frequency domain and time domain functions. Because they are part of the 7000 Series, 7L12 and 7L13 users are offered all the benefits of a growing, innovative group of Tektronix products. The feature comparison chart will show the features that are equal or similar and indicate the features unique to each unit. In the description and specifications, statements refer to either analyzer, except where noted.

Much effort has gone into human engineering factors to make the 7L12 and 7L13 operation easier and to reduce the chance of human error. A case in point is CRT READOUT, a unique, automatic way of putting display parameters on screen for ease of display interpretation and photographic recording. 7000-Series mainframes with CRT READOUT will display Reference Level, dB/div, Frequency Span, Resolution and Time/div on screen when used with either analyzer. In addition, Center Frequency and Video Filter Bandwidth will be displayed when used with the 7L13. All display parameters are calibrated and quantitative information is displayed on both front panel and CRT READOUT. CRT READOUT of display parameters is another unique Tektronix Spectrum Analyzer feature.

Another human engineering innovation is the RF input and reference level self-computing differential mechanism. This mechanism provides direct readout of the full-screen reference level, RF attenuation, and maximum input power for linear operation. Values are presented in dBm on the front panel. The 7000-Series Oscilloscope mainframes with CRT READOUT will also display the full screen reference level value in dBm on the CRT. The 7L13 displays center frequency with LED and CRT READOUT. A panel indication showing an uncalibrated condition appears when display sweeping rates are faster than optimum on the 7L13.

Noise-level measurements are easy to make on both units and interfering noise, on other displays, is minimized by a selection of video filtering. Each of these units feature horizontal amplifier, time base and trigger functions for time domain displays. The Tektronix-introduced 3-MHz resolution mode enhances narrow-pulse spectrum analysis and provides demodulation of your signal for time-domain waveform measurements. A means is provided for using an external sweep source to slave the 7L13 to an external device, such as a recorder.

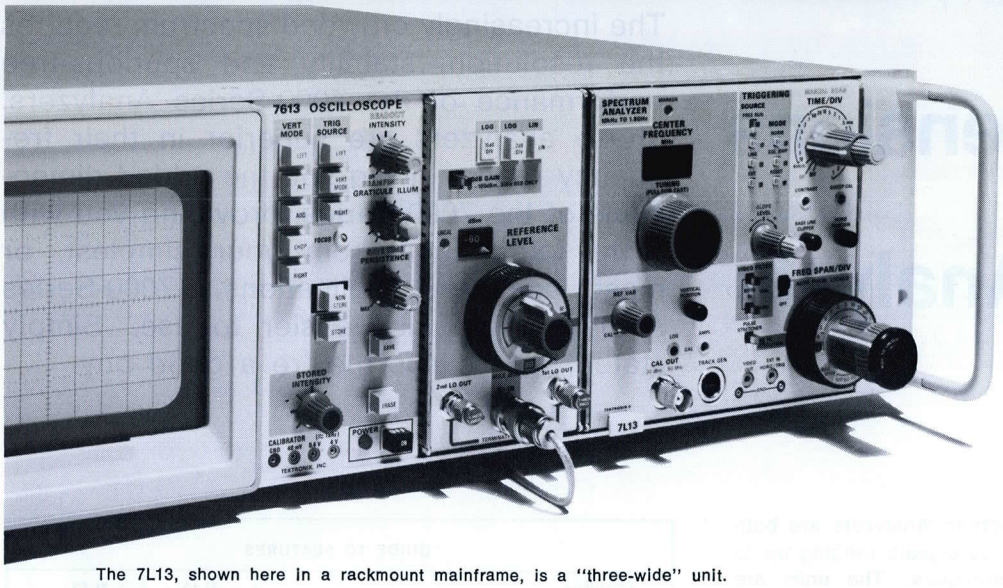
GUIDE TO FEATURES

Features	7L12	7L13
0-1800 MHz Use	X	X
70-dB Dynamic Range	X	X
Fully Calibrated Displays	X	X
Spurious Free	X	X
IM ≤70 dB	X	X
Auto Phase Lock	X	X
30-Hz Resolution Bandwidth		X
300 Hz to 3 MHz Res. Bandwidth	X	X
≤10 Hz FM'ing		X
—115 dBm Sensitivity	X	
—125 dBm Sensitivity		X
CRT READOUT		
Center Frequency		X
Video Filter Bandwidth		X
Reference Level	X	X
dB/div	X	X
Resolution Bandwidth	X	X
Frequency Span	X	X
START Mode	X	
Calibrator	X	X
Front Panel Provision for Tr Gen		X
Provision for Recorder	X	X
Time Domain Mode	X	X
Simultaneous Frequency and Time Domain Mode	X	
Resolution Bandwidth Shape Factor 4 to 1 (Except at 30 Hz in 7L13)	X	X
Use Below Tuning Range to 0 Hz	X	X
Recommended Mainframe	All	Storage
Noise Level Measurement	X	X
Pulsed RF Measurements	X	X
Plug-in Width	2	3
Single Knob Tuning		X
LED Readout Center Frequency		X

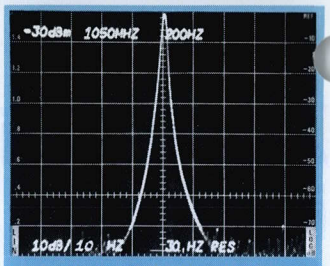
Examine specifications for complete information.

SPECTRUM ANALYZER
7L12, 7L13 *0 - 1800 MHz Plug-ins*

New

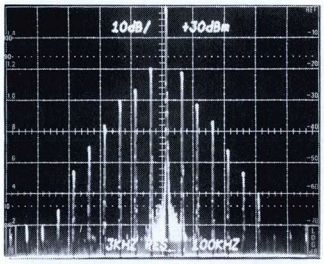


The 7L13, shown here in a rackmount mainframe, is a "three-wide" unit.

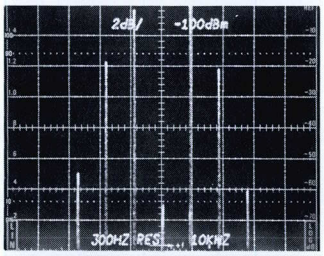


A signal at 1050 MHz showing the exceptional 30-Hz resolution bandwidth capability of the 7L13. Note the CRT READOUT of center frequency. (Mainframe 7904)

1



2



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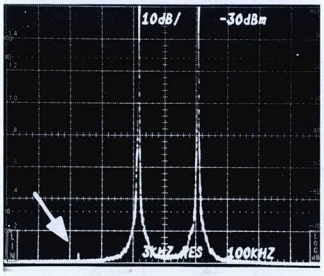


(1) Measure signals all the way from one watt down to 5 x 10^{-15} watt. This is a display of a +30 dBm level carrier and sidebands. Sideband levels in the display range down to 70 dBm below the reference level of +30 dBm.

(2) You can accurately measure small amplitude difference, even at the maximum sensitivities. The frequency modulated carrier of —113 dBm (center screen) is clearly displayed free of noise.

(3) Spurious-free measurements—Here two full-screen signals, at —30 dBm separated by about 200 kHz, result in a very small intermodulated distortion product (arrow) of approximately —110 dBm, 10 dB outside the specified 70-dB dynamic range.

(4) Display and measure more signals without changing plug-ins. You can display a full 0-1800 MHz spread of signals. The fundamental and the second and third harmonic of a 600-MHz signal are all seen together in this display.

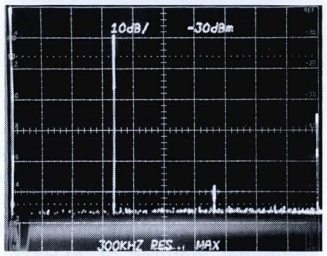
(5) The 300-Hz resolution bandwidth of the 7L12 sharply resolves signals even where frequency separation is small.

(6) Simultaneous real-time scope and spectral displays make up one of the unique Tektronix approaches to RF measuring systems. (Mainframe 7904 with 7A19, 7L12 and 7B92).

(7) Here the modulation envelope (lower trace) is compared simultaneously to the original modulating pulses (upper trace). Pulse modulation envelopes can be displayed because of the Tektronix 3-MHz resolution bandwidth mode for time-based displays.

Numbered displays were photographed with a 7L12. Examine specifications for complete performance information.

4



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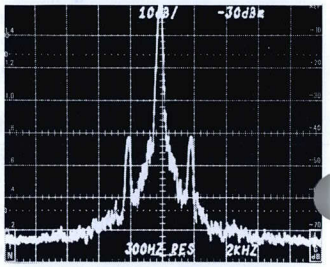

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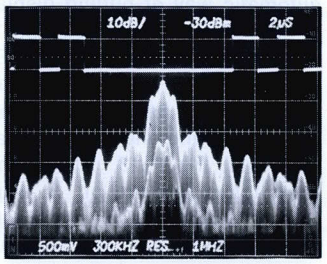

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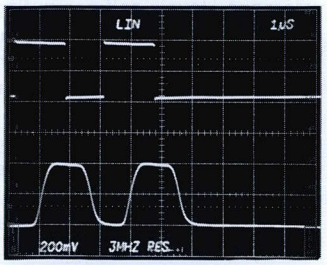


OTHER TEKTRONIX ANALYZERS

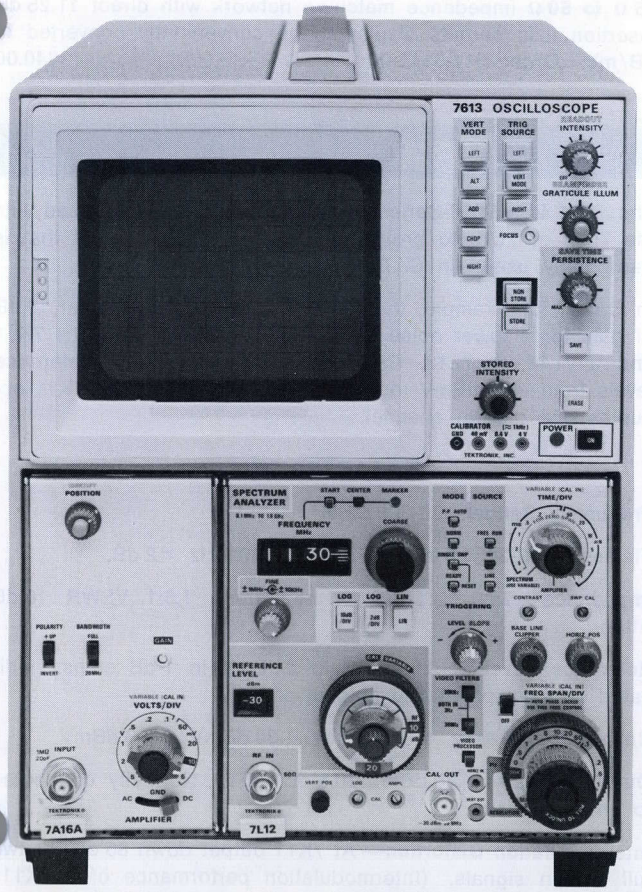
TEKTRONIX Spectrum Analyzers such as the 491, 1401A and the analyzers plug-ins for 530/540/550 and the 560 Series have proven to be particularly valuable in selected application areas. Full descriptions are located in this section.

7L12:	**100 kHz to 1.8 GHz,**
7L13:	**10 kHz to 1.8 GHz,**
1L5 and 3L5:	**50 Hz to 1 MHz,**
1L20:	**10 MHz to 4.2 GHz,**
491:	**10 MHz to 40 GHz,**
491 Option 1:	**10 MHz to 2.0 GHz,**
491 Option 2:	**1.5 GHz to 40 GHz,**
1401A (50 Ω) and 1401A-1 (75 Ω):	**1 MHz to 500 MHz.**

The 7L13 is a swept front-end spectrum analyzer plug-in with exceptionally useful resolution over the range of 10 kHz to 1800 MHz. Resolution bandwidth is 30 Hz with incidental FM'ing reduced to only 10-Hz maximum by phase locking. Excellent long-term stability and absence of FM'ing make possible separation and measurements of signals with very small frequency differences. This capability will enable engineering and service activities to meet the demands of those working in the increasingly crowded and sophisticated area of high frequency communications.

Both units feature 4-to-1 resolution shape factor, in the range of resolution bandwidths from 300 Hz to 3 MHz, enabling users of these analyzers to measure low-amplitude signals that are located close to full screen signals. At 30-Hz resolution bandwidth, the 7L13 has 12-to-1 shape factor.

The 7L12 is a two-wide plug-in and the 7L13 is a three-wide plug-in unit. These swept front-end analyzers, when used with any 7000-Series Oscilloscopes, display a spectrum of signal energy within any frequency span to 1.8 GHz. If your work requires separation of signals with very small frequency differences, we suggest consideration of a storage mainframe for increased usefulness at the sweep rates required to achieve accurate displays at narrowest resolution and video filter settings. Be sure to read "Note about Phosphors and Graticules" before making a mainframe selection. Full mainframe specifications are located elsewhere in this catalog.



The 7L12 Spectrum Analyzer in a cabinet-type mainframe is easily carried.

CHARACTERISTICS

Frequency Tuning Range—7L13 range is 10 kHz to 1.8 GHz. Resolution is within 1 MHz. Accuracy is ± (5 MHz + 20% of frequency span/div). 7L12 range is 100 kHz to 1.8 GHz continuously variable; accuracy ± (10 MHz + 1% of dial indication).

Frequency Span—Calibrated steps, in 1-2-5 sequence from 200 Hz/div to 100/div MHz (7L13). 500/div Hz to 100/div MHz (7L12). Accuracy is within 5% of the span selected and linearity is within 5%, over the center 8 division of a 10 division display. A MAX SPAN position provides approximately 1.8 GHz (1800 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Display Flatness— ±1.5 dB over any selected frequency span, with respect to the display level at 50 MHz.

LOG 10 dB/div Mode—Provides a calibrated 70-dB dynamic range. Accuracy within ±0.1 dB/dB to a maximum of 1.5 dB over the 70-dB dynamic range.

LOG 2 dB/div Mode—Provides a calibrated 14-dB dynamic range. Accuracy within ±0.4 dB/2 dB to a maximum of 1.0 dB over the 14-dB range.

Linear Mode—Provides a linear display, within 10% over the graticule height.

Reference Level—Calibrated levels in decade steps, from —100 dBm to +30 dBm, within ±2 dB extended to —110 dBm to +30 dBm in the 7L13. (Includes attenuator and gain switching effects when the two are not off-setting each other.) In the 7L13, a UNCAL indicator signifies when the display is not calibrated, due to sweep rates exceeding optimum.

Calibrator— 50 MHz ±0.01% with an absolute amplitude level of —30 dBm to ±0.3 dB.

RF Attenuator—Calibrated 10 dB steps. Accuracy, ±0.2 dB or 1% of dB reading, whichever is greater.

Gain—Range is 70 dB with a gain selector extended to 80 dB in the 7L13, when operating with 30-Hz resolution bandwidth. The selector is an eight-position switch that changes the IF gain in 10-dB steps. Four positions (blue sector) provide three 10-dB steps, for a total of 30-dB gain change in the 10-dB/div display mode. All eight positions of the selector provide 70 dB of gain change in the 2 dB/div and LIN display modes. In the 7L13 the additional 10 dB, for 30-Hz resolution, is selected with a push button. Accuracy is within ±1 dB/10 dB step to a total of ±1.5 dB when the VARIABLE control is in its CAL detent. The VARIABLE control with approximately 10-dB range, provides continuous gain adjustment between each calibrated step.

Resolution—Resolution bandwidth selections from 30 Hz to 3 MHz (7L13), and 300 Hz to 3 MHz (7L12) in decade steps are provided. Bandwidth accuracy, at the 6-dB down level, is within 20% of the resolution selected. Shape factor over the 60 dB to 6 dB level is 12:1 or better for 30-Hz resolution and 4:1 or better for 300-Hz to 3-MHz resolution settings. Signal level change over all bandwidths is less than 0.5 dB.

Sensitivity for a CW Signal (Signal + noise = twice noise)—in LIN vertical Mode. —125 dBm at 30 Hz (7L13 only), —115 dBm at 300 Hz, —108 dBm at 3 kHz, —100 dBm at 30 kHz, —90 dBm at .3 MHz, —80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Intermodulation Distortion—The third order is down 70 dB or more from two —30 dBm signals within any frequency span.

SPECTRUM ANALYZER
7L12, 7L13 *0 - 1800 MHz Plug-ins*

New

Second order is down 70 dB or more from two —40 dBm signals.

Spurious Signals from Internal Sources (Residual Response)— Equal to or less than —100 dBm, referred to the first mixer input when terminated in 50 Ω.

Incidental FM'ing (7L13)— 10 Hz (P-P) when phase locked. 20 kHz (P-P) for 5 seconds when not phase locked.

Incidental FM'ing (7L12)— Phase locked mode: 200 Hz (P-P) maximum; not phase locked: 20 kHz (P-P) maximum.

Stability (7L13)— Within 2 kHz, 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.

Maximum Input Power Level— —30 dBm with the RF attenuator at 0 dB, for linear operation. +30 dBm with the RF attenuator at 60 dB. (+30 dBm is also the power rating of the RF attenuator.) NOTE: The maximum input power level to the RF attenuator is 1 watt average and 200 watts peak. Maximum safe input is +30 dBm.

Sweep Modes and Rate—Selection of an external sweep source, manual sweep, or calibrated sweep rates from 10 s/div to 1 μs/div, in a 1-2-5 sequence are provided. Sweep rate accuracy is within 2% of that selected.

Triggering—The trigger signal source can be external, internal, or the line voltage. The signal is AC coupled from the line or internal source and DC coupled from the external source. Frequency range is approximately 15 Hz to 1 MHz.

Note about Phosphors and Graticules— 7000-Series mainframes, except storage versions, are normally shipped with P31 phosphor. Slow swept displays sometimes are more easily viewed with P7 phosphor (an option with most mainframes). Check mainframe specification before ordering. External spectrum analyzer graticules for 7000-Series mainframes come with the units (see included accessories). See mainframe specification for availability of CRT option with internal spectrum analyzer graticules.

Included Accessories—Spectrum Analyzer Graticule: Clear plastic implosion shield with LOG, LIN, REF and f (frequency) direction markings. TEKTRONIX Part No. 337-1439-01 for 7403N Oscilloscope and 337-1159-02 for other 7000-Series Oscilloscopes. Filter Light Amber (378-0684-01); 50 Ω Coaxial Cable, with BNC connectors, 6 foot (012-0113-00); BNC Male to N Female Adapter (103-0058-00).

Order 7L12 SPECTRUM ANALYZER **$4850**
Order 7L13 SPECTRUM ANALYZER **$6500**

RECOMMENDED ACCESSORIES

P6201 Probe—For those measurements sensitive to loading, you should consider the P6201 Active Probe with bandwidth of DC to 900 MHz and with loading effects of only 100 kΩ, 3 pf with no attenuation, and 1 meg/1.5 pf with 10X attenuation.

A DC block 015-0221-00 is required for analyzer input protection.

P6201 6-FT PROBE order 010-6201-01 ..... $395

DC Block (For applying signals riding on a DC potential.) Maximum potential is 50 V DC. Order 015-0221-00 ..... $18.50

75 Ω to 50 Ω minimum loss attenuator with DC block. Order 011-0112-00 ..... $27.50

75 Ω to 50 Ω impedance matching network with direct 11.25 dB insertion loss permits display to be conveniently converted to dB/mV. Order 011-0118-00 ..... $40.00

7K11 *CATV Preamplifier*

New

The 7K11 is a 7000-Series Plug-in Preamplifier to be used with the 7L12 or 7L13 to provide the full 75-Ω environment that is particularly useful in CATV spectrum analysis.

In CATV, for example, the 7K11 provides the additional 19 dB of gain for a lower noise and better sensitivity. With the 7K11 and a 7L12 or 7L13, CRT READOUT will display reference levels from +79 dBmV to 0 dBmV in 1-dB steps. The 7K11 occupies one plug-in channel.

CHARACTERISTICS

Frequency Range— 30-890 MHz.

Flatness— 50-300 MHz ±0.5 dB. 30-890 MHz ±2 dB.

Impedance— 75 Ω, 2:1 VSWR no Atten. 1.5:1 VSWR 10 dB Atten.

Reference Level— +79 dBmV to 0 dBmV in 1-dB steps. Indicated on front panel and readout on CRT.

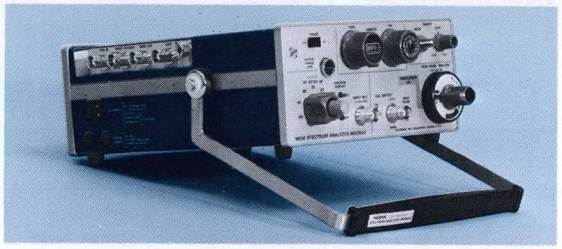
Calibrator— 50 MHz ±0.01% @ +30 dBmV ±0.3 dBmV.

Output Signal— —30 dBm ±0.5 dB, 50 Ω. Normally connected to analyzer input.

Intermodulation Distortion— At 7K11 output down 85 dB for two full screen signals. (Intermodulation performance of a 7K11/7L12 will be essentially that of the 7L12 alone.)

Order 7K11 CATV PREAMPLIFIER **$550**

- **GATED MODE for PULSED R.F. and TELEVISION**
- **75-OHM INPUT (1401A-1)**
- **50-OHM INPUT (1401A)**
- **AC, DC or BATTERY POWERED**
- **UP to 500 MHz in ONE DISPLAY**
- **FREQUENCY and AMPLITUDE CALIBRATOR**
- **60-dB LOG DYNAMIC RANGE**
- **INTERMODULATION DISTORTION MORE THAN 60-dB DOWN**
- **FLAT WITHIN 1.5 dB OVER 200 MHz**



1401A Spectrum Analyzer Module

The 1401A and 1401A-1 Spectrum Analyzer Modules are an expansion of the plug-in concept of using an oscilloscope for spectrum analysis. These modules, used with the SONY/TEKTRONIX 323, 324, or other oscilloscopes, provide measurement facilities in the 1-MHz to 500-MHz frequency range. The 1401A is designed for 50-Ω systems, the 1401A-1 is for use with 75-Ω systems. Statements about the 1401A apply also to the 1401A-1 unless otherwise indicated.

The 1401A and 1401A-1 are compatible with any oscilloscope having 0.5 V/div horizontal deflection factor (adjustable ±10%) and 1.2 V full-screen vertical deflection.

One of the unique features of the 1401A is automatic center frequency positioning in the search mode. At 50-MHz/div frequency span (dispersion), the center frequency automatically becomes 250 MHz, preventing a possible erroneous display. In the search mode, the center frequency control positions a negative marker to indicate that part of the spectrum which will appear at center screen when the frequency span is reduced to less than 50 MHz/div.

Design of the 1401A/323 provides for easy carrying and convenient viewing and access. Power may be obtained from the normal AC line, 6 to 16 VDC, or internal rechargeable batteries.

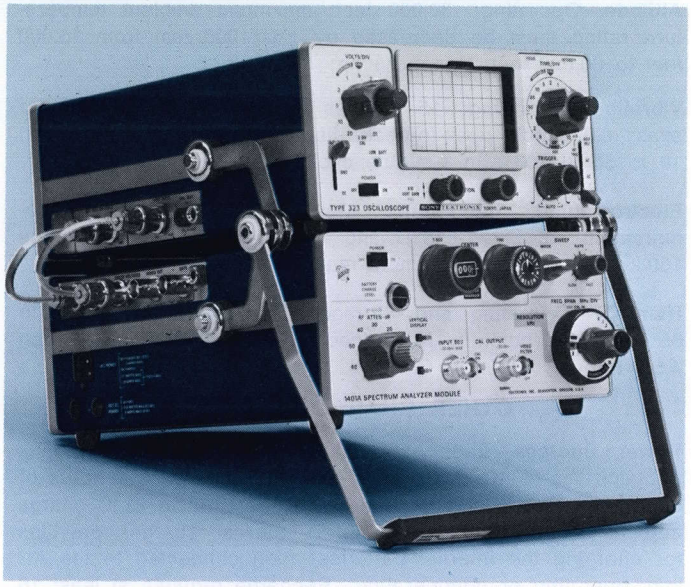
ANALYZER CHARACTERISTICS

Center Frequency—Continuously selectable with 10-turn digital frequency readout control over the range of 1 to 500 MHz. Absolute accuracy within ± (5 MHz +5% of dial reading). Fine control provides a calibrated variation of up to plus or minus 1 MHz, within 10%.

CW Sensitivity	1401A	1401A-1
3 kHz Resolution	at least −100 dBm	at least −45 dBmV
100 kHz Resolution	at least −85 dBm	at least −30 dBmV
1000 kHz Resolution	at least −78 dBm	at least −23 dBmV

Frequency Span (dispersion)— 50 MHz/div to 100 kHz/div in steps (1-2-5 sequence), accurate within 10% over a 10 div display, plus 0 Hz span. Frequency span can be continuously varied (uncalibrated) from any calibrated value toward zero.

*Applications information is available through your TEKTRONIX Field Engineer or Representative.



1401A/323 Spectrum Analyzer System

Resolution Bandwidth— 3, 100, and 1000 kHz.

Display Flatness—Amplitude variations are within 1.5 dB to 200 MHz and 3 dB to 500 MHz.

Incidental FM— 20 kHz or less.

Intermodulation Distortion— 1401A at least 55 dB down with two signals at −30 dBm (+25 dBm 1401A-1), one MHz apart; 60 dB down with signals at −40 dBm (+15 dBm 1401A-1).

Frequency Stability—Within 50 kHz over any 5 minute interval after 20 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Input Power	1401A	1401A-1
Maximum with RF attenuation	+30 dBm	+80 dBmV
Without attenuation	−30 dBm	+25 dBmV

RF Attenuator— 0 to 60 dB in 10 dB steps (accurate within +0.2 dB + 1% of dB reading).

IF Gain Control—At least 30-dB range.

Vertical Display—Linear and log.

Dynamic Range—At least 60 dB in log mode at 10 dB/div.

SWEEP CHARACTERISTICS

Free Run—Sweep rate continuously variable from one sweep per second or less to at least 100 sweeps per second.

External Trigger—Accepts an external positive pulse of 1 to 10 V, at least 100 ns width, 1 MHz or less.

External Horizontal—Input accepts signal of 0 to +5 V. 0 V corresponds to approximately 0 frequency and +5 V corresponds to approximately 500 MHz in Search Mode. 10 V maximum input.

CALIBRATOR

Frequency— 50 MHz within 0.01%.

Amplitude of the Fundamental—1401A, −30 dBm; 1401A-1, +25 dBmV. Accuracy, within 0.3 dB at 25°C and within 0.5 dB from −15°C to +55°C.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Nonoperating: −55°C to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025-inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

OTHER CHARACTERISTICS

Power Sources—Battery operation: removable power pack contains 6 size "C" NiCd cells providing at least 3½ hours of operation. Maximum time is achieved at 20°C to 25°C charge and 20°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge position prevents battery self-discharge when not in use. Battery charge level is indicated on an expanded scale DC voltmeter. External DC source: operates from an external DC source of 6 V to 16 V, requires 4.8 W. External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 14 W maximum 115 V AC.

	1401A 1401A-1		323 324		1401A/323 1401A/324	1401A-1/323 1401A-1/324
	in	cm	in	cm	in	cm
Height	3.5	8.9	3.5	8.9	7	17.8
Width w/handle	8.5	21.6	8.5	21.6	9.5	23.8
Depth w/panel cover	10.5	27.0	10.5	27.0	10.5	27.0
Depth w/handle	13	33.0	13	33.0	14.5	37.2
	lb	kg	lb	kg	lb	kg
Net weight w/o accessories	7.5	3.4	≈ 8	≈ 3.6	≈15	≈ 6.8
Domestic shipping weight	13	5.9	≈14	≈ 6	≈23	≈10.4
Export-packed weight	21	9.5	≈22	≈10	≈31	≈14.0

SPECTRUM ANALYZER MODULE

1401A Included Accessories— 8-ft power cable assembly (161-0043-02); panel cover (200-0812-00); blue filter (378-0670-01); amber filter (378-0670-02); three 5½-inch, 50-Ω BNC to BNC cable assemblies (012-0214-00); 6-ft 50-Ω BNC to BNC cable assembly (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00); operator's handbook (1401A); instruction manual (1401A).

Order 1401A **$2400**

SPECTRUM ANALYZER MODULE

1401A-1 Included Accessories—Same as for 1401A except: Insert for instruction manual; two BNC to F adapters (013-0126-00); change 6-ft, 50-Ω BNC to BNC cable assembly to 6-ft 75-Ω BNC to BNC cable assembly (012-0113-01).

Order 1401A-1 ..... **$2450**

SPECTRUM ANALYZER SYSTEM

1401A/323 (P7 Phosphor) Included Accessories—Includes accessories for both the 1401A, 323 and a two-instrument handle conversion kit (040-0563-00).

1401A/323P7, Order 1401A-3 ..... **$3395**
1401A-1/323P7, Order 1401A-1-3 ..... **$3445**

SPECTRUM ANALYZER SYSTEM

1401A/324 (P7 Phosphor) Included Accessories—Includes accessories for both the 1401A, 324 and a two-instrument handle conversion kit (040-0563-00).

1401A/324P7, Order 1401A-4 ..... **$3725**
1401A-1/324P7, Order 1401A-1-4 ..... **$3775**

OSCILLOSCOPE SUMMARY

CHARACTERISTIC	323	324
Bandwidth	DC to 4 MHz	DC to 10 MHz
Risetime	90 ns	36 ns
Deflection Factor	10 mV/div to 20 V/div at full bandwidth 1 mV/div at 2.75 MHz	2 mV/div at 8 MHz
Input R and C	1 megohm paralleled by approx 47 pF	
Time Base	5 μs/div to 1 s/div	1 μs/div to 0.2 s/div
Magnifier	X10	X5
CRT Display Area	6 x 10 divisions (1/4-inch divisions)	
Phosphor	P7 supplied when ordered with 1401A or 1401A-1	
Amplitude Calibrator	Internal, 0.5 V at external jack	
Power Sources	Internal batteries External 6 to 16 V DC 90 to 136 V AC 180 to 272 V AC 48 to 440 Hz 14 W at 115 V AC	Internal batteries External 6.5 to 16 V DC 115 V AC ±10% 230 V AC ±10% 48 to 440 Hz 20 W at 126 V AC
Price with batteries	$995	$1325

The SONY/TEKTRONIX 323 and 324 are manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, they are available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—Waterproof blue vinyl, **Order 016-0112-00 $11**

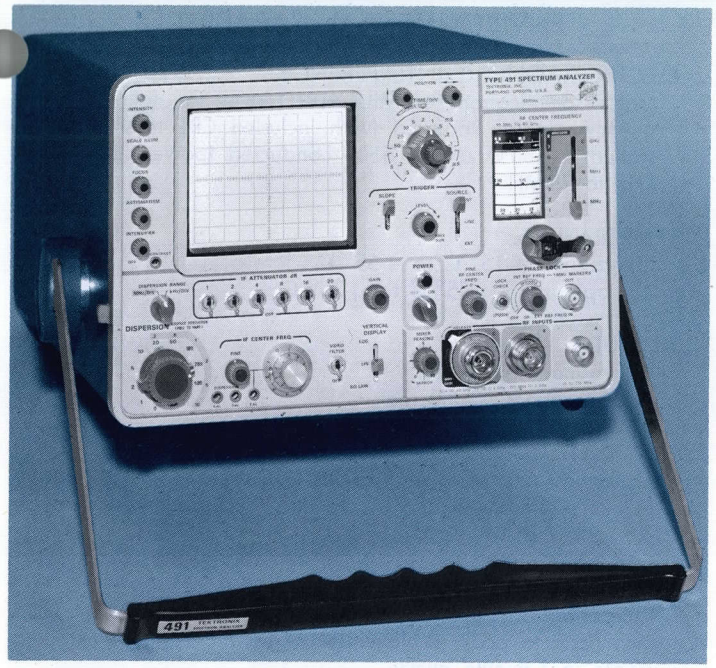
Handle Conversion Kit (for two instruments)—For combining an existing 323 or 324 Oscilloscope with 1401A or 1401A-1, for a system as shown, **Order 040-0563-00** **$33**

Handle Conversion Kit (for three instruments)—For combining an existing 323 or 324/1401A or 1401A-1 and 1501 TDR.
Order 040-0596-00 ..... **$55**

Power Pack—Extra power pack, in addition to the one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323.
Order 016-0119-02 ..... **$110**

Adapter—BNC 75 Ω to 50 Ω impedance matching network.
Order 011-0112-00 ..... **$27.50**

Battery Set—Set of 6 NiCd cells, **Order 146-0012-01** .. **$25.30**



- **COMPACT, LIGHT WEIGHT**
- **INTERNAL PHASE LOCK**
- **CALIBRATED DISPERSION TO 100 MHz**
- **COUPLED RESOLUTION**
- **WIDE-RANGE TIME BASE**
- **LOW POWER CONSUMPTION**
- **ENVIRONMENTALIZED**
- **ALL SOLID-STATE**
- **BATTERY POWER SUPPLY AVAILABLE**

The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is an easy-to-carry package weighing less than 40 pounds complete with accessories. The R491 is electrically identical, requires only 7 inches of rack height.

Operation is simple. Resolution and calibrated dispersion controls are coupled, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Since dispersion is calibrated, frequency differences can be read directly from the CRT. Internal phase lock provides stable displays even at 1 kHz/div dispersion.

Two modified instruments are available for applications which do not require the full center frequency range (10 MHz to 40 GHz) of the 491. These are the Option 1, (10 MHz to 2000 MHz) and the Option 2 (1.5 GHz to 40 GHz). Specifications for the Option 1 and Option 2 are the same as for the 491 except where noted.

Each instrument is completely self-contained, has oscilloscope-type time base and trigger circuits, 8 x 10-div CRT with P7 phosphor and internal graticule. They operate over a wide range of AC voltages, require only 55 W, maximum.

Operation, independent of AC power source, is made possible by the new 1105 Battery Power Supply.

CHARACTERISTICS

DIAL ACCURACY

± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION

1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div —MHz/div). Accuracy throughout full range of RF-center frequency control, within ±3% except at 2 MHz/div (±5%) and 1 MHz/div (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY*	
		1-kHz RESOLUTION	100-kHz RESOLUTION
1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
3	800 MHz to 2000 MHz	≥ —105 dBm	≥ —85 dBm
4	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
5	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
6	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
7	12.4 GHz to 18.0 GHz	≥ —90 dBm	≥ —70 dBm
8	18.0 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz ≥ —70 dBm to 40 GHz	≥ —60 dBm ≥ —50 dBm

*Signal + noise = 2 X noise

Bands 1-8 are covered in the 491.

Bands 1-3 are available in Option 1.

Bands 4-8 only are available in Option 2, bands 4-6 directly, bands 7-8 using optional accessories.

COUPLED RESOLUTION

1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

DISPLAY FLATNESS
Maximum amplitude variation over 100-MHz dispersions up to 12.4 GHz is 3-dB or less, except over 50-MHz dispersion in Band 1. Above 12.4 GHz the maximum amplitude variation (100-MHz dispersion) is 6-dB or less.

INCIDENTAL FM
Less than 300 Hz at fundamental, with Phase Lock.

FREQUENCY STABILITY
kHz/div dispersion range—±10 kHz throughout line voltage range after 1 minute; ±5 kHz/°C. MHz/div dispersion range—±200 kHz throughout line voltage range after 1 minute; ±20 kHz/°C.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω for coaxial inputs.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz adjustment of center frequency from 5 MHz/div to 0.2 MHz/div dispersion positions, ±10-MHz adjustment at 10 MHz/div, ±2.5-MHz adjustment from 500 kHz/div to 1 kHz/div dispersion positions.

VERTICAL DISPLAY (8 DIVISIONS)
Log — ≥40-dB dynamic range.
Linear
Square Law — ≥13-dB dynamic range.

HORIZONTAL DEFLECTION

INTERNAL SAWTOOTH GENERATOR
10 μs/div to 0.5 s/div in 15 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to approx 1.25 s/div.

TRIGGER SOURCE
Internal, external, or line. 100-V maximum external input (DC + peak AC).

TRIGGER REQUIREMENTS
0.2-div deflection or 0.2-V external from 20 Hz to 100 kHz.

CRT AND DISPLAY FEATURES

TEKTRONIX CRT
8 x 10-div display area (each div = 0.8 cm); P7 phosphor.

GRATICULE
Internal, no parallax, variable edge lighting.

DISPLAY FEATURES
Intensity, focus and astigmatism controls. Intensifier adjusts relative brightness of signal and baseline for convenient viewing and photography.

ENVIRONMENTAL CAPABILITIES

ELECTROMAGNETIC INTERFERENCE
Meets specifications of MIL-I-6181D over the following frequency ranges: Radiated (with included CRT mesh filter installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

TEMPERATURE
Operating: —15° C to +55° C.
Nonoperating: —55° C to +75° C.

ALTITUDE
Operating: 15,000 feet.
Nonoperating: 50,000 feet.

HUMIDITY
Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

VIBRATION
Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK
Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 1 shock per axis.

OTHER CHARACTERISTICS

POWER REQUIREMENTS
90 to 136 V AC or 180 to 272 V AC, 48 to 440 Hz; 55 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

REAR PANEL CONNECTORS
BNC connectors for external trigger input, sawtooth output (70 to 90 mV P to P) and recorder output (≥4 mV/div of displayed signal in LIN mode, DC-coupled, approx 600-Ω source resistance).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	≈7 in	18.2 cm
Width	≈12 in	31.6 cm
Depth (incl. panel cover)	≈20 in	50.0 cm
Depth (with handle extended)	≈22 in	54.7 cm
Net weight (w/o panel cover)	30 lb	13.6 kg
Weight (with panel cover and accessories)	38 lb	17.3 kg
Domestic shipping weight	≈50 lb	≈22.7 kg
Export-packed weight	≈62 lb	≈28.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	17.5 in	44.4 cm
Net weight	41 lb	18.6 kg
Domestic shipping weight	≈72 lb	≈32.7 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); instruction manual (070-0598-01). 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	**$4895**
R491 SPECTRUM ANALYZER (rackmount)	**$4995**
Option 1 (10 MHz to 2 GHz)	**Subtract $1395**
Option 2 (1.5 GHz to 40 GHz)	**Subtract $1195**
1105 BATTERY POWER SUPPLY	**$475**

See index for the location and full description of the 1105.

491 OPTION 1

The 491 Option 1 has a center frequency range of 10 MHz to 2000 MHz. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N) of the option. The appearance is the same as that of the 491 with the following exceptions: the C-band input is removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 OPTION 1 ONLY)

6-ft BNC cable, 50-Ω miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); power cable (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and special instruction manual.

The R491 Option 1 also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

491 OPTION 2

The 491 Option 2 has a center frequency range of 1.5 GHz to 40 GHz with optional accessories. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N). The appearance is the same as that of the 491 with the following exceptions: the A and B band inputs are removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 OPTION 2 ONLY)

6-ft N cable, RG 223/U coax (012-0114-00); power cable (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00); and special instruction manual.

The R491 Option 2 also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

OPTIONAL ACCESSORIES FOR THE 491 OPTION 2

NOTE: These accessories are required to extend the frequency range of the Option 2 from 12.4 GHz to 40 GHz.

Cable, TNC, coaxial, 2 feet (012-0115-00)	$ 11.00
Waveguide mixer adapter (119-0104-00)	$ 48.40
Waveguide mixer 12.4-18.0 GHz (119-0097-00)	$ 84.70
Waveguide mixer 18.0-26.5 GHz (119-0098-00)	$ 96.80
Waveguide mixer 26.5-40.0 GHz (119-0099-00)	$150.00

OPTIONAL ACCESSORIES FOR THE 491 OPTION 1 AND 2

BNC male to N female adapter (103-0058-00)	$ 3.05
BNC female to N male adapter (103-0045-00)	$ 2.65
10-dB attenuator, Type N fittings (011-0085-00)	$49.50
20-dB attenuator, Type N fittings (011-0086-00)	$49.50
40-dB attenuator, Type N fittings (011-0087-00)	$60.50

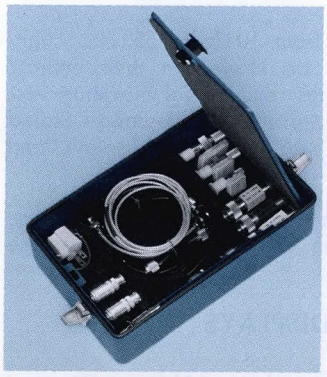
CONVERSION KITS

PORTABLE TO RACK-MODEL

Kit includes hardware and instructions to convert the 491 Analyzers for rack installations.
Order 040-0444-00 ..... $150

RACK MODEL TO PORTABLE

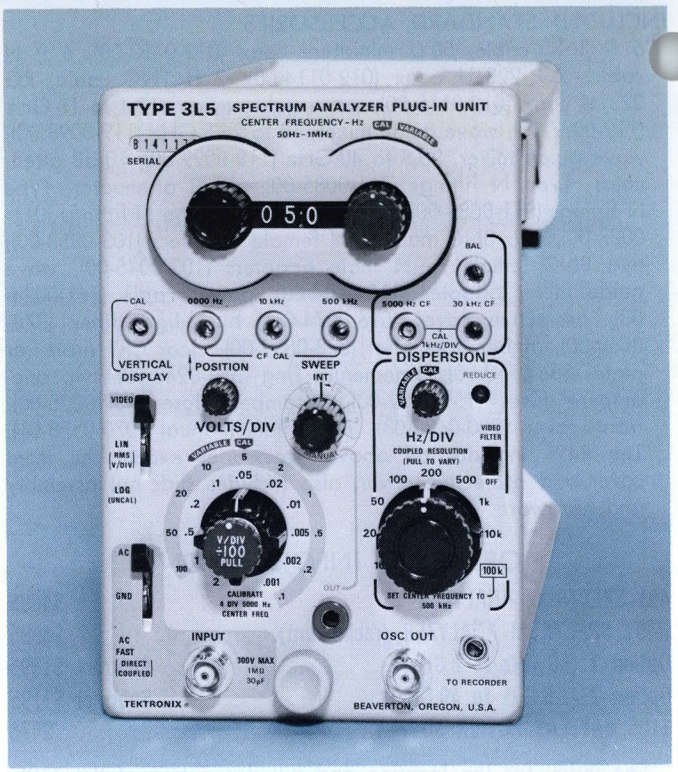
Kit includes cabinet, panel cover, oscilloscope cover, and instructions to convert the R491 Analyzers for portable operation.
Order 040-0445-00 ..... $93.50



ACCESSORY STORAGE

Included panel cover for the 491 and drawer for the R491 hold all standard accessories except manual and protective cover.

SPECTRUM ANALYZER
1L5 and 3L5 *50 Hz-to-1 MHz Plug-in*



- ***CALIBRATED VERTICAL DEFLECTION***
- ***CALIBRATED DISPERSION***
- ***10 Hz to 1 MHz IN ONE DISPLAY***
- ***TIME-BASED OR FREQUENCY-BASED DISPLAYS***
- ***RECORDER OUTPUT***

The 1L5 and 3L5 operate over a center-frequency range of 50 Hz to 1 MHz, and provide accurate spectral and time-based displays from 10 Hz to 1 MHz. Calibrated volts/cm and Hz/cm controls make the 1L5 and 3L5 as easy to use as the oscilloscope in which each is operated. The 1L5 operates in the 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The 3L5 operates in the 561B or 564B (and the earlier 561A and 564) Oscilloscopes in combination with a 2B67, 3B3, 3B4, or 3B5 Time-Base Unit.*

Resolution bandwidth extends from 10 Hz to 500 Hz. High-resolution spectral displays can be viewed in their entirety (even at the very slow sweep rates required for maximum resolution) with the 549 or 564B Storage Oscilloscope. Stored displays can also be compared with subsequent displays, and can be easily photographed for permanent record.

Applications include vibration studies, waveform analysis, and noise measurements. Others are listed in the reference section.

SPECTRAL DISPLAYS

CENTER FREQUENCY RANGE

50-Hz to 990-kHz, calibrated in 10-Hz, 100-Hz, 1-kHz and 10-kHz steps. Continuously variable to at least 1 MHz.

*IMPORTANT: Time Base Units with serial numbers under those listed require a simple modification to provide a sweep signal to the Analyzer. 2B67: 15180, 3B3: 4270, 3B4: 740. Modification Kit part number 040-0413-00.

CENTER FREQUENCY	ACCURACY
50 Hz to 990 Hz	±(5% + 50 Hz + 50 Hz/°C change)
1000 Hz to 9900 Hz	±(5% + 100 Hz + 100 Hz/°C change)
10 kHz to 99 kHz	±(5% + 3 kHz + 200 Hz/°C change)
100 kHz to 990 kHz	±(5% + 10 kHz + 200 Hz/°C change)

STABILITY

50 Hz to 9900 Hz — 100 Hz/hour or less with stable ambient temperature (±1°C).

DEFLECTION FACTOR

10 μV/cm to 2 V/cm, calibrated in RMS volt/cm (1-2-5 sequence). Accurate within 3% from 1 mV/cm to 2 V/cm, within 6% from 10 μV/cm to 500 μV/cm (÷100 pulled), for linear displays at maximum resolution. The uncalibrated variable control is continuous between steps (≈3:1).

CALIBRATED DISPERSION

10 Hz/cm to 100 kHz/cm in 9 steps. Accuracy at center frequencies of:

a) 50 Hz to 9900 Hz — ≤±10% (20°C to 30°C)
— ≤±20% (0°C to 50°C)

b) 10 kHz to 990 kHz — ≤15% (0°C to 50°C)

Linearity is within 3%.

COUPLED RESOLUTION

≤10 Hz to ≥500 Hz (20°C to 30°C), coupled with the dispersion control but separately switchable.

DISPLAY FLATNESS

Amplitude variations are within 0.5 dB from 10 Hz to 1 MHz at most deflection factors; except within +0.5 dB, —3 dB at 1 mV/cm and 2 mV/cm (or 10 μV/cm and 20 μV/cm with ÷100 pulled).

NOISE

≤5 μV RMS.

DYNAMIC RANGE

≥60 dB in LOG (uncalibrated) mode.

INTERMODULATION DISTORTION AND SPURIOUS SIGNALS
(1L5) ≥50 dB below the 6-cm signal level.
(3L5) ≥50 dB below the 8-cm signal level.

RECORDER OUTPUT
5 to 15 mV for 6-cm linear display, into 600-Ω.

LOCAL OSCILLATOR OUTPUT
Must sweep ≥1 MHz from ≈3 MHz to ≈2 MHz; ≥1 V P-P.

1L5 SWEEP MODES
Manual, internal and external. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. The 549 Storage Oscilloscope and the 556 Dual-Beam Oscilloscope provides an internally-coupled sweep to the Analyzer; external input is used with other oscilloscopes.

3L5 SWEEP MODES
Manual and internal. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. The 561B and 564B Oscilloscopes with time base unit provide an internally-coupled sweep to the Analyzer.

TIME-BASED DISPLAYS

BANDWIDTH
10 Hz to 1 MHz at most deflection factors; 10 Hz to 700 kHz at 0.1 V/cm and 0.2 V/cm (or 1 mV/cm and 2 mV/cm with ÷100 switch pulled).

DEFLECTION FACTOR
1 mV/cm to 100 V/cm in calibrated P-to-P steps (1-2-5 sequence), accurate within 3% (within 6% from 2 V/cm to 100 V/cm). Uncalibrated control provides continuous variation between steps, reduces gain by a factor of approx 3.

INPUT
1 megohm paralleled by approx 30 pF.
300 V DC + peak AC maximum input voltage.

OTHER CHARACTERISTICS

1L5 WEIGHTS

Net weight	8 lb	3.6 kg
Domestic shipping weight	≈13 lb	≈9.0 kg
Export-packed weight	≈21 lb	≈5.8 kg

3L5 WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	≈13 lb	≈5.8 kg
Export-packed weight	≈17 lb	≈7.7 kg

INCLUDED STANDARD ACCESSORIES
1X probe (010-0193-00), banana-to-banana cable (012-0031-00), BNC-to-banana cable (012-0091-00), plug (134-0052-00), plug protector (134-0076-00).

Order 1L5 SPECTRUM ANALYZER UNIT $1300
Order 3L5 SPECTRUM ANALYZER UNIT $1400

OPTIONAL ACCESSORIES

P6007 100X Probe Package, order 010-0150-00 ..... $38
P6012 10X Probe Package, order 010-0203-00 ..... $44
600-Ω Termination (BNC), order 011-0092-00 ..... $19.80

50 Hz-to-1 MHz Swept Frequency Source

- ***SLAVED SPECTRUM ANALYZER-SWEPT FREQUENCY DISPLAYS***
- ***50-Hz to 1-MHz CENTER FREQUENCY***
- ***1-MHz DISPERSION CAPABILITY***

The Swept Frequency Converter is an accessory unit to the 1L5 or 3L5 Spectrum Analyzer Plug-In Units. It accepts the local oscillator output from the analyzer and converts it to a signal source slaved to the center frequency and dispersion setting of the analyzer.

The result is a signal source with center frequency range of 50 Hz to 1 MHz, single frequency (analyzer in MANUAL SWEEP mode) or swept frequency with dispersion capability of 1 MHz max to 100 Hz min. It provides for variable amplitude control and regulation for constant output within 0.5 dB. Sweep rate is controlled by the horizontal time base.

CHARACTERISTICS

OUTPUT FREQUENCY—50 Hz to 1 MHz, selectable within the center frequency range of the Spectrum Analyzer.

OUTPUT VOLTAGE—4 V P-P to 8 V P-P max behind 600 Ω.

OUTPUT FREQUENCY FLATNESS—within 0.5 dB into 600 Ω.

OSCILLATOR INPUT VOLTAGE (from Spectrum Analyzer) 0.8 V P-P to 2 V P-P.

OUTPUT REGULATION
FAST—effective in preserving amplitude flatness when lowest frequency component is not less than 10 kHz and sweep rate is 10 ms/div or faster.
SLOW—used when frequency is less than 10 kHz and for sweep rates slower than 10 ms/div.

OUTPUT AMPLITUDE RECOVERY (output regulator FAST to SLOW)—10 s or less to recover to same amplitude as FAST.

OUTPUT RESISTANCE—600 Ω within 15%.

POWER REQUIREMENTS—90 VAC to 272 VAC, 50 to 400 Hz.

INCLUDED STANDARD ACCESSORIES
600-Ω termination (011-0092-00); two BNC cables (012-0075-00); BNC-to-dual banana adapter (103-0090-00).

SWEPT FREQUENCY CONVERTER, order 015-0107-00 .. **$330**

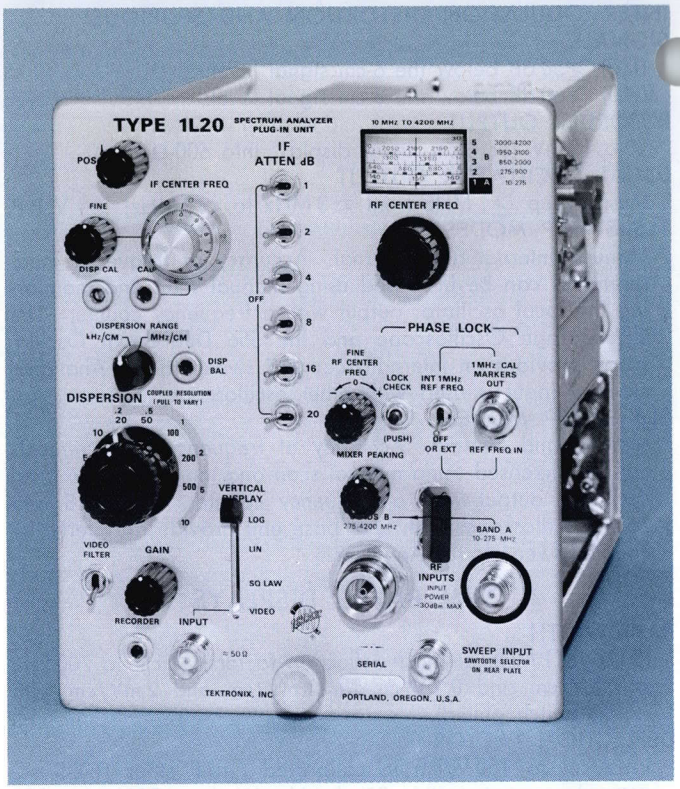
A 0 to 51 dB switch attenuator for use with the 1L5 or 3L5. The input resistance is 600 Ω (within 2%). The attenuation error is within 0.05 dB/dB. Power rating is ⅛ W max. Bandwidth is DC to 1 MHz, order 011-0093-00 ..... $100

- ***INTERNAL PHASE LOCK***
- ***CALIBRATED DISPERSION TO 100 MHz***
- ***COUPLED RESOLUTION***
- ***AMPLITUDE VARIATIONS WITHIN 3 dB OR LESS***
- ***RECORDER OUTPUT***

BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY* 1-kHz RESOLUTION	MINIMUM CW SENSITIVITY* 100-kHz RESOLUTION
1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
3	850 MHz to 2 GHz	≥ —100 dBm	≥ —80 dBm
4	1.95 GHz to 3.1 GHz	≥ —95 dBm	≥ —75 dBm
5	3 GHz to 4.2 GHz	≥ —90 dBm	≥ —70 dBm

*Signal + noise = 2X noise

Operating convenience and performance is offered in multi-band plug-in units for all TEKTRONIX 530, 540, 550 or (with adapter) 580-Series Oscilloscopes.



BUILT-IN PHASE LOCK circuit synchronizes the analyzer local oscillator with a stable reference frequency (internal 1 MHz or external 1 to 5 MHz). When the local oscillator is locked in phase to the reference frequency, the local oscillator stability approaches that of the reference frequency. This allows very narrow dispersion at high frequencies where the analyzer would normally be limited by oscillator drift, microphonics, and other perturbations. Phase lock can be used to view any signal within the tuning range of the analyzer.

CALIBRATED DISPERSION from 1 kHz/cm to 10 MHz/cm makes frequency measurement as easy and accurate as time measurement. Frequency differences can be read directly from the CRT.

COUPLED RESOLUTION from 1 kHz to 100 kHz greatly simplifies operation, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Dispersion and resolution controls can be uncoupled and operated separately if desired, for optimized viewing of a particular signal.

DIAL ACCURACY
± (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION
1 kHz/cm to 10 MHz/cm in 1-2-5 sequence, 2 ranges (kHz/cm—MHz/cm). Accuracy of 10-cm display, throughout full range of IF center frequency control, within ±3% except at 2 MHz/cm (±5%) and 1 MHz/cm (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for PRF measurements.

BANDWIDTH RESOLUTION
1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

DISPLAY FLATNESS
Amplitude variations are within 3 dB over the full 100-MHz dispersion range (or less) except over 50 MHz in Band 1.

INCIDENTAL FM (LO + IF)
300 Hz or less at LO fundamental when phase locked.

PHASE LOCK
Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

INPUT IMPEDANCE
Approx 50 Ω.

MAXIMUM INPUT POWER
—30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF ATTENUATOR
51 dB in 1-dB steps, ±0.1 dB/dB.

IF GAIN CONTROL
>50-dB range.

IF CENTER FREQUENCY
±25-MHz range from 5 MHz/cm to 0.2 MHz/cm, ±10 MHz at 10 MHz/cm. ±2.5-MHz range in all kHz/cm positions. FINE control has ±1-MHz and ±50-kHz range in MHz/cm and kHz/cm modes respectively.

VERTICAL DISPLAY (6 cm)
Log—≥40-dB dynamic range.
Linear
Square Law—≥13-dB total dynamic range.
Video— ≤16 Hz to ≥10 MHz, approx 50-Ω input resistance.

RECORDER OUTPUT
12 mV to 20 mV with 6-cm linear display.

WEIGHTS

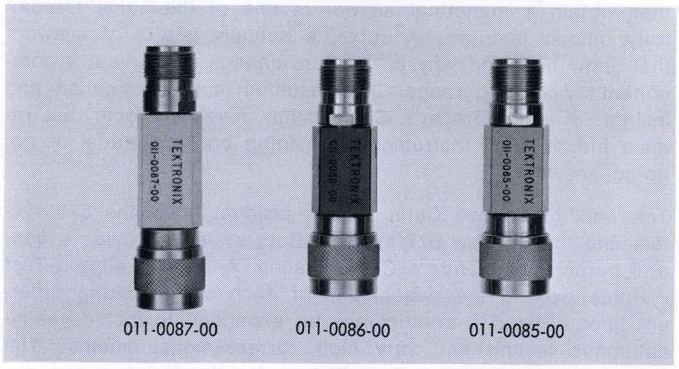
Net weight	≈8 lb	3.4 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES
Patch cord, BNC to banana (012-0091-00); plug protector (134-0076-00); tini-plug (134-0052-00).

Order 1L20 SPECTRUM ANALYZER UNIT $2550

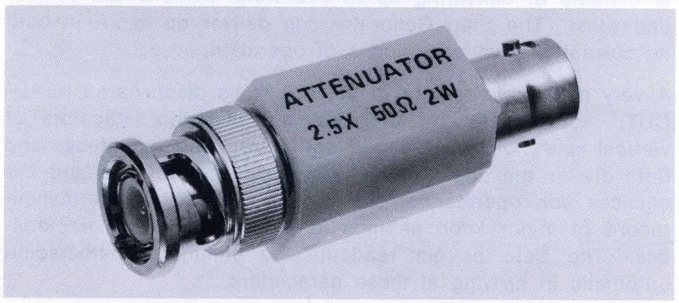
OPTIONAL ACCESSORIES

50-Ω ATTENUATORS



Attenuators are all supplied with Type N fittings. See accessory section for adapters for other series. Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300-W peak. Impedance is 50 Ω.

10-dB attenuator, order 011-0085-00 ..... $49.50
20-dB attenuator, order 011-0086-00 ..... $49.50
40-dB attenuator, order 011-0087-00 ..... $60.50



DESCRIPTION	PART NUMBER	PRICE
50-Ω feedthrough termination	011-0049-01	$15.00
50-Ω 10X attenuator	011-0059-01	18.15
50-Ω 5X attenuator	011-0060-01	18.15
50-Ω 2X attenuator	011-0069-01	18.15
50-Ω 2.5X attenuator	011-0076-01	18.15
50-Ω feedthrough termination (5 watt)*	011-0099-00	21.00

CHARACTERISTICS (for 50-Ω termination and attenuators above).

Accuracy of Indicated Attenuation Ratio is ±2% at DC; ±3% at 500 MHz. Power Rating is 2 watts.

Voltage Standing Wave Ratio (VSWR) is less than 1.1 up to 250 MHz. *VSWR less than 1.1 up to 100 MHz.

The Curve Tracer is a self-contained measurement system which includes power supplies, function generators, measurement circuitry and a CRT display. Its great measurement range and flexibility qualify the Curve Tracer for evaluating and analyzing many different types of components. The Curve Tracer also provides a powerful tool for in-circuit troubleshooting.

I-V characteristics (current vs. voltage) are conventionally displayed for components whether in or out of their circuit environments. The ability to plot a characteristic curve rather than obtain a numerical answer is one of the curve tracer's truly unique features. A curve is actually a plot of answers that show how and why parameters change throughout a component's operating range. The result is more information and insight. A curve tracer's CRT display reveals effects that remain hidden from instruments providing only numerical or go, no-go answers.

Tektronix offers two Curve Tracer product lines, the 576 system and the all New 577 system. Both systems provide a general purpose or standard Curve Tracer. Additional plug-in Test Fixtures expand the capabilities of each system along different lines. The 576 system may be expanded to include semi-automatic testing and very high current measurements. The 577 system includes a Test Fixture for linear integrated circuits. Another significant innovation in the New 577 system is the availability of a storage display.

THE 576 SYSTEM

The 576 Curve Tracer with the standard test fixture is a rugged, high power measurement system which has become an industry standard over the past several years. The Collector Supply is capable of delivering up to 220 watts peak to the device-under-test. The Step Generator can deliver up to 2A in both its current and voltage modes of operation.

A very noticeable feature of the 576 is its display-area READOUT. Adjacent to the CRT are alphanumeric indicators of vertical and horizontal deflection factor, step amplitude, and Beta/div or gm/div. Readout decreases set-up time and the chances for operator error. It also provides a permanent record of major knob settings in photographs of characteristics. The Beta or gm readout also eliminates bothersome arithmetic in arriving at these parameters.

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 an operator to make more precise measurements.

Other distinct 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, push buttons to check display zero and calibration, and illuminated graticule.

For a description of plug-in capability see the 172 and 176 sections.

THE 577 SYSTEM

The 577/177 Curve Tracer with Standard Test Fixture retains most of the important features and performance of the 576 and is smaller and lighter. New design techniques enhance the 577/177 with unique advantages of its own. Low current measurements are facilitated by several features. First, current sensing resistors are small, resulting in less capacitive looping. (Electronic overrange detection and protection in the 577/177 substitutes for the high power resistors of the 576). Second, current sensing always takes place in the Collector Supply lead, permitting measurements on three terminal active devices at the lowest current ranges and eliminating the need for a correction to the horizontal deflection factor. Third, a display filter reduces vertical deflection noise. Fourth, the availability of a storage display permits the operator to trace a curve where otherwise only a dot display would be available, a typical situation for very low current measurements.

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, knob skirt readout that indicates scale factor changes, independent magnifiers that increase resolution on either or both CRT axes, fewer controls and a beam finder.

For a description of plug-in capability see the 178 Section.

STORAGE IN CURVE TRACERS

Storage display (available in the 577 system only) provides new measurement capability and convenience to the Curve Tracer. Characteristics of a device-under-test can be stored on the CRT during heating or cooling of the device. The results can show temperature sensitivity and zero T.C. points. 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.

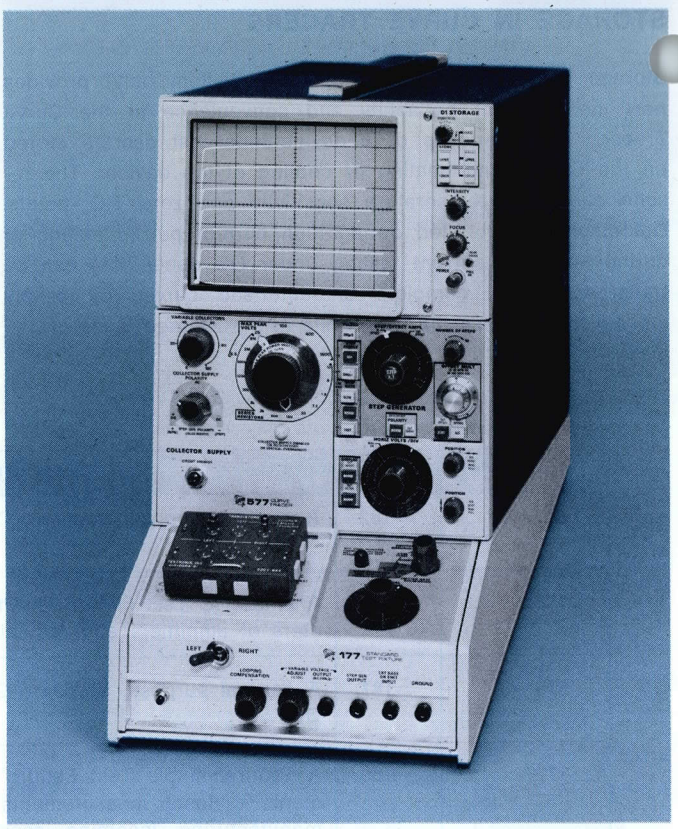
The split screen feature of the storage display is useful for making comparisons, whether simply comparing one component with another or for troubleshooting. When using the Curve Tracer to troubleshoot a circuit board for example, the I-V characteristic of a good circuit can be stored in one-half of the screen while the corresponding response of a suspect circuit is displayed on the lower half.

Comparisons can also be made by overlaying the characteristics of one device on top of the stored characteristics of another. By using the Curve Tracer's ability to invert the display polarity, the characteristics of a PNP transistor may be overlayed on those of an NPN.

PRODUCT	PAGE	MEASUREMENT CAPABILITIES	PRICE
577/177	182	A general purpose, Standard Curve Tracer with storage or non-storage display.	**$2300** **$1850**
178	184	A Linear IC Test Fixture for the 577. Measures DC and low frequency parameters of amplifiers and regulators.	**$ 900**
576	187	A general purpose, Standard Curve Tracer with or without display-area READOUT.	**$3150** **$2650**
172	189	A Programmable Test Fixture for the 576. Programs up to eleven measurements for faster measurements and fewer errors in applications such as device manufacturing, incoming inspection and device evaluation.	**$1400**
176	191	A Pulsed High-Current Fixture for the 576 which extends collector current range to 200 amps peak and base current range to 20 amps peak.	**$1600**
5CT1N	192	A plug-in curve tracer for the TEKTRONIX 5000-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	**$ 350**
7CT1N	192	A plug-in curve tracer for the TEKTRONIX 7000-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	**$ 400**
CT71	166	A low-cost semiconductor tester which displays characteristic curves of transistors, FETs and diodes. Manufactured by Telequipment, a Tektronix, Inc. subsidiary.	**$ 795**

New

- **STORAGE or NON-STORAGE DISPLAY**
- **BETTER LOW CURRENT MEASUREMENTS**
- **KELVIN SENSING for HIGH CURRENT TESTS**
- **KNOB SKIRT SCALE FACTOR READOUT**
- **FEWER CONTROLS**
- **OPTIONAL LINEAR IC TEST FIXTURE**



A general description of the 577/177 Curve Tracer is located in the Curve Tracer Reference section.

CHARACTERISTICS

Characteristics of the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

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 up to the maximum 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 maximum peak power to the device-under-test when changing voltage ranges.

Collector Supply Interlock—Protects operator from 100-, 400- and 1600-volt ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Number of Steps—Selectable from 1 to 10 full-amplitude steps. Selectable up to approximately 95 steps when using STEP X0.1 multiplier.

Offset—The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either A or OPPOSE steps. Maximum range of offset is 10 full-amplitude steps.

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 2A on the highest amplitude setting with 5 volts 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 volts) derating to 0 mA at 20 volts.

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%.

Automatic Scale Factor Readout—Change in step amplitude is indicated by lights behind the knob skirt when using the STEP X0.1 multiplier.

Step Rate—Selectable at 1X (SLOW), 2X (NORM) or 4X (FAST) line frequency.

Step Family—Repetitive or single family.

Pulsed—Steps can be gated on for a duration of approximately 300 μs for testing at low duty cycle.

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.

DEFLECTION CONTROLS

VERTICAL DEFLECTION	NORMAL	MAGNIFIED
Collector Current (1-2-5 Sequence) Accuracy	2 nA/div to 2 A/div 3% ± 1 nA	0.2 nA/div to 0.2 A/div 4% ± 1 nA

HORIZONTAL DEFLECTION	NORMAL	MAGNIFIED
Collector Volts (1-2-5 Sequence) Accuracy	50 mV/div to 200 V/div 3%	5 mV/div to 20 V/div 4%
Base Volts (1-2-5 Sequence) Accuracy	50 mV/div to 2 V/div 3%	5 mV/div to 0.2 V/div 4%
Step Generator Accuracy	1 step/div 4%	0.1 step/div 5%

Accuracies are a percentage of highest on-screen value.

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-inch with a 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.

OTHER CHARACTERISTICS

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.

Power Requirements— 100, 110, 120 VAC or 200, 220, 240 VAC all within ±10%. 50 to 60 Hz, 155 watts maximum at 110 VAC 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	
Height	19.8 in	50.3 cm	4.0 in	10.2 cm
Width	8.8 in	22.4 cm	7.9 in	20.1 cm
Depth	23.0 in	58.4 cm	6.0 in	15.2 cm
Net Weight	40 lb	18.1 kg	2.5 lb	1.1 kg
Domestic Shipping Weight	≈47 lb	≈21.3 kg	≈8 lb	≈3.6 kg
Export-packed Weight	≈67 lb	≈30.4 kg	≈13 lb	≈5.9 kg

Note: When the 577 and 177 are ordered together their combined shipping weight is: Domestic ≈50.5 lb or ≈23 kg; Export ≈70.5 lb or ≈32 kg.

Included Accessories—Transistor adapter for most bipolar transistors and some MOS FET's (013-0098-01), axial lead diode adapter with Kelvin sensing terminals (013-0111-00) and protective cover for test connection area (337-1194-00).

ORDERING INFORMATION

177 STANDARD TEST FIXTURE **$300**
577/D1 STORAGE CURVE TRACER MAINFRAME **$2000**

ALTERNATE MAINFRAME

The following mainframe is identical to the 577/D1 except it has a non-storage display unit.

577/D2 CURVE TRACER MAINFRAME **$1550**

(Note: The 577/D1 Storage Curve Tracer mainframe is recommended for use with the 178 Linear IC Test Fixture)

Option 10, 10 x 10-cm GRATICULE ..... **Add $35**

The Option 10 provides a CRT with a 10 x 10-cm graticule (10 x 12 usable area). The standard CRT has a 8 x 10-div graticule. Option 10 is available with either storage or nonstorage display.

OPTIONAL ACCESSORIES

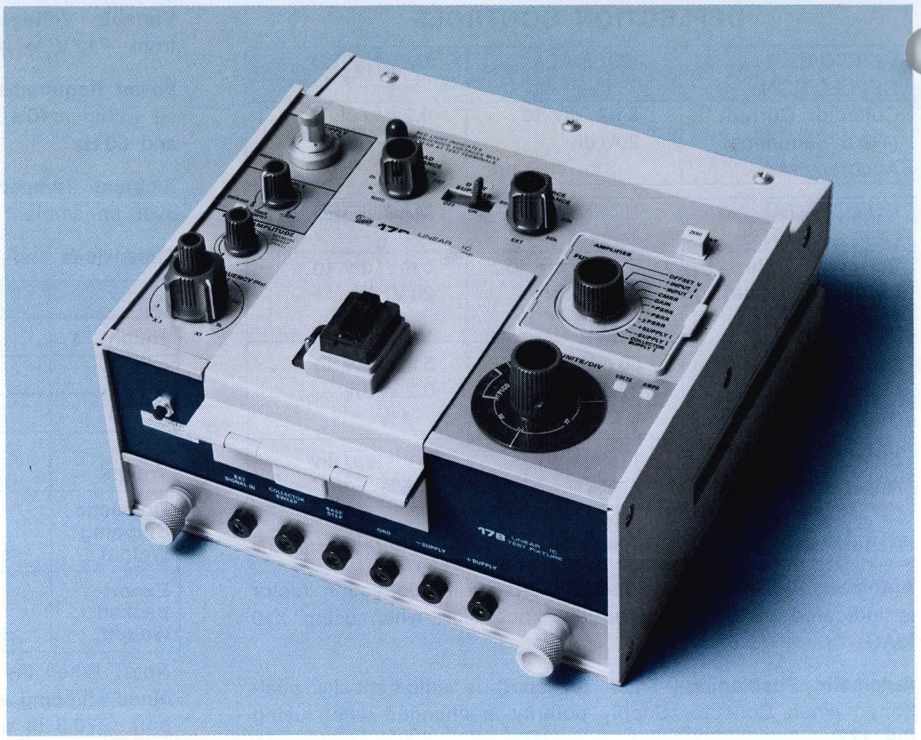
Camera—C-5, see camera section for complete description.
Order C-5 Camera $185

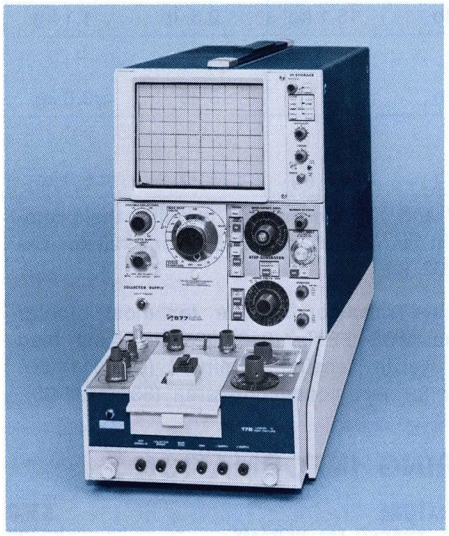
Scope-Mobile® Cart—With storage drawer.
Order 201-1 ..... $165

Test set-up chart—Package of 250.
Order 070-1639-00 ..... $5.50

178 *Linear IC Test Fixture*

New





- **MEASURES:**
  - GAIN
  - OFFSET V
  - BIAS I
  - CMRR
  - PSRR
- **DISPLAYS:**
  - THERMAL EFFECTS
  - POPCORN NOISE
  - PARAMETER NONLINEARITIES

The 178 extends curve tracer measurements to include many parameters of linear integrated circuits. It is designed to operate in a 577/D1 (storage) curve tracer mainframe. As with a general purpose or standard curve tracer, parameters are obtained from the CRT display, not from meter readings, numeric indicators or go, no-go lights. The result is more information about the device-under-test.

Operational amplifiers make up the greatest single class of linear integrated circuits. In order to test amplifiers, the 178 Linear IC Test Fixture departs from the open-loop approach used in a standard curve tracer. In a standard curve tracer the control lead of the device-under-test (DUT) is subjected to one or more test signals and the response or output is displayed on the CRT. However, the operational amplifier's high gain (100,000 is common) makes this measurement technique impractical. For this reason the 178 tests an amplifier DUT in closed-loop configuration, by making it part of a feedback loop. The DUT's output is determined by the 178 front panel. In some tests it remains at a fixed DC voltage and in others it follows a low frequency signal. At all times the DUT's input remains under the control of the feedback loop so that the required output is achieved. It should be noted that the 178 reverses the customary roles of dependent and independent variables by controlling output and measuring input.

An operational amplifier's GAIN is one of the important parameters that can be measured using the 577 Curve Tracer with the 178 test fixture. While the amplifier DUT is actually part of a feedback loop, the gain measurement still determines the DUT's open-loop gain. Figure 1 shows a stored display of an amplifier's characteristics, its inverting input (vertical deflection factor 100 μV/div) as a function of its output voltage (horizontal deflection factor 5 V/div). Two curves are shown for comparison purposes; one with an output load of 50 K ohms, the other 1 K ohms. True zero volts DC on the vertical axis is far off screen (offset voltage measured over 400 μV on this amplifier). However, in gain measurement, only the relative change of input voltage is needed. The curves were traced at approximately .05 Hz and effectively represent the DC transfer characteristics of the operational amplifier.

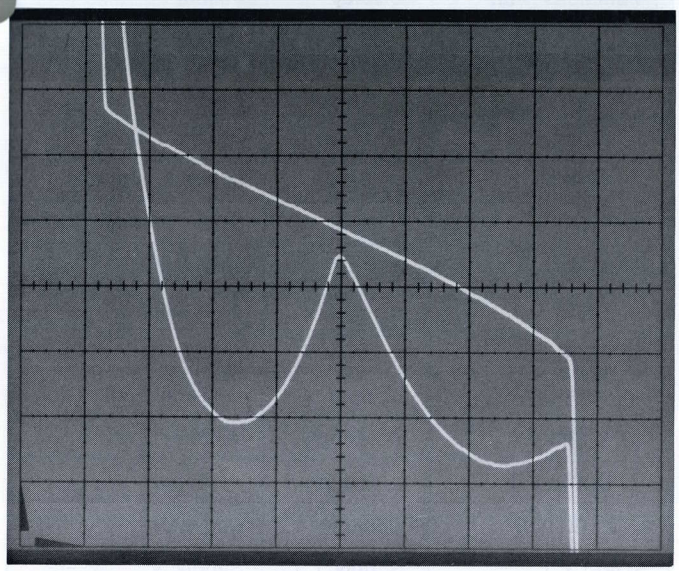


Figure 1

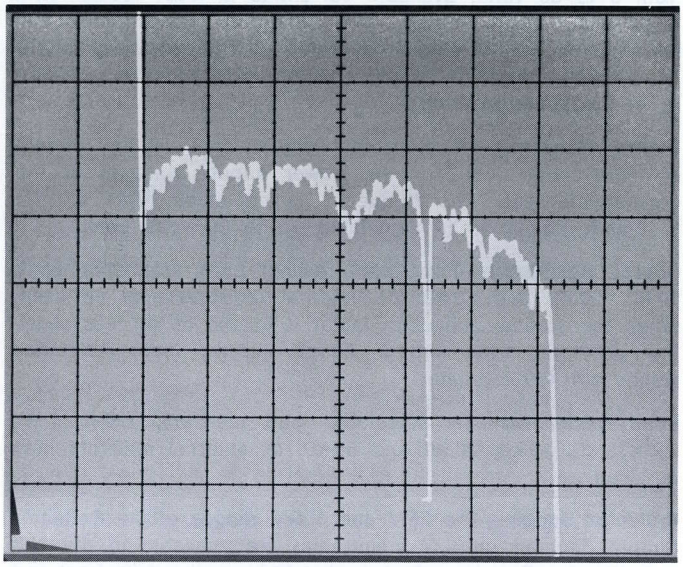


Figure 2

The well-behaved linear curve is produced with the 50 kilohm load. Such a curve is the response of an ideal DC amplifier. The amplifier's gain of 110,000 can be determined by dividing the change in output voltage by change in input voltage; this gain holds true for large or small output signals. With such ideal curves the amplifier performance can be predicted from a single numeric value for its gain. In addition, the measurement of amplifier gain can be made using either large or small signals.

The unusually shaped curve is produced with the 1 kilohm load on the amplifier's output terminal. With such a characteristic curve it is difficult to assign a single numeric value for DC gain. Thermal effects completely overshadow and effectively mask any input voltage change that is due to amplifier gain. The result, as shown, is degraded DC performance. For an output voltage change from zero volts to plus five volts the input voltage changes 185 μ volts, reflecting an effective gain of only 27,000. This gain is only one-fourth of the value measured with a 50 kilohm load.

Another undesirable characteristic of operational amplifiers that readily shows up on the curve tracer's CRT is popcorn noise (also called flicker noise). Figure 2 is the GAIN curve for an amplifier that has a large amount of popcorn noise. The vertical deflection factor is 100 μV/div, the horizontal 5 V/div. Notice the one large, spurious spike with an amplitude of over 400 μ volts. Because of the closed-loop testing, popcorn noise appears directly as equivalent input noise signal.

Other characteristics displayed by the curve tracer with a 178 test fixture are input offset voltage, input currents, common mode rejection, power supply rejection and power supply currents.

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.

178 *Linear IC Test Fixture*

New

Power Supplies—Positive and negative supplies are adjustable from 0 to 30 volts; 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 volts peak.

Source Resistance—Four input resistor pairs selectable, 65 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 400 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. Except as noted, the horizontal display monitors the point controlled by the sweep generator signal and the deflection factor is selected on the collector volts segment of the 577 HORIZ VOLTS/DIV switch. In tests where the amplifier's output V is not displayed, the output V is held to zero volts.

Input V is the differential voltage between the amplifier's inverting and non-inverting inputs. Δ input V is the change in this voltage with any offset voltage nulled out. Range of nulling voltage is ± 25 mV.

Selectable Functions with Standard Op Amp Card	Vertical Display	Horizontal Display
OFFSET V	input V	output V
+ INPUT I	+ input I	common mode V
— INPUT I	— input I	common mode V
CMRR	Δ input V	common mode V
GAIN	Δ input V	output V
+ PSRR	Δ input V	+ Supply V
— PSRR	Δ input V	— Supply V
± PSRR	Δ input V	+ Supply V[1]
+ SUPPLY I	+ Supply I	+ Supply V
— SUPPLY I	— Supply I	— Supply V
COLLECTOR SUPPLY I	Collector Supply I	Collector Supply V[2]

[1]The + Supply and — Supply are both swept out of phase at the same amplitude in ± PSRR function. Horizontal display is the + Supply voltage only.

[2]The Sweep Generator is not utilized in COLLECTOR SUPPLY 1 function.

Zero—Single push button provides a zero reference to the CRT display and, in functions four through eight, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

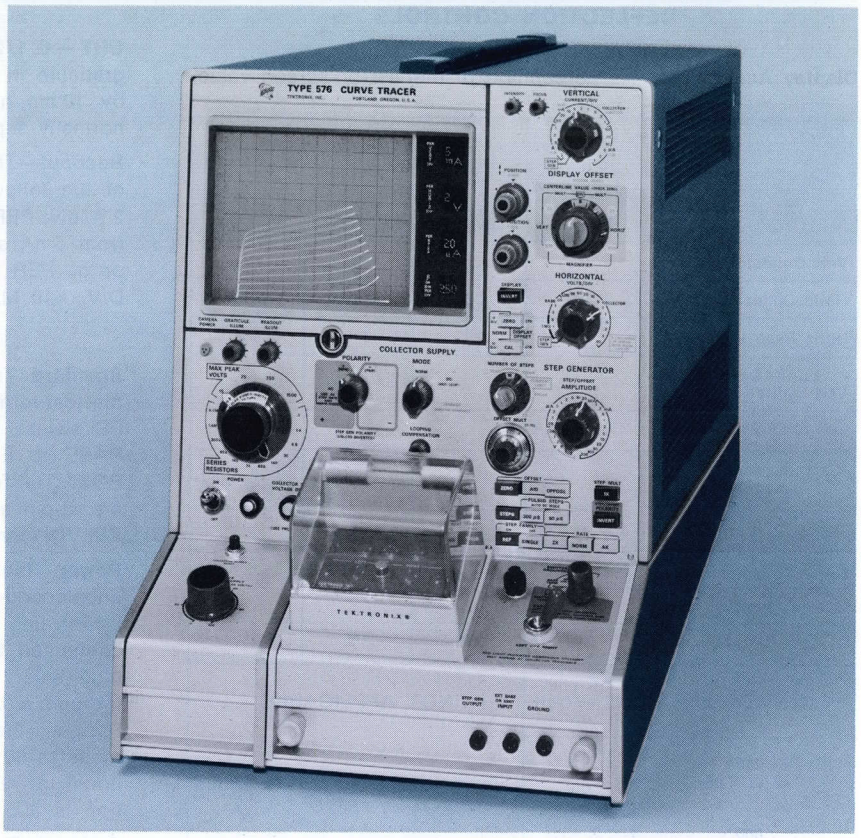
Dimensions and Weights

Height	4.5 in	11.4 cm
Width	7.9 in	20.1 cm
Depth	7.8 in	19.8 cm
Net Weight	3.3 lb	1.5 kg
Domestic Shipping Weight	≈9 lb	≈4.1 kg
Export-Packed Weight	≈14 lb	≈6.4 kg

Included Accessories—Eight patch cords (012-0200-00), dual-in-line 16 pin IC socket (136-0442-00), Standard Op Amp Card with cover (670-2567-00), interchangeable nomenclature panel for function switch (333-1770-00).

ORDERING INFORMATION

178 LINEAR IC TEST FIXTURE **$900**



- **AUTO SCALE-FACTOR READOUT INCLUDING β/div or g_m/div**
- **CALIBRATED DISPLAY OFFSET with MAGNIFIER**
- **KELVIN SENSING for HIGH CURRENT TESTS**
- **OPTIONAL TEST FIXTURES**
  - **PROGRAMMABLE TEST FIXTURE**
  - **HIGH-CURRENT FIXTURE**

A general description of the 576 Curve Tracer is located in the Curve Tracer Reference Section.

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 0.1X MULT) to 200 mA/step, 1-2-5 sequence. Max current (steps and aiding offset) is X20 AMPLITUDE setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Max voltage (steps and aiding offset) is at least 10 V. Max opposing offset current is X10 AMPLITUDE switch setting or 10 mA, whichever is less. Max opposing voltage is limited at 1 V to 3 V.

Voltage Mode—Step/offset amplitude range is 5 mV/step (with 0.1X MULT) to 2 V/step, 1-2-5 sequence. Max voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Max current (steps and aiding offset) is at least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short circuit current limiting is 20 mA, 100 mA, 500 mA +100%, —0%; 2 A +50%, —0%. Max opposing offset voltage; X10 AMPLITUDE switch setting. Max opposing current; limited at 5 mA to 20 mA.

Accuracy—Incremental; within 5% between steps, within 10% with 0.1X MULT. Absolute; within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater. Offset multiplier; 0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

Step Rates— 0.5X, 1X (NORM), and 2X the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps—Approx 80 μs or 300 μs width, at NORM or 0.5X rates.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the AC position. Step polarity may be inverted by actuating the INVERT push button.

Step Family—REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps—Digitally selectable between 1 and 10.

DEFLECTION CONTROLS

Display Accuracies—As percentage of highest on-screen value.

NORM and DC MODES	NORMAL	OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
		100-40 div	35-15 div	10-0 div
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20 or 2 nA	3% plus 50 mV/vert div			
500, 50 or 5 nA	3% plus 125 mV/ vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor—Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

Horizontal Deflection Factor—Collector volts; 50 mV/div to 200 V/div, 12 steps (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.

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— 6 1/2-inch rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied; P2 and P7 are optional without extra charge.

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 mV/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

OTHER CHARACTERISTICS

Standard Test Fixture—A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

Power Requirements—Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-change line-voltage range selector accommodates 90 VAC to 136 VAC or 180 VAC to 272 VAC (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights

Height	15.0 in	38.1 cm
Width	11.5 in	29.2 cm
Depth	23.0 in	58.2 cm
Net Weight	70.5 lb	32.0 kg
Domestic shipping weight	≈107 lb	≈48.5 kg
Export-packed weight	≈127 lb	≈57.6 kg

Included Accessories—Transistor adapter (013-0098-01), FET adapter (013-0099-01). TO3 adapter (013-0100-00), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), large in-line adapter (013-0138-00), small in-line adapter (013-0139-00) and protective cover (337-1194-00).

Order 576 CURVE TRACER $3150

INSTRUMENT OPTION

The 576 Option 1 deletes the parameter readout module, but maintains provision for insertion of the module (020-0031-00) at any time.

Order Option 1 ..... **Sub $500**
Order Auto Scale-Factor Readout Module (020-0031-00) **$580**
Order Option 72, P2 Phosphor ..... **No Charge**
Order Option 76, P7 Phosphor ..... **No Charge**

OPTIONAL ACCESSORIES

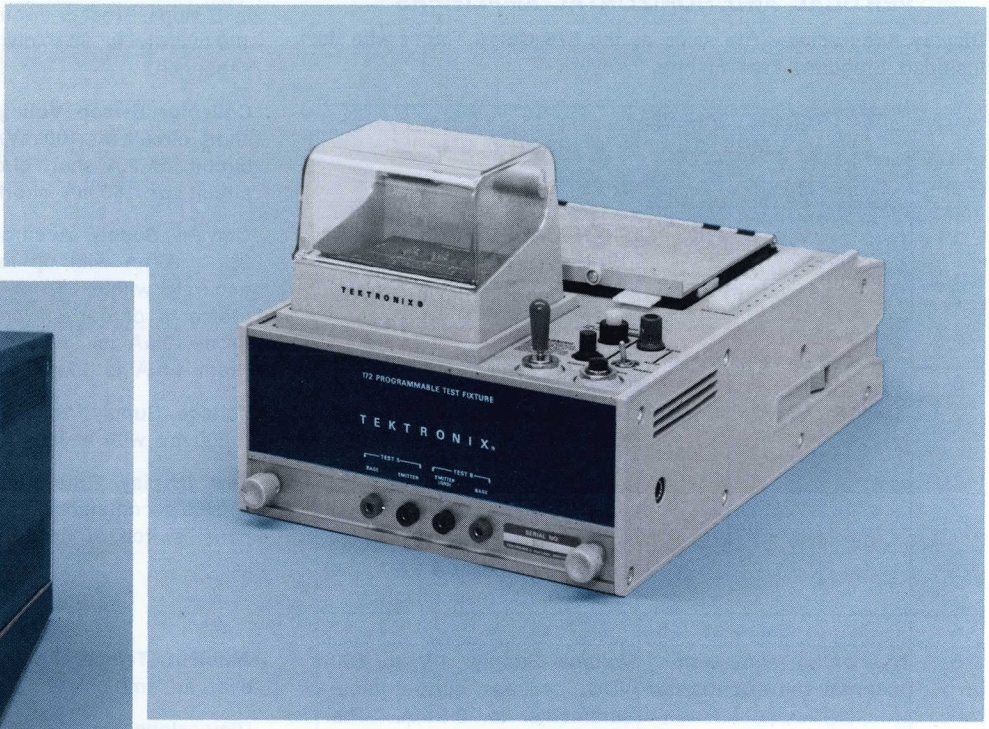
Camera—See Oscilloscope/Camera Adapters chart in camera section of this catalog.

Scope-Mobile® Cart—With storage drawer.
Order 202-1 ..... $1

Test Set-up Chart—Package of 250
Order 070-0970-01 ..... $5.50

For additional accessories, see Curve Tracer Accessories pages.

- **PROGRAMS TESTS on J FETs, TRANSISTORS and DIODES**
- **UP to 11 PROGRAM TESTS**



576 with 172 inserted

The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program a sequence of tests on J FETs, transistors and diodes.

The 172 can greatly reduce total test time in applications where 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 while the device remains in the test socket.

The 172 can also greatly reduce the chance for error. Even experienced operators are likely to make errors in applications where repeated adjustments in control settings are needed. The 172 removes this error source. Once the 172 is programmed, an operator with little or no experience can make tests quickly and accurately since the automatic programming removes human errors.

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.

Programming is straightforward. Inserting plastic pins in holes in the programming card sets individual test conditions. Omit the pin from a particular test hole and the 172 skips that test. After installing the program pins in the card, the card is put into the card reader portion of the 172 and the operator starts the test sequence.

Standard accessories include a plastic limit card upon which the programmer graphs the test limits. This card is then placed against the 576 display area for quick comparison of test results and limits. When testing several different devices, program and limit cards may be made up in advance. Retaining the programmed cards speeds incoming inspection. When a shipment is received, the operator selects the card for a device, inserts it into the 172 and completes the inspection. Programmed testing frees technically trained personnel to concentrate on more creative processes.

The 172 makes three types of tests that are under the control of the programming card. First, for measurements such as β and saturation voltage, single characteristic curves can be programmed. Second, leakage measurements can be made with three different lead arrangements. Third, breakdown voltage measurements can be made with five different lead arrangements. In addition to these tests that are controlled from the program card, the 172 permits tests controlled manually from the 576 front panel.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies—The same as the 576 Curve Tracer with its included Standard Test Fixture.

TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE
TEST	XSTR	J FETs	DIODES	CAPABILITIES
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 FETs 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 VDC. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is 1 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 110 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.

Vertical Deflection Factor—Test 1 and 2 (Collector or Emitter Current): I_c, 1 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA 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 MΩ 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 circuit, 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

Height w/cover	6.5 in	16.5 cm
Width	7.8 in	19.7 cm
Depth	12.4 in	31.4 cm
Net weight	11.5 lb	5.2 kg
Shipping weight	≈16 lb	≈7.3 kg
Export weight	≈23 lb	≈10.4 kg

Included Accessories—One protective cover, five programming cards, 250 programming card pins, five CRT overlay limit cards.

Order 172 PROGRAMMABLE TEST FIXTURE **$1400**

OPTIONAL ACCESSORIES

Programming Cards—Package of 25 programming cards without pins or limit cards.
Order 016-0198-01 ..... $35

CRT Limit Cards—Package of 25 limit cards without programming cards or pins.
Order 016-0510-01 ..... $15

Programming Pins—Package of 1000 programming pins without programming or limit cards.
Order 016-0519-01 ..... $20

Foot Switch—For manually sequencing the programmed test.
Order 260-1189-01 ..... $16.50

Programming Accessories Package—Includes one programming card, one CRT limit card and 50 programming card pins.
Order 016-0518-00 ..... $5

- **200 AMP PEAK COLLECTOR DISPLAYS**
- **20 AMP PEAK BASE SUPPLY**

576 with 176 inserted

The 176 Pulsed High-Current Fixture extends the capabilities of the 576 Curve Tracer by providing pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over dissipation. The 176 "front porch" configuration fits in place of the 576 Standard Test Fixture, and is programmed from the 576 mainframe except for controls not provided on the mainframe. The collector pulse is slaved to the 576 in regard to width and repetition rate. The pulse width is selected by depressing the 300 μs or 80 μs push button on the 576 mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT push button on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP push button on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP push buttons provide inputs to the fiber-optic readout to display actual values. **If STEP GENERATOR AMPLITUDE or VERTICAL CURRENT/DIV controls are moved out of the five highest current settings, the multiplication of the affected function automatically drops back to X1.**

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width— 300 μs or 80 μs determined by 576.

Repetition Rate—Power-line frequency.

Polarity— + or — determined by 576 polarity control.

Amplitude—Ranges are 15, 75, 350 volts nominal, controlled by MAX PEAK VOLTS switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

Maximum Peak Watts—Three illuminated push buttons select 10, 100, 1000 watts maximum peak power.

STEP GENERATOR

Current Ranges (X10 STEP selected)—Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.

576 Offset Multiplier— 0 to X100 576 AMPLITUDE switch setting.

Step Rate—Power-line frequency.

Pulsed Steps— 300 μs or 80 μs wide.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT push button.

Accuracy (Current steps including offset)—Incremental is within 5% between any two steps; within 10% with 0.1X STEP MULT. Absolute is within 3% of total output ± 1% of one step or within 3% of one step, whichever is greater.

VERTICAL AMPLIFIER

Deflection Factor (X10 VERT selected)— 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid over a temperature range of 0°C to +40°C.

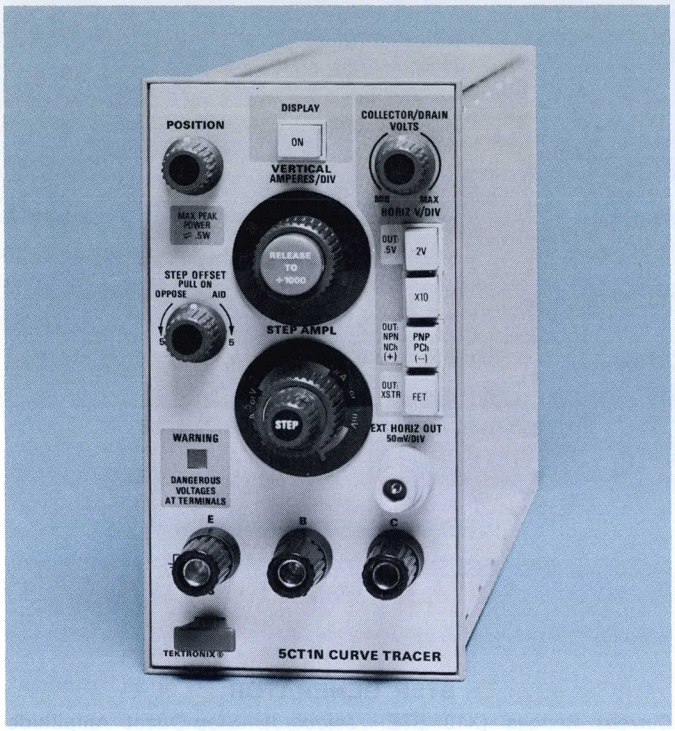
Dimensions and Weights

Height	4.6 in	11.8 cm
Width	7.9 in	20.0 cm
Depth	11.4 in	28.9 cm
Net weight	12.8 lb	5.8 kg

INCLUDED ACCESSORIES

TO-36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective cover (337-1194-00).

Order 176 PULSED HIGH-CURRENT FIXTURE $1600



- **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**
- **LIGHTED KNOB SKIRTS for SCALE FACTOR READOUT**
- **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. Horizontal deflection is achieved through a front panel source which drives the external input of a plug-in unit installed in the mainframe's horizontal compartment. The 7CT1N also operates in the horizontal compartments of the 7000-Series Oscilloscope Systems.

The following discussion and characteristics apply to both units.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are 1 μA/step to 1 mA/step for current and 1 mV/step to 1 V/step for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.

A front panel button switches the base/gate step generator output from current steps of the same polarity as the collector/drain sweep for checking transistors, to voltage steps of the opposite polarity of the collector/drain sweep for checking FETs in the depletion region. This button also internally switches the test fixture leads so that one test socket can be use to test both transistors and FETs.

The OFFSET control allows the base/gate step generator output to be offset at least 5 steps in the aiding or opposing direction for conveniently checking the enhancement region of FETs.

A ÷1000 button increases the sensitivity of the vertical display amplifier to 10 nA/div allowing leakage current measurements. When the button is pressed, the collector/drain supply is changed from a sweeping output to a DC output for checking leakage currents without looping aberrations.

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

Maximum Open Circuit Voltage—Within ±20%. Maximum short circuit current, within 30%.

Series Resistance—Automatically selected with horizontal volts/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning—When the horizontal volts/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. Maximum current (steps plus aiding offset) is X15 amplitude setting. Maximum voltage (steps plus aiding offset) is at least 13 V. Maximum 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 maximum. 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 volt 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
Domestic Shipping	≈4	≈2	≈6	≈3
Export Packed	≈9	≈4	≈11	≈5

Included Accessories—Test Fixture (013-0128-00) with two sets of test terminals, one with TO-5 basing and the other with TO-18 basing.

Order 5CT1N CURVE TRACER **$350**

Order 7CT1N CURVE TRACER **$400**

OPTIONAL ACCESSORIES

Adapters—For transistors with long leads.
Order 013-0069-00 ..... $10

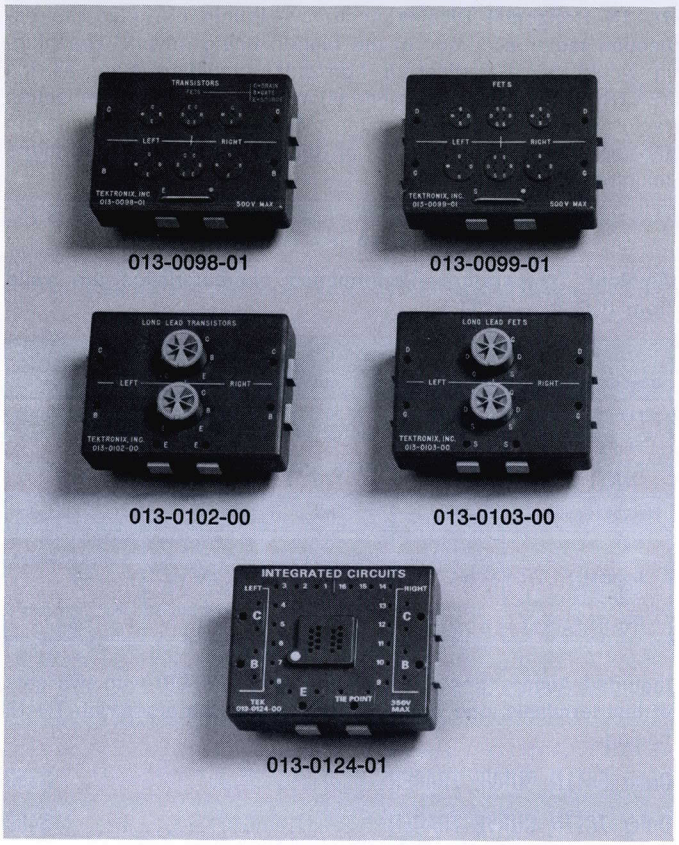
For transistors with TO3 or TO66 basing.
Order 013-0070-01 ..... $12

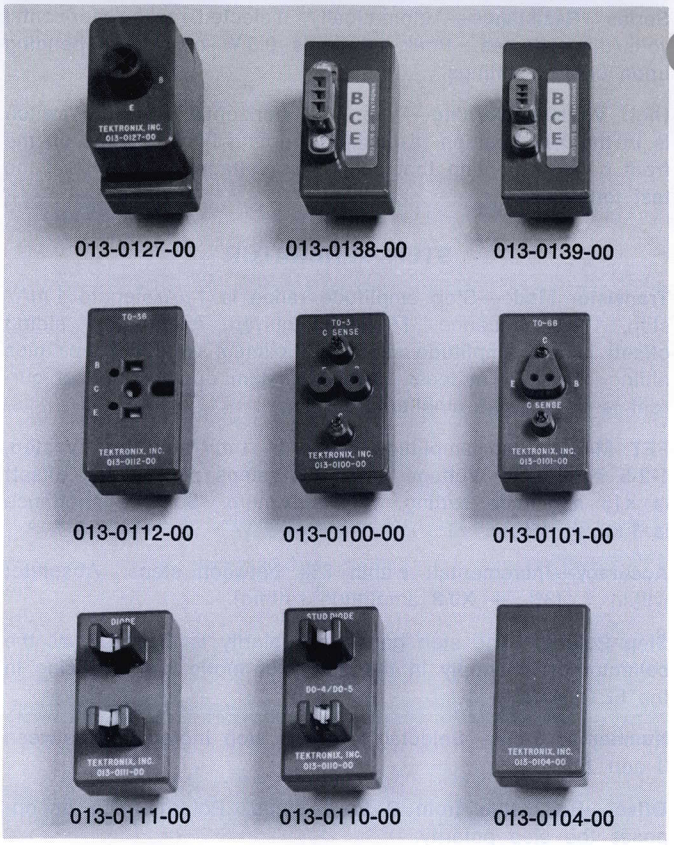
Diode Test Fixture—Holds axial-lead diodes.
Order 013-0072-00 ..... $9

Adapter Box Hardware—Allows mounting of additional semiconductor sockets. Order 013-0073-00 ..... $6

Power Transistor Socket—For power transistors with hook leads. Order 013-0074-00 ..... $14

Diode Test Adapter—Production test fixture for rapid handling.
Order 013-0079-00 ..... $32





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.

Transistor Adapter—Useful for most single and dual bipolar transistors and some MOS FET's.
Order (013-0098-01) $34

FET Adapter—Useful for most single and dual FET's.
Order (013-0099-01) $34

Long Lead Transistor Adapter—Accepts dual or single transistors with untrimmed leads.
Order (013-0102-00) $30

Long Lead FET Adapter—Accepts dual or single FET's with untrimmed leads.
Order (013-0103-00) $30

Integrated Circuit Adapter—Allows connection to multipin device packages. The appropriate Barnes Corporation socket is plugged into the integrated circuits adapter. The pins are then connected to the collector, base, or emitter terminals by means of the patch 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 Barnes Corporation Socket listed separately.

Order (013-0124-01) Includes 8 each 4-inch test leads .. $55

KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176 and 577/177 Curve Tracers.

Transistor Adapter—Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order (013-0127-00) $25

Large In-Line Adapter—Accepts large transistors with in-line leads. Approx spacing between terminals is 0.18 inch. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order (013-0138-00) $25

Small In-Line Adapter—Accepts small transistors with in-line leads. Approx spacing between terminals is 0.09 inch. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order (013-0139-00) $25

TO36 Adapater—Order (013-0112-00) $20

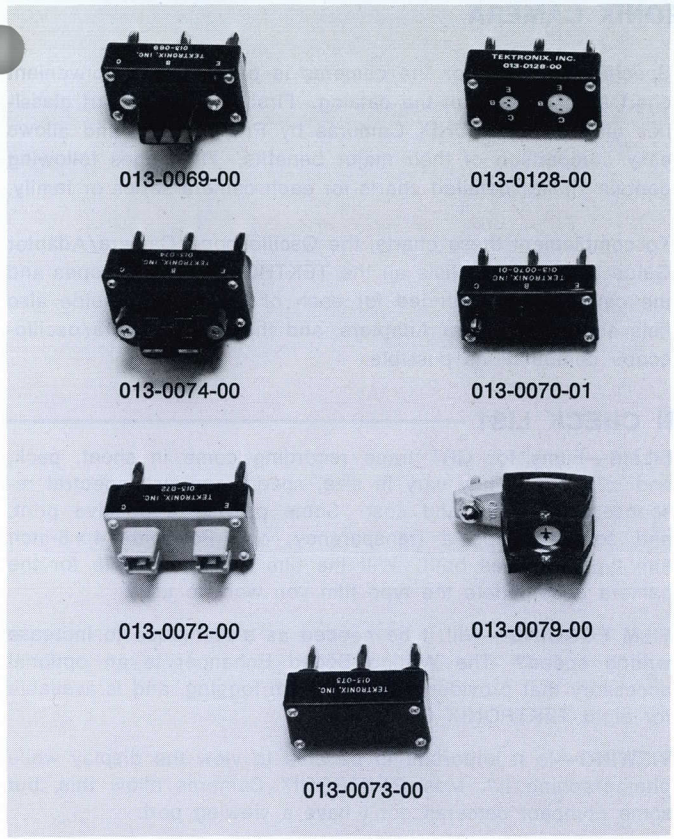
TO3 Adapter—Order (013-0100-00) $18

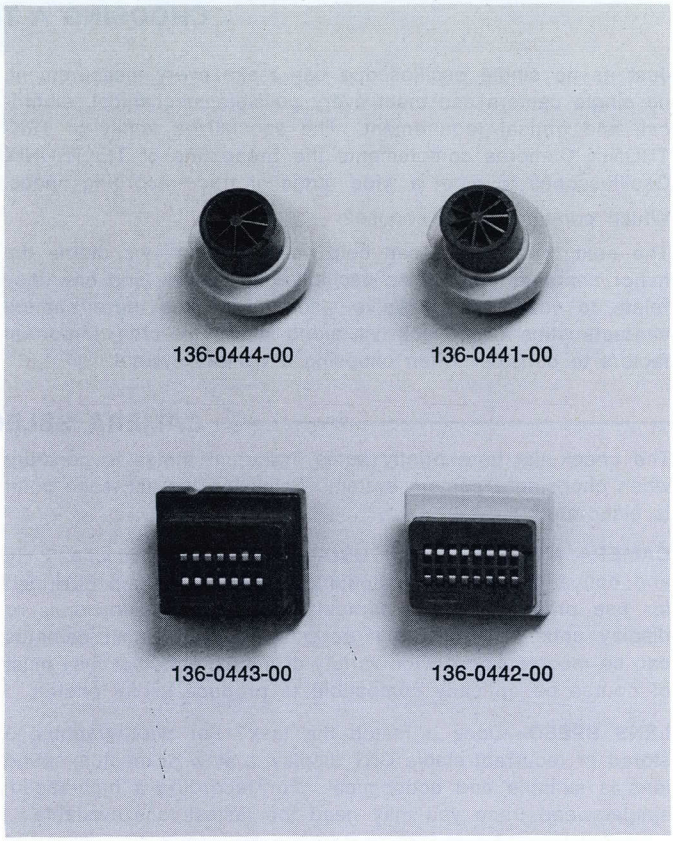
TO66 Adapter—Order (013-0101-00) $18

Axial Lead Diode Adapter—Order (013-0111-00) $14

Stud Diode Adapter—Order (013-0110-00) $14

Blank Adapter—For mounting special sockets.
Order (013-0104-00) $10





3 PIN ADAPTERS

The following accessories may be used with any of the Tektronix Curve Tracer products. They do not have Kelvin sensing contacts.

Long Lead Transistor Adapter—Order (013-0069-00) $10

TO5 or TO18 Transistor Adapter—Order (013-0128-00) .. $11

Power Transistor Adapter—For power transistors with hook leads.
Order (013-0074-00) $14

TO3 or TO66 Transistor Adapter—Order (013-0070-01) .. $12

Diode Test Adapter—Holds axial-lead diodes.
Order (013-0072-00) $9

Diode Test Adapter—Magnetically holds steel axial-lead diodes.
Order (013-0079-00) $32

Blank Adapter—For mounting special sockets.
Order (013-0073-00) $6

BARNES CORPORATION SOCKETS

These sockets are used with the integrated Circuits Adapter (013-0124-01) listed under Dual Width Adapters, and with the 178 Test Fixture.

8 lead TO package—Order (136-0444-00) $9.90

10 lead TO package—Order (136-0441-00) $11.00

14 lead dual-in-line package—Order (136-0443-00) $7.70

16 lead dual-in-line package—Order (136-0442-00) $7.70

CHOOSING A TEKTRONIX CAMERA

Just as no single oscilloscope can make every measurement, no single camera can meet every possible mechanical, electrical, and optical requirement. The specialized family of TEKTRONIX Cameras complements the broad line of TEKTRONIX Oscilloscopes to meet a wide range of trace-recording needs.

Which combination to choose?

The next three pages can help you. In them, we define the major characteristics of an oscilloscope camera, and how they relate to your needs. We've also summarized these camera characteristics in a check list, along with some other important factors to consider when choosing a camera system.

Specification data for the cameras is presented in convenient chart form throughout the catalog. First, a master chart classifies all the TEKTRONIX Cameras by Primary Use, and allows easy comparison of their major benefits. The pages following contain similar detailed charts for each camera series or family.

To complement these charts, the Oscilloscope/Camera/Adapter Guide on page 213 lists all the TEKTRONIX Oscilloscopes and the camera recommended for each of them. This Guide also lists eighteen Camera Adapters, and the many camera/oscilloscope combinations possible.

CAMERA SELECTION CHECK LIST

The check list here briefly notes important things to consider when choosing a camera system. Following the list, each point is elaborated.

CAMERA MOUNTING AND USE—Is the camera mechanically and optically compatible? Specific camera types are designed for use primarily with a particular series of oscilloscopes or display units. By means of optional adapters, most cameras can be mounted on a wide variety of instruments, but they must of course be optically compatible to produce useful photos.

LENS SPEED—Does it match the task? For photographing a stored or recurrent stable CRT display, a slow or medium-speed lens is suitable and economical. For recording a high-speed, single-sweep trace you may need the fastest lens available.

FIELD OF VIEW—Cameras are available for the CRT displays that range in size from 6 x 8 cm to 16 x 21 cm. Does the camera have sufficient field of view to fully record the entire display on the size film of your choice?

LENS MAGNIFICATION—Will the lens produce the size photo image you want? Magnification of the lens also affects the field of view and writing speed.

FILM BACKS—Is it desirable to interchange different types of film backs to allow use of different film types, picture sizes, and emulsion speeds? Except for the C-5 and C-10, all TEKTRONIX Cameras have interchangeable film backs.

MULTIPLE IMAGES—Is it desirable to record more than one CRT display on a single photo? The C-12 and C-27 Cameras have rotatable, indexed sliding backs that allow recording multiple images on one photo.

FILMS—Films for CRT trace recording come in sheet, pack, and roll form. They vary in size, speed, contrast, spectral response, resolution, and cost. Some provide a positive print, and some provide a transparency; one Polaroid[1] 4 x 5-inch film type provides both. Will the film backs available for the camera accomodate the type film you want to use?

FILM FOGGING—Will it be needed as a technique to increase writing speed? The Writing Speed Enhancer is an optional accessory that provides controlled film fogging, and is available for eight TEKTRONIX Cameras.

VIEWING—Is it important to be able to view the display while photographing it? Most TEKTRONIX Cameras allow this, but some compact cameras don't have a viewing port.

SHUTTER TRIGGERING—Must the shutter be operable by remote electrical control, or is manual operation of a mechanical shutter adequate? The all-electric C-50-Series Cameras need only a switch closure to ground for triggering; the optional Electric Shutter system for the C-12, C-27, and C-30-Series Cameras requires an insulated switch closure.

GRATICULE ILLUMINATION—Is it desirable to photograph the CRT graticule along with the trace? The graticules of some non-storage oscilloscopes and display units are not illuminated. Only the C-5 Camera with its built-in flash lamps can backlight and photograph the graticule of an oscilloscope that does not have graticule illumination.

CAMERA POWER—Four of the C-50-Series Cameras are electrically operated from +15 volts. Can your oscilloscope provide power, or will a Battery Pack be needed?

VIEWING

Most TEKTRONIX Cameras are hinge-mounted, and may be swung aside to allow a wide-angle view of the CRT display. **Except for the C-30 Series, most cameras also have a viewing port to allow observing the CRT with the camera latched in place.**

The light-weight, hook-mounted C-5, with a hinged door on top for angular viewing, can easily be slipped off the CRT bezel for full viewing. The C-27 and C-50-Series Cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the CRT display without interference from ambient light.

By means of mirrors, the C-12 viewing tunnel provides a straight-on view of the CRT to minimize parallax errors when photographing an external graticule. The optional Projected Graticule accessory for the C-12 provides parallax-free changeable graticules of any design.

FILMS

The three types of backs used on TEKTRONIX Cameras accommodate most all the films that are useful for CRT trace recording. These include sheet films, roll films, and several Polaroid Land films.

The most widely-used film is Polaroid Type 107. It is supplied in an 8-exposure pack and develops outside the film back in 15 seconds to produce a positive print with an image area of 7.3 x 9.5 cm. It has an ASA equivalent speed of 3,000 with 22-28 line-pairs/mm resolution. The equivalent in roll form is Type 47.

Polaroid 3,000-speed Pack Film and Roll Film are most suitable for recording stable CRT displays, and single-sweep traces of up to medium speeds. With controlled fogging provided by a Writing Speed Enhancer, the writing speed of both these films

[1]Registered Trademark Polaroid Corporation.

can be increased approximately four times to equal that of Polaroid Type 410 10,000-speed Roll Film. Type 410 film is especially suited for recording extremely fast single-sweep traces; its writing speed can be increased approximately two times with the Writing Speed Enhancer which is described on page 212.

Polaroid Roll Film Backs also accept Polaroid Type 46-L which provides a positive transparency suitable for use in slide projectors; it has an ASA equivalent speed of 800, with an image area of 6.2 x 8.3 cm, and 32-35 line-pairs/mm resolution.

Three of Polaroid's 4 x 5-inch films are also useful for CRT-display recording. The large image area of these films, 3½ x 4½ inches (8.9 x 11.4 cm), allows full-scale photography of 8 x 10-cm displays with the C-52 and C-58 Cameras which have unity-magnification lenses; an optional unity-magnification lens is also available for the C-12 and C-27 Cameras. The extra-wide-angle lens in the C-58 can fully expose the entire image area of these films with no vignetting.

Polaroid Type 52 4 x 5-inch Film has a wide tonal range and provides extremely good rendition of the CRT-display grey scale on a positive print. This characteristic is especially desirable when photographing brightness-modulated CRT displays such as those of scanning electron microscopes. Type 52 Film has an ASA equivalent speed of 400, and 22-28 line-pairs resolution.

Polaroid Type 55/PN 4 x 5-inch Film provides a medium-contrast print with 14-17 line-pairs/mm resolution, and a fine-grain negative with 150-165 line-pairs/mm resolution; it has an ASA equivalent speed of 50.

Polaroid Type 57 4 x 5-inch 3,000-speed film provides a medium contrast positive print with 22-28 line-pairs/mm resolution. Like Polaroid 3,000-speed Pack Film and Roll Film, Type 57 is very suitable for photographing stable CRT displays, and single-sweep traces of up to medium speeds.

Polaroid films are convenient and easy to use. They offer the advantages of development in seconds to a finished dry print with broad spectral response, good resolution, and high sensitivity. Polascope Type 410 is the fastest film available for use with oscilloscope cameras.

Conventional sheet films, and 70 mm and 120-size roll films can be used with the 4 x 5-inch and 2¼ x 3¼-inch Graflok Backs and the proper holder or adapter. A few of the many types of holders for these films are shown on page 209.

Conventional films provide a negative transparency from which unlimited contact prints or enlargement prints can be made. They offer the advantages of economy, and in the case of 70 mm roll film, high frame capacity with fast manual or automatic advance for photographing a large number of displays in rapid sequence.

Conventional films manufactured by Agfa, Ansco, DuPont, Eastman Kodak, Gavaert, and Ilford are available in several types and forms at ASA speeds from 64 to 1250. A detailed list of film types and their characteristics can be obtained from their respective manufacturers.

The ASA film-speed rating signifies the exposure requirements for general pictorial photography where the light has a very wide color spectrum. Since CRT phosphors emit light over a narrow spectrum, the ASA speed cannot be used to accurately predict the exposure requirements for oscilloscope trace photography, especially when recording fast, dim single-sweep traces.

LENSES

TEKTRONIX camera lenses differ mainly in speed, magnification, and field of view.

SPEED—The f-number of a lens inversely signifies its aperture size and speed. For example, the aperture of an f/1.4 lens is twice that of an f/2.8 lens of the same magnification and gathers four times more light. For recording a stored or stable recurrent CRT display, a lens as slow as the f/16 type in the C-5 Camera is adequate. On the other hand, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types in the C-31 and C-51 Cameras.

The following table lists the approximate relative light-gathering power of most TEKTRONIX camera lenses; the data is based on actual light transmission measurements.

Camera	Lens	Magnification	Relative Lens Speed
C-5	f/16	0.68	0.02
C-12†	f/1.9	0.85	0.65
	f/1.4	1.0	1.0
	f/1.3	0.5	1.7
C-27	f/1.9	0.85	1.0
	f/1.4	1.0	1.5
	f/1.3	0.5	2.6
C-30A	f/1.9	0.7	1.0
C-30A Opt 1	f/1.9	0.8	1.0
C-31	f/1.2	0.5	3.4
C-32	f/1.5	1.0	1.5
C-50	f/1.9	0.7	1.2
C-51	f/1.2	0.5	3.6
C-52	f/1.4	1.0	1.5
C-53	f/1.9	0.85	1.0
C-58	f/2.8	1.0	0.4
C-59	f/2.8	0.67	0.65

†The C-12 beam-splitter mirror transmits 65% of the CRT light to the lens, and reflects 35% through the viewing tunnel.

FIELD OF VIEW—The description for each TEKTRONIX 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 or 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. Even the five interchangeable lenses for the C-12 and C-27 Cameras have fixed magnification. One exception is the C-30A Camera which has a magnification range of 0.7 to 1.5 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. $M = \frac{\text{Image}}{\text{Object}}$ or $\text{Image} = M \times \text{Object}$.

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.

The sixteen types of lenses used in TEKTRONIX cameras represent six fixed magnifications ranging from 0.5 to 1.0.

In most cases, the magnification is selected to provide the largest possible complete image of a particular display. In the case of some 0.5 magnification lenses, it is to achieve high writing speed by concentrating the trace light in a smaller area on the film.

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. A photographic image of the trace is usually considered readable if the density difference between trace image and photo background is at least 0.1.

CAMERA SUMMARY

As shown in the chart below, each TEKTRONIX Camera is offered for use primarily with a particular series of oscilloscopes or display units for optimum system performance at a commensurate price.

Most TEKTRONIX Cameras can also be used effectively with many instruments other than those they were primarily designed for. The Oscilloscope/Camera/Adapter Guide on page 213 shows the many additional combinations possible.

CAMERA	PAGE	PRIMARY USE	PERFORMANCE FEATURES	LENS				SHUTTER	FILM BACKS		PRICE with back ordinarily used
				MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3¼ x 4¼-inch Polaroid Film except where noted)		ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	
C-5	205	5100 Series Oscilloscopes and TELEQUIPMENT D-83	Low price; easy to use	f/16	0.68	0.02	10.2 x 12.7 cm/ 4 x 5 inches	MECHANICAL	Polaroid[1] Pack	None	$185 Pack
C-10	205	611 11-inch Display Unit and some computer Display Terminals	Provides Polaroid 4 x 5-inch print of full CRT display	f/8	0.5	0.08	17.8 x 22.8 cm/ 7 x 9 inches (with Polaroid 4 x 5-inch film)		4 x 5 Graflok[2]	None	$450 Graflok
C-12	206	500 Series oscilloscopes with external graticules up to 8 x 10 cm	Straight-on binocular viewing. Optional Projected Graticule. Movable film backs. Four optional lenses.	f/1.9 (standard lens)	0.85	0.65†	8 x 10 cm/ 3.15 x 3.93 inches	MECHANICAL (Standard)	Polaroid Pack Film	Polaroid Roll Film and 4 x 5-inch Graflok	$590 Pack
C-27	206	500 Series oscilloscopes with internal graticules up to 10 x 10 cm	Selectable orientation of off-axis binocular viewing. Movable film backs. Four optional lenses.	f/1.9 (standard lens)	0.85	1.0	10 x 10 cm/ 3.93 x 3.93 inches (with Polaroid 4 x 5-inch film)				
C-30A	210	400 SERIES PORTABLE OSCILLOSCOPES	General-purpose with variable mag lens.	f/1.9	0.7 to 1.5	1.0[5]	8 x 10 cm/ 3.15 x 3.93 inches at 0.85 MAG setting[3]	ELECTRIC (Optional)	Polaroid Pack	Polaroid Roll and 2¼ x 3¼-inch Graflok	$525 Pack
C-30A Opt 1	210		General Purpose; Full Coverage of 8 x 10-cm CRT display	f/1.9	0.8	1.0	8 x 10 cm (no vignetting)		Polaroid Pack		$535 Pack
C-31	210		Fast writing speed with 0.5 mag lens.	f/1.2	0.5	3.4	8 x 9 cm/ 3.15 x 3.5 inches		Polaroid Roll	Polaroid Pack and 2¼ x 3¼-inch Graflok	$675 Roll
C-32	210		Full-size image with medium writing speed.	f/1.4	1.0	1.5	7 x 9 cm/ 2.75 x 3.5 inches at 1.0 MAG setting		Polaroid Pack	Polaroid Roll and 2¼ x 3¼-inch Graflok	$715 Pack
C-50	199	7000 SERIES OSCILLOSCOPES with 8 x 10 cm CRT's	General-purpose with 0.7 mag lens.	f/1.9	0.7	1.2	10.2 x 12.7 cm/ 4 x 5 inches[4]	ELECTRIC	Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$750 Pack
C-51	199		Fastest writing speed with 0.5 mag lens.	f/1.2	0.5	3.6	8 x 10 cm/ 3.15 x 3.93 inches		Polaroid Roll	Polaroid Pack and 4 x 5-inch Graflok	$1085 Roll
C-52	199		Full-size image with medium writing speed.	f/1.4	1.0	1.5	8 x 10 cm/ 3.15 x 3.93 inches (with Polaroid 4 x 5-inch film)		4 x 5-inch Graflok	Polaroid Pack and Roll Film	$1065 Graflok
C-53	199		General-purpose with 0.85 mag lens.	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 inches		Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$825 Pack
C-58	199		Full-size image of largest field at lowest price.	f/2.8	1.0	0.4	8.9 x 11.4 cm/ 3½ x 4½ inches (with Polaroid 4 x 5-inch film)		4 x 5-inch Graflok	Polaroid Pack and Roll Film	$590 Graflok
C-59	199	5400 Series; 7000 Series Oscilloscopes with 6½-inch CRT's; TELEQUIPMENT D-83	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 inches	MECHANICAL	Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$450 Pack

[1] Registered Trademark Polaroid Corporation

[2] Registered Trademark Graflex, Inc.

[3] Possible corner vignetting with some instruments

[4] Slight corner vignetting

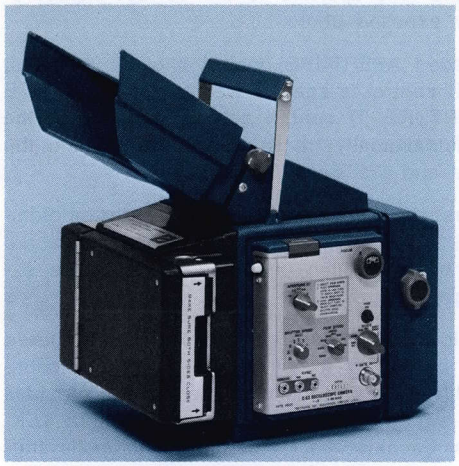
[5] At 0.7 MAG setting

* Relative light gathering power

† Beam-splitter mirror transmits 65% of CRT light to the lens and 35% to the viewing tunnel

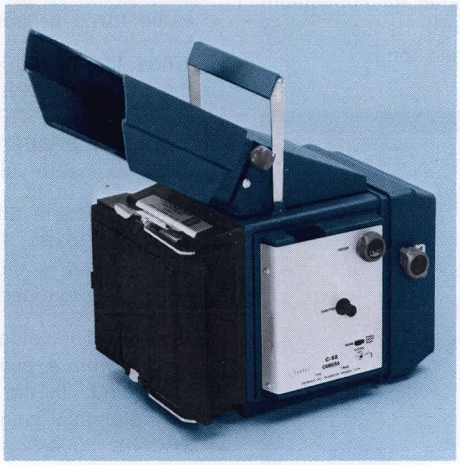
COMMON C-50 SERIES FEATURES

- COMPACT, LIGHTWEIGHT
- INTERCHANGEABLE FILM BACKS
- LIFT-OFF MOUNTING, SWING-AWAY HINGING



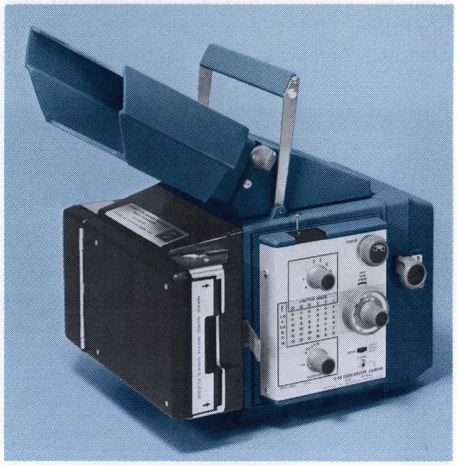
C-50, C-51, C-52, and C-53

- ELECTRONIC-CONTROLLED SHUTTER
- PHOTOMETER EXPOSURE AID
- RANGE-FINDER FOCUSING
- AUTOMATIC SINGLE-SWEEP CONTROL



C-58

- LOW COST
- UNITY-MAGNIFICATION LENS
- WIDE FIELD OF VIEW WITH NO VIGNETTING



C-59

- PHOTOMETER EXPOSURE AID
- RANGE-FINDER FOCUSING
- INTERNAL BATTERY POWER

Three distinct versions comprise the C-50-Series Cameras: (1) The C-50, C-51, C-52, and C-53, all with photometer exposure aid and electronic-controlled shutter; (2) the low-cost C-59 with photometer exposure aid and mechanical shutter; and the C-58 with mechanical shutter and wide-angle unity-magnification lens.

The six C-50-Series Cameras are designed for use with all TEKTRONIX 7000-Series Oscilloscopes. They can also be adapted to most TEKTRONIX 500-Series Oscilloscopes and 600-Series Display Units. Please refer to the Oscilloscope/Camera/Adapter Guide on page 213.

All the C-50-Series Cameras can be ordered with a Polaroid[1] Pack-Film or Roll-Film Back, or Graflok[2] 4 x 5-inch Back. All three backs can easily be removed and interchanged without fogging the film, and without need to refocus the camera.

See next five pages for details and waveform photographs.

See page 204 for Accessories and Ordering information.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-50	C-51	C-52	C-53	C-58	C-59
PERFORMANCE FEATURES	General purpose for CRT's up to 6½ inches; Medium writing speed, electric shutter	Fastest writing speed 0.5 mag lens; electric shutter	Full--size image; Medium writing speed; electric shutter	General purpose for 7000 Series with 8 x 10-cm CRT's**, electric shutter	Full-size image of largest field at lowest price. Slow writing speed	General purpose at lowest price. For CRT's up to 6½ inches; slow writing speed
LENS	f/1.9	f/1.2	f/1.4	f/1.9	f/2.8	f/2.8
MAGNIFICATION	0.7	0.5	1.0	0.85	1.0	0.67
RELATIVE LENS SPEED*	1.2	3.6	1.5	1.0	0.4	0.65
FIELD OF VIEW	10.2 x 12.7 cm with 3¼ x 4¼-inch film[3]	8 x 10 cm with 3¼ x 4¼-inch film	8 x10 cm with Polaroid 4 x 5-inch film	8 x 10 cm with 3¼ x 4¼-inch film	8.9 x 11.4 cm with Polaroid 4 x 5-inch film	10.2 x 12.7 cm with 3¼ x 4¼-inch film
SHUTTER	Electrically actuated, 4 to 1/60 second, plus Bulb and Time				Mechanically actuated 1 to 1/100 sec, Bulb and Time	Mechanically actuated 1 to 1/50 sec, Bulb and Time
FILM BACKS	These cameras may be ordered with a Polaroid Pack Back which accepts 3,000-speed film, a Polaroid Roll Back which accepts 3,000- and 10,000-speed film, or a 4 x 5-inch Graflok Back which accepts a Polaroid 4 x 5-inch Film Holder and 4 x 5-inch sheet-film holder. See ORDERING INFORMATION on page 204, and ACCESSORIES on page 209.					
PRICE (With Film Back Ordinarily Used)	$750 (Pack Back)	$1085 (Roll Back)	$1065 (Graflok Back)	$825 (Pack Back)	$590 (Graflok Back)	$450 (Pack Back)

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-50-P		C-51-R		C-52-G		C-53-P		C-58-G		C-59-P	
	In	cm	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	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	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	10.8	27.3
Weight (Approx)	lb	kg	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	6.0	2.7	7.0	3.2
Domestic Shipping	12.0	5.4	15.0	6.8	15.0	6.8	12.0	5.4	10.0	4.5	11.0	5.0
Export-Packed	24.0	10.9	27.0	12.2	27.0	12.2	24.0	10.9	22.0	9.9	23.0	10.4

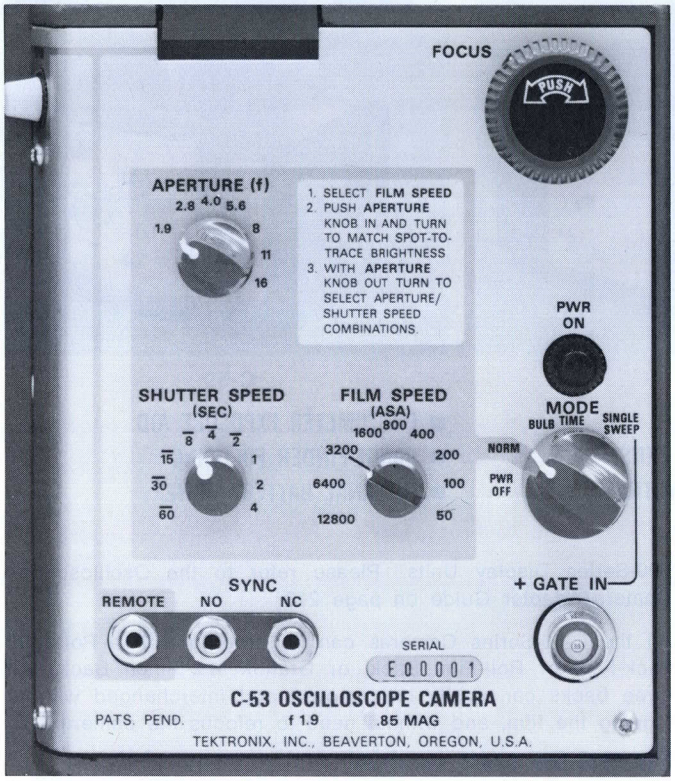
*Relative light-gathering power. (See Camera Reference Information for comparison of all Tektronix Cameras.)

**The C-53 lens records the largest practical image of an 8 x 10 cm CRT display on Polaroid 3¼ x 4¼-inch film.

[1] Registered Trademark Polaroid Corporation [2] Registered Trademark Graflex, Inc. [3] Slight corner vignetting

C-50, C-51, C-52, and C-53 CAMERAS

These electrically-powered cameras offer more convenience and flexibility of operation than any other trace-recording camera. The controls are grouped on one panel for convenient operation. With new-design, short-focal-length lenses, these compact cameras are less than eleven inches long.



COMMON FEATURES

Mode Switch—Turns on camera power and selects four modes of operation: Normal, Time, Bulb, and Single Sweep.

Focus—When the spring-loaded FOCUS control knob is pushed in, two vertical bars of light are projected onto the CRT screen. By turning the FOCUS control, the camera body can be moved in and out until the light bars coincide, which indicates that the camera is focused on the CRT screen. When the FOCUS control is released, the lamps extinguish and the camera is locked in focus.

Photometer Exposure Aid—The photometer exposure-aid operates similarly to exposure-value meters in conventional cameras. Mechanical analogues of film speed, phosphor type, shutter speed, and CRT-trace brightness are set by panel controls into a gear train which properly relates these factors. The operator can quickly and easily set the shutter controls for the exposure-value that will provide properly exposed photos of recurrent CRT displays over a wide range of trace brightness.

In procedure, the FILM SPEED knob is first set to match the ASA index of the film being used. Normally, the SHUTTER-SPEED selector is slaved to the APERTURE (f) control. Depressing the APERTURE control disengages it from the shutter, and it can be turned without affecting the shutter speed.

Depressing the APERTURE control knob also turns on the photometer light, which appears in the viewing tunnel as a small spot of light on the CRT screen. By turning the APERTURE control, the brightness of the photometer spot can be adjusted to match the brightness of the CRT trace. This sets the shutter speed and lens aperture to the correct exposure-value for a properly exposed photo.

When the spring-loaded APERTURE control knob is released, the SHUTTER-SPEED control is again slaved to the APERTURE control. If the APERTURE (f) control setting is changed, the SHUTTER SPEED automatically tracks with it to maintain the same exposure-value and the same film exposure.

Four selectable filters allow matching the color of the photometer spot to P1, P2, P11, and P31 phosphors. The filters are mounted on a thumbwheel which is interlocked with the exposure-photometer gear train.

Shutter—The electrically-controlled shutter can be triggered locally with a push button, or remotely with a switch closure to ground. In the SINGLE SWEEP mode, the camera provides an automatic single-sweep sequence when used with a TEKTRONIX 7000-Series Oscilloscope. When the shutter is triggered open, the camera arms the oscilloscope sweep. The shutter stays open until the sweep occurs, then closes five seconds after the sweep ends.

Camera Power and Sweep Reset—A 3-pin connector on the bezel of the TEKTRONIX 7000-Series Oscilloscopes provides +15 V power to the camera, and a sweep-reset signal (in single-sweep mode only) back to the oscilloscope. An optional Battery Pack allows use of these cameras with other oscilloscopes.

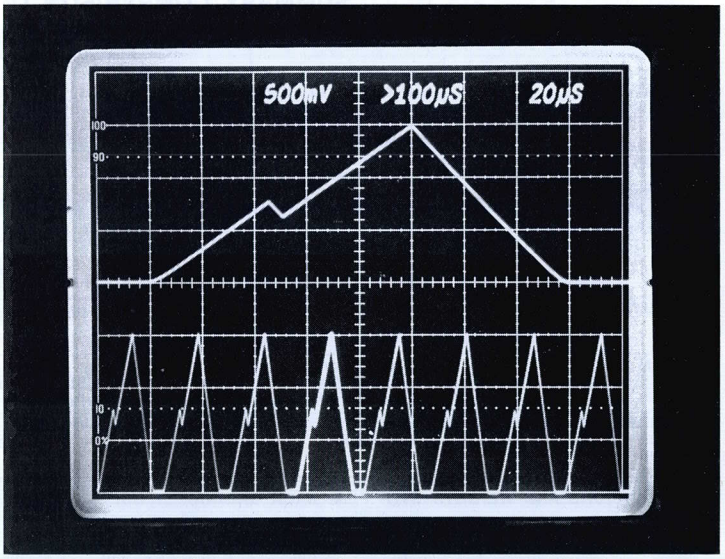
See page 204 for Ordering information.

C-50, C-51, C-52, and C-53 LENS SYSTEMS

The following four photos show each camera's field of view and lens magnification.

C-50 GENERAL-PURPOSE CAMERA

(f/1.9, 0.7 magnification lens)



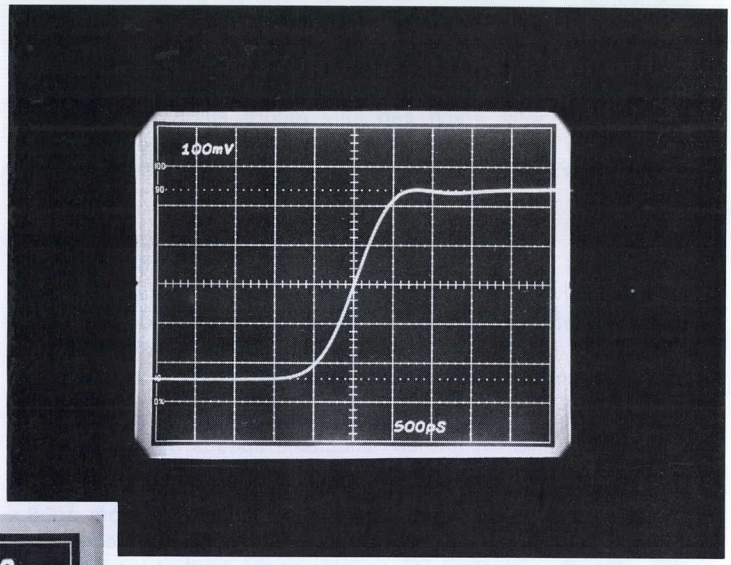
(Actual image area of Polaroid Type 107 Film)

7704A with 8 x 10-cm CRT

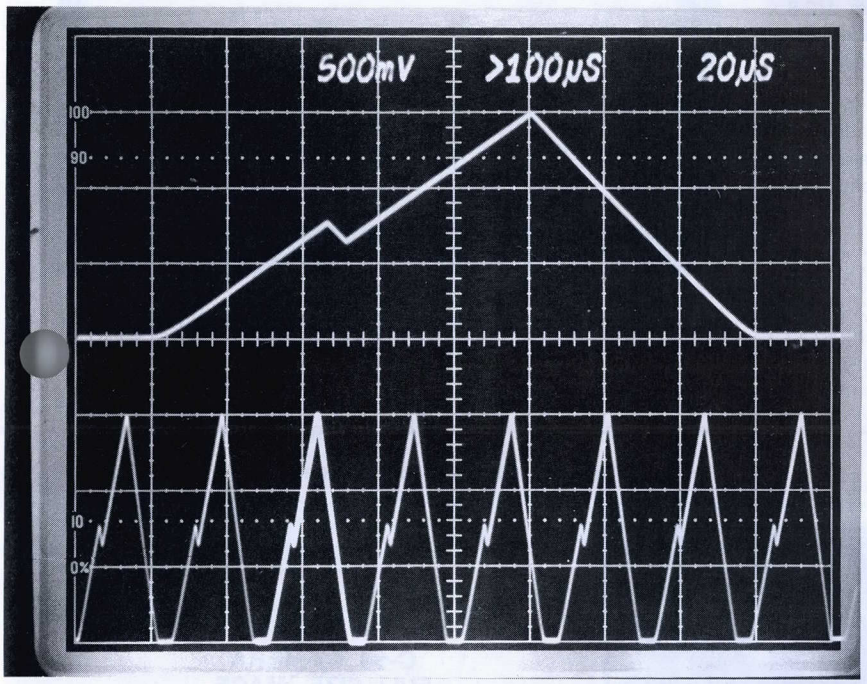
The C-50 can also record 6½-inch CRT displays, such as the 7603, on a Polaroid 3¼ x 4¼-inch film, but with some vignetting of the graticule corners. The C-50 Camera's f/1.9, 0.7 lens has a relative light-gathering power of 1.2.

C-51 CAMERA
MAXIMUM WRITING SPEED
(f/1.2, 0.5 magnification lens)
7904 with 8 x 10-cm CRT

The C-51 Camera provides the fastest writing speed of all the C-50-Series Cameras, and is recommended for use with all TEKTRONIX 500- and 7000-Series Oscilloscopes where maximum single-sweep writing speed is desired. Its f/1.2, 0.5 magnification lens has a light-gathering power of 3.6.



(Actual image area of Polaroid Type 107 Pack Film)



(Actual image area of Polaroid[1] Type 57 4 x 5-inch Film)

C-52 CAMERA
FULL-SIZE IMAGE
MEDIUM WRITING SPEED
(f/1.4, unity-magnification lens)
7704A with 8 x 10-cm CRT

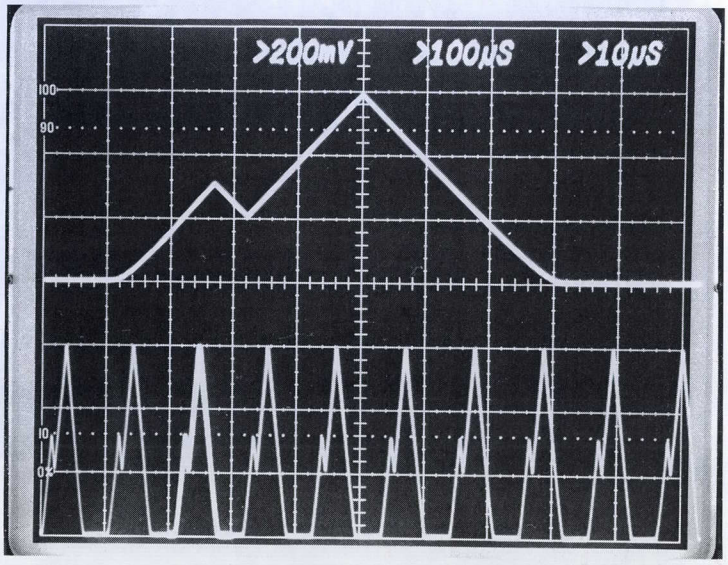
The C-52 Camera, using a Graflok[2] Back, provides a full-size image with sufficient writing speed for most medium-speed single-sweep applications. Its f/1.4, unity-magnification lens has a light-gathering power of 1.5.

Polaroid Pack Film and Roll Film Backs can be used with the C-52 but the 3¼ x 4¼-inch films used with these backs limit the camera's field of view to their actual image area, which is 7.3 x 9.5 cm.

C-53 CAMERA
GENERAL PURPOSE
(f/1.9, 0.85 magnification lens)
7704A with 8 x 10-cm CRT

The C-53 f/1.9 lens, which has a relative light-gathering power of 1.0, provides adequate writing speed for most general-purpose applications. The 0.85-magnification lens provides the largest practical image of an 8 x 10-cm CRT display that will fall within the 7.3 x 9.5-cm image area of Polaroid 3¼ x 4¼-inch film.

The C-58 and C-59 Cameras are described on the next two pages.



(Actual image area of Polaroid Type 107 Pack Film)

[1]Registered Trademark Polaroid Corporation
[2]Registered Trademark Graflex, Inc.

C-58 CAMERA
FULL-SIZE IMAGE

The C-58 Camera features an extra-wide-angle f/2.8 unity-magnification lens which can fully record all the image area of 4 x 5-inch film with no vignetting. Its simplified design with mechanically actuated shutter provides easy operation and low cost.

The C-58 is an ideal camera for general purpose oscilloscope photography where full-size photos are desired but without the need for fast writing speed. It is also well suited for providing vignette-free photos of brightness-modulated CRT displays such as those of scanning electron microscopes, ultrasonic scanners, and IR thermogram instruments.

Shutter—The mechanical shutter is actuated by a plunger on the control panel. It has six selectable speeds from 1 to 1/50 second, with Time and Bulb modes.

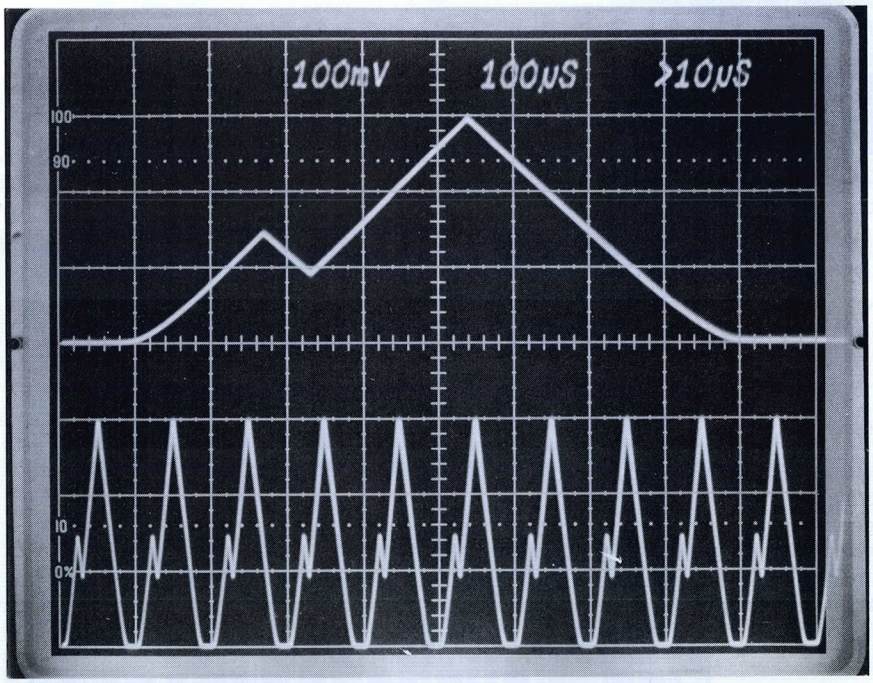
Aperture—The aperture is continuously adjustable from f/2.8 to f/16. The aperture (f) and shutter speed controls are readily accessible through the wide opening at the front of the camera.

Focus Control—The spring-loaded knob is pushed in and turned to focus the camera while observing the CRT display on the Graflok Back focusing screen, or a focus plate if a Polaroid Film Back is used. When the knob is released, the camera is locked in focus.

X-Sync Switch—A normally-open switch in the shutter closes when the shutter is operated fully open. One contact of this switch is grounded, and the other is connected to the X-SYNC switch on the control panel. When this panel switch is in NORM position, connection can be made to the mini-phone jack (just below the switch) for controlling test circuitry in conjunction with the camera shutter operation.

When the X-SYNC switch is in the SINGLE-SWEEP-RESET position, the shutter switch is connected via an adapter/bezel connector to the sweep-reset line of a 7000-Series Oscilloscope. When the camera shutter opens, the shutter switch arms the oscilloscope sweep when it is in Single-Sweep Mode.

See page 204 for Ordering Information.



(Actual image area of Polaroid Type 57 4 x 5-inch Film)

C-58 CAMERA
FULL-SIZE IMAGE
(f/2.8, unity-magnification lens)

7704A with 8 x 10-cm CRT

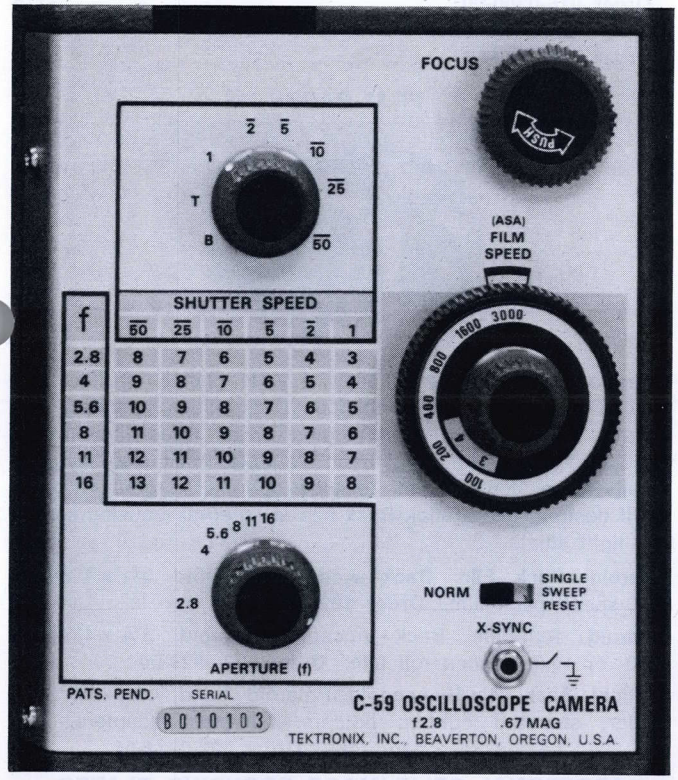
The C-58 Camera, using a 4 x 5-inch Graflok Back provides a full-size image without vignetting on 4 x 5-inch film. Its f/2.8, unity-magnification lens has a relative light-gathering power of 0.4. Polaroid[1] Pack Film and Roll Film Backs can also be used with the C-58. However, the 3¼ x 4¼-inch films for these backs limit the camera's field-of-view to their actual image which is 7.3 x 9.5 cm.

[1]Registered Trademark Polaroid Corporation.

C-59 CAMERA
LOW COST — GENERAL PURPOSE

The C-59 is a general-purpose camera which is suitable for most photographic needs. It is designed primarily for use with TEKTRONIX 7000-Series Oscilloscopes that have 6½-inch CRT's, but also fits directly onto all other 7000-Series Oscilloscopes with its standard adapter. The C-59 can also be used with any other oscilloscope that accommodates a TEKTRONIX C-27 Adapter; see Oscilloscope/Camera/Adapter Guide on page 213 for oscilloscope compatibility.

The C-59 features range-finder-focusing, and a photometer exposure-aid that allows the operator to quickly and easily set the camera controls for properly exposed photos of recurrent CRT displays over a wide range of trace brightness. Its f/2.8 lens is limited, however, to the single-trace recording of medium-speed traces. The optional WRITING SPEED ENHANCER described on page 212 can effectively increase the C-59's writing speed by a factor of at least two.



FEATURES

Focus—When the spring-loaded FOCUS control knob is pushed in, two vertical bars of light are projected onto the CRT screen. By turning the FOCUS control, the camera body can be moved in and out until the light bars coincide which indicates that the camera is focused on the CRT screen. When the FOCUS control is released, the lamps extinguish and the camera is locked in focus.

Photometer Exposure Aid—The FILM SPEED control is set to match the ASA index of the film being used. Depressing the PHOTOMETER switch turns on the photometer light which appears in the viewing tunnel as a small spot of light on the CRT screen. By turning the knob concentric with the FILM SPEED control, the photometer spot brightness can be adjusted to match the CRT trace brightness. The number appearing in the dial window of the photometer brightness control is the EXPOSURE VALUE for the combination of film speed and CRT trace brightness. A chart on the control panel shows the combinations of SHUTTER SPEED and APERTURE (f) control settings that coordinate with this EXPOSURE VALUE number to provide a correctly exposed photo.

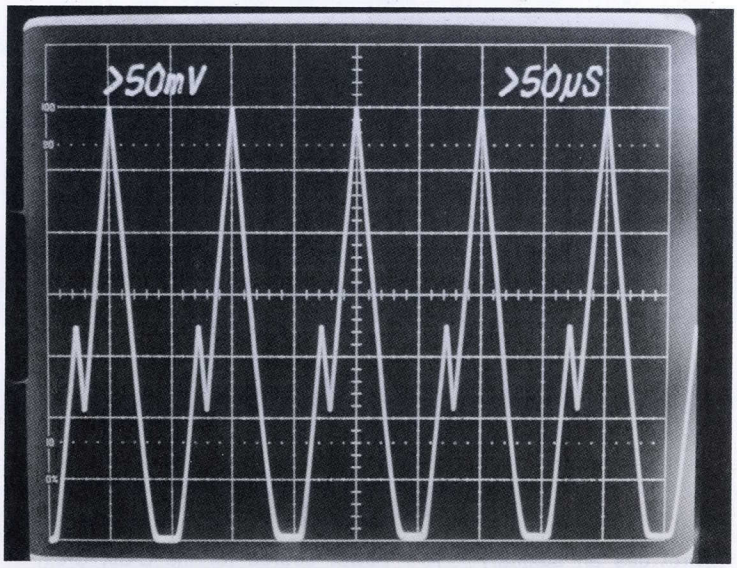
An absorption filter over the photometer lamp provides an approximate color match of the photometer light spot to P 31 phosphor. Optional filters may be ordered for P1, P2, and P11 phosphors.

X-Sync Switch—A normally-open switch in the shutter closes when the shutter is operated fully open. One contact of this switch is grounded, and the other is connected to the X-SYNC slide switch on the control panel. When this panel switch is in NORM position, connection can be made to the mini-phone jack (just below the switch) for controlling test circuitry in conjunction with the camera shutter operation. When this switch is in the SINGLE-SWEEP RESET position, the shutter switch is connected internally to the single-sweep reset line in the oscilloscope (7000-Series only).

Camera Power and Sweep Reset Connector—A three-pin connector on the CRT bezel of TEKTRONIX 7000-Series Oscilloscopes mates with a similar connector on the standard C-59 Adapter to provide +15 V power and ground connection to the camera. The third pin connects the camera shutter X-Sync SWITCH to the single-sweep-reset line in the oscilloscope. Internal batteries supply power for the photometer and focus lamps when the C-59 is used with an oscilloscope other than a 7000 Series. Whenever the C-59 is attached to a 7000-Series Oscilloscope, the camera automatically disconnects its internal batteries and selects +15 V power from the oscilloscope.

See page 204 for Ordering Information and Accessories.

C-59 CAMERA
LOW COST, GENERAL PURPOSE
(f/2.8, 0.67 magnification lens)



(Actual image area of Polaroid Type 107 3¼ x 4¼-inch Film)

7603 with 6½-inch CRT

The C-59 Camera can record the entire display of 6½-inch CRT's on Polaroid 3¼ x 4¼-inch film. Its f/2.8, 0.67 magnification lens has a light-gathering power of 0.65.

ORDERING INFORMATION

All C-50-Series Cameras include a mounting adapter 016-0249-03 for TEKTRONIX 7000-Series Oscilloscopes. See Oscilloscope/Camera/Adapter Guide on page 213 for camera/oscilloscope compatibility data.

C-50

C-50-P CAMERA, Pack-Film Back $750
C-50-R CAMERA, Roll-Film Back $785
C-50-G CAMERA, 4 x 5 Graflok Back $715

C-51

C-51-P CAMERA, Pack-Film Back $1050
C-51-R CAMERA, Roll-Film Back $1085
C-51-G CAMERA, 4 x 5 Graflok Back $1015

C-52

C-52-P CAMERA, Pack-Film Back $1100
C-52-R CAMERA, Roll-Film Back $1135
C-52-G CAMERA, 4 x 5 Graflok Back $1065

C-53

C-53-P CAMERA, Pack-Film Back $825
C-53-R CAMERA, Roll-Film Back $860
C-53-G CAMERA, 4 x 5 Graflok Back $790

C-58

C-58-P CAMERA, Pack-Film Back $625
C-58-R CAMERA, Roll-Film Back $665
C-58-G CAMERA, 4 x 5 Graflok Back $590

C-59

C-59-P CAMERA, Pack-Film Back $450
C-59-R CAMERA, Roll-Film Back $485
C-59-G CAMERA, 4 x 5 Graflok Back $415

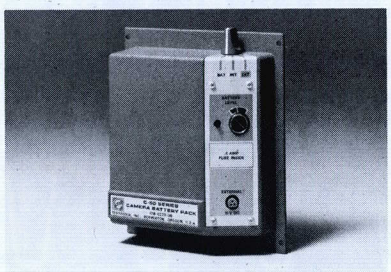
Eight AA alkaline cells are included with each C-59 Camera.

Included Accessories—For all camera modules: Focus plate for Polaroid Pack-Film Back (378-0893-02); focus plate for Polaroid Roll-Film Back (387-0893-01); (Graflok Back includes a focusing screen).

C-50 SERIES OPTIONAL ACCESSORIES

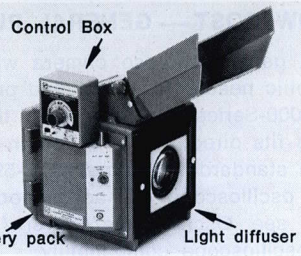
Camera Mounting Adapters—Available for most TEKTRONIX 500- and 7000-Series Oscilloscopes and 600-Series Display Units. See page 213 for camera/oscilloscope compatibility and adapter part numbers.

BATTERY PACK



Provides an auxiliary +15 V power source for the C-50, C-51, C-52, and C-53 when using them with oscilloscopes that don't provide camera power. 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 pounds.
Order 016-0270-00 ..... $90

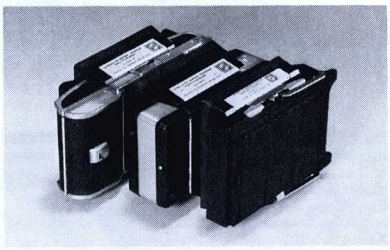
WRITING SPEED ENHANCER



Provides automatic controlled film-fogging to increase writing speed by up to 4 times for 3000 ASA film and 2.5 times for 10,000 ASA film. For C-50, C-51, C-53, and C-59 only; not for C-52 and C-58. Please refer to page 212 for details.

Writing Speed Enhancer for C-50 Camera,
Order 016-0278-00 ..... **$175**
Writing Speed Enhancer for C-51 Camera,
Order 016-0279-00 ..... **$175**
Writing Speed Enhancer for C-53 Camera
Order 016-0300-00 ..... **$175**
Writing Speed Enhancer for C-59 Camera,
Order 016-0290-00 ..... **$175**

FILM BACKS



Three optional film backs allow a wide choice of films and provide flexibility of performance. Dark slides included with Polaroid Backs allow interchanging of all three films backs without exposing the film. Each Polaroid Back also includes a split-image focusing plate to allow optional image-type focusing if desired; the Graflok Back has an integral focusing screen and light shield.

Polaroid[1] Pack Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film. **Order 122-0926-00** **$95**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000- or 10,000-speed roll film. **Order 122-0929-00** **$120**

Graflok[2] Back, 4 x 5—Accepts Polaroid Land 4 x 5-inch film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders (see page 209). **Order 122-0931-01** **$60**

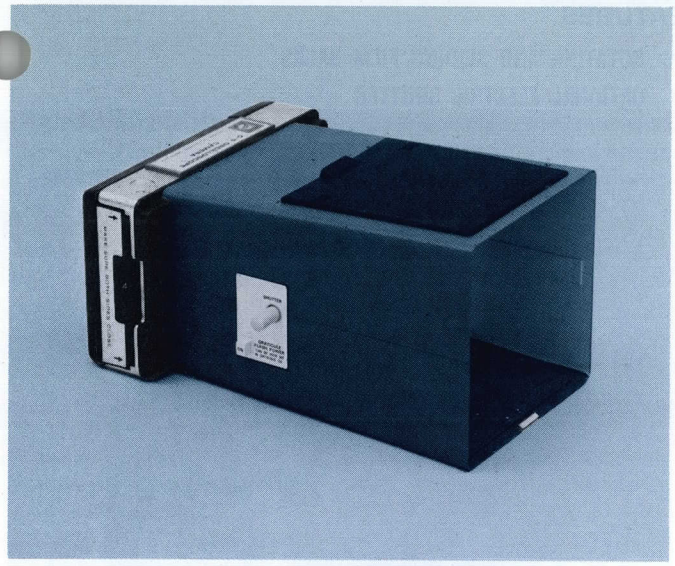
ADDITIONAL SPLIT-IMAGE FOCUSING PLATES

For Polaroid Pack Back, **Order 387-0893-02** **$1.25**
For Polaroid Roll Back, **Order 387-0893-01** **$1.25**

CARRYING CASE

Holds a complete C-50-Series Camera with extra film-backs and accessories. **Order 016-0177-00** **$88**

[1]Registered Trademark Polaroid Corporation
[2]Registered Trademark Graflex, Inc.



- **EASY TO USE**
- **FIXED FOCUS**
- **LIGHTWEIGHT**
- **LOW COST**

The C-5 Camera is recommended for photographing the 4 x 5-inch CRT display of TEKTRONIX 5100-Series Oscilloscopes and 603 and 604 Display Units. The camera hook-mounts directly onto these instruments without need for an adapter. The C-5 also mounts directly onto all 7000-Series Oscilloscopes, the 601 and 602 Display Units, the 528 TV Monitor, and the 577 Curve Tracer. No adapters are available for other instrument types.

The C-5 features a battery-powered, variable-intensity, pulsed graticule-illuminator for photographing 6½-inch size CRT screens that have non-illuminated graticules. A hinged door in the top of the camera housing provides a convenient view of the CRT.

The C-5's f/16 lens is relatively slow and should not be used where medium or higher single-shot writing speeds are required. The rear lens can easily be removed to extend the focus to infinity for indoor-scene photography of objects at a distance of four feet and beyond with ordinary room light.

Lens—f/16 (fixed) with a magnification of 0.68. Provides a 2¾ x 2⅜-inch image of 4 x 5-inch CRT displays, and a 5.3 x 6.6-cm photo image of 8 x 10-cm CRT displays. Both on Polaroid Type 107 Pack Film.

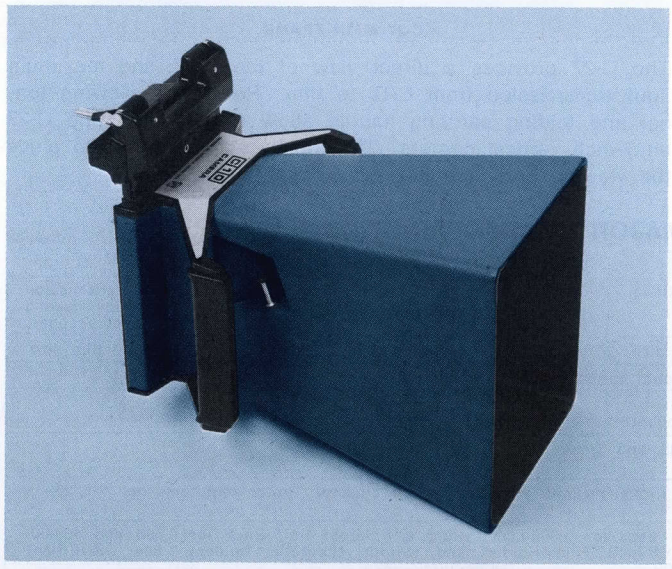
Shutter—Mechanically actuated with speeds of 1/5, 1/10, and 1/25 second plus Bulb and Time.

Film Back—Permanently attached Polaroid[1] Pack-Film Back accepts 3000-speed pack film which develops outside the camera in 15 seconds.

DIMENSIONS	inches	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.2	13.3	NET	2.9	1.3
WIDTH	7.5	19.1	DOMESTIC SHIPPING	5.0	2.3
LENGTH	10.0	25.4	EXPORT-PACKED	10.0	4.5

Order C-5 CAMERA **$185**
Includes—Two 9-V batteries (146-0017-00).

C-10



- **LIGHTWEIGHT**
- **FIXED FOCUS**

The C-10 is a fixed-focus, light-weight camera for use with TEKTRONIX Display Products that utilize the 611 Display Unit 11-inch CRT. These include the 611 Display Unit and the 2A, 4010-1, 4012, and 4013 Computer Display Terminals.

The C-10 is hand held against the CRT for photographing the display.

Lens—f/8, 0.5 magnification. Records the entire 16.2 x 21-cm display of the 611 CRT on Polaroid 4 x 5-inch Film. The aperture is adjustable from f/8 to f/22.

Shutter—Mechanically actuated, with speeds selectable from 1 to 1/125 second, plus Bulb and Time.

Film Back—The C-10 is furnished with a Polaroid 4 x 5-inch Film Holder which attaches to a 4 x 5-inch Graflok[2] Back on the camera. The Graflok Back also accepts Graflok 4 x 5-inch Film Holders and Film-Pack Adapters. The Polaroid 4 x 5-inch Film Holder accepts Polaroid 4 x 5-inch film packets which develop outside the camera in 15 seconds.

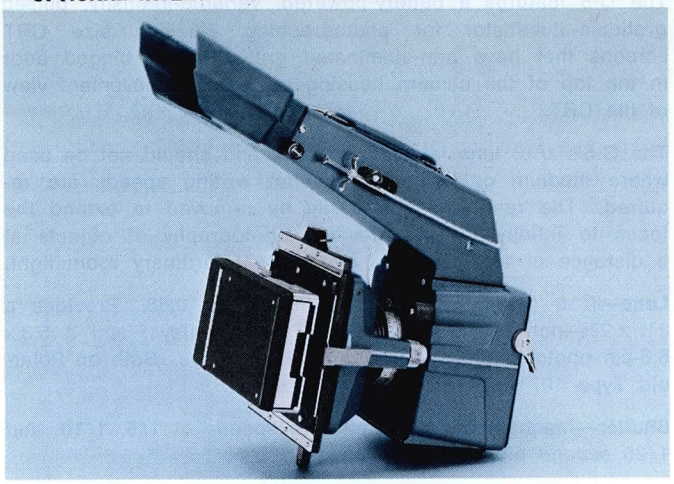
DIMENSIONS	inches	cm	WEIGHTS (approx)	lb	kg
HEIGHT	8.8	22.3	NET	5.5	2.5
WIDTH	10.4	26.4	DOMESTIC SHIPPING	8.0	3.6
LENGTH	13.8	34.9	EXPORT-PACKED	16.0	7.2

Order C-10 CAMERA **$450**

[1]Registered Trademark Polaroid Corporation.
[2]Registered Trademark Graflex, Inc.

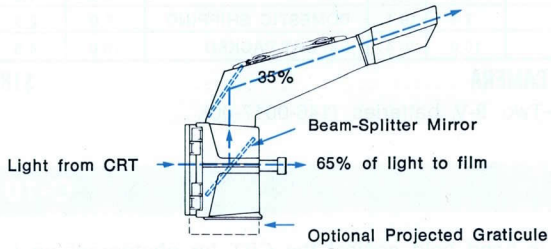
COMMON FEATURES

- LIFT-OFF MOUNTING, SWING-AWAY HINGING
- OPTIONAL INTERCHANGEABLE LENSES
- ROTATING AND SLIDING FILM BACKS
- OPTIONAL ELECTRIC SHUTTER



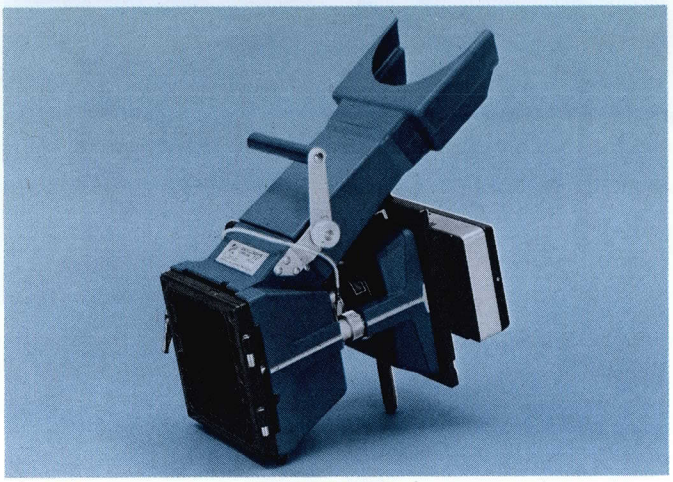
C-12 CAMERA

The C-12 is recommended for use with TEKTRONIX 500-Series Oscilloscopes that have external graticules up to 8 x 10 cm in size.



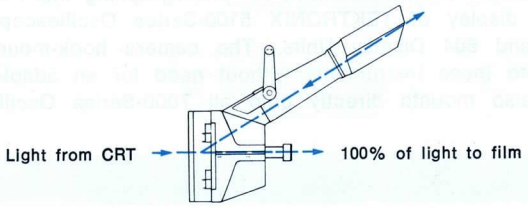
C-12 MAIN FRAME

The C-12 mirror system provides a straight-on view of the CRT, and minimizes parallax due to an external graticule. An optional Projected Graticule accessory provides changeable parallax-free graticules of various patterns; see page 208.



C-27 CAMERA

The C-27 is recommended for use with TEKTRONIX 500-Series Oscilloscopes that have internal graticules up to 10 x 10 cm in size.



C-27 MAIN FRAME

The C-27 provides a direct view of the CRT, and maximum light transmission from CRT to film. Removable viewing tunnel and folding carrying handle allow rack-stacking the C-27 on 7-inch vertical centers. The frame can be rotated to place the viewing port at either side, or at the bottom.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-12	C-27
PERFORMANCE FEATURES	Straight-on binocular viewing via beam-splitting mirror. Optional Projected Graticule for zero parallax.	Off-axis binocular viewing. No mirrors; max light-transmission to film. Four viewing-tunnel positions. Removable viewing tunnel for compact stacking on rack-mounted oscilloscopes.
FIELD OF VIEW	Up to 8 x 10 cm depending on lens magnification and film size.	Up to 10 x 10 cm depending on lens magnification and film size.
STANDARD LENS	f/1.9 0.85 magnification. Four other interchangeable optional lenses are also available. (See next page and page 209.)	
RELATIVE† LENS SPEED	0.65 Light-dividing action of beam-splitter mirror taken into account.	1.0 (Reference)
STANDARD SHUTTER	Mechanically actuated; Speeds: 1 to 1/50 sec., plus Bulb and Time.	
OPTIONAL ELECTRIC SHUTTER	Speeds: 1 to 1/50 sec., plus Bulb and Time. Remote triggering with insulated switch closure. Power requirements: 115/230 V, 50 to 60 Hz. See page 209.	
FILM BACKS	Both cameras can be ordered with a Polaroid Pack-Film Back for 3,000-speed film, a Polaroid Roll Back for 3,000 and 10,000-speed film, or a 4 x 5-inch Graflok Back for Polaroid 4 x 5-inch Film Holder, and various sheet-film holders. See ORDERING INFORMATION on next page, and ACCESSORIES on page 209.	
PRICES	$590 (With Pack Back)	$590 (With Pack Back)

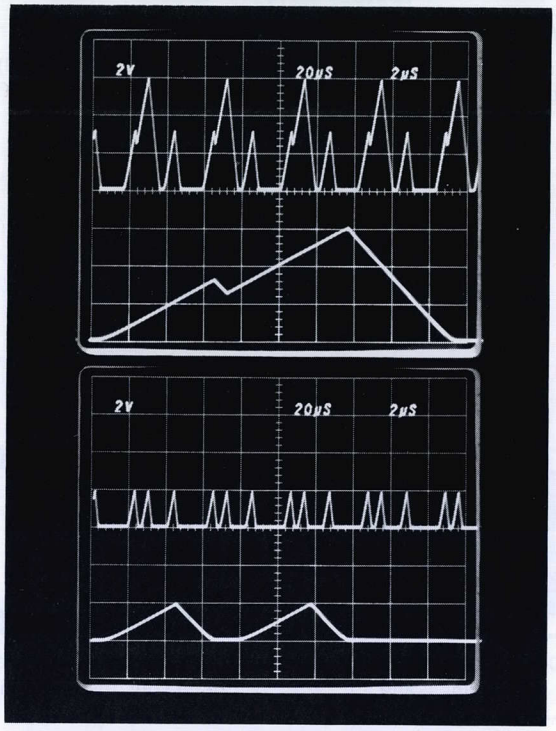
DIMENSIONS	C-12		C-27	
	in	cm	in	cm
Height	15.4	39.1	17.2*	43.6
Width	7.5	19.1	7.5	19.1
Length	17.3	43.9	13.4*	34.1

WEIGHTS	C-12		C-27	
	lb	kg	lb	kg
Net	12.3	5.5	10.5	4.7
Domestic Shipping	16.0	7.2	14.0	6.3
Export-Packed	33.0	13.6	36.0	16.3

*Without viewing tunnel, the C-27 height is 8 inches, and length is 12 inches.

† Relative light-gathering power. For relative speed of optional lenses, see CUSTOM CAMERAS on next page. See Camera Reference Information for comparison with other TEKTRONIX Cameras.

FILM ECONOMY



**C-12 or C-27 with 0.5 Mag Lens
8 x 10 cm CRT**

The C-12 and C-27 film backs can be oriented vertically or horizontally and through nine detent positions to allow multiple exposure on one photo. Two 0.5 magnification lenses are available for the C-12 and C-27 cameras: an f/1.9 lens for medium writing speed, and an f/1.3 lens for high writing speed.

ORDERING INFORMATION

Included Accessories—For C-12 and C-27: cable release (122-0586-02); split-image focus plate for Polaroid Pack-Film Back (378-0893-02); split-image focus plate for Polaroid Roll-Film Back (387-0893-01); (Graflok Back has an integral focusing screen).

All C-12 and C-27 cameras are sold without mounting adapters; see table on page 213 for oscilloscope compatibility and adapter part numbers.

MECHANICAL SHUTTER CAMERAS

(with f/1.9, 0.85 magnification lens)

C-12

C-12-P CAMERA, Pack-Film Back $590
C-12-R CAMERA, Roll-Film Back $625
C-12-G CAMERA, 4 x 5 Graflok Back $555

C-27

C-27-P CAMERA, Pack-Film Back $590
C-27-R CAMERA, Roll-Film Back $625
C-27-G CAMERA, 4 x 5 Graflok Back $555

OPTION 9 for C-12 and C-27 Cameras ..... NO CHARGE

Replaces mechanical shutter witn electric shutter only. The SPEEDCOMPUTER power-supply control box and mounting bracket are not included. Control voltage must be supplied by customer. When ordering, include "OPTION 9" with regular camera order number.

ELECTRICALLY ACTUATED CAMERAS

(with f/1.9, 0.85 magnification lens and electrically controlled shutter)

Includes Electric Shutter and SPEEDCOMPUTER power-supply-control box and mounting bracket.

See Specification Chart on preceding page for details.

C-12

C-12-PE CAMERA, Pack-Film Back $860
C-12-RE CAMERA, Roll-Film Back $895
C-12-GE CAMERA, 4 x 5 Graflok Back $825

C-27

C-27-PE CAMERA, Pack-Film Back $860
C-27-RE CAMERA, Roll-Film Back $895
C-27-GE CAMERA, 4 x 5 Graflok Back $825

C-12 and C-27 CUSTOM CAMERA OPTIONS

All versions of the C-12 and C-27 Cameras can be ordered with any of the four optional lenses listed here. When ordering desired lens option, include OPTION NUMBER below with regular camera order number.

LENS TYPE & PURPOSE	RELATIVE SPEED†	OPTION NUMBER	PRICE
FILM ECONOMY—f/1.9, 0.7 magnification. Records two 6 x 10-cm, or three 4 x 10-cm on 3¼ x 4¼-inch film. Also records one 10 x 10-cm display on same size film with C-27 only.	0.78 with C-12 1.2 with C-27	Option 1	**Add $20**
MEDIUM WRITING SPEED—f/1.9, 0.5 magnification. Records two 8 x 10-cm CRT displays on 3¼ x 4¼-inch film.	0.9 with C-12 1.4 with C-27	Option 2	**Add $40**
FULL-SIZE IMAGE—f/1.4, 1.0 magnification. Records full-size image of 8 x 10-cm CRT display on 4 x 5-inch film with optional Graflok Back.	0.97 with C-12 1 5 with C-27	Option 3	**Add $205**
HIGH WRITING SPEED—f/1.3, 0.5 magnification. Records two 8 x 10-cm CRT displays on 3¼ x 4¼-inch film.	1.7 with C-12 2 6 with C-27	Option 4	**Add $180**

†Relative light-gathering power. Light loss through beam-splitting mirror taken into account for C-12. See Camera Reference Information.

CUSTOM C-12 and C-27 CAMERAS

The C-12 and C-27 cameras can be ordered with any of four optional lenses, with any of three types of film backs and with mechanical or electric shutter.

OPTIONAL ACCESSORIES

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes and some non-TEKTRONIX Oscilloscopes. See page 213 for oscilloscope compatibility.

C-12 Projected Graticule—Provides changeable parallax-free graticules with an area for write-in data. For details, see next page.

Writing Speed Enhancer—Provides automatic-controlled film-fogging to increase writing speed ≈3 times for 3000 ASA film and ≈2.0 times for 10,000 ASA film. The enhancer can be used with any of the five interchangeable lenses available for the C-12 and C-27, including the f/1.4—1.0 magnification lens. Refer to page 212 for details and ordering information.

Optional Film Backs—Polaroid Roll-Film and Pack-Film Backs, and two sizes of Graflok backs allow a wide choice of films and provide flexibility of performance. All three film backs can be interchanged without fogging the film. Several types of cut-film and roll-film holders are available for use with the Graflok backs. See page 209 for more information.

X-Sync Cable—Coiled cable has standard ASA connector which mates to the flash sync connectors on the C-12 and C-27 camera shutters and SPEEDCOMPUTER. Other end of cable has miniature phone plug. Order 012-0364-01 ..... $8.00

Carrying Case—Holds one C-12 or C-27 Camera,
Order 016-0208-01 ..... **$95**

PROJECTED GRATICULE FOR C-12

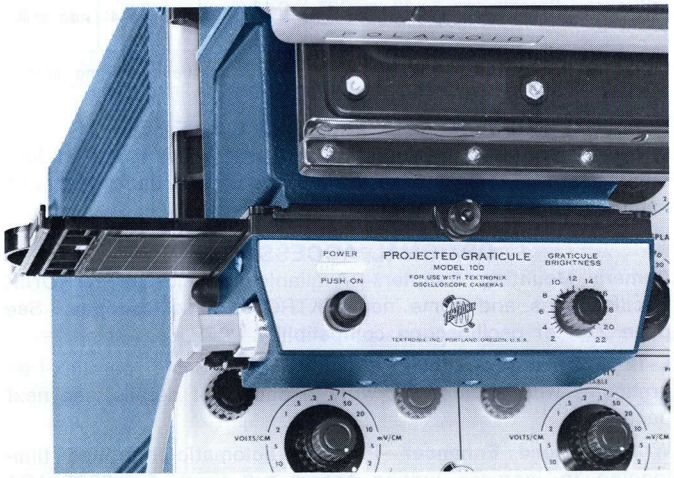
The Projected Graticule provides changeable parallax-free graticules of any pattern, and a means of recording write-in data on the photograph.

Parallax is the difference between the CRT-and-graticule display as seen in the C-12 viewing tunnel, and as seen through the lens when the oscilloscope has an external graticule. It occurs because (1) the external graticule is separated from the CRT phosphor plane by the optical thickness of the CRT face-plate, and (2) the operator's view of the display through the viewing tunnel is approximately 20 inches away, whereas the lens is much closer to the CRT. The difference in the two distances and in the angles-of-view over the display field produces a small amount of parallax between the viewed and photographed images.

The Projected Graticule utilizes the beam-splitter mirror in the C-12 to present a virtual image of a graticule at the object plane of the camera. When the camera is focused on the CRT trace, the graticule image lies in the same optical plane as the CRT phosphor screen. Accordingly, the camera photographs the graticule and the CRT display in exactly the same relationship as seen by the operator through the C-12 viewing tunnel.

Special graticules, reference waveforms, or any pattern that can be produced on a film transparency can be imposed on the CRT display.

The Projected Graticule provides an 8 x 10-cm image area, a portion of which can be used for write-in data.



The Graticule Film transparency is held in a slide holder which is easily slipped in and out of the Projected Graticule case, making possible rapid changes of graticules.

The slide assembly included with the Projected Graticule has a clear window. Additional slide assemblies are available in three colors so that the graticule image can match or contrast the CRT phosphor.

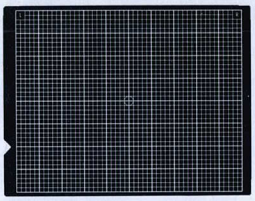
Operates on 90 to 130 V, or 180 to 260 V; 50 to 440 Hz.

Although the Projected Graticule case is small (it adds only 2¼ inches below the camera) clearance problems may occur with some plug-in unit/probe combinations. If in doubt about compatibility, please consult your Tektronix Field Engineer, Representative, or Distributor.

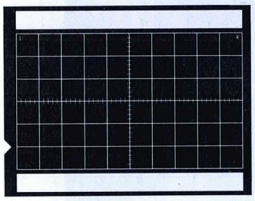
Included Accessories

Power cable (161-0015-01)

One clear-window graticule slide assembly (122-0659-00)
Two graticule films and one mask film as shown here:



8 x 10-cm graticule with full minor lines



6 x 10-cm graticule with short minor lines and write-in area

6 x 10-cm graticule mask to black out the write-in area when not used

PROJECTED GRATICULE for 115 volts.
Order 016-0204-00 ..... **$195**

PROJECTED GRATICULE for 230 volts.
Order 016-0234-00 ..... **$195**

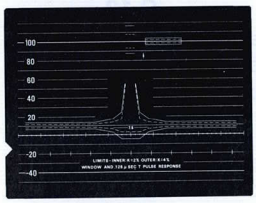
OPTIONAL ACCESSORIES

ADDITIONAL GRATICULE SLIDE ASSEMBLIES ..... **$3.30 each**

Clear Window 122-0659-00	Green Window 122-0668-00
Blue Window 122-0667-00	Amber Window 122-0669-00

ADDITIONAL GRATICULES and MASKS ..... **$1.55 each**

Shown below is one of seventeen additional graticule films and masks that are also available. Please consult your Tektronix Field Office, Representative, or Distributor for information on film patterns available.



MECHANICAL SHUTTER/LENS

Shutter speeds from 1 to 1/100 second, plus Bulb and Time.

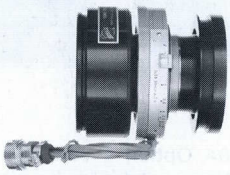
f/1.9—0.7 MAG lens, film economy.
Order 122-0547-00 ..... **$200**

f/1.9—0.5 MAG lens, medium writing speed.
Order 122-0549-00 ..... **$220**

f/1.4—1.0 MAG lens, full-size image.
Order 122-0608-00 ..... **$385**

f/1.3—0.5 MAG lens, high writing speed.
Order 122-0662-00 ..... **$360**

f/1.9—0.85 MAG lens, general purpose.
Order 122-0692-00 ..... **$200**



ELECTRIC SHUTTER/LENS

Requires SPEEDCOMPUTER for operation. SPEEDCOMPUTER and electric shutter are included with all C-12-E and C-27-E Cameras.

f/1.9—0.7 MAG lens, film economy, electric shutter.
Order 122-0772-00 ..... **$200**

f/1.9—0.5 MAG lens, medium writing speed, electric shutter.
Order 122-0773-00 ..... **$220**

f/1.4—1.0 MAG lens, full-size image, electric shutter.
Order 122-0840-00 ..... **$385**

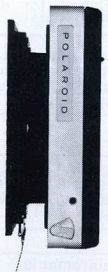
f/1.3—0.5 MAG lens, high writing speed, electric shutter.
Order 122-0769-00 ..... **$360**

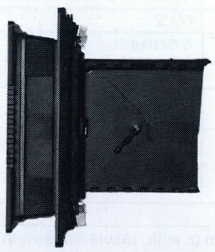
f/1.9—0.85 MAG lens, general purpose, electric shutter.
Order 122-0771-00 ..... **$180**

SPEEDCOMPUTER. **Order 122-0767-02** **$280**

Bracket for C-12, C-27. **Order 122-0713-00** **$7.70**

FILM BACKS





Polaroid Pack-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film. Split-image focusing plate included.
Order 122-0671-00 ..... **$95**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000 and 10,000-speed roll film. Split-image focusing plate included.
Order 122-0603-00 ..... **$120**

Additional split-image focusing plates
for Polaroid Pack Back, **Order 387-0893-02** **$1.25**

for Polaroid Roll Back, **Order 387-0893-01** **$1.25**

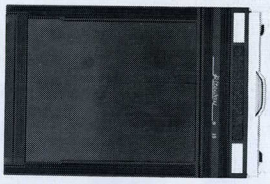
4 x 5-inch Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, roll-film holders, Polaroid 4 x 5-inch Film Holder. **Order 122-0604-00** **$60**

2¼ x 3¼-inch Graflok Back with Focusing Screen accepts standard cut-film holders, film-pack adapters, 120 roll-film holders. **Order 016-0233-00** **$95**

ACCESSORIES FOR GRAFLOK BACKS

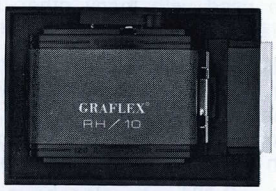
(For C-12, C-27, C-30 Series and C-50 Series)

Shown here are a few of the film holders available for use with the Graflok Backs to allow use of sheet film, roll film, film packs, and Polaroid 4 x 5-inch Film. Order these accessories from the manufacturer or from your local camera store.



Graphic Cut-Film Holder—Darkroom load-2 sheets of cut film. (Two dark slides required). Fidelity brand ASA type or equivalent for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1284 for 4 x 5-inch Graflok Backs.

Graphic Film Pack Adapter—For daylight loading of 16-exposure film packs. Graflex Catalog #1232 for 2¼ x 3¼-inch Graflok Backs. Graflok Catalog #1234 for 4 x 5-inch Graflok Backs.



Grafmatic Film Holder—Darkroom load-6 sheets of cut film. Graflex Catalog #1266 for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1268 for 4 x 5-inch Graflok Backs.

RH/8 120 Roll-Film Holder—8 exposures, 2¼ x 3-1/16 inches, use with 0.7 MAG lens. Graflex Catalog #1290 for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1294 for 4 x 5-inch Graflok Backs.

RH/10 120 Roll-Film Holder—10 exposures, 2¼ x 2¾ inches, use with 0.5 MAG lens. Graflex Catalog #1291 for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1295 for 4 x 5-inch Graflok Backs.

RH/12 120 Roll-Film Holder—12 exposures, 2¼ x 2¼ inches use with 0.5 MAG lens. Graflex Catalog #1292 for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1296 for 4 x 5-inch Graflok Backs.

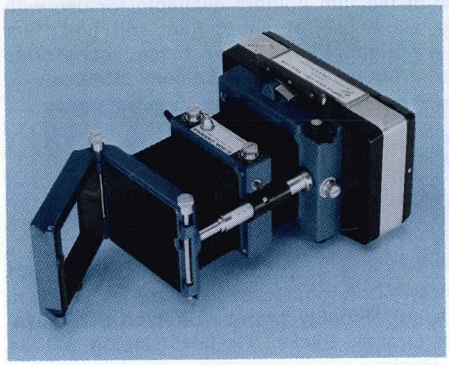
RH/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ inches, use with 0.5 MAG lens. Graflex Catalog #1293 for 2¼ x 3¼-inch Graflok Backs. Graflex Catalog #1297 for 4 x 5-inch Graflok Backs.

RH/50 70 mm Film Holder—50 exposures, 2¼ x 2¾ inches, use with 0.5 MAG lens. Graflex Catalog #1240 for 4 x 5-inch Graflok Backs only.

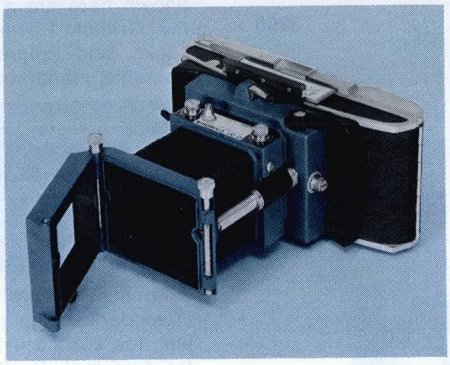
Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5-inch single exposure Film Packets.

COMMON FEATURES

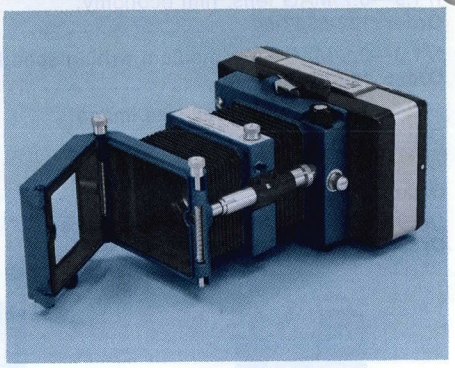
- COMPACT, LIGHTWEIGHT
- EASILY-ACCESSIBLE CONTROLS
- OPTIONAL ELECTRIC SHUTTER AND SPEEDCOMPUTER



C-30A



C-31



C-32

The C-30-Series Cameras are recommended primarily for the TEKTRONIX 400-Series Portable Oscilloscopes. They can also be used with many other TEKTRONIX Oscilloscopes and Display Units by means of adapters listed on page 213.

The standard C-30A, and the C-31 and C-32 are supplied with an 016-0360-00 Adapter which allows the camera to slide-mount directly onto the 422, 453A, 454A, and 485 Oscilloscopes and the 491 Spectrum Analyzer; all these instruments have an 8 x 10 division CRT display (0.8 cm/div).

The C-30A can also be ordered as an Option 1 Model which comes equipped with an 016-0301-00 Adapter Frame/Corrector Lens to allow its use on the 432, 434, 465, and 475 Oscilloscopes[1]. The Adapter Frame/Corrector Lens increases the C-30A's field-of-view so it can photograph the entire 8 x 10-cm CRT display of these oscilloscopes; the 434 CRT display is actually 7.8 x 9.8 cm but it also requires the Option 1 Model of the C-30A for full-screen coverage.

The C-30A Option 1 can also be used with any standard C-30 Series Camera Adapter by simply removing the Corrector Lens which is normally mounted over the front of the camera's lens. A standard C-30A Camera can also be converted to an Option 1 Model by means of an 016-0301-00 Adapter Frame/Corrector Lens as listed on page 213.

No Adapter Frame/Corrector Lens assemblies are available for allowing use of the C-31 and C-32 Cameras with the 432, 434, 465, and 475 Oscilloscopes.

All C-30-Series Cameras swing open left or right, and can be quickly detached from the adapter at the hinges. All cameras can be ordered with an integral Electric Shutter in place of the standard mechanical shutter; these "E" model cameras include a SPEEDCOMPUTER control box which supplies operating power to the electric shutter.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-30A	C-30A OPTION 1	C-31	C-32
PERFORMANCE FEATURES	General Purpose with variable magnification for 422, 453A, 454A, 485 and 491	General Purpose for 432[1], 434, 465 and 475 oscilloscopes	Fast Writing Speed with 0.5 Magnification for 422, 453A, 454A, and 485 oscilloscopes	Full-Size image with Medium Writing Speed for 422, 453A, 454A, 485 and 491
LENS	f/1.9	f/1.9	f/1.2	f/1.4
MAGNIFICATION	1.5 to 0.7 in ten detent steps	0.8 only with corrector lens. (lens can be removed for normal C-30A MAG Range)	0.5 fixed	1.0 (detent steps also at 0.85, 0.9, 1.1 and 1.2 but with some distortion)
RELATIVE LENS SPEED*	1.0 at MAG setting of 0.7	1.0	3.4	1.5
FIELD OF VIEW	8 x 10 cm at MAG setting of 0.85. (Possible corner vignetting with some instruments)	8 x 10 cm	8 x 9 cm	7 x 9 cm at MAG setting of 1.0 (increases to 8 x 10 cm at MAG setting of 0.85 but with some distortion)
STANDARD SHUTTER	Mechanically actuated, 4 to 1/50 sec, plus Bulb and Time.			
OPTIONAL ELECTRIC SHUTTER	Speeds: 4 to 1/60 sec, plus Bulb and Time. Remote triggering with insulated switch closure. Power requirements: 115/230 v, 50 to 60 Hz. See next page for ordering information.			
FILM BACKS	All cameras can be ordered with a Polaroid[2] Pack Back for 3,000-speed film, a Polaroid Roll Back for 3,000- and 10,000-speed film, or a 2¼ x 3¼-inch Graflok[3] Back for sheet film holders, film pack adapters and 120 roll film holders such as listed on preceding page.			
PRICE (With Film Back Ordinarily Used)	$525 (With Pack Back)	$535 (With Pack Back)	$675 (With Roll Back)	$715 (With Pack Back)

DIMENSIONS AND WEIGHTS WITH FILM BACKS ORDINARILY USED	C-30A-P		C-30A-P Option 1		C-31-R		C-32-P	
	Inches	cm	Inches	cm	Inches	cm	Inches	cm
Height	5.1	13.0	5.1	13.0	5.5	14.0	5.5	14.0
Width	7.5	19.1	7.5	19.1	9.1	23.1	7.5	19.1
Length	10.4	25.4	10.4	26.4	10.6	26.9	10.0	25.4
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg
Net	4.8	2.2	5.0	2.3	6.8	3.1	5.0	2.3
Domestic Shipping	9.0	4.1	9.0	4.1	12.0	5.4	9.0	4.1
Export-Packed	14.0	6.4	14.2	6.4	17.0	7.7	14.0	6.4

*Relative light gathering power—(See Camera Reference Information for comparison of all TEKTRONIX cameras)

[1]The internal graticule in the 432, and 453A Models 1, 2, 3, and 4 is non-illuminated and thus is not photographable. The 434 graticule is also nonilluminated, but it will photograph when the CRT is in the stored mode.

[2]Registered Trademark, Polaroid Corporation.

[3]Registered Trademark, Graflex, Inc.

ORDERING INFORMATION

All C-30-Series Cameras except the C-30A Option 1 model include a Mounting Adapter 016-0306-00 for the 422, 453A, 454A, and 485 Oscilloscopes, and the 491. The C-30A Option 1 model includes an Adapter Frame/Corrector Lens for the 432, 434, 465, and 475 Oscilloscope.

MECHANICAL SHUTTER CAMERAS

C-30A

C-30A-P CAMERA, Pack-Film Back $525
C-30A-R CAMERA, Roll-Film Back $560
C-30A-G CAMERA, Graflok Back $490
Option 1, ADPT-FRAME CORR-LENS ..... Add $10

C-31

C-31-P CAMERA, Pack-Film Back $640
C-31-R CAMERA, Roll-Film Back $675
C-31-G CAMERA, Graflok Back $605

C-32

C-32-P CAMERA, Pack-Film Back $715
C-32-R CAMERA, Roll-Film Back $750
C-32-G CAMERA, Graflok Back $680

ELECTRICALLY-ACTUATED CAMERAS

(Includes SPEEDCOMUTER control box)

C-30A

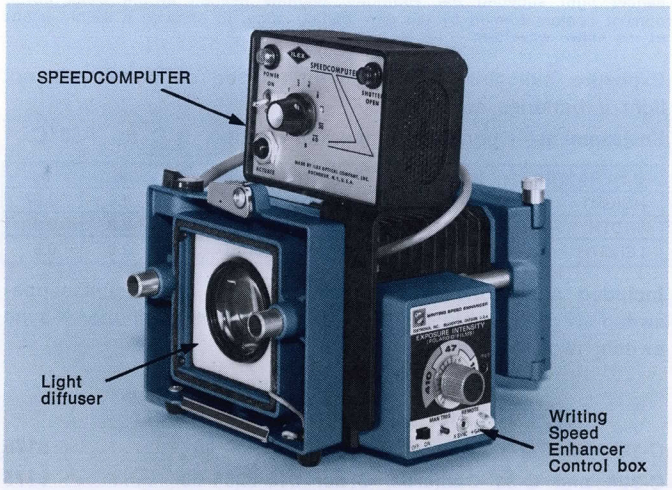
C-30A-PE CAMERA, Pack-Film Back $795
C-30A-RE CAMERA, Roll-Film Back $830
C-30A-GE CAMERA, Graflok Back $760
Option 1, ADPT-FRAME CORR-LENS ..... Add $10

C-31

C-31-PE CAMERA, Pack-Film Back $910
C-31-RE CAMERA, Roll-Film Back $945
C-31-GE CAMERA, Graflok Back $875

C-32

C-32-PE CAMERA, Pack-Film Back $985
C-32-RE CAMERA, Roll-Film Back $1020
C-32-GE CAMERA, Graflok Back $950



C-31-PE shown with Writing Speed Enhancer (film back removed) and SPEEDCOMPUTER which controls the electric shutter.

Included Accessories—For all camera models: Split-image focusing plate for Polaroid Pack-Film Back or Polaroid Roll-Film Back; (Graflok Back includes a focusing screen).

OPTIONAL ACCESSORIES

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes. See page 213 for camera/oscilloscope compatibility and adapter part numbers.

Writing Speed Enhancer—Provides automatic controlled film-fogging to increase writing speed ≈ 3 times for 3000 ASA film and ≈2.0 times for 10,000 ASA film. For C-30A and C-31 only. Please refer to page 212 for details.
Order 016-0284-00 ..... **$175**

Film Backs—Three optional film backs allow a wide choice of films and provide flexibility of performance. Dark slides are included with Polaroid backs to permit interchanging of all three film backs without exposing the film. Each Polaroid Back also includes a split-image focusing plate; the Graflok Back has an integral focus screen and light shield.

Polaroid Pack-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film, **Order 122-0752-00** **$95**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 10,000- or 3000-speed roll film, **Order 122-0754-00** **$120**

Graflok Back, 2¼ x 3¼-inch with focusing screen—Accepts standard cut-film holders, film-pack adapters, 120 roll film holders (see page 209), **Order 122-0755-00** **$95**

Additional Split-Image Focusing Plates

For Polaroid Pack Back, **Order 387-0893-02** **$1.25**
For Polaroid Roll Back, **Order 387-0893-01** **$1.25**

Carrying Case—Holds one C-30 Series Camera and all standard accessories including up to three film backs, extra adapters and film. The case is constructed of heavy-gage, high-impact plastic and has a vacuum-formed styrene liner. Dimensions are 7-3/16 x 13-3/16 x 15-3/16 inches.
Order 016-0126-00 ..... **$45**

X-Sync Cable—Coiled cable has standard ASA connector which mates to the flash sync connector on C-30-Series Cameras, C-12 and C-27 Cameras and SPEEDCOMPUTERS. Other end has miniature phone plug. **Order 012-0364-01** **$8.00**

C-30A Portra Lens—Extends the front focal length of the C-30A lens for photographing test setups. The depth of field when using the portra lens will vary with the f/stop and magnification setting used. At f/1.9 there is very little depth of field; while at f/16, the depth of field is several feet. At a distance of 21 inches, a subject area 22 inches in diameter can be covered.
Order 016-0246-00 ..... **$12**

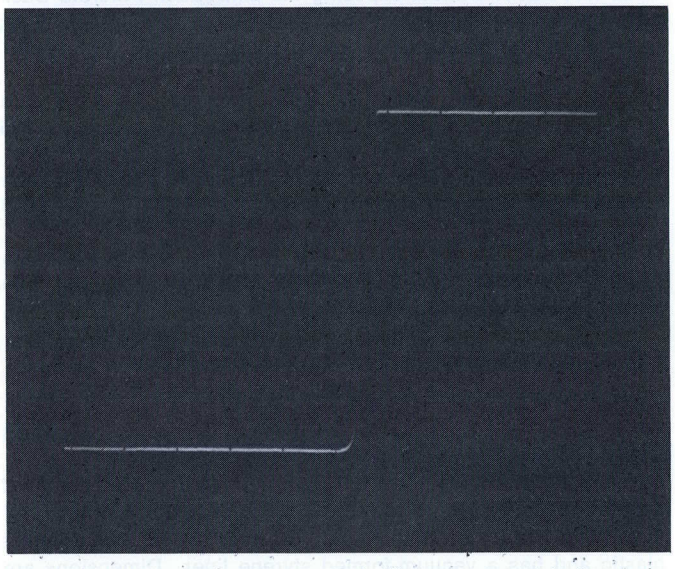
Writing Speed Enhancer

The TEKTRONIX Writing Speed Enhancer provides automatic, accurately-controlled fogging of the film to increase writing speed.

The writing speed of Polaroid Type 47 3,000-speed Roll Film and Type 107 3,000-speed Pack Film can be increased ≈3 times, while the writing speed of Polaroid Type 410 10,000-speed Roll Film can be increased ≈2 times.

The battery-powered unit is easy to install and easy to use. It is available for all TEKTRONIX cameras except the C-5, C-10, C-32, and C-52.

The Enhancer consists of a battery-powered control box which mounts on the camera, and four light-emitting diodes in a plastic light diffuser which fits around the camera's rear lens. When the Enhancer is triggered, the four diodes emit a half-second burst of low-level red light which is diffused directly onto the film to provide a uniform fog background.



This Polaroid Type 107 3,000-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.

The following table lists the approximate relative writing speed of three types of Polaroid Film and the gains that can be achieved with controlled fogging.

Polaroid Film Type	Relative Film Speed (approximate)		
	No Enhancement		
	With Front Illumination of Print for Viewing	With Back Illumination of Print for Viewing	With Fogging by Writing Speed Enhancer
107 (3,000 pack)	1.0 (Reference)	Print Base is Opaque	3.0
47 (3,000 roll)	1.0	1.2	3.0
410 (10,000 roll)	2.0	2.2 - 2.4	4.0

CHARACTERISTICS

Triggering—Manual push button, or automatic when connected to camera X-sync, or oscilloscope + gate.

Exposure Time—Approximately 0.5 seconds.

Repeatability—Within 5%.

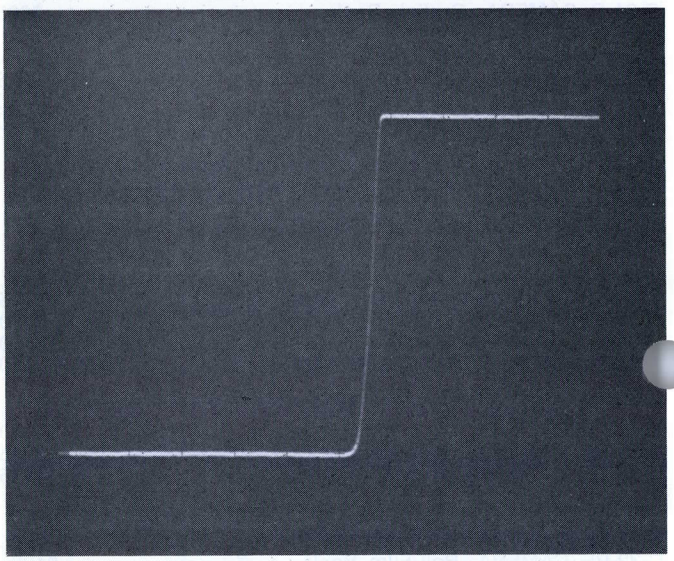
Illumination—Four light-emitting diodes in a specially designed diffuser.

Power—Two 9-V batteries; life expectancy approx 1 year.

The intensity of the light from the diodes is set by a control knob which has a dial showing ranges of adjustment for Polaroid Film Types 47, 107, and 410.

The Enhancer can be triggered in three ways: by a push button 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 the sweep occurs, after the sweep occurs, or at the same time the sweep occurs. These 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.

The following photos illustrate how the controlled fog exposure from a Writing Speed Enhancer can reinforce an extremely dim trace exposure to increase writing speed and still maintain good contrast.



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 development centers formed by the dim leading edge, to produce a visible image of the entire waveform.

Exposure Indicator—A light-emitting diode on panel (will not light if batteries are low).

Environment—Operating temperature range, 0°C to +50°C.

DIMENSIONS	In	cm	WEIGHTS (approx)	lb	kg
HEIGHT	3.0	7.6	NET	0.6	0.27
WIDTH	1.3	3.3	DOMESTIC SHIPPING	2.0	0.9
LENGTH	2.5	6.4	EXPORT-PACKED	2.0	0.9

Included Accessories—Cable for triggering from oscilloscope-sweep + gate; cable for triggering from camera-shutter X-sync switch; two 9-V batteries.

ORDERING INFORMATION
WRITING SPEED ENHANCER for:

C-12 and C-27 Cameras, Order 016-0280-00 ..... $175
C-30A and C-31 Cameras, Order 016-0284-00 ..... $175
C-50 Camera, Order 016-0278-00 ..... $175
C-51 Camera, Order 016-0279-00 ..... $17
C-53 Camera, Order 016-0300-00 ..... $17
C-59 Camera, Order 016-0290-00 ..... $175

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	C-12 ADAPTER PART NUMBER	C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-50 SERIES ADAPTER PART NUMBER[4]
422	C-30A			016-0306-00 (included with camera)	
432[1], 434[2]	C-30A Opt 1			016-0301-00 Adapter Frame/ Corrector Lens (included with camera)	
453A, 454A	C-30 Series			016-0306-00 (included with camera)	
465, 475	C-30A Opt 1			016-0301-00 Adapter Frame/ Corrector Lens (included with camera)	
485	C-30 Series			016-0306-00 (included with camera)	
491	C-30A				
502A	C-59				
503, 504	C-12 or C-27	016-0226-01	016-0225-03	016-0243-00	016-0225-03
519	C-51 or C-27-662		Integral with 519		Integral with 519
520A	C-59				
521	C-59		016-0295-00		016-0295-00
522	C-59				
528	C-59	016-0263-00	016-0249-03	016-0248-00	016-0249-03
529	C-59	016-0217-00	016-0224-00	016-0244-00	016-0224-00
544, 545B	C-27 or C-12				
546, 547	C-27 or C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03
549	C-12			016-0243-00[5]	
556	C-27 or C-12			016-0243-00	
561B, 564B	C-27 or C-12	016-0217-00	016-0224-00	016-0244-00	016-0224-00
565	C-59	016-0226-01	016-0225-03	016-0243-00	016-0225-03
568	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00
575	C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03
576	C-12, C-27, C-50 or C-59	See Adapter Frame/Corrector Lens Systems at right			
577[6]	C-5 or C-59[2]	016-0263-00[6]	016-0249-03[6]	016-0248-00[6]	016-0249-03[6]
601, 602	C-30A	016-0263-00	016-0249-03	016-0248-00	016-0249-03 (included with camera)
603[6] [7]	C-5 or C-59				
604[6] [8]	C-5				
647A	C-27-662 or C-51		016-0223-00		016-0223-00
5030	C-12, C-27	See Adapter Frame/Corrector Lens Systems at right			
5031	C-50 or C-59				
5100 Series[6]	C-5	016-0263-00[2] [6]	016-0249-03[2] [6]	016-0248-00[2] [6]	016-0249-03[2] [6]
5403	C-5 or C-59 or C-50[6]	016-0263-00[6]	016-0249-03[6]	016-0248-00[6]	016-0249-03[6]
7313	C-53	016-0263-00			
7403N[6]	C-59 or C-50	016-0299-00			
7503	C-53				
7504	C-53	016-0263-00			
7514	C-53				
7603[6]	C-59 or C-50	016-0299-00			
7603N Opt 11	C-53				
7613	C-53 or C-58P	016-0263-00	016-0249-03	016-0248-00	016-0249-03 (included with camera)
7623	C-53 or C-58P				
7704A	C-51				
R7903	C-51				
7904	C-51				
Tektronix D83[6]	C-59 or C-5				
some Hewlett-Packard	call TEKTRONIX Field Office or Representative	016-0229-00	016-0228-00		016-0228-00
some Fairchild Dumont			016-0227-00		016-0227-00

CAMERA ADAPTER PART NUMBERS and PRICES			
016-0217-00	$20	016-0243-00	$20
016-0223-00	$30	016-0244-00	$20
016-0224-00	$33	016-0248-00	$25
016-0225-03	$20	016-0249-03	$25
016-0226-01	$20	016-0263-00	$20
016-0227-00	$30	016-0295-00	$20
016-0228-00	$25	016-0299-00	$20
016-0229-00	$25	016-0301-00	$35
016-0242-00	$30	016-0306-00	$30

C-30A OPTION 1 ADAPTER FRAME/CORRECTOR LENS

The C-30A Option 1 comes equipped with an 016-0301-00 Adapter Frame/ Corrector Lens to allow its use on the 432, 434, 465, and 475 Oscilloscopes. The camera's field of view is increased so it can photograph the entire 8 x 10-cm CRT display of these oscilloscopes.

ADAPTER FRAME/CORRECTOR LENS FOR C-12 or C-27 CAMERA

This adapter allows a C-12 or C-27 Camera to photograph displays and adjacent scale-factor readout on the 576 Curve Tracer, 5030, and 5031 Oscilloscopes. A corrector lens is included to compensate for the increased distance 2⅞ inches from CRT to film. Object-to-image ratio with a standard camera (0.85 MAG lens) is about 1:0.45. The adapter frame requires use of a standard camera adapter (016-0226-01 for C-12, or 016-0225-03 for C-27), not included.

Order 016-0264-01 ..... $35

ADAPTER FRAME/CORRECTOR LENS SYSTEMS for C-50 and C-59 CAMERAS

These adapter systems expand the field of view of the C-50 and C-59 Cameras so they can photograph the large-screen CRT and adjacent scale-factor display on the 576 Curve Tracer, and the 5030 and 5031 Oscilloscopes. To achieve the larger field of view, the Adapter Frame places the camera back from the CRT an additional 1⅜ inches. The corrector lens compensates for this added distance to the CRT screen, and reduces the lens-system magnification so it will fully record the CRT and readout display on Polaroid 3¼ x 4¼-inch film. Since the adapter frame places the camera 1⅜ inches back from the CRT screen, the Range-Finder-Focusing system of the C-50 and C-59 Cameras cannot be utilized to indicate when the camera is focused on the CRT screen. Instead, use a Graflok Back or a Focus Plate.

For C-50 Camera,
Order 016-0271-00 ..... $50

For C-59 Camera,
Order 016-0288-00 ..... $50

Focus plate for Polaroid Roll-Film Back,
Order 387-0893-01 ..... $1.25

Focus plate for Polaroid Pack-Film Back,
Order 387-0893-02 ..... $1.25

[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 016-0270-00 for power when not used with 7000-Series Oscilloscopes.

[5]C-30-Series Cameras can only be mounted and removed from the 549 by means of the camera hinges.

[6]Only the C-5 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 1 Model.

[8]The C-59 also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

TEKTRONIX Adapters for mounting Beattie Coleman, DuMont, and Hewlett-Packard cameras on TEKTRONIX Oscilloscopes. The outside diameter of the mounting ring is 5⅝ inches. Net weight of each adapter is approximately 1 pound.

INSTRUMENT	CAMERA	ADAPTER	PRICE	INSTRUMENT	CAMERA	ADAPTER	PRICE
540 & 550 Series, 502A, 503, 504, 565 and 575.	Beattie Coleman: Models K-5, K-5R, KD-5, Mark IIA, Mark II-911, 565A, & Polexa.	014-0018-00	$11.00	647A	Beattie Coleman: All models listed at left.	014-0017-00	$11.00
				529	DuMont: All models listed at left. HP: Model 196(A).	014-0031-00	$9.35
561B, 564B, 567, and 568.	DuMont: Models 296, 298, 299, 302(B), 321A, 353, 450(A), & 453/454A Series. HP: Models 195A, 196(A), 197A, and 198A.	014-0016-00	$11.00	528, 601, 602, 603, 604, 5100 and 7000 Series	Beattie Coleman: All models listed at left. DuMont: 450(A) and 453/453/A Series. HP: Models 195A and 197A.	014-0045-00	$50.00

GLOSSARY OF CAMERA AND PHOTOGRAPHIC TERMS

ASA FILM-SPEED INDEX—The method of specifying film speed for general photography in the United States. Since the ASA index is based on the response of film to sunlight and tungsten light, it cannot be used directly as an accurate exposure guide for the narrow color spectrum emitted by CRT phosphors, especially for recording fast single-sweep traces where exposures fall at the threshold sensitivity of the film.

CAMERA ADAPTER—Attaches to an oscilloscope so that a camera can be mounted on it. Adapters are needed for all TEKTRONIX Cameras except the C-5 and C-10.

CRT BEZEL—The front-panel frame around the CRT; it may be a removable graticule cover or a flanged frame which is integral to the instrument.

EXPOSURE VALUE—For every product of film speed (ASA) times luminance (footlamberts), there is a product of lens opening (f-number)^2 times inverse shutter speed (1/t) that will produce a picture. The exposure value, E_v is 2 log (f-number) — log t. When luminance and film speed are fixed, the inverse shutter speed and the f-number can be varied inversely, keeping their product constant, or keeping the sum of their logs, E_v, constant.

FIELD OF VIEW—The effective field of view of an oscilloscope camera may be defined as the maximum-size CRT display that the camera can record. It is determined by the combined effects of the magnification and angular field of view of the lens, and field-limiting apertures in the camera adapter, camera body or film holder, and the image area of the film.

FILM FOGGING—A technique of increasing writing speed by deliberately fogging the film to enhance the undeveloped trace image.

FILM IMAGE AREA—The actual area of the film which can produce an image. The image area of conventional sheet films, and roll films that don't have sprocket holes, is as large as the film. Polaroid prints are masked to produce a border; for example, Type 107 Pack Film is designated as 3¼ x 4¼-inch film; its actual image area is 9.5 x 7.3 cm or 2⅞ x 3¾ inches.

LENS MAGNIFICATION—A number M which signifies the image-to-object ratio of a lens system. $M = \frac{\text{Image size}}{\text{Object size}}$ or image size = M x Object size.

LIGHT-GATHERING POWER—The illumination in an image plane that a lens can produce from an object, relative to the brightness or luminance of the object. It is sometimes referred to as "lens speed."

VIGNETTING—The loss of the periphery of the image due to restriction of off-axis light rays by the lens-mounting barrels or edges of the glass elements. In a positive print, it usually appears as darker areas of the image at the corners of the photo. It contributes to the angular limits of the field of view of the lens.

- **DIGITAL LED READOUT**
- **LOW COST**
- **3¼-LB. SINGLE, COMPACT UNIT**
- **INTERNAL RECHARGEABLE BATTERIES**
- **ENVIRONMENTALIZED**
- **EIGHT SILICON SENSOR PROBES QUICKLY INTERCHANGED WITHOUT RECALIBRATION**

The TEKTRONIX J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory or in the field.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are changed. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 2½-digit LED display can be easily read under low ambient conditions.

All probes are silicon photo-diodes for maximum stability and linearity. The excellent stability eliminates the need for routine zero adjustments. Integrated circuits are used extensively in the J16 to achieve stable operation, low power requirements, small size, and light weight.

Under normal usage, internal rechargeable nickel cadmium batteries will only need recharging weekly. A battery charger is supplied. For continuous operation, an AC power supply is available which replaces the battery pack.

A shoulder strap provides carrying ease. The cabinet and probes have a standard threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

J6511 Illuminance Probe

The J6511 is an illuminance probe with readout in footcandles or lumens/m^2 (lux) (J6511 opt 2). A multilayer glass filter and silicon photodiode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe and J16 allows the user to be out of the field of view while making measurements. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces. Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction as the J6511.

J6502 Irradiance Probe

The J6502 measures irradiance in microwatts/cm^2 or milliwatts/m^2 (J6502 opt 2). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm. Typical applications include laser research experiments and measurements of radiant efficiency.

An optional filter holder is available to mount standard 1-inch diameter customer-supplied filters of up to ⅜ inch thickness. Where high intensity sources are used (over 1990 μWatt/cm^2), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.)

Where the 1 sq cm sensor is not completely filled by the source, for example with a laser beam, the reading obtained represents μWatts instead of μWatts/cm^2 (J6502), or milliwatts x 10^{-4} instead of milliwatts/m^2 (J6502 opt 2). Small variations in sensor area can add $\pm$5% uncertainty to this measurement.

A low-profile version of the probe (J6512), physically similar to the J6511, is availabe for use where space is restricted.

J6503 Luminance Probe

The J6503 measures luminance in footlamberts or candelas/m^2 (nit) (J6503 opt 2) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface. Typical applications include measuring brightness of television screens and street signs, and light reflected from work surfaces and movie screens.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 12 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m^2 (nit) (J6503 opt 2) indicator automatically lights when the J6503 is connected.

J6504 Uncorrected Probe

This probe is designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters. The J6504 is useful for checking light sources used in photoresist or photoprocessing applications and comparisons of ultraviolet light sources.

A HOLD switch allows the reading to be stored at any time. No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

A low-profile version of the probe (J6514), physically similar to the J6511, is available for use where space is restricted.

The optional filter holder does not fit low profile probes. Two-inch round filters of up to ¼-inch thickness will fit the J6514 without need for adapters.

J6505 LED Test Probe

The principal application of the J6505 is measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 to 710 nm). The J6505 measures illuminance in footcandles or lumens/m^2 (lux) (J6505 opt 2), which can easily be converted into luminous intensity in candelas.

An adapter supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adapter excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adapter to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adapter in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (opt 2), 1 lumen/m^2 represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 to 710 nm. This close match requires compromising in the 380 to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the adapter must be used with the J6501 and the same conversion factor for luminous intensity applies.

J16 CHARACTERISTICS

Display— 2½-digit LED readout and three LED's automatically indicating correct units for probe in use.

Stability—Within 2% per year.

Linearity—Within 2% over the entire range, enabling single point calibration.

Integration Time—Approximately 100 milliseconds.

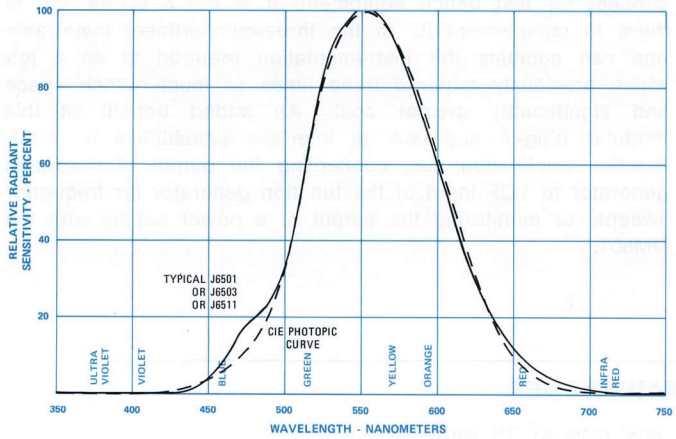
Calibration—Electrical calibration of the J16 is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

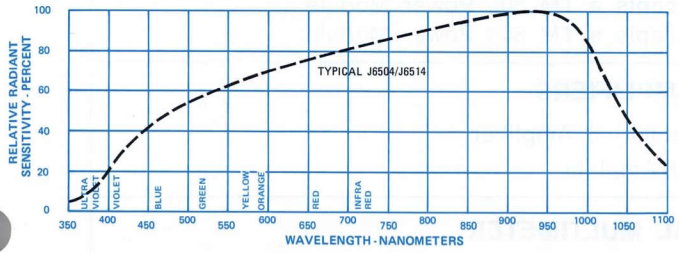
Power Requirements—Internal rechargeable NiCd batteries only need recharging weekly in normal usage. Two hours of continuous operation is provided. (A battery charger is supplied.)

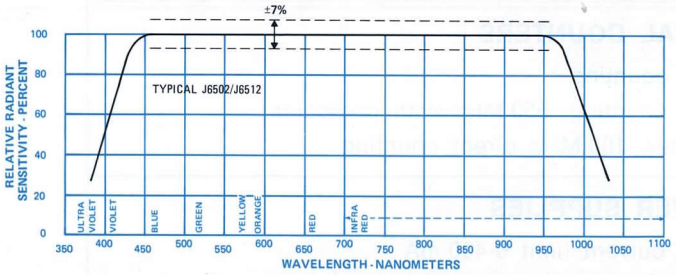
PROBE CHARACTERISTICS

	Readout Units	J6501	J6502/J6512	J6503	J6504/J6514	J6505	J6511
Range	US	0.001 to 1990 footcandles	0.001 to 1990 microwatts/cm^2	0.1 to 199,000 footlamberts	Relative response only	0.0001 to 199 candelas	0.001 to 1,990 footcandles
	Metric (SI)	0.01 to 19,900 lumens/m^2 (lux)	0.01 to 19,900 milliwatts/m^2	1.0 to 1,990,000 candelas/m^2 (nits)	Relative response only	0.0001 to 199 candelas	0.01 to 19,900 lumens/m^2 (lux)
Accuracy (Including J16)	US Metric (SI)	Within 5% of NBS standards and $\pm$1 digit in last place. Probes individually calibrated to tungsten light source traceable to NBS.			Probe-to-probe accuracy within $\pm$5% with tungsten light source	Same as J6501	Same as J6501
Spectral Response	US Metric (SI)	Within 2% (integrated) of CIE photopic curve (color corrected)	Flat within $\pm$7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve	UV enhanced silicon spectral curve (250-1200 nm)	Within 2% (integrated) of CIE photopic curve from 600-710 nm)	Same as J6501
Acceptance Angle	US Metric (SI)	50% sensitivity at 48° off axis	50% sensitivity at 48° off axis	8 degrees	Approximately cosine	50% sensitivity at 48° off axis	Cosine corrected
Stability	US Metric (SI)	Within 2% per year					
Linearity	US Metric (SI)	Within 2% over entire range enabling single point calibration					

TYPICAL PROBE SPECTRAL CHARACTERISTICS







Environmental Capabilities

Ambient Temperature—Nonoperating, −50°C to +75°C; operating, −15°C to +40°C.

Altitude—Nonoperating, to 50,000 feet; operating, to 15,000 feet.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

Vibration—Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inches P-P (4 g's) from 10 to 55 to 10 Hz in 1-minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

Dimensions & Weights—With probe and battery pack installed.

Dimensions	in	cm	Weights (approx)	lb	kg
Height	2.4	6.0	Net	3.3	1.5
Width	4.6	12.3	Domestic Shipping	5.0	2.3
Length	8.0	20.3	Export-packed	10.0	4.5

ORDERING INFORMATION

Photometer/Radiometer without Probes

Readout Units*	Power Source	Voltage	Order† Information	Price
US	Battery	115 V, 60 Hz battery charger	**J16**	**$600**
US	Battery	230 V, 50 Hz battery charger	**J16 opt 1**	**Add $5**
US	AC	115 V, 60 Hz	**J16 opt 3**	**No Charge**
US	AC	230 V, 50 Hz	**J16 opt 4**	**No Charge**

†For a J16 with metric readout, specify option 2 in addition to above ordering information. No additional charge.

*Refer to Readout Units of Probe Characteristics chart.

J16-TV Package—for TV color monitor set-up. The package includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, Probe Extension Cable.

Order J16-TV for 115 V, 60 Hz battery charger **$895**
Order J16-TV Option 1 for 230 V, 50 Hz battery charger. **Add $5**

For a J16-TV with metric readout, specify Option 2 in addition to above ordering information. No additional charge.

Included Accessories
For battery operated J16—battery pack, battery charger, shoulder strap, manual.

For AC operated J16—AC power supply, shoulder strap, manual.

PROBES

Specify probe with option 2 for metric readout J16's
No additional charge.

J6501, Illuminance Probe **$200**
J6502 or **J6512,** Irradiance Probe **$250**
J6503, Luminance Probe **$250**
J6504 or **J6514,** Uncorrected Probe **$150**
J6505, LED Probe, includes LED adapter **$300**
J6511, Illuminance Probe, cosine corrected **$250**

Optional Accessories

Actual spectral curve of any probe is available on initial order, at additional cost of $35

42-inch Probe Extender Cable—connects J16 and probe.
Order 012-0414-00 ..... **$30**
Spare Battery Pack—Order 016-0539-00 ..... **$66**
Cables up to 30 ft in length ..... Available on special order
Analog output ..... Available on special order
BCD output ..... Available on special order
A **10X amplifier** for the J6505 probe is available on special order.

Light Occluder—for use when setting up color TV monitors.
Order 016-0305-00 ..... **$15**
Filter Holder—mounts one-inch diameter filters, of up to ⅜ inch thickness, to probes (except J6511, J6512, J6514).
Order 016-0527-00 ..... **$11**
LED Adapter—Order 014-0047-00 ..... **$55**
AC Power Supply—allows J16 to be used without batteries.
Order 119-0404-00 115 V, 60 Hz **$82.50**
Order 119-0404-01 230 V, 50 Hz **$82.50**

Please use the return card, inside front cover, to write for application notes describing the use of the J16 Photometer/Radiometer.

- **LOW COST PER FUNCTION**
- **INTERCHANGEABLE PLUG-INS**
- **SMALL SIZE for EASY SETUP and REDUCED CLUTTER**
- **DESIGNED for BENCH, RACK, or MOBILE USE**
- **REAR PANEL ACCESS to PLUG-IN INTERFACE**
- **INTRA-COMPARTMENT PLUG-IN INTERFACE for SPECIFIC APPLICATIONS**
- **FRONT PANELS COLOR CODED by FUNCTION**
- **RELIABLE, EASY to MAINTAIN**

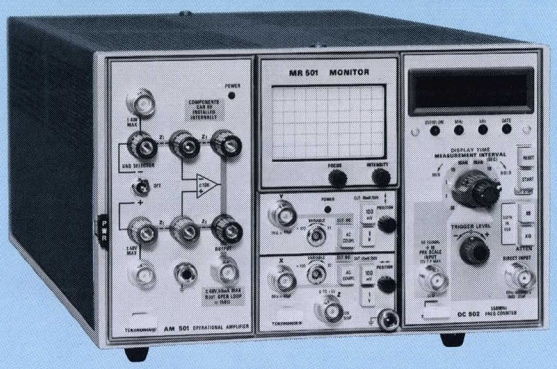
The TM 500 Test and Measurement System is a totally new concept for test bench equipment. It is not a scope, but is there to complement it. In the three-compartment mainframe one can combine the instrumentation required to do a job which previously required three times as much bench space and significantly greater cost. An added benefit of this modular plug-in approach is interface capabilities in multi-function application, i.e., connecting the output of the ramp generator to VCF input of the function generator for frequency sweeps, or monitoring the output of a power supply with the DM501.

PRODUCT	PAGE	
		MAINFRAMES
TM 501	**232**	Easy to carry; Powers any one of 18 plug-ins
TM 503	**232**	Compact, multi-function (powers any three TM 500 plug-ins)
203 Option 1	**233**	Mobile Test Station accepts a TM 503 Power Module
204 Option 1	**233**	Mobile Test Station accepts a TM 503 Power Module
		AMPLIFIERS
AM 501	**220**	High performance, Operational Amplifier
AM 502	**221**	DC-coupled, Differential Amplifier
		DIGITAL MULTIMETER
DM 501	**223**	4½ digit. 0.1% DC voltage accuracy
		DIGITAL COUNTERS
DC 501	**224**	7 digit 110 MHz direct counting
DC 502	**224**	7 digit 110 MHz direct counting, 550 MHz with prescaler
DC 503	**224**	7 digit Universal Counter, 100 MHz direct counting
		POWER SUPPLIES
PS 501	**226**	Floating output 0-20 V, current limit 0-400 mA
PS 501-1	**226**	Same as PS 501, readout by 10 turn potentiometer
PS 501-2	**226**	Same as PS 501, readout by dual-range meter
PS 502	**226**	Dual-Tracking power supply, 10-20 V or 20-40 V
PS 503	**226**	Dual power supply 0-20 V or 0-40 V
		GENERATORS
FG 501	**231**	Function Generator, 5 waveforms, .001 Hz to 1 MHz
PG 501	**228**	Pulse Generator, 5 Hz to 50 MHz
PG 502	**228**	Pulse Generator, 250 MHz general purpose
PG 505	**229**	Pulse Generator, 100 kHz, 80 V general purpose
RG 501	**230**	Ramp Generator, 10 μs minimum ramp duration
SG 502	**230**	RC Oscillator, 500 kHz sine and squarewaves
		MONITOR
MR 501	**222**	2 MHz X-Y Monitor

More to come . . . all in convenient plug-in format for more value

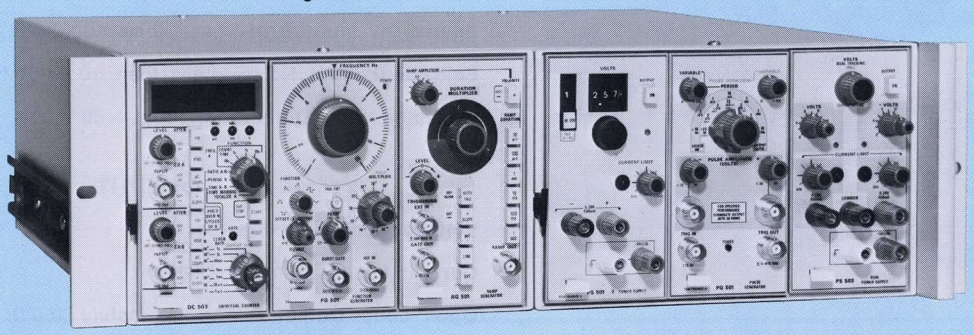
18 PLUG-INS FOR ANY OF THESE CONFIGURATIONS

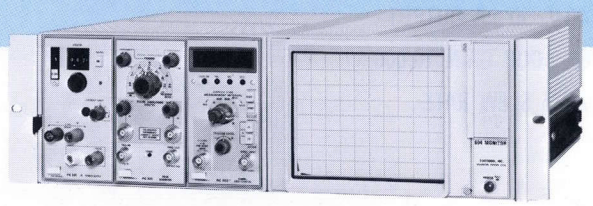
*With the **TM 501** compact easy-to-carry power module for any one of the 18 plug-ins currently offered.*



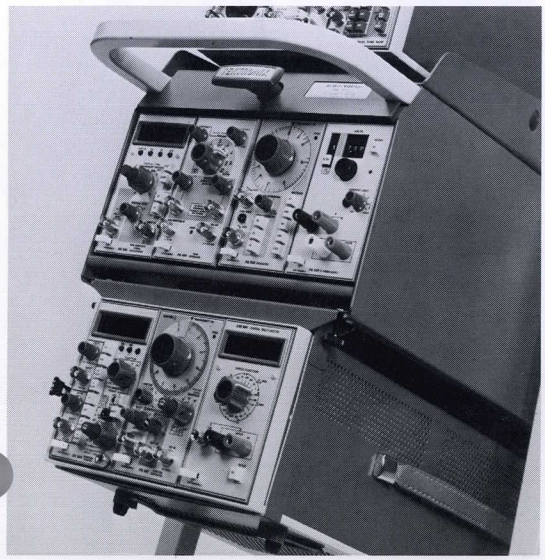
*With the **TM 503** three-compartment power module for compact, multi-function installations.*

*With one or two **TM 503s** in a rack installation for up to three or six functions in 5¼ inches of rack height.*





*With a **TM 503** and **604** Monitor or **603** Storage Monitor. Either monitor available with internal time base or may be swept with the RG 501 plug-in module.*



ADVANTAGES OF THE TM 500 SYSTEM

Low cost per function using the plug-in concept.

Compact and neat for reduced bench clutter.

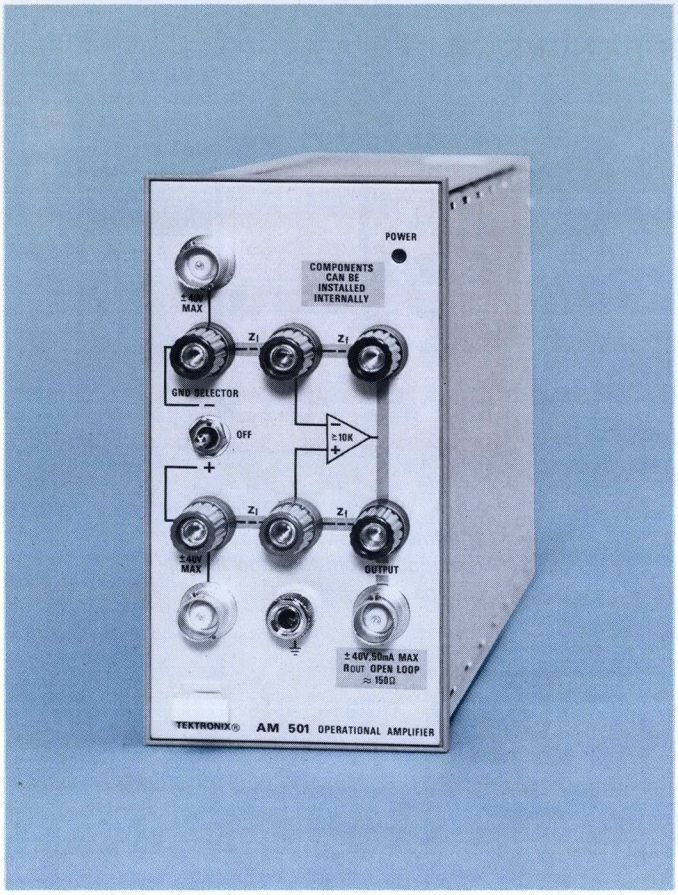
Intra-compartment interface and auxiliary outputs for specific applications (see mainframe options).

Simplified construction, plug-in design for ease of maintenance—less down time.

***Mobile Test Station with TM 503** powers up to 3 TM 500 Series plug-ins. The 203 Option 1 SCOPE-MOBILE® cart also stores up to 4 additional plug-ins for use in the TM 500 System. A scope or other instrument mounts on the tilting platform.*

TM 500-SERIES TEST and MEASUREMENT SYSTEM
AM 501 *Operational Amplifier*

New



- ± 40 V, 50 mA OUTPUT
- OPEN LOOP GAIN 10,000
- 50 μV/s SLEW RATE

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 op-amp amplification 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 25°C.

Equivalent Input Drift—Less than 100 μV/°C.

Equivalent Input Noise—Less than 10 μV RMS.

Maximum Safe Differential Input— 80 V.

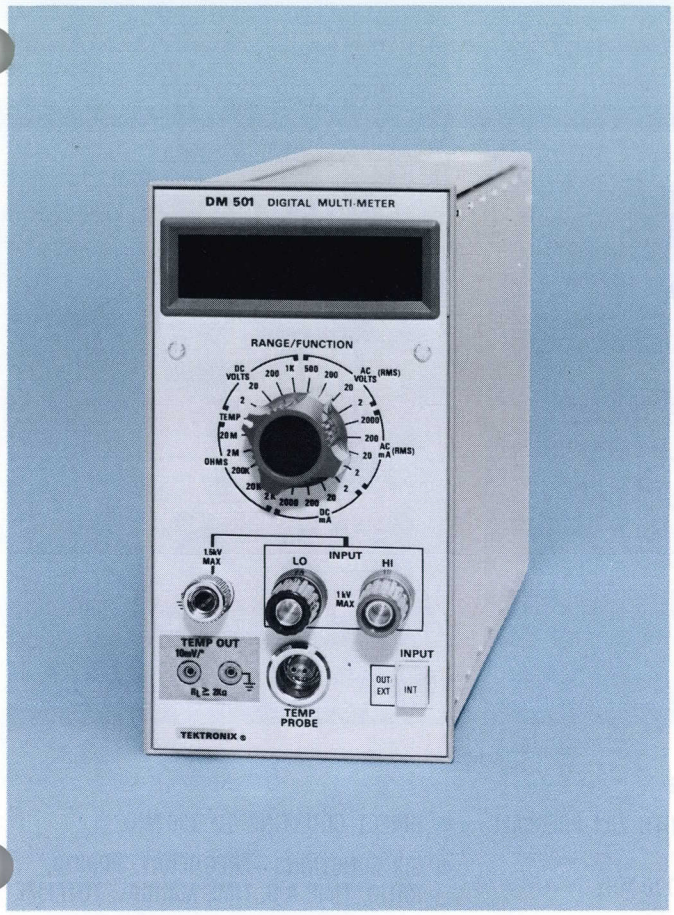
OUTPUT

Voltage Range—At least ±40 V.

Current Limit—At least ±50 mA.

Open Loop Output R—Approximately 150 Ω.

AM 501 OPERATIONAL AMPLIFIER **$225**



- **0.1% DC VOLTAGE ACCURACY**
- **4½-DIGIT LED DISPLAY**
- **AUTO POLARITY**
- **MEASURES VOLTS, CURRENT, RESISTANCE, TEMPERATURE**
- **FULLY ISOLATED SERIAL BCD OUTPUT**

DC VOLTAGE

Range— 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.

Input R— 10 MΩ, constant.

Ref to RMS removed from front panel voltage + current range. A-2721 spec sheet is correct. Temp. range accurate within ± 1.5° C (2.7° F) - 55° to +125° C (-67° F to 257° F) within ± 2.5° C (4.5° F) 125° C to 150° C (258° F to 302° F).

AC VOLTAGE

Range— 2 V, 20 V, 200 V and 500 V full scale (19999 max reading), average responding, RMS calibrated, accurate within 0.5% of reading ±2 counts from 40 Hz to 10 kHz. Useful to 100 kHz.

Resolution— 100 μV.

Input— 10 MΩ, constant.

AC & DC CURRENT

Range— 2 mA, 20 mA, 200 mA, 2 A full scale (19999 max reading), AC RMS calibrated, average responding.

Resolution— 100 nA.

Accuracy—DC Amps, 0.2% of reading ±2 counts; AC Amps, 0.6% of reading ±1 count from 40 Hz to 10 kHz. Useful to 100 kHz.

RESISTANCE

Range— 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ full scale (19999 max reading). Accuracy within 0.3% ±2 counts to 2 MΩ, 0.5% ±2 counts on 20 MΩ scale.

Resolution— 0.1 Ω.

TEMPERATURE MEASUREMENT

Range— —55° C to +150° C (—67° F to +302° F selected by internal switch), using included temperature probe, accurate within 2° C (3.6° F). The temperature probe functions regardless of the DM 501 mode or range setting and provides a front-panel analog signal output of 10 mV/° (into 2 kΩ or greater), thus by using an external voltage indicator, temperature may be measured simultaneously with any other function. If temperature probe is not desired, order Option 1. If temperature capability is not desired, order Option 2; this capability cannot be ordered at a later date.

OTHER CHARACTERISTICS

Overrange Indication—Blinking display.

Measurement Rate— 5 measurements/second.

Maximum Common-Mode Voltage— 1.5 kV isolation to ground (except interface connection).

Normal-Mode Rejection Ratio— 40 dB min at 60 Hz.

Common-Mode Rejection Ratio—With a 1-kΩ imbalance, at least 80 dB at 60 Hz.

Ambient Temperature—Performance characteristics are valid over a temperature range of +15°C to +40°C.

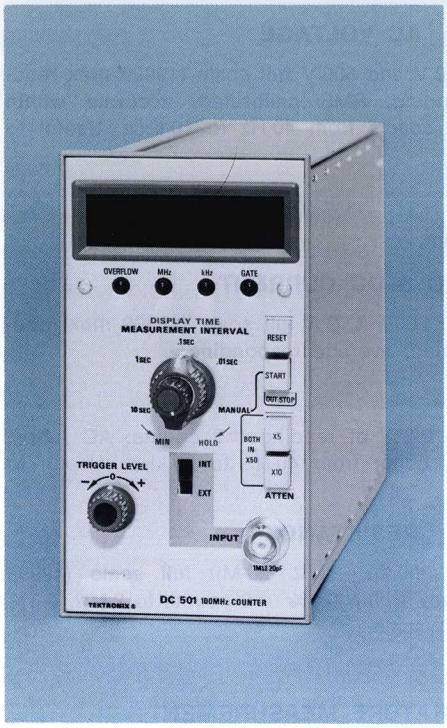
ORDERING INFORMATION

DM 501 DIGITAL MULTIMETER **$495**

DM 501 OPTIONS

Option 1 W/O TEMP PROBE (P6058) ..... **Sub $60**

Option 2 W/O TEMP CAPABILITY AND PROBE ..... **Sub $100**



DC 501

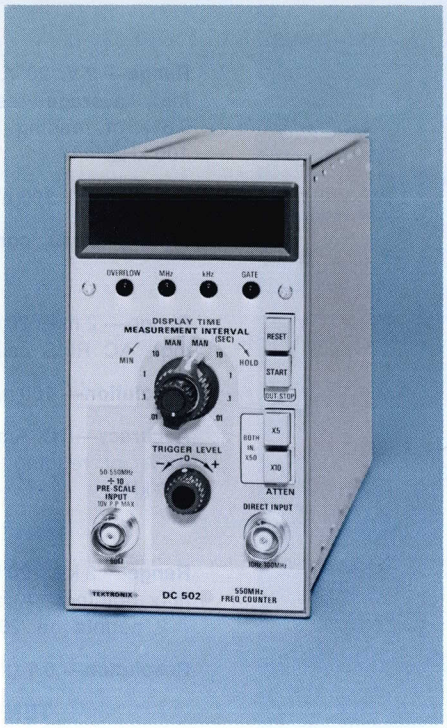
- DIRECT COUNTING TO 110 MHz
- 7-DIGIT LED DISPLAY
- MANUAL START/STOP (TOTALIZE)
- AUTO RANGE AND TIME BASE OPTIONS

DC 501 DIGITAL COUNTER **$550**
Option 1 5 MHz TIME BASE ..... **Add $95**

Auto Measurement Interval—Automatically selects the optimum measurement interval for the input, and displays the appropriate MHz or kHz indication. Overflow is only indicated for frequencies in excess of 99.99999 MHz.

Option 2 AUTO MEASUREMENT .... **Add $65**

Panel has been changed to indicate 110 MHz.

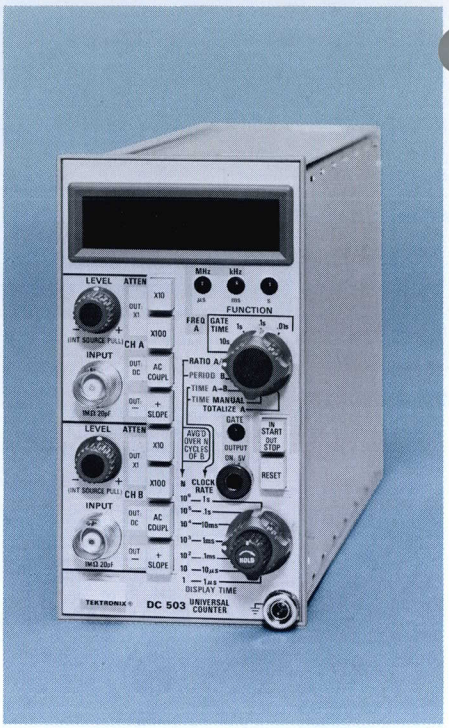


DC 502

- COUNTS TO 550 MHz WITH 10X PRESCALE (50-Ω INPUT)
- DIRECT COUNTING TO 110 MHz
- 7-DIGIT LED DISPLAY
- MANUAL START/STOP (TOTALIZE)
- TIME BASE OPTION

Same as DC 501 except:
Prescale ÷ 10 input—50 MHz to 550 MHz. 50-Ω impedance, 10 V P-P maximum input, 500 mV P-P sensitivity.

DC 502 DIGITAL COUNTER **$895**
Option 1 5 MHz TIME BASE ..... **Add $95**



DC 503

- DIRECT COUNTING TO 100 MHz
- SIX FUNCTIONS—FREQUENCY, PERIOD, RATIO, TIME A-B, TIME MANUAL, TOTALIZE
- PERIOD AND RATIO AVERAGING
- 7-DIGIT LED DISPLAY
- TIME BASE OPTION

All features of DC 501 plus:

Dual Channels—Separate inputs, attenuators, coupling and trigger level controls.

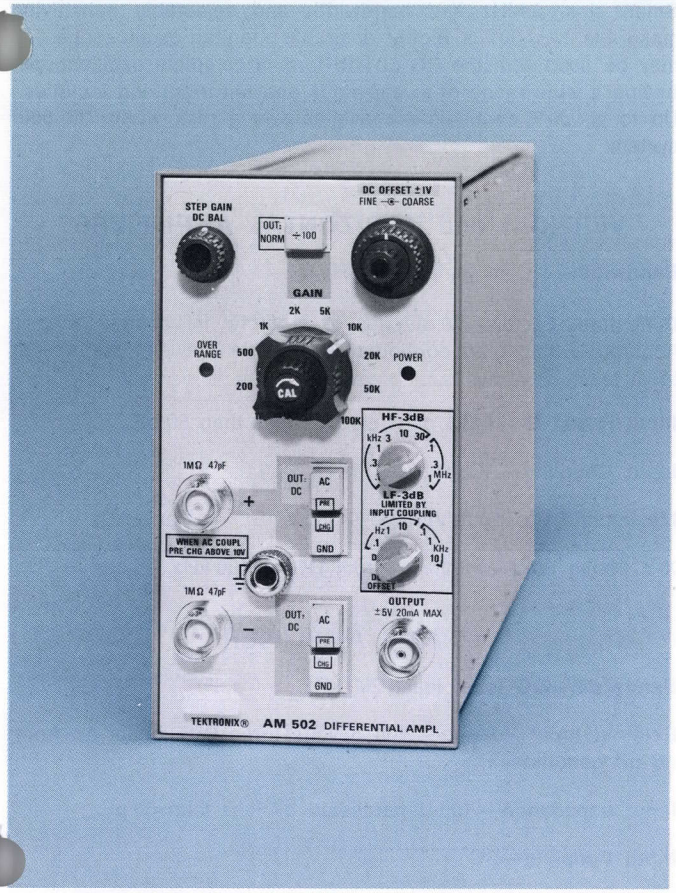
Ratio A/B—Measures the ratio of channel A signal frequency to channel B signal frequency averaged over N cycles of B. N selectable from 1 to 10^6 in decade steps.

Period B—Measures the period of the channel B signal, averaged over N cycles of B. N selectable from 1 to 10^6 in decade steps. Resolution is 1 μs/cycle B.

Time A—B—Measures the time between channel A trigger (start) and channel B trigger (stop). Clock rates selectable from 1 s to 1 μs in decade steps.

Time Manual—Measures the time between start/stop commands from front panel pushbuttons. Clock rates selectable from 1 s to 1 μs in decade steps.

DC 503 DIGITAL COUNTER **$695**
Option 1 5 MHz TIME BASE ..... **Add $95**



- 1-to-100,000 GAIN
- 100 dB CMRR
- SELECTABLE UPPER and LOWER —3 dB POINTS
- DC-to-1 MHz BANDWIDTH

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, display 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— 1 to 100,000, 1, 2, 5 sequence, accurate within 2%.

Frequency Response—DC to 1 MHz within +25%, DC coupled. 2 Hz or less (low frequency —3 dB point) with input AC coupled.

HF —3 dB POINT—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz.

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, ±5 V.

Maximum Safe Inputs—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.

OUTPUT

Maximum Output— ±5 V, ±20 mA, output resistance is 5 Ω or less.

Minimum Load Impedance— 250 Ω.

Maximum Input Gate Current— 50 pA at 25° C.

Maximum Noise— 25 μV or less (tangentially measured).

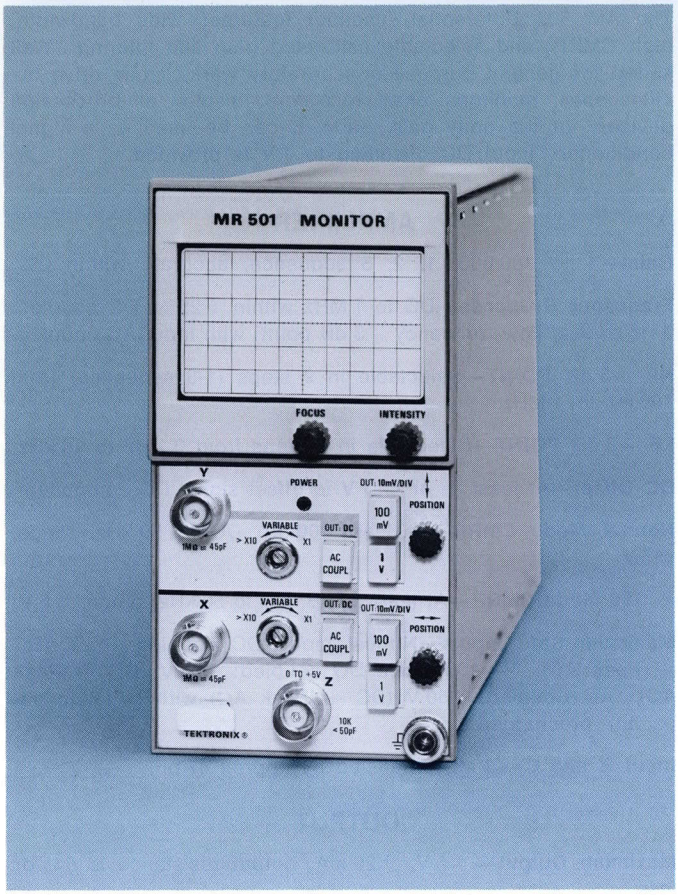
Overrange—Front-panel lamp indicates most overrange conditions.

Maximum Voltage Drift— 100 μV/°C

AM 502 DIFFERENTIAL AMPLIFIER **$475**

÷ 100 mode CMRR spec applies over a ± 50V range, not ± 5 V as stated in cat — A-2737 spec sheet.

New



- 2 MHz X-Y BANDWIDTH
- 10 mV to 10 V DEFLECTION FACTORS
- DC to 200 kHz Z-AXIS INPUT
- COMPATIBLE WITH RG 501

Small size, 2 MHz X-Y bandwidth and selectable sensitivity make the MR 501 a highly desirable monitor oscilloscope. It may be used with the RG 501 to form a complete oscilloscope having a wide range of sweep rates and full triggering facilities. Up to six X-Y channels are available in a rack width TM 500 system.

VERTICAL and HORIZONTAL AMPLIFIERS

Bandwidth—DC to at least 2 MHz

Deflection Factor— 10 mV/div to 1 V/div in decade steps. Accurate within 3%, continuously variable between steps and to at least 10 V/div.

Input R and C— 1 MΩ paralleled by less than 50 pF.

Input Coupling—AC or DC.

Maximum Safe Input Voltage— 350 V (DC + peak AC).

X-Y Phase Shift—within 1° from DC to 100 kHz.

Z AXIS AMPLIFIER

Bandwidth—DC to at least 200 kHz.

External Input Voltage—Plus 5 volts turns CRT beam on from an off condition.

Input Impedance— 10 kΩ paralleled by less than 50 pF.

Input Coupling—DC

CRT

Graticule—Internal 6 x 10 divisions, 0.203 inch/div.

Phosphor—P31

MR 501 X-Y MONITOR **$395**

COMMON CHARACTERISTICS

Bright LED Displays— 7-digit stored display with automatic decimal point positioning. Leading zeroes (those to the left of the most significant digit or decimal point) are blanked. Register overflow is indicated by a flashing display in the DC 503 Universal Counter, and by a front panel LED in the DC 501 and DC 502 Counters. Other LEDs are used to indicate kHz or MHz units, and gate open.

Display Time—Continuously variable from approx 0.1 s to approx 10 s, plus hold mode for infinite viewing.

Measurement Accuracy—Within ± 1 count ± time-base accuracy.

Standard Time Base—Internal 1-MHz crystal oscillator accurate within 1 part in 10^5 over 0-50°C temperature range. Long-term drift within 2 parts in 10^5 per month.

Optional Time Base (Option 1)—Internal 5-MHz crystal oscillator accurate within 5 parts in 10^7 over 0-50°C temperature range. Long-term drift within 1 part in 10^7 per month.

Input R and C—Approx 1 MΩ, approx 20 pF. (Except DC 502 additional prescale 50-Ω input). 50 Ω, approx 20 pF when optional interface connection is wired to INT (DC 501 and DC 503 only).

Maximum Input Voltage— 500 V (DC + peak AC, or peak-to-peak AC) at 1 kHz or iess.

Totalizing—Counts events from 0 to 10^7 at a maximum rate of 110 MHz. Stop, start, and reset commands are via front panel pushbuttons.

Measurement Intervals (Count Time)—Selectable in decade steps.

Measurement Intervals	Resolution
10 ms	100 Hz
100 ms	10 Hz
1 s	1 Hz
10 s	0.1 Hz
Manual	1 count

Data Inputs/Outputs—Available at plug-in connector for routing to optional rear-panel connectors on all Power Modules, or for intra-compartment routing in the TM 503 Power Module. BCD serial-by-digit (parallel data for one digit at a time), plus lines for MHz light and decimal point (except DC 503), timing, and control functions.

	DC 501 110-MHz COUNTER	DC 502 550-MHz COUNTER	DC 503 100-MHz UNIVERSAL COUNTER
FREQUENCY RANGE	10 Hz to 110 MHz	10 Hz to 110 MHz using direct input 50 MHz to 550 MHz using ÷10 prescale input	CH A: 0 Hz (DC coupled) or 10 Hz (AC coupled) to 100 MHz CH B: 0 Hz (DC coupled) or 10 Hz (AC coupled) to 10 MHz
COUPLING	AC	AC	DC or AC
ATTENUATION	X1, X5, X10, X50	X1, X5, X10, X50	X1, X10, X100
TRIGGER SENSITIVITY	300 mV P-P	300 mV P-P, except 500 mV P-P using ÷10 prescale input	300 mV P-P
TRIGGER LEVEL	±2 V	±2 V	±1.5 V

DC 501, DC 502, DC 503. Improved stability & accuracy. See separate spec sheets A2722, 2723, 2724 for details.

COMMON CHARACTERISTICS

+20 V Floating Supply

Primary Power Input—Determined by power module (TM 501 or TM 503).

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— 4.8 to 5.2 VDC 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.

Stability—0.5% or less drift.

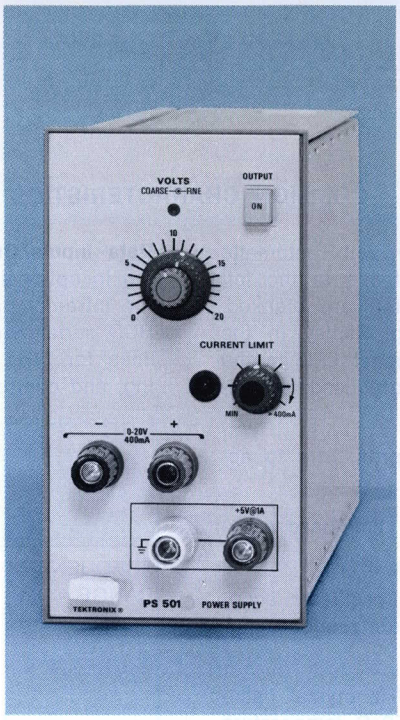
Overload Protection—Automatic current limiting and over-temperature shutdown.

Data Inputs/Outputs

Available at plug-in connector for routing to optional rear-panel connectors on all Power Modules, or for intra-compartment routing in the TM 503 Power Module.

- Supply output through rear connection
- Remote sense
- Remote analog voltage control (Except PS 502)
- Remote analog current limit control (Except PS 502)

Front-panel controls and connections should be disabled if interface access is desirable.



PS 501
POWER SUPPLY

- FLOATING OUTPUT, 0 - 20 V
- 0 TO 400 mA
- PRECISE REGULATION
- LOW RIPPLE AND NOISE

Output— 0 V to ±20 VDC.

Current Limit— 0 mA to 400 mA.

Minimum Resolution— 10 mV.

Regulation, Line—Within 5 mV for a ±10% line voltage change.

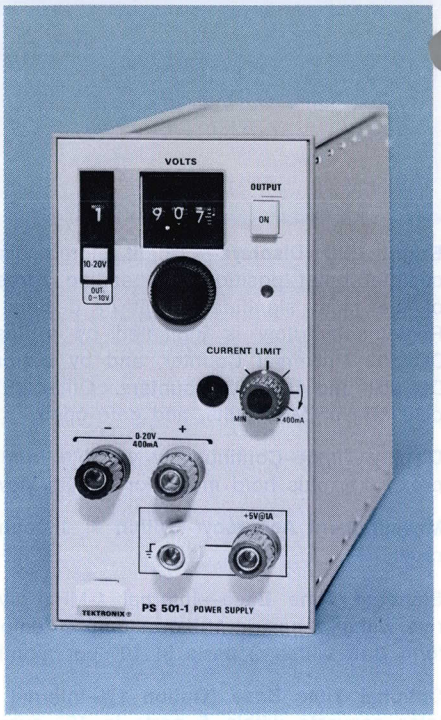
Regulation, Load—Within 1 mV with a 400 mA load change.

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.

PS 501 POWER SUPPLY **$95**



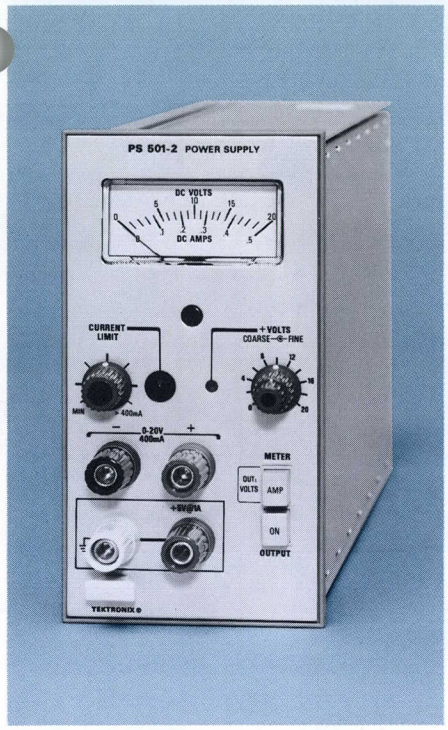
PS 501-1
POWER SUPPLY

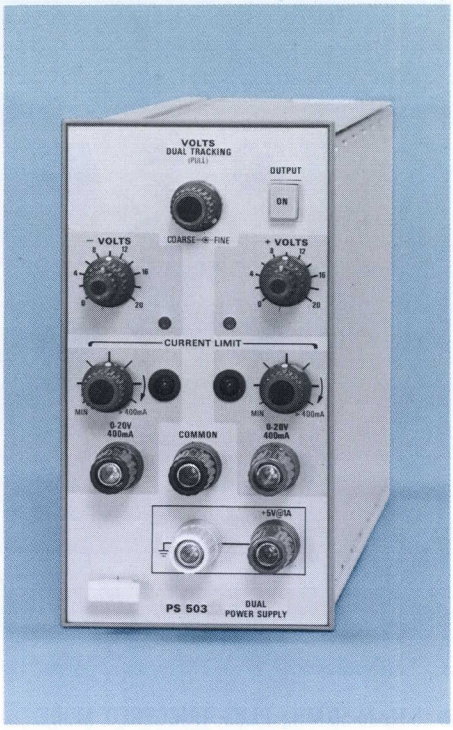
- PRECISION VOLTAGE CONTROL
- EASY TO READ AND SET
- OTHER FEATURES OF PS 501

Minimum Resolution— 1.6 mV.

Voltage is selectable within 0.5% by a 10 turn potentiometer with a 3-digit in-line dial and range switch.

PS 501-1 POWER SUPPLY **$130**





PS 501-2
POWER SUPPLY

- DUAL-RANGE METER READOUT
- OTHER FEATURES OF PS 501

Meter—Dual-range, 0 to 500 mA or 0 to 20 VDC.

PS 501-2 POWER SUPPLY **$150**

PS 502
DUAL TRACKING POWER SUPPLY

- 10 - 20 V SUPPLY
- SIMPLE AND COMPACT
- IDEAL FOR BREADBOARDS AND CLASSROOM USE

Output— 10 V to 20 VDC with respect to the common terminal or 20 to 40 VDC across the + and — terminals.

Current Limit—Fixed, 400 mA.

Minimum Resolution— 7 mV.

Regulation, Line—Within 5 mV for a 10% line voltage change.

Regulation, Load—Within 50 mV with a 400 mA change.

Ripple and Noise— 3 mV P-P or less; 1 mV RMS or less.

Temperature Coefficient— 0.02% / °C or less.

Transient Recovery Time— 50 μs or less for a constant voltage to recover within 10 mV of nominal output voltage after a 300 mA change in output current.

PS 502 POWER SUPPLY **$130**

PS 503
DUAL POWER SUPPLY

- + and — INDEPENDENT CONTROLS
- TRACKING VOLTAGE CONTROL
- PRESET VOLTAGE BOOST OR DROP
- OTHER FEATURES OF PS 501

Output— 0 V to 20 VDC with respect to the common terminal or 0 V to 40 VDC across the + and — terminals. Outputs can be varied independently or at a constant ratio.

Current Limit— 0 to 400 mA on each supply.

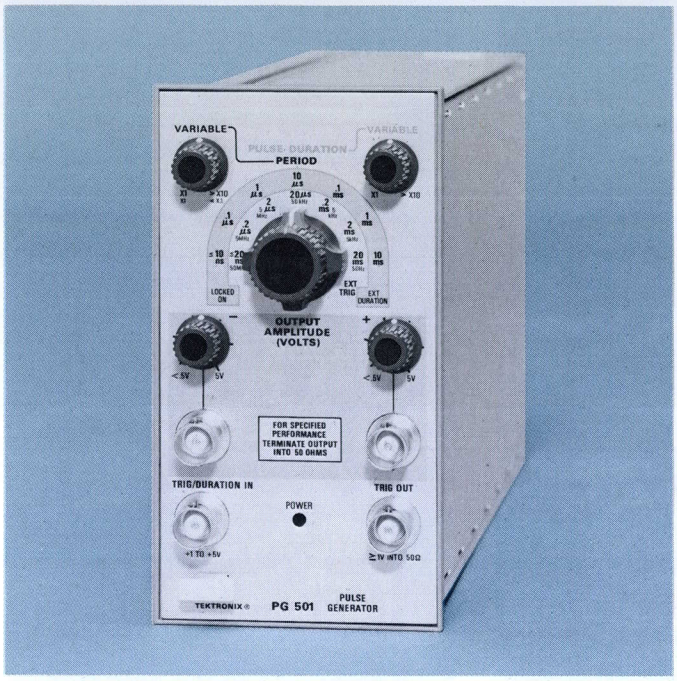
PS 503 POWER SUPPLY **$180**

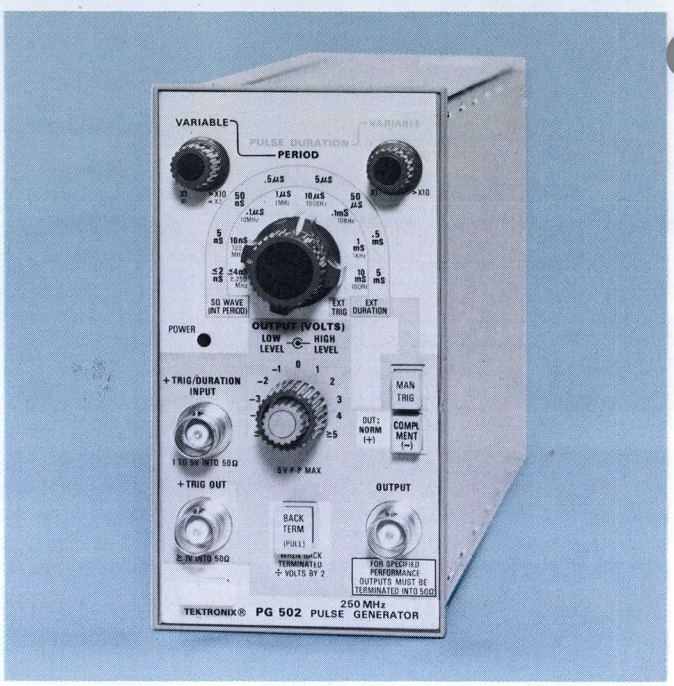
TM 500-SERIES TEST and MEASUREMENT SYSTEM

PG 501 *Pulse Generator*

PG 502 *Pulse Generator*

New





- 5 Hz-to-50 MHz PLUS TRIGGERED MODE
- 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 Risetime and Falltime— 3.5 ns or less.

Aberrations—Within 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.

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.

PG 501 PULSE GENERATOR **$295**

- 10 Hz to 250 MHz
- 1 ns RISETIME
- 5 V PULSE AMPLITUDE INTO 50 Ω
- INDEPENDENT PULSE TOP and BOTTOM LEVEL CONTROLS
- SELECTABLE INTERNAL REVERSE TERMINATIONS
- SHORT PROOF OUTPUT

The PG 502 (250-MHz Pulse Generator) features: fast rise and fall time; independent top and bottom pulse levels; and adjustable puse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic 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 approximately 50% duty factor.

Duty Factor—At least 50% in normal mode, approximately 100% in complement mode. Minimum off time is 2 ns.

Pulse Risetime and Falltime—Less than 1 ns.

Aberrations—Within 5% at maximum output.

Pulse Top Flatness—Within 2%.

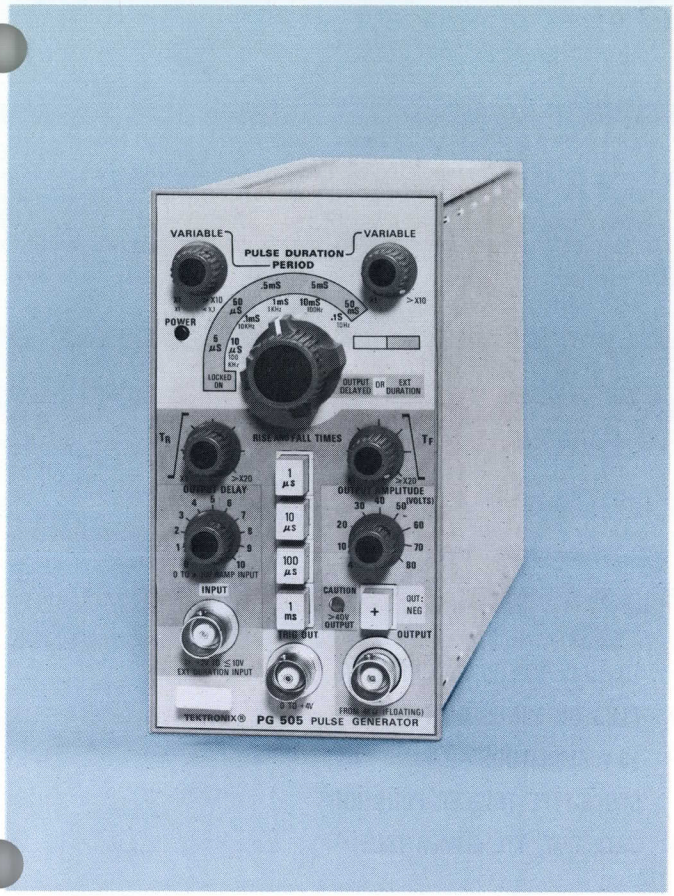
Pulse Amplitude— 5 V peak to peak, independent top and bottom level controls.

Offset— ±5 V maximum, depends on amplitude setting.

Trigger Output—At least 1 V into 50 Ω, occurring approx 10 ns prior to pulse output.

External Trigger/Duration Input—Trigger threshold less than 1 V; reset threshold greater than 0.1 V; maximum input 5 V.

PG 502 PULSE GENERATOR **$995**



- 10 Hz-to-100 kHz
- 80 V OUTPUT
- VARIABLE DURATION
- VARIABLE RISE and FALL TIME
- DELAY MODE

The PG 505 Pulse Generator features: floating output; high output amplitude (80 volts); independently adjustable rise and fall times; and variable pulse period. The instrument is useful in physiological laboratories for simulating nerve impulses and in the educational lab as a general purpose pulse generator.

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—To 95% and (DC) locked on mode.

Pulse Risetime and Falltime— 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% peak to peak at maximum output into 4 kΩ, 20 pF load.

Residual DC Offset—less than 0.5% at maximum output.

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%.

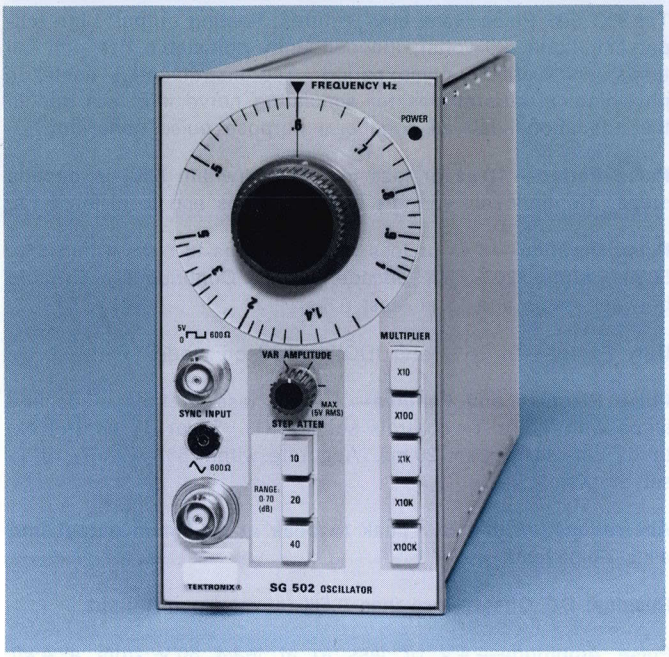
Delay Jitter—Less than 0.1% with a 10 V ramp input signal.

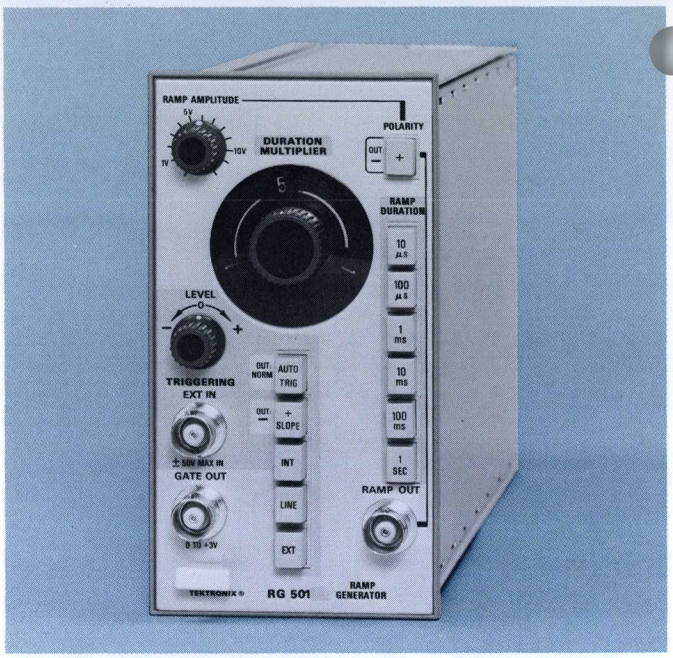
Custom Pulse Duration Range— 5 μs and slower depending on internally installed capacitor.

Custom Pulse Period Range— 10 μs and slower depending on internally installed capacitor.

PG 505 PULSE GENERATOR **$265**

TM 500-SERIES TEST and MEASUREMENT SYSTEM
SG 502 *RC Oscillator*
RG 501 *Ramp Generator*





- **5 Hz to 500 kHz SINE and SQUARE WAVES**
- **LOW DISTORTION SINE**
- **5 V RMS OPEN CIRCUIT—600 Ω SOURCE**
- **0-40 dB CONTINUOUSLY VARIABLE PLUS 0-70 dB in 10-dB STEPS**

SINEWAVE

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 push buttons. Accurate within 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion—Less than 0.1% from 20 Hz to 50 kHz. Less than 1% over the remaining frequency range. Typical less than 0.03% from 20 Hz to 50 kHz, less than 0.2% over the remaining range.

Hum and Noise—Less than 0.1% of rated output.

Maximum Output Voltage—5 V RMS open circuit; 2.5 V RMS into 600 Ω.

Output Impedance—600 Ω.

SQUAREWAVE

Frequency Range—Same as sinewave. The square wave switches on at the 0° and 180° of sine out.

Rise and Fall Time—50 ns or less.

Amplitude— +5 V, fixed, open circuit

Output Impedance—600 Ω.

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 **$295**

- **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.

Ramp 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. Falltime is 100 ns or less. Gate source impedance is 160 Ω, within 5%.

Output Characteristics—Minimum load resistance, 3 kΩ; maximum 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.

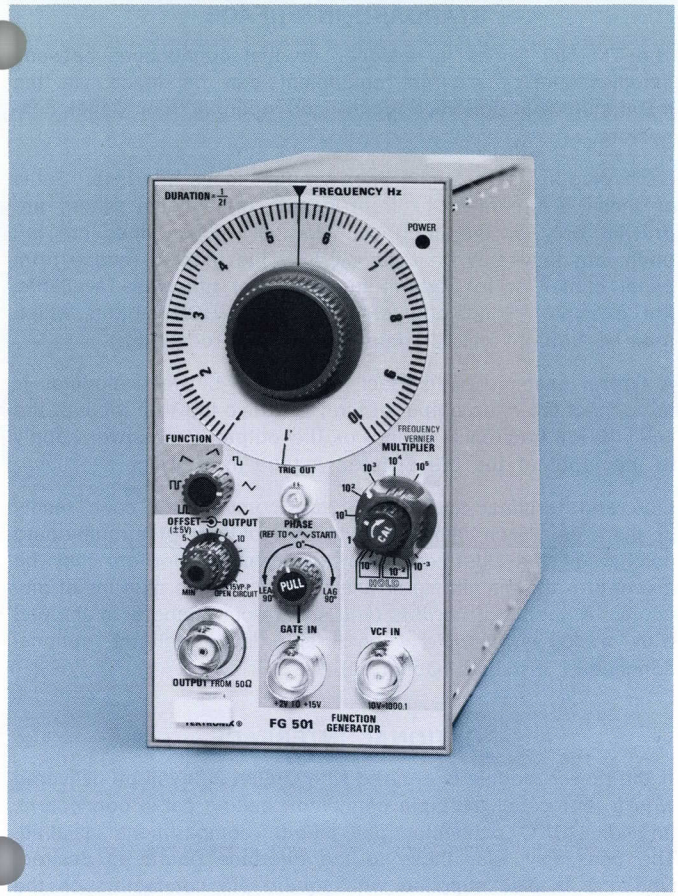
External Triggering—Sensitivity is at least 200 mV P-P, DC to 100 kHz. Input impedance approx 9.5 kΩ. 50 V (DC + peak AC) maximum input.

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 **$175**



- 5 WAVEFORMS—SINE, SQUARE, TRIANGLE, PULSE, RAMP
- .001 Hz to 1 MHz
- VCF and GATED BURST
- HOLD MODE
- TRIGGER OUT

Output Waveforms—Sinusoidal, square, triangle, positive pulse, negative pulse, positive ramp and negative ramp. Also a fixed squarewave trigger from the TRIG OUT connector. Pulses and ramps have a 20% or 80% duty cycle; occurs at ≈1.6X dial frequency (X1 or greater); 2X dial frequency (less than X1), limited to ≤1 MHz.

Frequency Range—0.001 Hz to 1 MHz in decade steps.

Dial Range—X1 to X10 calibrated; accurate within 3% of full scale. (0.1 to less than 1, uncalibrated).

Time Symmetry—Within 1% from 0.001 Hz to 1 MHz.

Amplitude—15 V P-P open circuit; 7.5 V P-P into 50 Ω load. 0.5 V P-P minimum open circuit; 0.25 V P-P minimum into 50 Ω load.

Offset Range—±5 V open circuit, ±2.5 V into 50 Ω load.

Hold Mode—Holds output DC level to instantaneous value present when control is actuated. Level is constant to within 5% for 1 hour at 25°C on lowest three ranges.

Frequency and Amplitude Stability (including offset)—Drift with temperature; within 2% from 0.1 Hz to 1 MHz; within 10% from 0.001 Hz to less than 0.1 Hz. Drift with time; within 0.1% for 10 minutes; within 0.25% for 24 hours.

Sinewave Distortion—1% or less from 0.001 Hz to 1 Hz; 0.5% or less from 1 Hz to 20 kHz; 1% or less from 20 kHz to 100 kHz; 2.5% or less from 100 kHz to 1 MHz.

Squarewave and Pulse Response—Less than 100 ns rise and fall times; within 5% total aberrations.

Triangle and Ramp Linearity—Within 1% from 0.001 Hz to less than 100 kHz; within 2% from 100 kHz to 1 MHz.

Voltage Controlled Frequency (VCF)—External DC or AC voltage control of output frequency; 0 to +10 V change at VCF input changes output frequency upward 1000:1 from minimum dial setting; 0 to −10 V change at VCF input changes output frequency downward 1000:1 from maximum dial setting; within any multiplier range. Bandwidth is at least 50 kHz; input impedance is 10 kΩ. Slew rate is 0.5 V/μs.

Burst/Gate—Input signal requirement is at least +2 V, not to exceed +15 V. Squarewave input impedance is 1 kΩ. Burst length is determined by the selected output frequency and gate pulse width. Bursts are synchronous with the gate. Phase is continuously variable from −90° to +90°.

Trigger Output Amplitude—+2.5 V squarewave into a 600-Ω load. TTL compatible.

FG 501 FUNCTION GENERATOR **$325**

CHARACTERISTICS

Power Requirements— 100, 110, 120, 200, 220 and 240 VAC ±10%; internally selected with quick change jumpers. Line frequency range; 48 to 440 Hz.

Power Consumption—Maximum primary power approx 120 W (TM 503) and 35 W (TM 501) at high line (with plug-ins). Actual power consumption depends on plug-in selection and operating modes.

Operating Temperature— 0° to 50°C. Includes power modules and all plug-in combinations. The TM503 power module contains a thermal cutout for overtemperature protection.

Operating Altitude Range—To 15,000 feet. Includes power modules and all plug-in combinations.

Lines Available at the Module Interface connector

Digital Counters

BCD serial by digit	Reset
Range code (Except DC 502)	Time slot zero
Scan clock out	Data good
Scan clock in and internal scan disable	Signal in (selected by front panel switch)

These lines allow for external data logging and processing via the BCD output and associated signals. They also allow the external system to initiate the taking of a measurement, and control the rate at which the BCD serial data is scanned.

Digital Multimeter

Scan clock out	Most significant digit
Decimal point	Data transfer
BCD serial by character	Polarity
Least significant digit	

Power Supplies

Supply output through rear connection

Remote sense

Remote analog voltage control (Except PS 502)

Remote analog current limit control (Except PS 502)

Amplifiers

Signal Out, Signal In

Monitor

X, Y, and Z Inputs

SIGNAL SOURCES	FG 501	PG 501	PG 502	PG 505	RG 501	SG 502
Trigger Out	X	X	X	X		
Trigger In			X	X	X	
Signal Out	X				X	X
Gate Out					X	
Gate In	X			X		
VCF In	X					
Amplitude Monitor		X				
Squarewave Out						X
Sync In						X

STANDARD INTERFACE

The TM 500 Series is designed so that connections between modules and/or external equipment can be made via the mainframe rear interface board and optional rear panel connectors.

Each plug-in has selected lines brought to its interface. Some of these are parallel to front panel connections, others are present only at the interface. Normally, these lines are left open, but they may be connected by the user to reduce front panel clutter or to perform functions not otherwise available. For example, digital counters have serial BCD outputs which may be brought out for data logging or processing.

A typical example of interface connection between modules is to connect the ramp output of the RG 501 to the VCF input of the FG 501 for frequency sweep, or the output of a power supply to the input of the DM 501 for voltage monitoring.

Line and terminal assignments are common for each family of modules. Each family has its own pattern of circuit board notches at the interface. Interface terminal barriers may be inserted in the mainframe so that it only accepts plug-ins of one family. A supply of barriers (and square-pin jumpers) is shipped with the power module when it is ordered with the optional connectors installed (Option 2).

OPTIONAL INTERFACE

If the power module is ordered with Option 2, it will be delivered with a rear panel multi-pin connector, mating cable connectors, and one BNC connector per plug-in compartment installed. The user may wire these to the interface board as desired. Option 2 is also supplied with square pin connectors on the rear interface board for connection between modules using the supplied jumpers terminated with square-pin receptacles. However, it is feasible to solder the desired connections without the square pins installed. Also, it is feasible to install the rear panel connectors at a later date.

Power Module Dimensions and Weights

	CABINET				RACKMOUNT	
	TM 501		TM 503			
Dimensions	In	cm	in	cm	in	cm
Height	6	15.2	6	15.2	5.3	13.5
Width	3.9	9.9	8.7	22.1	19.0	48.0
Length	15.3	38.8	15.3	38.8	15.6	39.6
Weight (approx)	lb	kg	lb	kg		
Net	5.4	2.4	9.5	4.3		
Domestic Shipping	13	5.9	17	7.7		
Export Packed	20	9.1	24	10.9		

500-Series Plug-in Dimensions and Weights

Dimensions	in	cm	Weights (approx)	lb	kg
Height	5.0	12.5	Net	2.2	1
Width	2.6	6.7	Domestic Shipping	10.0	4.5
Length	12.0	30.5	Export Packed	15.0	6.9

ORDERING INFORMATION

(Plug-ins Not Included)

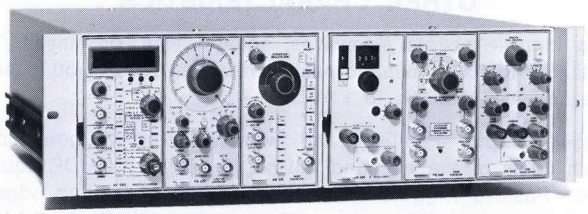
TM 501 POWER MODULE	$115
Option 2 INTERFACE	Add $55
TM 503 POWER MODULE	$150
Option 2 INTERFACE	Add $75

MONITOR ORDERING INFORMATION

(See page 255 for more information)

603 STORAGE MONITOR	$1100
OPTION 4 TIME BASE	Add $125
604 MONITOR	$ 700
OPTION 4 TIME BASE	Add $125

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 603 or a 604 in a standard rack width.
Order 040-0624-00 ..... $44

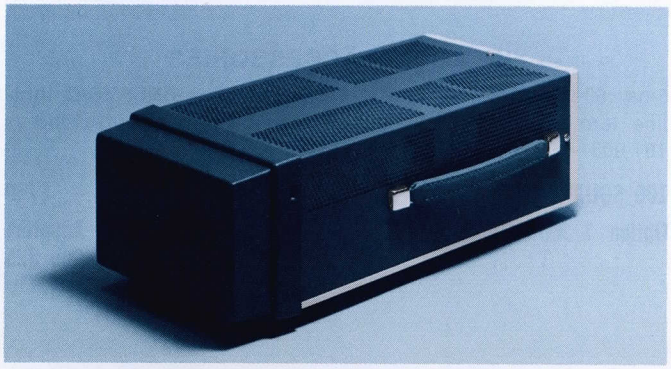


RACKMOUNTING FOR TM 503

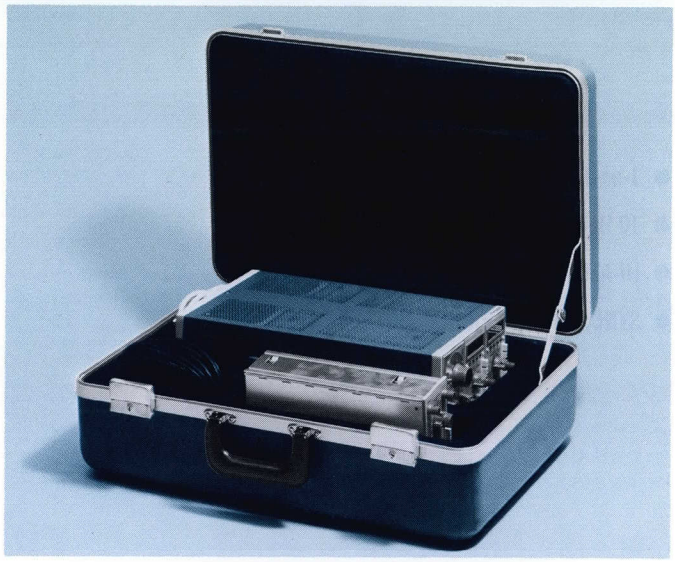
Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0617-00 ..... $66

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two TM 503s side-by-side in a standard rack width.
Order 040-0616-00 ..... $44

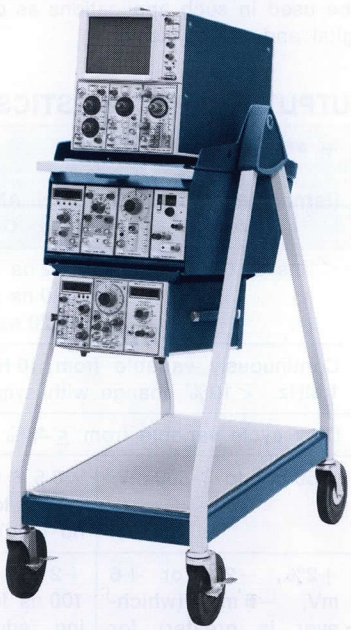
Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.
Order 040-0618-00 ..... $22



TM 503 snap-on front panel cover protects instrument knobs and jacks during transportation or storage.
Front Panel Cover, Order 016-0562-00 ..... $10



TM 503 Carrying Case, accepts one TM 503, plus either a spare TM 500 plug-in or a 200 Series miniscope. A third compartment accepts miscellaneous cables, accessories, or tools.
Carrying Case, Order 016-0565-00 ..... $85



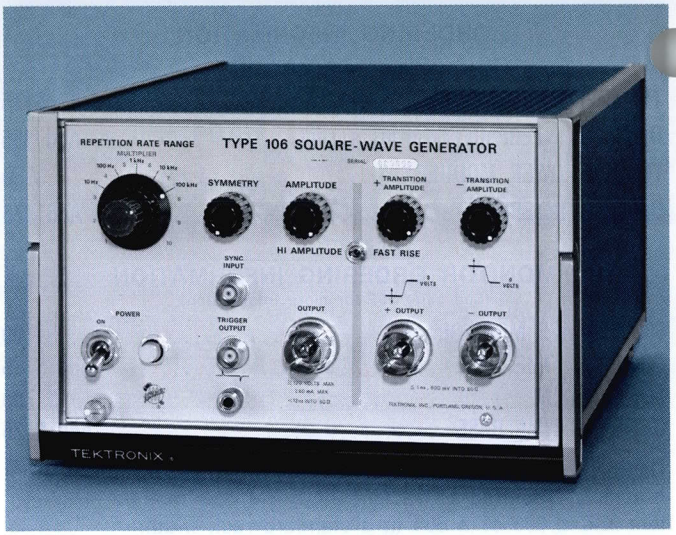
MOBILE TEST STATION

203 Option I SCOPE-MOBILE® cart is an easy to move test station. It accepts any TM 503 Power Module and can store four additional plug-ins for use in TM 500 System.
Order 203 Option I $195

204 Option I SCOPE-MOBILE® cart. Same as above but stores five plug-ins, Order 204 Option I $225

106 *Squarewave Generator*

- 1-ns RISETIME
- 10 Hz-to-1 MHz REPETITION RATE
- HI-AMPLITUDE OR FAST-RISE OUTPUTS
- SYNC INPUT, TRIGGER OUTPUT



This general-purpose generator provides simultaneous positive- and negative-going output transitions with 1-ns or less risetime into 50 Ω, or positive-going, hi-amplitude output with 12-ns or less risetime into 50 Ω. A clean transition and flat top make the 106 ideal for checking oscilloscope transient response. It can be used in such applications as diode recovery, core testing, digital and analog design.

OUTPUT CHARACTERISTICS

CHARACTERISTICS	+ and − FAST-RISE OUTPUTS (terminated in 50-Ω load)	HI-AMPLITUDE OUTPUT
Risetime	≤1 ns at 0.5 V	≤12 ns at 12 V ≤20 ns at 0.5 V ≤120 ns with no load
Repetition Rate	Continuously variable from 10 Hz to at least 1 MHz. <10% change with symmetry control	
Symmetry	Duty cycle variable from ≤45% to ≥55%	
Amplitude	≤50 mV to ≥500 mV	≤0.5 V to ≥12 V, (≤7 V to ≥120 V with no load)
Aberrations	+2%, −2% or +6 mV, −6 mV (whichever is greater) for first 5 ns following leading edge. Typically +0.5%, −0.5% for remainder of pulse top	+2%, −2% for first 100 ns following leading edge. Typically +0.5%, −0.5% for remainder of pulse top

OTHER CHARACTERISTICS

Sync Input—Accepts sinewaves, squarewaves, or pulses. Accepts 5 V-to-100 V peak-to-peak sinewave, 2.5 V-to-50 V pulse or squarewave, 100 Hz to 1 MHz.

Trigger Output—Positive- and negative-going triggers occur within 50 ns of the rise and fall of the HI-AMPLITUDE squarewave. Positive triggers occur within 50 ns of leading edge of fast-rise outputs. Risetime is 50 ns and amplitude is 0.1 V or more into 50 Ω. Time jitter is less than 300 ps.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 103.5 V to 126.5 V or 207 V to 253 V, 50 to 60 Hz. Low or high range selected by rear-panel switch. Approx 85-watts maximum power consumption at 115 V AC.

Dimensions and Weights

Height	6 in	15.2 cm
Width	9 in	22.8 cm
Depth	≈15 in	40.0 cm
Net weight	18 lb	8.2 kg
Domestic shipping weight	≈22 lb	≈9.9 kg
Export-packed weight	≈29 lb	≈13.2 kg

INCLUDED ACCESSORIES

5-ns, 50-Ω RG213 cable (017-0502-00); GR-to-BNC, 50-Ω thruline termination (017-0083-00); (Power cable for MOD 146B is 161-0031-00).

106 SQUAREWAVE GENERATOR **$750**

Option 1 MOD 146B (less cabinet for mounting in Rack Adapter) ..... **Sub $25**

- 250-ps RISETIME PULSES
- ALTERNATE PULSES OF EQUAL OR DIFFERENT TIME DURATION
- 0-55 V CALIBRATED VARIABLE AMPLITUDE
- SELECTABLE POLARITY

The 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS

CHARACTERISTICS	PERFORMANCE
RISETIME	Less than 250 ps
AMPLITUDE	Adjustable from 0 through 50 V
REPETITION RATE	Preset between 550 p/s and 720 p/s (using two charge lines)
PULSE DURATION	0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate
DECAY	approx 10% in 300 ns
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω

Charge Lines—Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

External DC Charge Voltage Inputs—Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volt input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

Power Requirement—Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

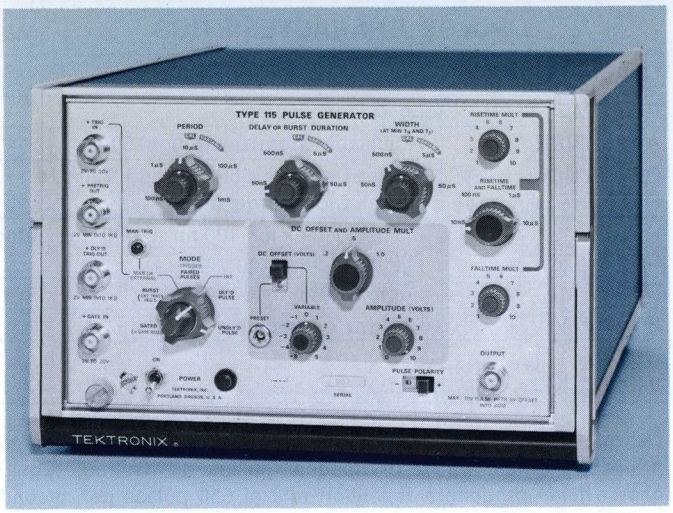
Dimensions and Weights

Height	≈8 in	19.7 cm
Width	≈5 in	12.2 cm
Length	≈12 in	30.2 cm
Net weight	≈8 lb	3.8 kg
Domestic shipping weight	≈17 lb	≈7.7 kg
Export-packed weight	≈28 lb	≈12.7 kg

Included Accessories—Charge network (017-0067-00); three 5-ns 50-Ω RG123 cables (017-0502-00); 3-conductor power cable (161-0010-03).

109 PULSE GENERATOR **$550**

115 *10-ns Pulse Generator with Delay*



- **100 Hz-to-10 MHz REPETITION RATE**
- **VARIABLE DC OFFSET**
- **VARIABLE RISETIME AND FALLTIME**
- **PAIRED, BURST, GATED, UNDELAYED, AND DELAYED PULSES**
- **CLEAN PULSES—TOTAL ABERRATIONS 3% OR LESS P-P**
- **±10 VOLTS INTO 50 Ω**
- **SHORT-PROOF OUTPUT**

The 115 is a 10-MHz, 10-V, general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude, and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, shapes, and other characteristics are required.

OPERATING MODES

Gated—Provides output pulses for the duration of input gate. First pulse is nearly coincident with input gate and recurs at a repetition rate determined by PERIOD control setting.

Burst—Provides output pulses for the duration of the burst time when initiated by external triggering pulse. Pulse repetition rate determined by PERIOD control. The first pulse in the burst will lag the trigger pulse initiating the burst by an amount dependent upon risetime selected.

Paired Pulses—Provides pairs of pulses; one at the time of normal undelayed pulse, and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Delayed Pulse—Provides pulse at the end of delay time.

Undelayed Pulse—Sequence of pulses with repetition rate set by PERIOD control.

OUTPUT CHARACTERISTICS (terminated in 50-Ω load)

Risetime and Falltime— 10 ns to 100 μs in four ranges, continuously variable.

Period— 100 ns to at least 10 ms in five ranges, continuously variable. (MINIMUM PULSE SEPARATION 50 ns or less, between the 50% amplitude points of any two adjacent pulses, with risetime and falltime set to minimum.)

Duty Factor—At least 75%, limited by minimum pulse separation.

Width— 50 ns to at least 500 μs in four ranges, continuously variable.

Delay or Burst Time— 50 ns to at least 500 μs in four ranges, continuously variable (refer to pulse separation performance limit above).

Amplitude—Three ranges, continuously variable. At least ±10 V to less than ±200 mV with MULTIPLIER at X1, ±5 V to ±50 mV with MULTIPLIER at X0.5 and ±2 V to ±20 mV with MULTIPLIER at X0.2.

Aberrations— +3%, −3%, total 3% P-P, or 200 mV times the DC OFFSET AND AMPLITUDE MULTIPLIER settings, whichever is greater.

DC Offset—Three ranges, continuously variable. At least ±5 V with MULTIPLIER at X1, at least ±2.5 V with MULTIPLIER at X0.5, and at least ±1 V with MULTIPLIER at X0.2.

TRIGGERING

A two-position, front-panel switch provides selection of internal or external trigger source. A manual push button provides a means to trigger a single undelayed pulse, delayed pulse, pulse pair, or burst of pulses.

INPUTS

+ TRIGGER

	PULSE	SINEWAVE
FREQUENCY	At least 0.5-V/μs rate of rise	1 kHz to 10 MHz
MINIMUM AMPLITUDE	+2 V	2-V peak
MAXIMUM AMPLITUDE	+20 V, decreasing to +4 V at 10 MHz	20-V peak, decreasing to 4-V peak at 10 MHz

+ Gate—Accepts gate from +2 V to +20 V.

AUXILIARY OUTPUTS

+ Pretrigger—At least 2 V into 1 kΩ.

+ Delayed Trigger—At least +2 V into 1 kΩ.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of +20°C to +30°C.

Power Requirements— 90 to 136 V AC or 180 to 272 V AC, 48 to 66 Hz, 115 watts at 115 V AC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights

Height	6 in	15.3 cm
Width	9 in	22.8 cm
Depth	≈16 in	42.0 cm
Net weight	15 lb	6.8 kg
Domestic shipping weight	≈20 lb	≈9.1 kg
Export-packed weight	≈27 lb	≈12.2 kg

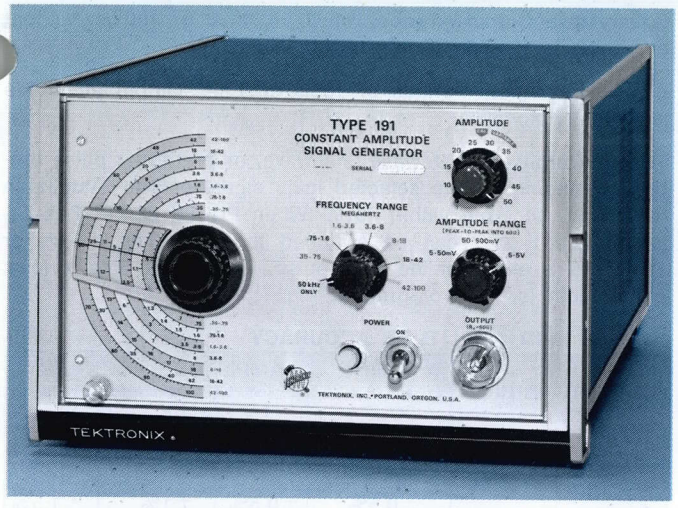
INCLUDED ACCESSORIES

50-Ω, 5-W termination (011-0099-00); 50-Ω BNC cable (012-0057-01). Option 1 also includes detachable power cord (161-0031-00).

115 PULSE GENERATOR **$1075**

Option 1 MOD 146B ..... **Sub $25**
(less cabinet for mounting in rack adapter)

Constant-Amplitude Signal Generator 191



- **350-kHz to 100-MHz SINEWAVES**
- **5-mV to 5.5-V CONSTANT AMPLITUDE**
- **50-kHz AMPLITUDE REFERENCE**

The 191 is a variable-frequency, sinewave generator with a constant-amplitude output over the entire frequency range. Both output amplitude and frequency are calibrated. Amplitude is held constant during frequency variations by continuous sampling of peak-to-peak voltage.

OUTPUT CHARACTERISTICS

Frequency Range—Continuously variable and calibrated in 7 ranges from 350 kHz to 100 MHz, plus 50-kHz reference output. Accuracy within ±2% of selected frequency with output terminated in 50 Ω or unterminated (except ±5% on 0.5-5 V range with output unterminated).

Amplitude Range— 5 mV to 5 V peak-to-peak in 3 ranges (10 calibrated steps per range) into 50 Ω termination. Unterminated output is 2X indicated output. Amplitude is continuously variable (uncalibrated) between steps and to 10% over the top of each range.

Amplitude Accuracy— 50-kHz reference output accurate within ±3% of indicated amplitude on 0.5-5 V range, ±4% on 50-500 mV range, and ±5% on 5-50 mV range, into ±1% 50 Ω termination. Accuracy improved with a more accurate termination. Unterminated output is 2X indicated amplitude, at same accuracy. When the frequency is varied from 350 kHz to 100 MHz, the output amplitude into 50 Ω (at the output connector or through no more than 5 ns of RG8 cable) will not vary more than ±3% from actual amplitude at 50 kHz, except when using the 5-mV range the output may vary +3%-5% on frequencies from 42 MHz to 100 MHz.

Harmonic Content—Typically less than 5%.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 103.5 V to 126.5 V or 207 V to 253 V, low or high range selected by rear-panel switch. 50 to 400 Hz, approx 25 watts.

Dimensions and Weights

Height	6 in	17.1 cm
Width	9 in	22.8 cm
Depth	≈16 in	40.0 cm
Net weight	16 lb	7.2 kg
Domestic shipping weight	≈21 lb	≈9.5 kg
Export-packed weight	≈32 lb	≈14.5 kg

INCLUDED ACCESSORIES

5-ns, 50-Ω RG213 cable (017-0502-00); 50-Ω GR to BNC thru-line termination (017-0083-00); right-angle, 3-conductor power cable (161-0024-03); (power cable for MOD 146B is 161-0031-00).

191 CONSTANT-AMPLITUDE SIGNAL GENERATOR $695

Option 1 MOD 146B (less cabinet for mounting in rack adapter) ..... Sub $25

284 *70-ps Pulse Generator*

- **PULSE OUTPUT WITH 70-ps OR LESS RISETIME**
- **SINEWAVE AND SQUAREWAVE OUTPUTS**
- **COMPACT, SOLID-STATE DESIGN**

The 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pretrigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent 50-Ω signal source for TDR measurements. The 284 is available in a cabinet version, or modified for rackmounting in a standard 19-inch rack using the optional Rack Adapter.

OUTPUT CHARACTERISTICS

Pulse Output— 70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of approx 50 kHz. Aberrations immediately following positive-going transitions are less than ±3%, 3% total peak-to-peak; after 2 ns, less than ±2%, 2% total peak-to-peak. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

Squarewave Output—Periods of 10 μs, 1 μs, or 100 ns. Output amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

Sinewave Output—Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

Trigger Output—Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When PULSE OUTPUT is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

TIMING AND AMPLITUDE ACCURACY

OUTPUT	PERIOD	TIMING ACCURACY	AMPLITUDE ACCURACY		
			1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs 1 μs	±0.5%	±0.5%	±1%	±1.5%
	100 ns	±0.05% *	±2% †	±2.5% †	±3% †
Sine-wave	10 ns 1 ns	±1%		±20%	

* crystal controlled

† 20 ns after transition

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements—6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

Dimensions and Weights

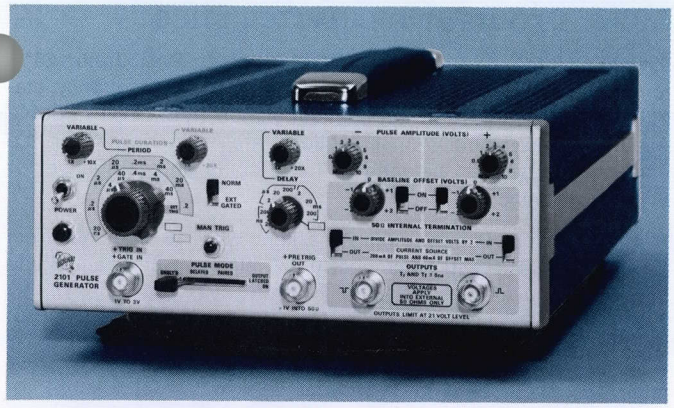
Height	6 in	15.3 cm
Width	≈5 in	11.4 cm
Depth	15 in	38.1 cm
Net weight	8 lb	3.6 kg
Domestic shipping weight	≈16 lb	≈7.2 kg
Export-packed weight	≈24 lb	≈10.9 kg

INCLUDED ACCESSORIES

50-Ω, BNC coaxial cable (012-0057-01); right angle, 3-conductor power cable (161-0024-03) standard; (161-0031-00) with Option 1.

284 PULSE GENERATOR **$700**

Option 1 MOD 146B ..... **Sub $25**
(less cabinet for mounting in rack adapter)



- 2.5 Hz-to-25 MHz REPETITION RATE
- VARIABLE BASELINE OFFSET
- 5-ns RISETIME AND FALLTIME
- PAIRED, UNDELAYED, DELAYED, AND OUTPUT LATCHED ON MODES
- EXTERNAL GATE INPUT
- SIMULTANEOUS POSITIVE- AND NEGATIVE-GOING PULSES—10 VOLTS INTO 50 Ω
- SHORT-PROOF OUTPUTS

The 2101 is a compact, 25-MHz, 10-V, general-purpose pulse generator with simultaneous positive- and negative-going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration, and delay, within the calibrated range of the respective control. Ranges may be extended by user-supplied capacitors to reduce the repetition rate and to increase the duration and delay. The only limiting factor in extending the range is the physical size of the user-supplied timing capacitors.

An external gate input permits output pulses for the duration of the gate signal, useful for all pulse modes, except OUTPUT LOCKED ON mode. Independent baseline offset controls are provided for the positive-going and negative-going pulse outputs.

OUTPUT CHARACTERISTICS
(terminated in 50-Ω load)

Risetime and Falltime— 5 ns or less.

Period— 40 ns to 400 ms in 7 ranges, continuously variable (MINIMUM PULSE SEPARATION— 20 ns or 20% of DURATION, whichever is greater, between the 50%-amplitude points of any two adjacent pulses).

Duty Factor—At least 80% for periods 100 ns or greater; at least 70% for the 0.2 s DURATION position. As the period is decreased below 100 ns, the duty factor decreases to 50% at 40 ns period. Minimum off time is 20 ns.

Duration— 20 ns to 400 ms (to 4 s with external trigger) in 7 ranges, continuously variable.

Delay— 20 ns to 4 s in 8 ranges, continuously variable (refer to pulse separation performance limit above).

Amplitude— 50-Ω Internal Termination Switched Out: 0.3 V or less to 10 V, continuously variable. Current output is 6 mA or less to 200 mA, continuously variable. 50-Ω Internal Termination Switched In: 0.2 V or less to 5 V.

Baseline Offset— 50-Ω Internal Termination Switched Out: At least + and −2 V, + and −40 mA, continuously variable around zero. 50-Ω Internal Termination Switched In: At least + and −1 V, continuously variable around zero. Control calibrated for external load impedance of 50 ohms.

Aberrations— +3%, −3%, or total of 3% P-P, or +100 mV, −100 mV, or total of 100 mV P-P, whichever is greater.

OPERATING MODES

Undelayed—Sequence of pulses with repetition rate set by PERIOD control.

Delayed—Pulse output is delayed for a time interval determined by DELAY controls. Delay time is the time between leading edges of an undelayed pulse and the delayed pulse.

Paired—Provides pairs of pulses, one at the time of normal undelayed pulse and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Output Latched On—A DC output is provided which is locked to a level determined by PULSE AMPLITUDE and OFFSET controls.

TRIGGERING

PERIOD switch provides selection of internal or external trigger source. A manual push button provides a means to produce one pulse generation cycle when the PERIOD switch is set for EXT TRIG.

INPUTS

+ Trigger— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC to peak AC. Input resistance 200 Ω.

+ Gate— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC + peak AC. Input resistance 200 Ω.

OTHER CHARACTERISTICS

+ Pretrigger Out—At least 1 V into 50 Ω.

Source Resistance— 50 Ω within 5% with the internal termination switched in.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 90 to 136 V AC or 180 to 272 V AC, 48 to 440 Hz, 55 watts maximum at 115 V AC and 60 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

Dimensions and Weights

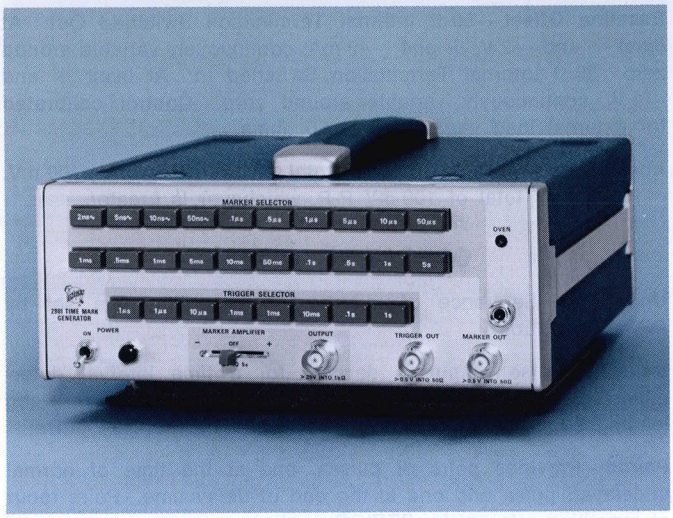
Height	≈4 in	10.9 cm
Width	8 in	20.3 cm
Depth	≈15 in	37.5 cm
Net weight	≈8 lb	3.6 kg
Domestic shipping weight	≈15 lb	≈6.8 kg
Export-packed weight	≈25 lb	≈11.3 kg

INCLUDED ACCESSORIES

Two 50-Ω, 5-W terminations (011-0099-00); three 50-Ω BNC cables (012-0117-00).

2101 PULSE GENERATOR **$800**

2901 *Time-Mark Generator*



- **16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES**
- **500-MHz SINEWAVE OUTPUT**
- **CRYSTAL-CONTROLLED OSCILLATOR**

The 2901 is a compact, wide-range, time-mark generator. It is CRYSTAL-CONTROLLED and provides 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES, and 8 TRIGGER-PULSE INTERVALS.

Marker push buttons are self-canceling so that when any marker button is pushed other buttons are automatically released. More than one marker interval can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The 2901 is fully solid-state, utilizing digital integrated circuits extensively. Outputs are derived from a temperature-stabilized, 10-MHz, crystal oscillator. A rear-panel connector is provided to allow the 2901 to be used as a divider for external oscillator inputs. This instrument offers great versatility for many laboratory or production-line applications.

OUTPUT CHARACTERISTICS

Crystal-Controlled Oscillator— 10 MHz ±10 P/M from 20° to 30°C, 10 MHz ±20 P/M from 0° to 50°C. Frequency stability is within 3 P/M in any 24-hour period from 20°C to 30°C. Accuracy and stability specifications are valid only after the instrument has been plugged in for 2 hours and turned on for at least 30 minutes.

Marker Output—Positive-going markers with 16 intervals from 0.1 μs to 5 s in 1-5-10 sequence, 0.5 V minimum peak amplitude into 50 Ω.

Marker Amplifier Output—Positive- or negative-going markers with 14 intervals from 1 μs to 5 s in 1-5-10 sequence. 25-V minimum amplitude into 1 kΩ from 5 μs to 5 s; at least + or −22 V into 1 kΩ at 1 μs.

Sinewave Outputs— 5-ns, 10-ns, and 50-ns sinewave signals at Marker Output connector with 0.5-V minimum peak-to-peak amplitude into 50 Ω. 2-ns sinewave signal at Marker Output connector with 0.3-V minimum peak-to-peak amplitude into 50 Ω.

Trigger Output—Positive-going pulses with 8 intervals of 0.1 μs to 1 s in 1-10 sequence, 0.5-V minimum amplitude into 50 Ω, 1-V minimum amplitude into 1-MΩ.

External Clock Input—Required signal amplitude is at least 2-V peak-to-peak for sinewaves, or at least 2-V peak for pulses into 50 Ω. Frequency range is 50 kHz or less, to at least 10 MHz. The 2 ns, 5 ns, 10 ns, and 50 ns sinewaves are operative only when the external oscillator input is 10 MHz.

OTHER CHARACTERISTICS

Operating Temperature Range— 0°C to +50°C.

Dimensions and Weights

Height	≈4 in	10.9 cm
Width	8 in	20.3 cm
Depth	≈11 in	27.6 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

INCLUDED ACCESSORIES

Two 50-Ω, BNC coaxial cables (012-0057-01); 50-Ω, BNC termination (011-0049-01).

2901 TIME-MARK GENERATOR **$740**

OPTIONAL ACCESSORIES

Rack Adapter for TEKTRONIX Generators

Adapts the generators for rackmounting in a 19-inch rack, in 5¼ inches of panel height. The 106 occupies half-rack width. Two 106's can be mounted side by side, or alongside other half-rack width generators such as the 191 Constant Amplitude Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 106 may also be mounted with a quarter-rack width 284 Pulse Generator.

The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

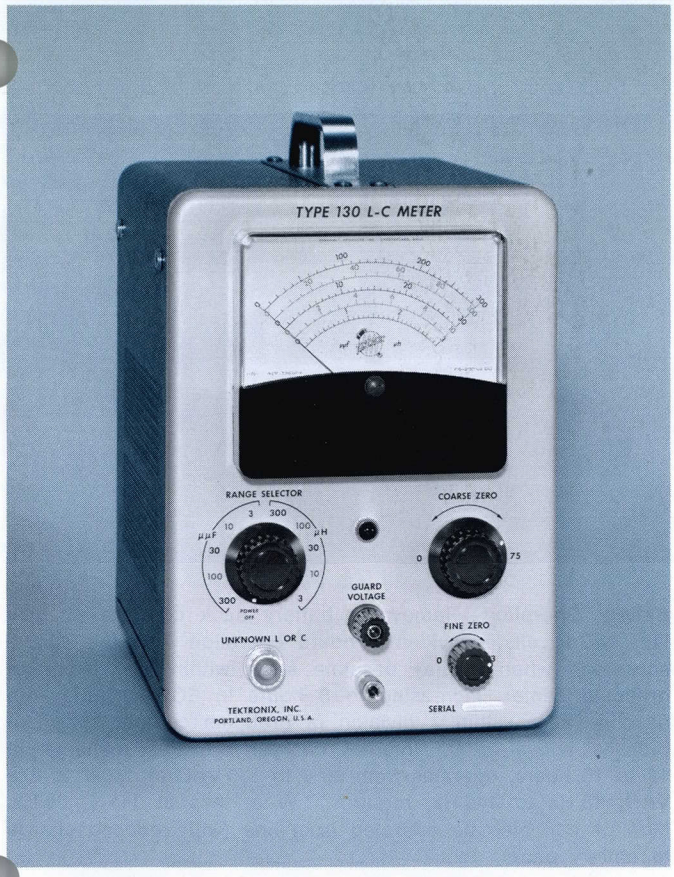
Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

RACK ADAPTER, order 016-0268-00 ..... **$250**
Includes a half-rack width blank panel (333-1384-00).

106, 115, & 191 MOUNTING KIT, order 016-0186-00 ..... **$15**

284 MOUNTING KIT, order 016-0187-00 ..... **$27**
Includes a quarter-rack width blank panel assembly (01
0109-00).

2101 & 2901 MOUNTING KIT, order 016-0188-00 ..... **$7.50**



- ***MEASURES UP TO 300 μH OR 300 pF***
- ***EASY-TO-READ 4½-INCH METER***
- ***CONVENIENT OPERATION***

The 130 L-C Meter is a direct-reading reactance meter that measures small reactances in a series mode at a frequency between 125 kHz and 140 kHz. Meter indicates inductance up to 300 μH and capacitance up to 300 pF. The unknown inductor or capacitor is part of a resonant circuit whose frequency is compared to a 140-kHz reference oscillator. Meter indicates the two oscillators' frequency difference but is calibrated directly in μH and pF. Measurement of very small reactances is possible by using special measurement procedures that are described in the instrument instruction manual.

The 130 is particularly useful for measuring small capacitances in the presence of environmental strays. A front-panel Guard Voltage output connector provides in-phase drive to the environmental capacitance to eliminate strays from the measurement. Thus it is possible to measure vacuum tube interelectrode capacitances. Up to 300 pF environmental capacitance around an unknown capacitor can be guarded if the guard terminal loading is not excessive. Loading limits are outlined in the instruction manual.

Resistance loading compensation is optimized for 117-volts RMS operation. The following loads will not appreciably alter the measurement indication:

Capacitance: as low as 100-kΩ shunt.
Inductance: as low as 20-kΩ shunt, up to 10-Ω series.

Correction tables in instruction manual indicate needed corrections for other values of load resistance. Actual corrections determined for each instrument at time of each recalibration.

RANGE SELECTION

Microhenrys—0 to 3, 10, 30, 100, and 300.
Picofarads—0 to 3, 10, 30, 100, and 300.

ACCURACY

Meter indicates within 3% of full scale. Full scale accuracy of any one range can be improved by special calibration at the time measurement is made.

POWER REQUIREMENTS

40 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V to 250 V operation.

DIMENSIONS AND WEIGHTS

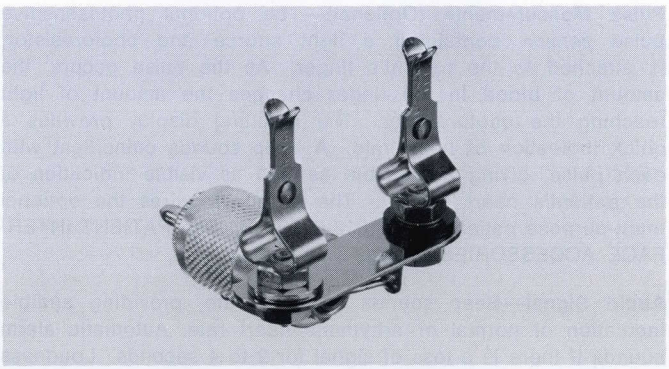
Height	≈11 in	27.0 cm
Width	7 in	17.8 cm
Depth	≈11 in	28.3 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	≈14 lb	≈ 6.4 kg
Export-packed weight	≈21 lb	≈ 9.5 kg

INCLUDED ACCESSORIES

P93C Probe package (010-0003-00); black output lead (012-0014-00); red output lead (012-0015-00); 3-conductor power cable (161-0010-03).

130 DIRECT-READING L-C METER $350

OPTIONAL ACCESSORY



PRODUCTION TEST FIXTURE

Reduces production time required to sort and test capacitors and inductors, order 013-0001-00 . . . . . $7.90

PHYSIOLOGICAL MONITOR 410

- **ECG, EEG, or PULSE WAVEFORMS**
- **SOLID-STATE RELIABILITY, QUICK TURN-ON**
- **HEART RATE BEEP and ARREST ALARM**
- **UP to 8 HOURS OPERATION on INTERNAL BATTERY PACK**

The 410 provides dynamic displays of the electrocardiogram, electroencephalogram, or pulse. It is especially useful to the anesthesiologist during surgery, and battery operation allows its continuous use as the patient moves into recovery and special care area.

Ease of operation, with a minimum of controls, contributes to the usability of the 410, as do its other features: 4-second recovery after overdrive by defibrillator or cauterizer, output for strip-chart recorder, and a cabinet finish that is durable and washable.

ECG Measurements—Heart rates from 35 beats/min to 180 beats/min can be directly read by observing the point on the CRT graticule scale where the second R wave occurs. A beep sound coincides with each R wave. Thus a sudden change in heart rate can be quickly detected, without constant observation of the display.

The 410 is supplied with a heavy-duty limb lead cable intended for use during surgery and in general ECG monitoring applications. Six commonly-used lead configurations can be selected: I, II, III, aV_R, aV_L, and aV_F. Disposable, pre-gelled electrodes are supplied. Common needle electrodes, plate electrodes, Ag/AgCl electrodes and other miscellaneous types, including the V. Mueller back pad, may also be used.

EEG Measurements (Optional)—The optional EEG electrode cables (+ and —) accept the same electrodes and use the same attachment methods as mentioned for ECG measurements. The EEG cables require the optional multi-purpose patient cable (012-0120-00). See PATIENT INTERFACE ACCESSORIES listing.

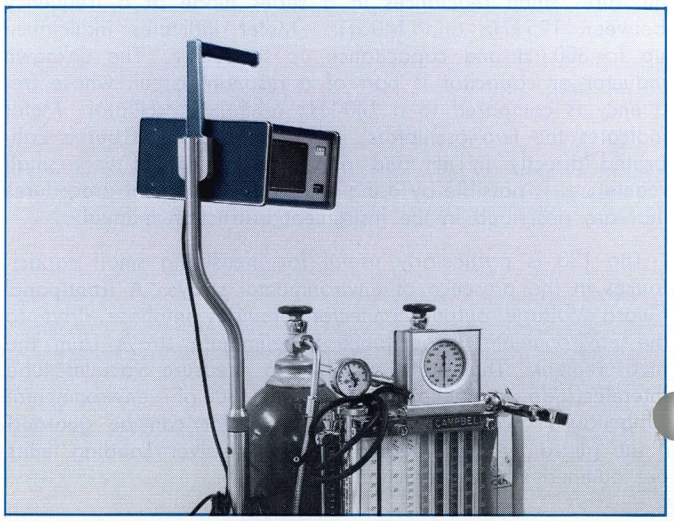
Pulse Measurements (Optional)—The optional photosensitive pulse sensor, containing a light source and photoresistor, is attached to the patient's finger. As the pulse occurs, the amount of blood in the finger changes the amount of light reaching the photoresistor. The resulting display provides a quick indication of heart rate. A beep sounds coincident with each pulse, giving an audible as well as visible indication of the patient's heart activity. The sensor requires the optional multi-purpose patient cable (012-0120-00). See PATIENT INTERFACE ACCESSORIES listing.

Audio Signal—Beep sounds at heart rate, providing audible indication of normal or arhythmic heart rate. Automatic alarm sounds if there is a loss of signal for 2 to 4 seconds. Loudness is adjustable. Using the audio output jack disconnects the internal speaker. Signal is disabled in the EEG mode.

Battery Operation—Removable battery pack contains 10 size "C" NiCd cells, provides 6 hours operation with full accessory load when display baseline stays within 3 divisions of graticule center, increasing to 8 hours in ECG or EEG with baseline kept within 1 division of graticule center. Time decreases above 25°C. Internal charger provides recharge in 14 to 16 hours, operates from 90 V to 136 VAC or 180 V to 272 VAC, 48 Hz to 440 Hz, requires 7 W or less at 115 V, 60 Hz. Monitor can also be operated from line (with reduced charge to battery pack).

The battery pack incorporates an automatic battery disconnect that terminates discharge before batteries are harmed. The disconnect is activated if the instrument is operated for a prolonged period with the battery condition indicator in the red area.

Portability—During surgery the Monitor can be conveniently positioned (using the optional mounting stand) at the five-foot level on the anesthesiologist's gas machine for easy viewing, then lifted off and carried with the patient to the recovery room. The 12½-pound weight and battery operation permit ease of use during ambulance transport, and continuous monitoring as patients are moved through emergency, surgery, and recovery areas.



Bandwidth—ECG and Auxiliary modes—0.1 Hz or less to 250 Hz, ±15%. EEG mode—0.1 Hz or less to 100 Hz, ±15%.

Sensitivity—ECG mode—20 mm/mV, ±5%. EEG mode—10 mm/50 μV, ±5%. Auxiliary mode—2 mm/mV, ±5%.

Common-Mode Rejection Ratio—At least 100,000:1 in ECG and EEG modes, at 60 Hz, and with 5-kΩ source impedance imbalance. Good rejection reduces the effects of electrostatically coupled or magnetically induced interference which may otherwise be displayed along with the patient's signal.

Common-Mode Dynamic Range—+3 V to −3 V.

Differential Dynamic Range—Monitor gain characteristics are valid with an input terminal DC potential difference (offset) of up to 50 mV. Typically less than 10 mV difference exists between Ag/AgCl electrodes. At least 100 mV of either polarity can be applied with no more than 5% reduction in amplifier gain.

Differential Input Resistance—2 MΩ ±15% in EEG and ECG mode, 20 MΩ ±15% in Auxiliary mode.

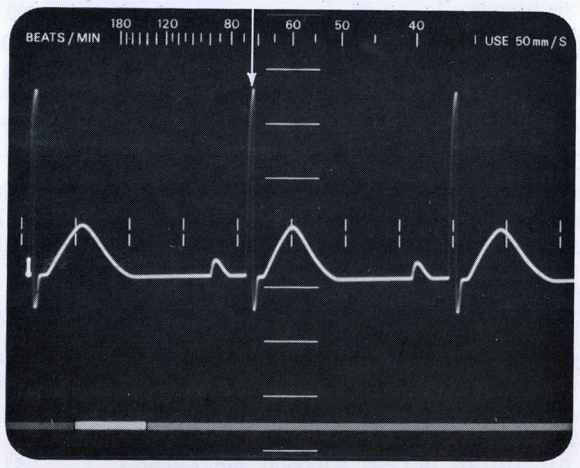
Drift—0.5 cm or less per hour after 10-second warm-up.

Display Noise—0.1 cm or less in the calibrated EEG mode, input shorted.

Sweep Speeds—25, 50, and 100 mm per second; accurate within 5%. Sweep is triggered in ECG and AUX operating modes.

Waveform Size—Vertical size of ECG, EEG, and pulse waveforms is continuously variable from ⅓ to 3 times the height of the calibrated display.

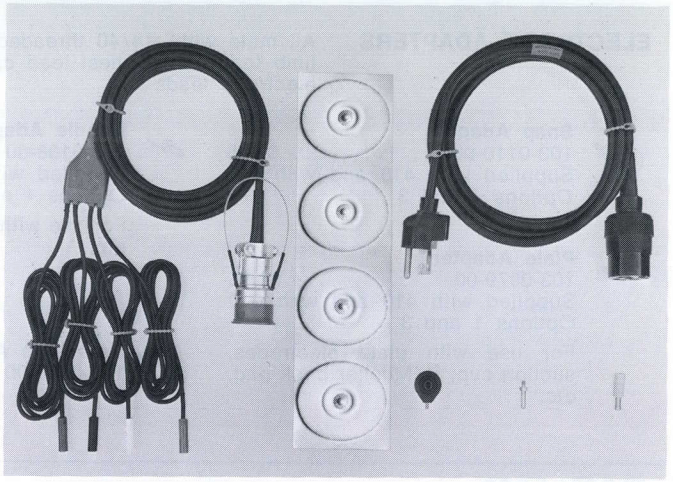
Cathode-Ray Tube—5-inch rectangular CRT has 8 x 10-cm viewing area. P-7 phosphor has long decay time for convenient viewing at slow sweep speeds. The external graticule has a graduated heart-rate scale at the top, a battery-condition scale at the bottom, and a vertical and horizontal center-line scale marked in centimeters.



Simulated ECG display—Approx 72 beats/minute

Dimensions and Weights

Height	5.4 in	13.7 cm
Width without handle	8.5 in	21.6 cm
Width with handle	9.1 in	23.2 cm
Depth without handle	10.8 in	27.3 cm
Depth with handle	12.9 in	32.7 cm
Weight without accessories	12.5 lb	5.7 kg
Domestic shipping weight	≈23 lb	≈10.4 kg
Export-packed weight	≈34 lb	≈15.4 kg



Included Accessories—Limb lead cable (012-0165-00); 12 GEL-PAD* disposable pregelled Ag/AgCl electrodes, 3 packs of 4 each (119-0354-00); 4 electrode snap adapters (103-0110-00); 4 plate adapters (103-0079-00); 4 needle adapters (103-0108-00); power cable (161-0058-01).

*TM NDM Corporation

INSTRUMENT OPTIONS

The 410 may be purchased with different accessories, or without the full complement of included accessories. These options allow maximum flexibility and value for the user. If requirements are expanded subsequent to initial purchase, additional accessory packages are available. See next page.

Chest Lead, Option 1—The chest lead option includes a heavy duty chest lead cable intended for patient monitoring in an intensive care environment (012-0161-00); 9 GEL-PAD* disposable pregelled Ag/AgCl electrodes, 3 packs of 3 each (119-0353-00); 3 electrode snap adapters (103-0110-00); 3 plate adapters (103-0079-00); 3 needle adapters (103-0108-00); power cable (161-0058-01).

Basic Accessory, Option 2—Includes power cable (161-0058-01). Select patient interfaces from next page.

Multi-Purpose Cable, Option 3—Includes multi-purpose cable (012-0120-00); electrode lead LA (012-0169-00); electrode lead LL (012-0170-00); electrode lead RA (012-0171-00); electrode lead RL (012-0172-00); electrode lead C (012-0173-00); 5 plate adapters (103-0079-00); 5 needle adapters (103-0108-00); 5 snap adapters (103-0110-00); 3 packs of 4 each GEL-PAD* disposable pregelled Ag/AgCl electrodes (119-0354-00); power cable (161-0058-01).

ORDERING INFORMATION

410 Physiological Monitor **$975**

410 OPTIONS

Option 1, Chest Lead ..... **Sub $15**
Option 2, Basic Accessory ..... **Sub $100**
Option 3, Multi-Purpose Cable ..... **Add $50**

ELECTRODE ADAPTERS

All mate with #4/40 threaded ends of limb lead cable, chest lead cable, and electrode leads

Snap Adapter
103-0110-00 ..... $1.65
Supplied with 410 and with 410 Options 1 and 3

Plate Adapter
103-0079-00 ..... $0.85
Supplied with 410 and with 410 Options 1 and 3

For use with plate electrodes, suction cup, V. Mueller back pad, etc.

Needle Adapter
103-0108-00 ..... $1.20
Supplied with 410 and with 410 Options 1 and 3

For use with hypodermic needles, etc.

Bare Wire Adapter
103-0080-00 ..... $3.75

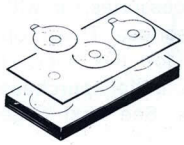
ELECTRODES

Reusable Ag/AgCl Electrodes

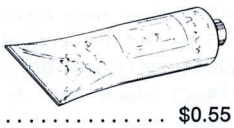
Mates with #4/40 threaded ends of limb lead cable, chest lead cable, and electrode leads.
119-0197-00 ..... $3.85

ATTACHMENT METHODS

For TEKTRONIX reusable electrodes

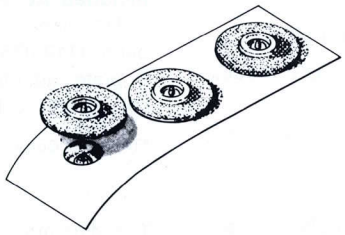


Adhesive Rings
Packs of 102 ea
006-1099-00 ... $4.05



Electrode Paste
5-oz tube
006-1098-00 ..... $0.55

Surgical Tape or Self-Adhering Foam Pads (use 3M Reston No. 1560 or 1561) can also be used.

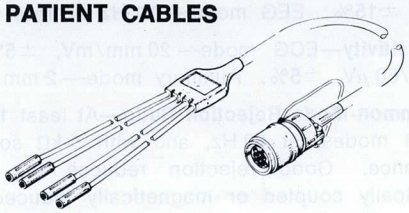


GEL-PAD disposable pregelled Ag/AgCl
NDM catalog #1030 packs of 3 each. Sold only in boxes of 10 packs, order 10 ea 119-0353-00 ..... $2.30

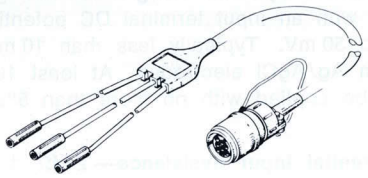
NDM catalog #1040 packs of 4 ea. Sold only in boxes of 10 packs, order 10 ea 119-0354-00 ..... $2.95

GEL-PAD and other compatible brands of disposable electrodes can be purchased from local hospital supply outlets.

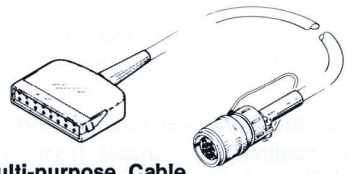
PATIENT CABLES



Limb Lead Cable
012-0165-00 ..... $77
Supplied with 410

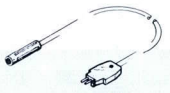


Chest Lead Cable
012-0161-00 ..... $71.50
Supplied with 410 Option 1



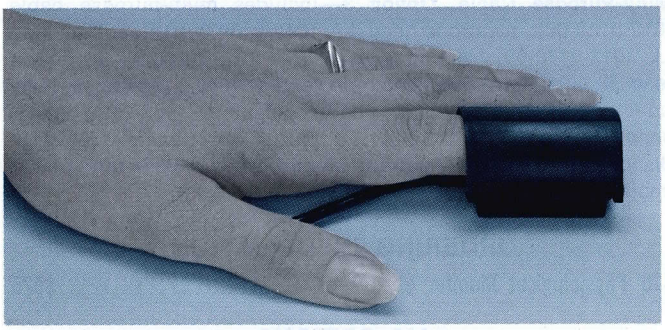
Multi-purpose Cable
012-0120-00 ..... $84.70
For use with pulse sensor, ECG and EEG electrode leads
Supplied with 410 Option 3

Electrode Leads .. all leads .. $8.80
Use only with cable 012-0120-00



LA 012-0169-00
LL 012-0170-00
RA 012-0171-00
RL 012-0172-00
C 012-0173-00
+EEG 012-0174-00
—EEG 012-0175-00

OPTIONAL ACCESSORIES



Pulse Sensor Assembly—Photoresistive sensor for pulse indication, used only with option 3 or optional multi-purpose patient cable (012-0120-00). Order 015-0104-01 ..... $72.60

Mounting Stand Kit—Mounts the 410 at the five-foot level, permits swiveling and tipping the Monitor for convenient viewing. Hardware supplied with the fixture attaches to gas machine, bed, flat or round surface up to 1½-inch diameter. Order 016-0110-00 ..... $44

Mounting Bracket—Mounts the 410 to flat surface, permits tipping the Monitor for convenient viewing. Mounting screws not included. Order 407-0393-01 ..... $5.50

Mini-phone Plug—For audio output jack, order 134-0079-00 ..... $1.05

Battery Pack—Extra battery pack, in addition to the one supplied with the 410, allows one pack to charge while the other is powering the Monitor. Pack contains 10 size "C" NiCd cells and battery charger.
Order 016-0107-02 (for SN B100000 and ABOVE) $155
Order 050-0478-00 (for SN B099999 and BELOW) $160

7-Pin Connector—For rear-panel output, order 131-0551-01 ..... $18.00

2-Pin Electrode Plug—Order 134-0089-00 ..... $2.55

7-Pin Plug—Used on pulse sensor, order 134-0090-00 .. $3.85

The 2600 Series is a modular instrumentation system of signal generators and signal conditioners. Plug-In Modules permit a building block approach to specialized systems.

These major components, described fully on the following pages, comprise the system:

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

26A1 Operational Amplifier Plug-In, easily adapted for many uses, including processing of signals generated by other plug-ins.

26A2 Differential Amplifier Plug-In, capable of amplifying low-level signals up to 100,000 times with up to 50,000:1 CMRR.

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

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

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

2620 Stimulus Isolator, allowing true differential stimulation for biophysical applications.

The interconnection system stresses flexibility and ease of set-up change. The plug-in unit front-panel pin connectors are duplicated at the rear connector, permitting interconnection through the pull-out interconnection board system. An optional interconnection board is available which, in addition, has integrated circuit sockets to permit the easy addition of logic gates, buffers, amplifiers, etc. Spare connectors, lines, and power sources are available in anticipation of future and specialized requirements.

The characteristics of the input and output signals maintain compatibility not only with each other, but with other units such as the 7000 Series, 4501, 601, 602, 611, etc. Where applicable, inputs and outputs from the units are fully compatible with commercial logic such as DTL, TTL, etc.

Stimulus Isolator 2620

- **PHYSIOLOGICAL STIMULUS ISOLATION**
  True differential stimulation
- **CONSTANT CURRENT OUTPUT**
- **BIPHASIC or MONOPHASIC OUTPUT**
- **UP to 30 mA with 100 V COMPLIANCE**

The 2620 Stimulus Isolator is a tristable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from ground-referenced generators connected to the input, thus permitting true differential tissue stimulation.

Pulse polarity and timing are determined by the input signal via an optical coupler and may be supplied from a 2600-Series pulse generator or other suitable source. The output pulse amplitudes are controlled independently at the Isolator control panel.

Power is provided by two nickel-cadmium "D" cells, operating a DC-to-DC converter. Recharging is provided by an external charger such as the Mallory BC-16, available from your local supplier.

INPUT

Required Current for + Output—+10 mA to +20 mA.

Required Current for − Output—−10 mA to −20 mA.

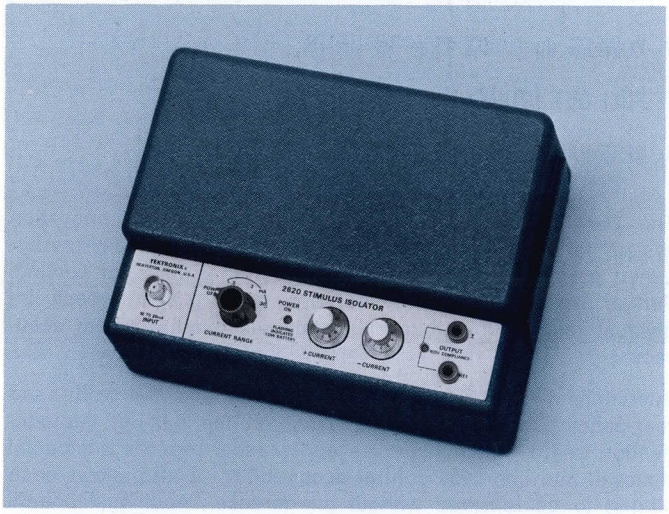
OUTPUT

Isolation, Output to Input—Impedance, $1 \times 10^{10}\ \Omega$ or greater, shunted by 10 pF or less. Voltage, 500 V maximum.

Ranges—0 to ±300 μA, 0 to ±3 mA, or to ±30 mA. +current and − current are independently variable and continuously calibrated.

Maximum voltage is 100 V. Output impedance is greater than 10 MΩ shunted by approximately 25 pF.

Accuracy—30 mA range, within 3% if indicated current ±600 μA. 3 mA range, within 3% of indicated current ±60 μA. 300 μA range, within 4% of indicated current ±6 μA.



Indicator—Lamp indicates the presence of an output signal.

Risetime, Falltime—Less than 2 μs when load resistance is 3.3 kΩ or less.

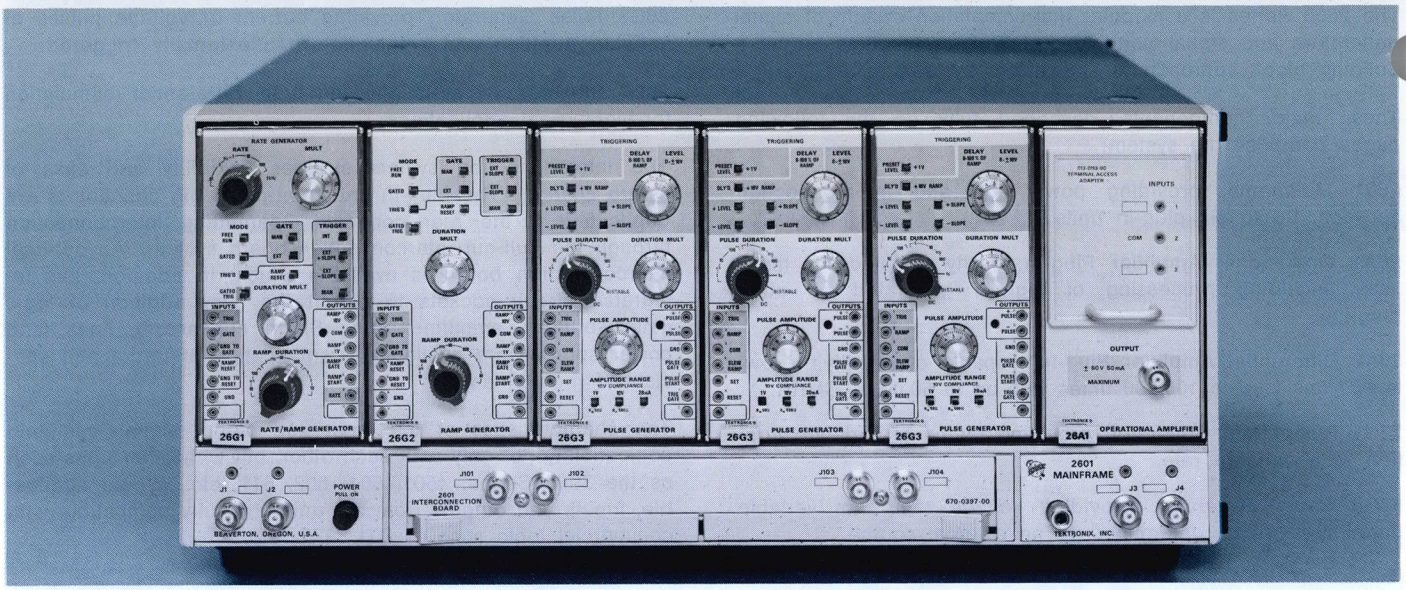
DIMENSIONS AND WEIGHTS

Height	≈3 in	7.9 cm
Width	8 in	20.4 cm
Depth	≈6 in	15.0 cm
Net weight	≈3 lb	1.25 kg

INCLUDED ACCESSORIES

Dual banana plug (103-0142-00); two nickel-cadmium batteries (146-0005-00).

Order 2620 STIMULUS ISOLATOR **$450**
Extra Batteries, 146-0005-00 (order two each) $9.10



- **POWERS up to SIX PLUG-IN UNITS**
- **PULL-OUT INTERCONNECTION BOARD**
- **REAR-PANEL INPUT/OUTPUT CONNECTORS**

The 2601 Mainframe is a power supply and interconnection system for 2600-Series plug-in units. Its electronically-preregulated power supplies require no fan or vent holes for cooling. Further regulation, when necessary, takes place in each individual plug-in unit, thus enhancing the overall system accuracy.

Interconnection between the six plug-ins and the front- and rear-panel connectors can be made on the pull-out interconnection board, which improves appearance, reduces accidental removal, and improves control accessibility. It also allows each plug-in to be removed without interference. Additional boards may be ordered to permit different interconnection formats to suit various requirements.

CHARACTERISTICS

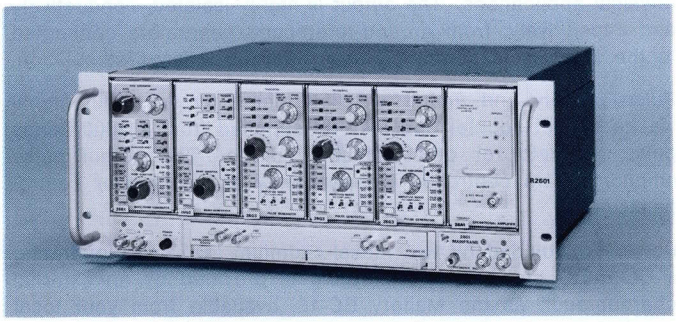
Interconnection System—Inputs and outputs to plug-ins are duplicated through the plug-in connector and the 2601 internal wiring to the pull-out interconnection board. Interconnection on the board (as well as on the front panels) is by a 0.040-inch pin-and-jack system. Low-level inputs, high-level outputs, and high-frequency signals are connected via front panel BNC connectors to maintain maximum transmission fidelity.

Preregulated Power Supplies—+17 V at 1.25 A, −17 V at 1.25 A, +7 V at 6.5 A. These supplies are typically regulated within each module to +15 V, −15 V, and +5 V. Supplies are available on the pull-out interconnection board, as well as to each plug-in.

Power Requirements—Quick-change line voltage selector permits operation from nominal line voltages of 100 V, 110 V, 115 V, 127 V, 220 V, 230 V, 240 V, 250 V; ±10%. 95 W maximum. Line frequency range, 48 Hz to 440 Hz.

DIMENSIONS AND WEIGHTS

	2601		R2601	
	In	cm	in	cm
Height	≈8	20.1	7	17.9
Width	≈18	44.8	19	48.4
Depth	≈17	42.0	16	39.5
	lb	kg	lb	kg
Net weight	≈22	10.1	23	10.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈41	≈18.6	≈42	≈19



RACKMOUNT VERSION

Electrically identical to the 2601, the R2601 has the feet and handle replaced with flanges for mounting in a 7-inch space in a standard 19-inch rack. A slide-out assembly is available as an optional accessory.

INCLUDED ACCESSORIES

6 two-inch patch cords (012-0200-00); 4 six-inch patch cords (012-0201-00). R2601 also includes rackmount hardware (016-0164-00).

2601 MAINFRAME **$495**

R2601 MAINFRAME (rackmount) **$495**

Option 1 ..... **Sub $45**

Without pull-out interconnection board and patch cords.

Refer to the last page of this section for optional accessories.

- **±50 V, 50 mA OUTPUT**
- **OPEN LOOP GAIN 10,000**
- **5 MHz UNITY-GAIN BANDWIDTH**

The 26A1 is an operational amplifier with a wide output voltage swing, wide common-mode range, and high slewing rates suited to a broad range of applications, including final processing of signals generated in the 2600-Series system. Plug-in terminal access adapters provide space for the necessary operational amplifier input and feedback elements; the characteristics of the operational amplifier can be altered by simply replacing adapters or the clip-on components.

OPERATIONAL AMPLIFIER

Open Loop Gain—At least 10,000 into 1 kΩ load.

Unity-Gain Bandwidth—At least 5 MHz into 1 kΩ load.

Common-Mode Rejection Ratio—At least 10,000:1 at 60 Hz.

Slew Rate—At least 50 V/μs into 1 kΩ load.

INPUT

Common-Mode Input Voltage Range—At least ±50 V.

Input Leakage Current—300 pA or less at 25°C.

Equivalent Input Drift—100 μV/°C or less.

Equivalent Input Noise—10 μV RMS or less.

Maximum Safe Differential Input—100 V.

OUTPUT

Voltage Range—At least ±50 V.

Current Limit—At least ±50 mA.

Output Resistance—150 Ω or less.

WEIGHTS

Net weight	≈2 lb	0.7 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

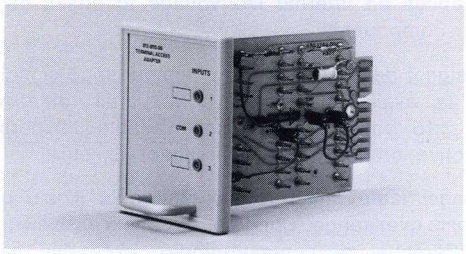
INCLUDED ACCESSORIES

3 two-inch patch cords (012-0200-00); terminal access adapter (013-0113-00); resistor-capacitor kit (020-0039-00).

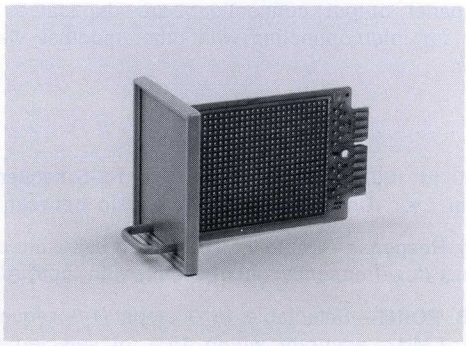
26A1 OPERATIONAL AMPLIFIER **$280**

Please refer to the last page of this section for optional accessories.

OPTIONAL ACCESSORIES



Additional Terminal Access Adapters—Order 013-0113-00 . $17



Terminal Access Adapter Kit

Contains mechanical parts for custom-building terminal access adapter. One section of the etched circuit board mates the adapter connector in the plug-in unit; the remainder of the board is a construction area for passive or active circuitry.

Order 013-0114-00 ..... $10

- **100-to-100,000 GAIN**
- **50,000:1 CMRR**
- **SELECTABLE UPPER and LOWER —3 dB POINTS**
- **DC-to-1-MHz BANDWIDTH at ALL GAIN SETTINGS**

The 26A2 is a DC-coupled differential amplifier designed for use in the 2600-Series modular instrument system. Excellent common-mode rejection, high gain, and selectable high- and low-frequency —3 dB points, make the 26A2 suitable for low-frequency, low-level applications.

There are many factors which affect the usability of high-gain, wideband differential amplifiers. Noise (if excessive) can make the high-gain positions unusable. Since noise is related to bandwidth, noise can be greatly reduced with a HF —3 dB POINT selector when the application allows. DC drift can also hinder measurements causing the trace to move offscreen rapidly. A small signal DC component, perhaps a few millivolts, would also place a DC-coupled display offscreen at 10 μV/div. There are three ways to reject this DC voltage: (1) AC coupling the input if the signal frequency is high enough to be unaffected (2 Hz, LOWER —3 dB POINT). (2) AC coupling with the LF —3 dB POINT selector which allows lower bandwidth selection down to 0.1 Hz. (3) DC OFFSET which supplies an internal DC voltage to offset, or reject, the DC signal component.

A guard signal derived from the common-mode signal within the amplifier is available on the front panel for driving cable shields. ±15 volts DC is also available to permit use of special active probes, transducer adapters, etc.

A front-panel lamp and a coincident logic signal output indicates most over-range conditions of excessive input signal (either differential or common-mode), excessive gain, or excessive offset.

All front-panel output connections are duplicated at a rear connector for interconnecting with other modules via the 2601 Mainframe.

AMPLIFIER

Gain— 100 to 100,000 in 10 steps in a 1-2-5 sequence, accuracy within 2%. Uncalibrated variable gain between steps.

Frequency Response—DC-to-1 MHz within 15%, direct-coupled. 2 Hz or less (low-frequency —3 dB point) with input AC-coupled.

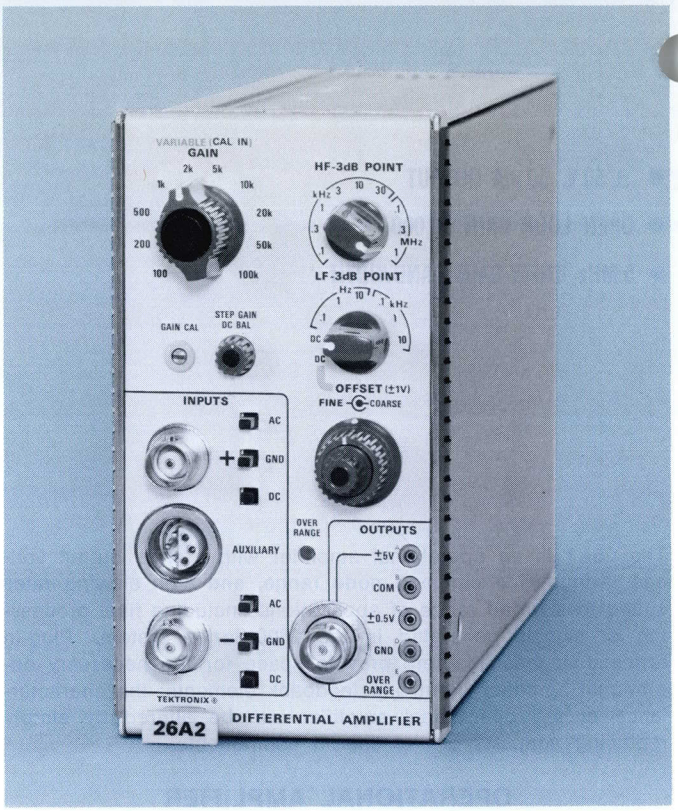
HF —3 dB POINT—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 15% of selected frequency.

LF —3 dB POINT—Selectable in 6 decade steps from 0.1 Hz to 10 kHz, accurate within 20% of selected frequency.

DC Offset—At least + or — 1 V to offset signal DC component.

Common-Mode Rejection Ratio— 50,000:1 or greater, DC to 50 kHz. Range, ±5 V (DC-coupled input).

Maximum Safe Inputs—Direct coupled, 15 V (DC + peak AC); AC-coupled, 500 V DC plus 15 V peak AC.



Input R and C— 1 MΩ paralleled by approximately 20 pF.

Differential Signal Range— 50 μV at 100,000 gain, increasing to —50 mV to +50 mV at 100 gain.

OUTPUT

High-Amplitude Output— ±5 V, ±20 mA maximum, short-proof to ground or ±15 V. Output resistance 5 Ω or less.

Low-Amplitude Output— ±0.5 V maximum. Output resistance 50 Ω within 2%.

Maximum Voltage Drift— 10 μV P-P per minute; 20 μV P-P per hour; 100 μV per °C.

Maximum Noise— 25 μV or less (tangentially measured).

Overrange—Lamp and coincident logic signal indicates most overrange conditions.

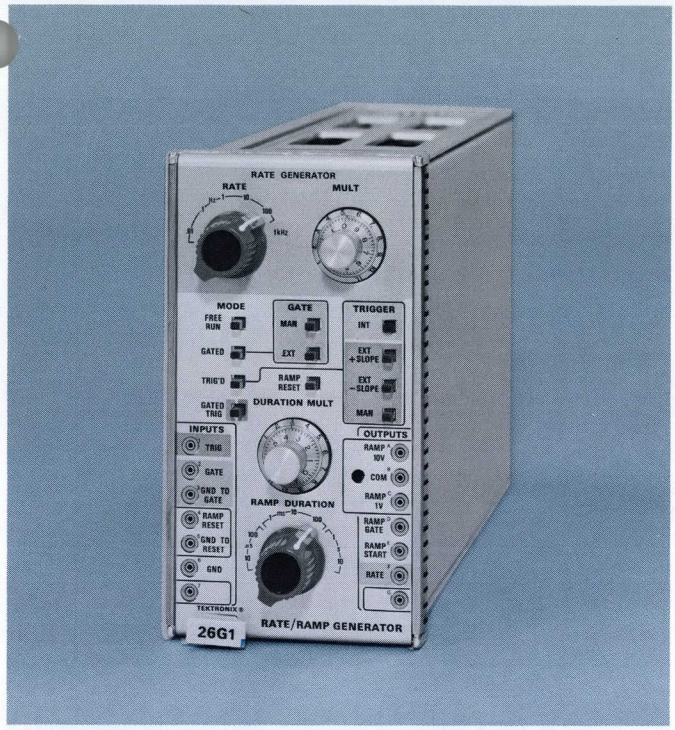
WEIGHTS

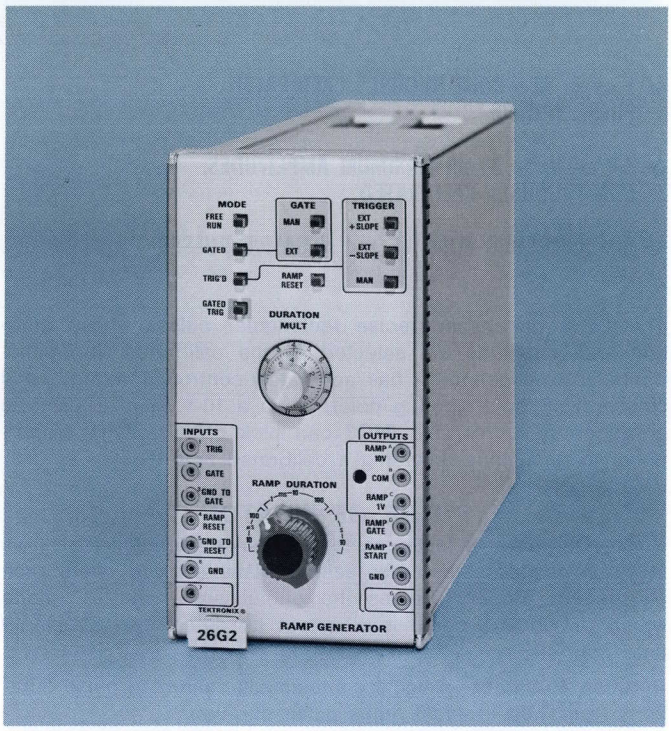
Net weight	≈2 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

26A2 Differential Amplifier **$550**

OPTIONAL ACCESSORIES

6-pin connector for the auxiliary input.
Order 131-1065-00 ..... $11





- **0.01 Hz to 11 kHz CONTINUOUSLY CALIBRATED RATES (26G1 Only)**
- **10 μs to 110 s CONTINUOUSLY CALIBRATED RAMPS**
- **FREE-RUN, GATED and TRIGGERED RAMP MODES**

The 26G1 and 26G2 Generators produce a ramp voltage well suited to analog timing applications such as delayed triggering of pulse generators. The ramp can be triggered or gated, or both. In the 26G1 the ramp can be triggered externally, manually, or from its rate generator; the 26G2 does not have the rate generator and can be triggered externally or manually.

All front-panel connections are duplicated at the rear connector for interconnecting with other modules via the mainframe.

RATE GENERATOR (26G1 Only)

Repetition Rate—Continuously calibrated from 0.01 Hz to 11 kHz.

Output—Amplitude, +3 V within 20%; pulse width, 1.5 μs within 30%; risetime, 100 ns or less. Output resistance is approximately 50 Ω.

RAMP GENERATOR

Ramp Duration—Continuously calibrated from 10 μs to 110 s.

Output Indicator—Indicates ramp in progress or has just occurred.

MODES

Free Run—Provides successive ramps.

Gated—Successive ramps are generated for the duration of gate signal. Last ramp is not terminated at end of gate. Internal connector permits gate to also control rate generator.

Triggered—One ramp cycle is generated for each trigger.

Gated Triggered—Allows ramp to be generated by triggers only during the time a gate signal is present.

Ramp Reset—Terminates ramp and resets circuitry for generation of new ramp (locks out ramp until released).

INPUTS

Trigger—Requires at least 1 V to generate ramp. Positive or negative slope is selectable.

Gate—Ramp generated while gate is elevated to at least 1 V (26G1 and/or rate generator with internal jumper).

Ground to Gate—Closure to ground provides ramp gating.

Ramp Reset—Ramp is reset upon receipt of at least 1 V signal.

Ground to Reset—Closure to ground initiates ramp reset.

Ground—Provides reference ground (as opposed to high current or shield ground).

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

OUTPUTS

Ramp, 10 V—Provides 10 V ramp into at least 3 kΩ.

Common—Reference ground for ramp outputs.

Ramp, 1 V—Provides 1 V ramp with 50 Ω output resistance.

Ramp Gate—Provides +3 V signal during ramp generation.

Ramp Start—Provides +3 V pulse coincident with start of ramp.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

Net weight	≈2 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

INCLUDED ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00).

26G1 RATE/RAMP GENERATOR **$430**
26G2 RAMP GENERATOR **$300**

- **1 μs to 11 s CONTINUOUSLY CALIBRATED PULSE WIDTHS**
- **1 V, 10 V, or 20 mA MAXIMUM AMPLITUDES, CONTINUOUSLY CALIBRATED**
- **SIMULTANEOUS POSITIVE and NEGATIVE PULSES**

The 26G3 generates precise rectangular pulses whose duration and amplitude are selected by the calibrated front-panel controls. The generator has accurately-controlled voltage level selection of the triggering point; when a 10-V ramp is used as a triggering source, the 26G3 can pick off a voltage proportional to time, thus providing a calibrated time delay.

PULSE GENERATOR

Pulse Duration—Selects calibrated pulse durations of 1 μs to 1 s in decade steps. Also selects Bistable mode where each succeeding trigger reverses the output state, and DC mode which provides a continuous output as determined by amplitude controls.

Duration Multiplier—Selects continuously calibrated pulse durations from 1.00 to 11.00 times pulse duration.

Output Indicator—Indicates pulse is in progress or has just occurred.

Output—Simultaneous (within 50 ns) positive and negative pulses, continuously calibrated over three ranges: 0 to 1 V, 0 to 10 V, or 0 to 20 mA.

Accuracy—Amplitude, within 1% of full scale after the first 10%. Within 3% of indicated duration from 1 μs to 100 ms, within 5% on 1 s range.

Source Resistance—1 V range, 50 Ω within 1%. 10 V range, 500 Ω within 1%.

Risetime, Falltime— 200 ns or less for pulse amplitudes of 10% to 100% of full scale.

Delay After Trigger— 250 ns or less.

TRIGGER MODES

Preset Level, 1 V—Triggering level passing +1 V initiates output pulses.

Delayed, +10 V Ramp—Triggering occurs as the +10 V ramp passes the amplitude level selected by the calibrated Delay control.

+ or — Triggering—Occurs at a selectable level and slope between 0 and + or —10 V.

INPUTS

Trigger—Accepts input signals for preset level, plus level and minus level modes.

Ramp—Accepts +10 V ramp for delayed trigger mode.

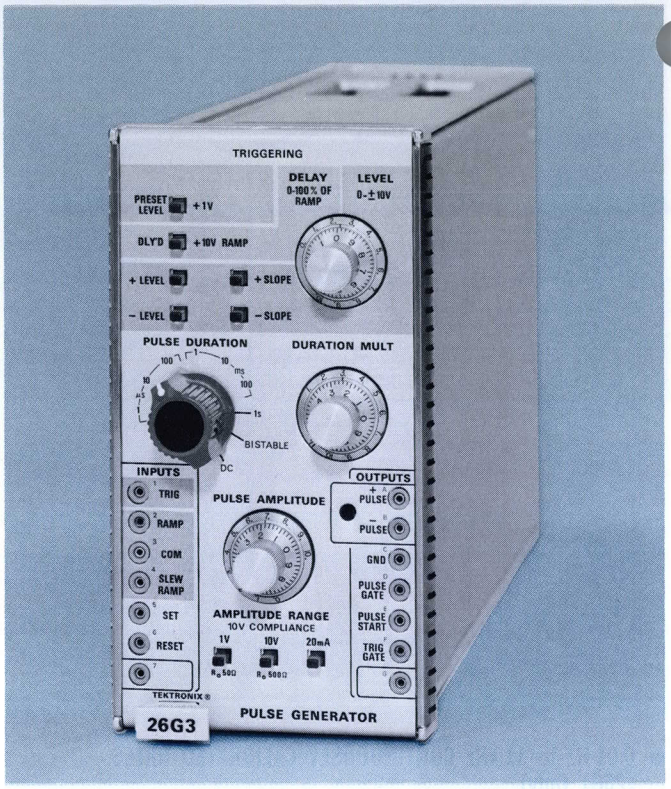
Common—Reference ground for ramp inputs.

Slew Ramp—Accepts signal to algebraically sum with ramp.

Set—At least +1 V required to set output to high state independent of other inputs.

Reset—At least +1 V required to reset output to low state independent of pulse width control.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.



OUTPUTS

+ Pulse, — Pulse—Provides simultaneous positive- and negative-going pulses.

Ground—Provides reference ground for output signals.

Pulse Gate—Provides +3 V gate signal, coincident with output pulse.

Pulse Start—Provides +3 V trigger signal, coincident with leading edge of pulse.

Trigger Gate—Provides a signal that is 0 V before triggering level is reached and +3 V after triggering level is passed.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

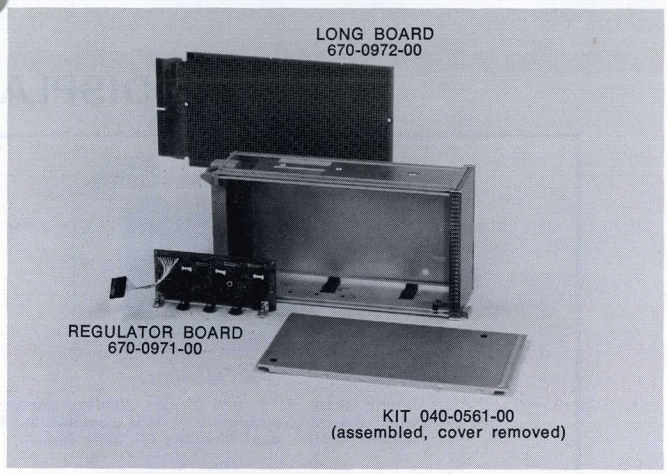
Net weight	≈2 lb	0.8 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	≈5.4 kg

INCLUDED ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00).

26G3 PULSE GENERATOR **$485**

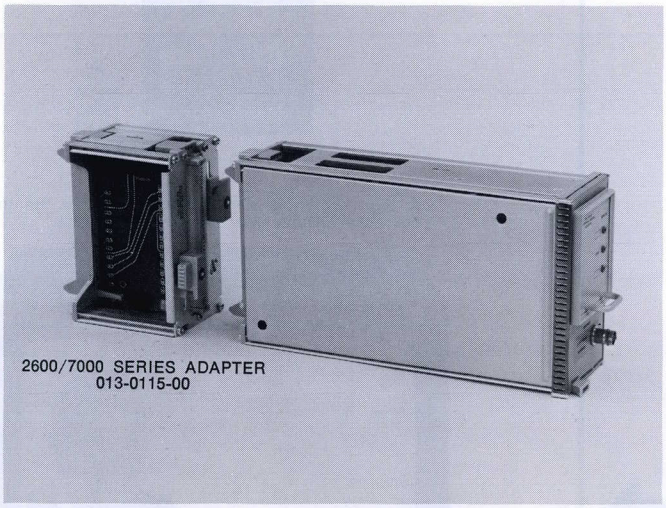
OPTIONAL ACCESSORIES



BLANK PLUG-IN KIT

Provides mechanical parts and instructions for construction of specialized plug-ins. The kit includes a short board to mate the plug-in to the mainframe connector; also available is a long board which has an area for circuitry construction, and a regulator board which provides +15 V, −15 V, and +5 V when installed in the blank plug-in.

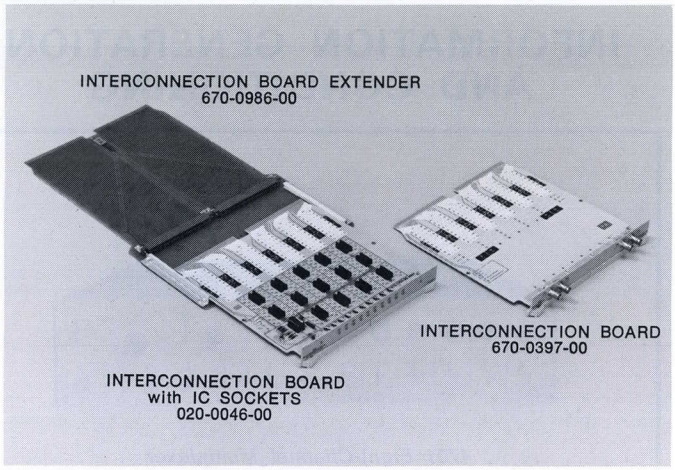
BLANK PLUG-IN KIT, 040-0561-00 ..... $30.25
LONG BOARD, 670-0972-00 ..... $27.50
REGULATOR BOARD, 670-0971-00 ..... $66.00



2600/7000-SERIES ADAPTER

Permits the 2600-Series Plug-ins to be operated in 7000-Series Oscilloscopes. The adapter provides regulated power to the plug-in and extends the plug-in length for mechanical compatibility. It also permits limited input or output interconnections between the plug-in and oscilloscope.

Order 013-0115-00 ..... $55.00



INTERCONNECTION BOARD

Additional interconnection boards permit plugging in different interconnection formats to suit varying requirements.

Order 670-0397-00 ..... $71.50

INTERCONNECTION BOARD with IC SOCKETS

In addition to the interconnection area, this board has 14 sockets for 16-pin dual in-line package integrated circuits, and a regulated 5-V supply. Each socket pin is connected to a 40-mil pin jack. Construction is possible of virtually unlimited combinations of plug-in functions with DIP IC logic gates, pulse transformers, resistor networks, operational amplifiers, etc.

Order 020-0046-00 ..... $140.00

INTERCONNECTION BOARD EXTENDER

Allows access to board connectors while instrument is in operation.

Order 670-0986-00 ..... $66.00

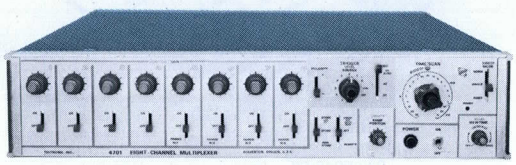
CABLES, CORDS, AND CONNECTORS

BNC-to-0.040 inch Pin Adapter Cable, 175-1178-00 .... $11.00
2-inch Red Patch Cords (package of 25), 012-0200-01 .. $22.00
6-inch Blue Patch Cords (package of 25), 012-0201-01 .. $25.00
12-inch Black Patch Cords (package of 25), 012-0202-01 $30.00
Pin/Jack Combination (package of 50), 020-0036-00 ... $16.50
Panel Jacks (package of 25), 020-0037-00 ..... $8.25
Board Jacks (package of 25), 020-0038-00 ..... $4.40

R2601 SLIDE-OUT ASSEMBLY

Order 351-0296-00 ..... $16.20

INFORMATION GENERATION AND CONDITIONING



4701 Eight-Channel Multiplexer

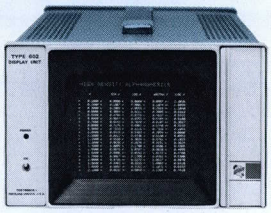
Display the inputs from as many as eight different signal sources on a single display unit with the 4701 8-channel multiplexer. See details on page 268.

4503 Scan Converter

The 4503 Scan Conversion Storage Unit provides a graphical storage medium with write-in and read-out scanning electronics. This unit is designed to provide large screen video displays of graphic and alphanumeric data and video pictures written on its storage CRT. Information is both written and read by a time-shared electron beam.

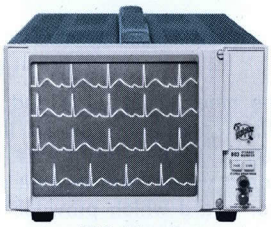
Uses include displaying data symbols, graphs, facsimile images, industrial process monitoring, biophysical monitoring, education and training, computer display and other applications where a TV display is desired. See details on page 267.

DISPLAY



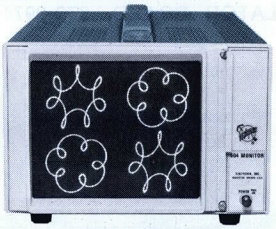
602 Monitor

Bright, sharp X, Y, and Z axis displays are yours with the high-resolution 1-MHz bandwidth 602 Display Unit. Specifications on page 254.



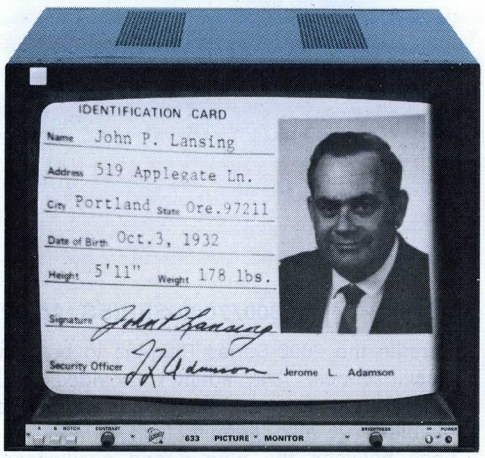
603 Monitor

Choose bright, flicker-free stored displays, or nonstored conventional displays with the low-cost big screen 603 Storage Display Monitor. Details on page 255.



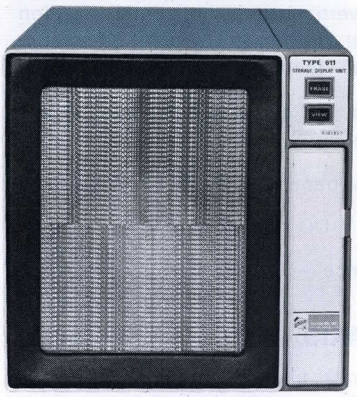
604 Monitor

A big CRT in a small package. That's the low-cost 604 Display Monitor. See page 256.

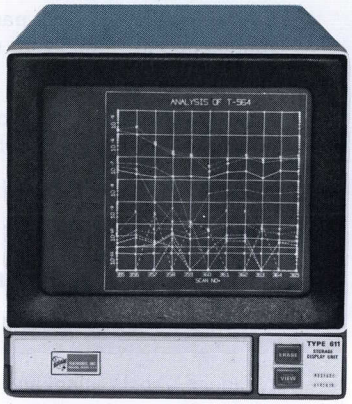


630 Series Monitors

MONITORS

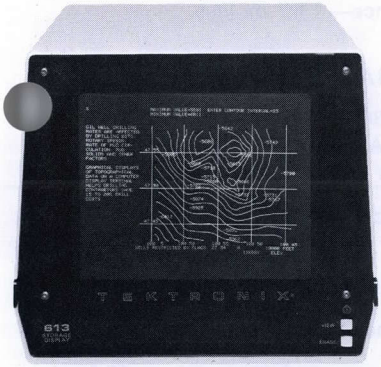


611 Monitor

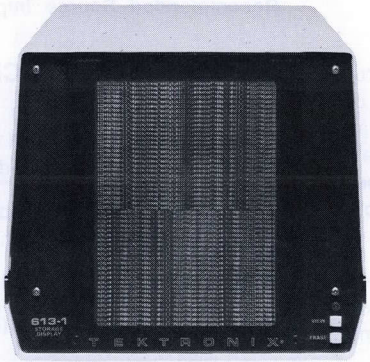


611-2 Monitor

Fill the big 8¼ by 6⅜-inch display screen of the 611 Storage Monitor with as many as 4000 alpha-numeric characters, or graphic displays of great complexity. Page 258 has the full story.

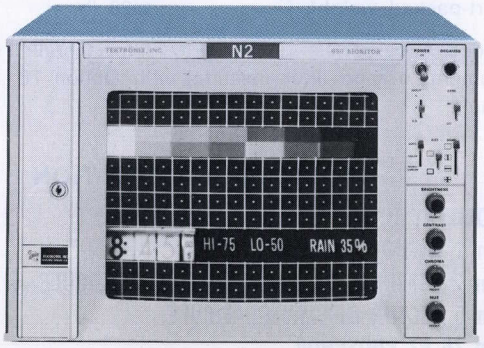


613 Monitor



613-1 Monitor

Big news in storage tubes is the brightness of the 613 bistable storage CRT. See page 260.

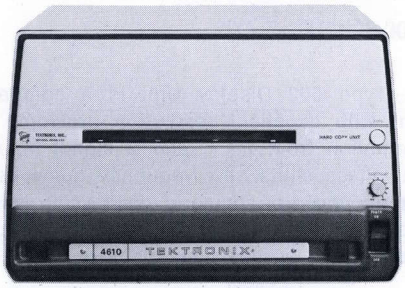


650 Series Monitors

HARD COPY

4601 Hard Copy Unit

Sharp, legible, permanent dry copies of your computer terminal displays are yours in seconds at low cost with the 4601 Hard Copy Unit. See page 262.



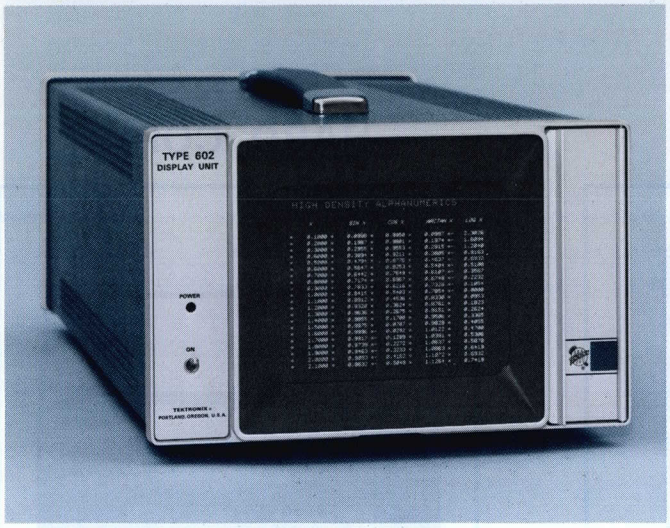
4610 Hard Copy Unit

The 4610 is a worthy partner for the popular 4010-1 Computer Display Terminal, making legible, high-resolution, permanent hard copies directly from the 4010 Series Computer Terminals and the 613 Monitors. See page 264.

4632 Video Hard Copy Unit

The 4632 provides permanent hard copies from television picture signals or from refreshed alphanumeric/graphic terminals. The unit is self-contained and extremely simple to operate. High quality copies are produced in seconds and exit into a built-in stacking tray. See page 266 for details.

602 *Display Unit*



- **1-MHz X AND Y BANDWIDTH**
- **100-mV/cm X AND Y DEFLECTION FACTORS**
- **X-Y PHASE DIFFERENCE WITHIN 1° TO 1 MHz**
- **UNIFORMLY SMALL SPOT SIZE**
- **DC-COUPLED Z AXIS**

The Type 602 Display Unit is a compact, solid-state instrument with excellent resolution providing accurate displays of information from X, Y, and Z signal inputs. Application areas are: phase shifts and frequency ratios using *Lissajous* figures, graphic and alphanumeric displays from computers, high-resolution raster displays, with intensity modulation, and Y-T plots of amplitude versus time displays.

Permanent records of the Type 602 display are provided on Polaroid film using the TEKTRONIX C-30A Camera with adapter. Two Type 602's may be mounted side-by-side using an optional rack adapter.

CRT DISPLAY

TEKTRONIX CRT— 5-inch flat-faced rectangular CRT with P31 phosphor standard, P7 phosphor optional.

Display Size— 8 cm vertically and 10 cm horizontally.

Graticule—Standard graticule: Internal, parallax-free, variable illumination. Supplied with standard 602, as shown above. Optional graticule: Internal 8 x 10-cm outline (no graticule lines). Supplied with Option 2.

Trace Width—Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5-μA beam current.

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 2% in the vertical direction, and 6% in the horizontal direction.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

Bandwidth—DC to 1 MHz at 3-dB down.

Deflection Factor—Vertical: 90 mV/cm to 135 mV/cm, internally variable. Horizontal: 90 mV/cm to 110 mV/cm, internally variable.

Phase Difference—Not more than 1° between X and Y amplifiers up to 1 MHz.

Beam Position—Front panel vertical and horizontal position ranges permit setting zero signal position to any point on screen. Position shift is not more than 1 mm/h after 20-min warm up.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ ±10% paralleled by 30 pF or less.

Maximum Input Voltage— ±10 V DC plus peak AC.

Recommended Source Impedance— 1 kΩ or less.

Z AXIS

A linear Z-axis amplifier permits intensity modulation of the writing beam. Analog input: DC to 1 MHz over 0.0 V to +1 V range. Signal input is a BNC connector on the rear panel.

Input R and C— 100 kΩ ±10% paralleled by 70 pF or less.

Maximum Input Voltage— ±10 V DC and peak AC.

Recommended Source Impedance— 1 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz. 50 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Temperature—Electrical specifications are valid over the range of 0°C to +50°C ambient.

Finish—Blue vinyl painted cabinet, aluminum construction.

Dimensions and Weights (cabinet included)—

Height	6 in	15.3 cm
Width	8½ in	21.6 cm
Depth	17⅜ in	44.1 cm
Net Weight	17½ lb	7.9 kg
Domestic shipping weight	≈22 lb	≈9.9 kg
Export-packed weight	≈28 lb	≈12.7 kg

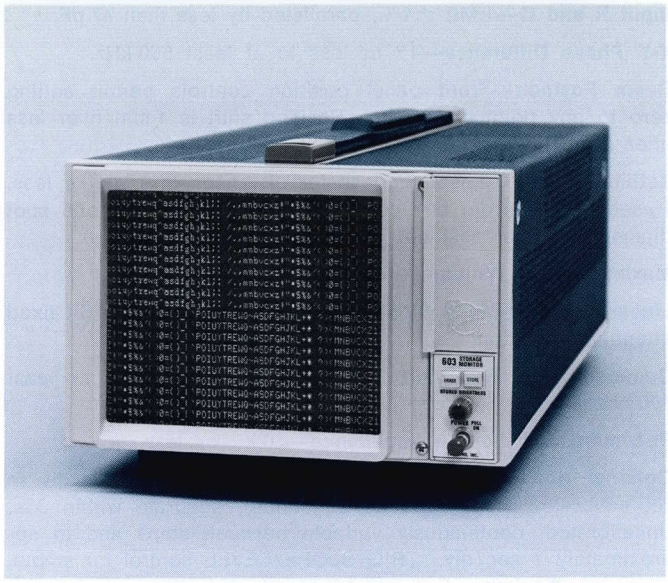
Included Accessories—Smoke-gray filter installed on standard instrument; orange filter installed with Option 76; maintenance manual.

ORDERING INFORMATION

602 DISPLAY UNIT	**$950**
Option 1 WITHOUT CABINET	**Subtract $25**
Option 2 INTERNAL 8 x 10-cm OUTLINE GRATICULE	**No Charge**
Option 5 VECTOR DISPLAY GRATICULE	**Add $25**
Option 76 P7 PHOSPHOR	**No Charge**

OPTIONAL ACCESSORIES

5¼-inch rack adapter (016-0115-02); panel assembly (016-0116-00); C-30A camera; Type 602 to C-30A adapter; C-30A camera carrying case.



- **LOW-COST X-Y MONITOR**
- **TIME BASE OPTION**
- **6-1/2-INCH STORAGE CRT**
- **1 MILLION DOTS/SEC WRITING SPEED**
- **VARIABLE STORED BRIGHTNESS**
- **VIEW FOR EXTENDED PERIODS**
- **DIFFERENTIAL INPUTS**

The 603 is an X-Y monitor for displaying alphanumeric and graphic data in either a refreshed or stored mode on a 6½-inch CRT. It is well suited for applications such as ultrasonic detection systems, electron microscope systems, radiation and thermal scanning systems, speech therapy, mechanical pressure, volume and vibration analysis, medical and biophysical systems.

Now available is an optional, horizontal time-base. With calibrated sweep rates, conventional Y-T measurements are a valuable addition to the 603's high-performance X-Y monitor features.

The Tektronix-developed bistable storage CRT used in the 603 eliminates the need for costly memory devices to refresh the display. Brightness of stored displays may be adjusted to obtain optimum photographic results, to integrate multiple traces and extend storage time to at least ten hours. Permanent records of the 603 display can be obtained on Polaroid prints using the TEKTRONIX C-5 Camera.

Operating functions are remotely programmable through a rear panel connector which interfaces directly with TTL systems. X-Y-Z differential inputs are available via BNC connectors. A remote program connector is also available for positive inputs.

CRT DISPLAY AND STORAGE

Cathode-Ray Tube—6½-inch flat-faced bistable storage tube. Phosphor is similar to P1. 3.5-kV accelerating potential. Two storage tubes are available (standard CRT for a brighter stored display or Option 2 for a faster writing speed). When used in the nonstore mode, both tubes exhibit characteristics of a conventional CRT.

Writing Speed—Standard CRT, at least 20 div/ms; Option 2, at least 200 div/ms.

Dot Writing Time—Time required to write (store) one dot: standard CRT, 4 μs or less; Option 2 CRT, 0.5 μs or less.

Information Storage Rate—Standard CRT, at least 200 thousand dots/second; Option 2 CRT, at least one million dots/second.

Display Size—4 inches vertically, 5 inches horizontally. An internal nonilluminated graticule is available as Option 1.

Resolution—Stored, equivalent to 80 vertical x 100 horizontal stored line pairs. Nonstored, equivalent to 128 vertical x 160 horizontal line pairs.

Display Linearity—The voltage required to produce a 1 inch deflection from any point on the CRT will not vary more than 5%.

Viewing Time—At least one hour at normal intensity without loss of resolution. Viewing time can be extended to ten hours by utilizing the variable brightness control.

Erase Time—Approximately 250 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—DC to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

603 *Storage Display Monitor*

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—1° or less to at least 500 kHz.

Beam Position—Front panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Settling Time—0.2 μsec or less for distances of 1 div or less. 1 μsec or less from any point on the CRT to within one spot diameter of final position.

Maximum Input Voltage—±100 V DC plus peak AC.

Linear Common-Mode Signal Range—±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz.

Recommended Source Impedance—10 kΩ or less.

Optional Horizontal Time Base— 1 μsec/div to 0.1 sec/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 sec/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam in nonstored mode. Positive input to + input increases the display intensity.

To insure storage of each written dot the Z-axis on-time should be at least 4 μs with the standard CRT and at least 0.5 μs with Option 2 CRT. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

Bandwidth—DC to 5 MHz over usable range. Sensitivity is adjustable from 1 to 5 V.

Differential Input—CMRR at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

Maximum Input Voltage—±100 V DC plus peak AC.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz. 75 watts maximum at nominal line voltage.

Dimensions and Weights—See next page.

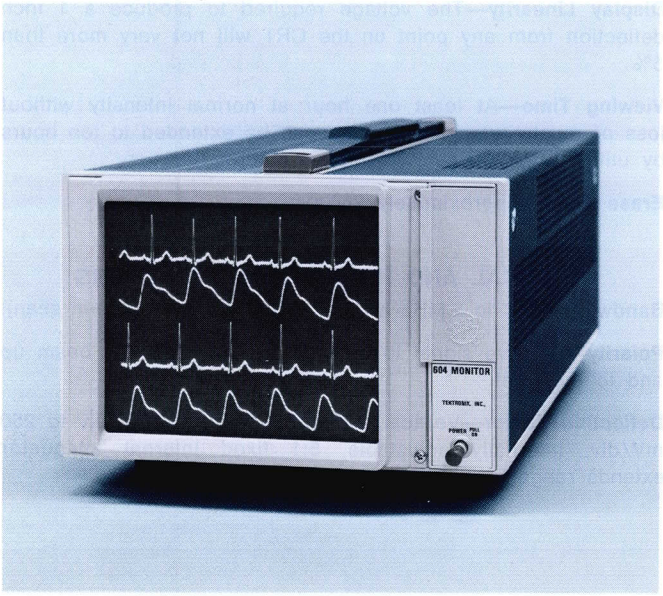
Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00); external graticule (331-0303-00).

ORDER INFORMATION

603 STORAGE MONITOR	$1100
OPTION 1 INTERNAL GRATICULE	No Charge
OPTION 2 FAST WRITING CRT	Add $25
OPTION 3 WITHOUT HANDLE AND FEET	Sub $10
OPTION 4 TIME BASE	Add $125

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

604 *Display Monitor*



- LOW-COST MONITOR
- TIME BASE OPTION
- 6½-INCH, EASY VIEWING CRT
- 2 MHz X AND Y BANDWIDTH
- DC-COUPLED 5 MHz Z AXIS
- X-Y PHASE DIFFERENCE WITHIN 1° TO 500 kHz
- DIFFERENTIAL INPUTS

The 604, with a 6½-inch CRT, ideally meets the display and space requirements of system designers in such applications as pulse height analysis, infrared detection, data communications systems testing, component and logic testing, vibration analysis and medical instrumentation. The 604 is also well

suited for many other applications including: phase shifts and frequency ratios using Lissajous figures, raster displays with intensity modulation and apparent dynamic three-dimensional illustrations. Calibrated horizontal sweep rates, available optionally, provide a convenient extension of the 604 measurement field. Visual display of computer-processed data enhances understanding of the processed information. Permanent records of the 604 display can be obtained on Polaroid prints using the TEKTRONIX C-5 Camera. Differential inputs are available via BNC connectors on the rear panel. Plus inputs are also available via a 25 pin connector.

CRT DISPLAY

Cathode-Ray Tube—6½-inch flat-faced rectangular CRT with P31 phosphor. Optional phosphors; P7 (includes orange filter) and P4.

Display Size—Internal parallax-free, nonilluminated graticule marked in 8 vertical and 10 horizontal divisions (½ in/div). Option 1 is without graticule.

Display Linearity—The voltage required to produce 1 inch deflection at any point on the CRT will not vary more than 5%.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—DC to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—Not more than 1° to at least 500 kHz.

Beam Position—Front panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Maximum Input Voltage—±100 V DC plus peak AC.

Linear Common-Mode Signal Range— ±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz, 50:1 to 100 kHz with 5X attenuator.

Recommended Source Impedance—10 kΩ or less.

Optional Horizontal Time Base— 1 μsec/div to 0.1 sec/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 sec/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth—DC to 5 MHz over usable range, sensitivity is adjustable from 1 to 5 V.

Differential Input—CMRR at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1% paralleled by less than 47 pF.

Maximum Input Voltage—±100 V DC plus peak AC.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz, 56 watts maximum at nominal line voltage.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00).

ORDER INFORMATION

604 MONITOR	$700
OPTION 1 WITHOUT GRATICULE	No Charge
OPTION 3 WITHOUT HANDLE AND FEET	Sub $10
OPTION 4 TIME BASE	Add $125
OPTION 5 VECTOR DISPLAY GRATICULE	Add $25
OPTION 74 P4 PHOSPHOR	No Charge
OPTION 76 P7 PHOSPHOR	No Charge

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

RACKMOUNTING FOR 603 AND 604

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a 603 Option 3 or 604 Option 3 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0601-00 ..... $66

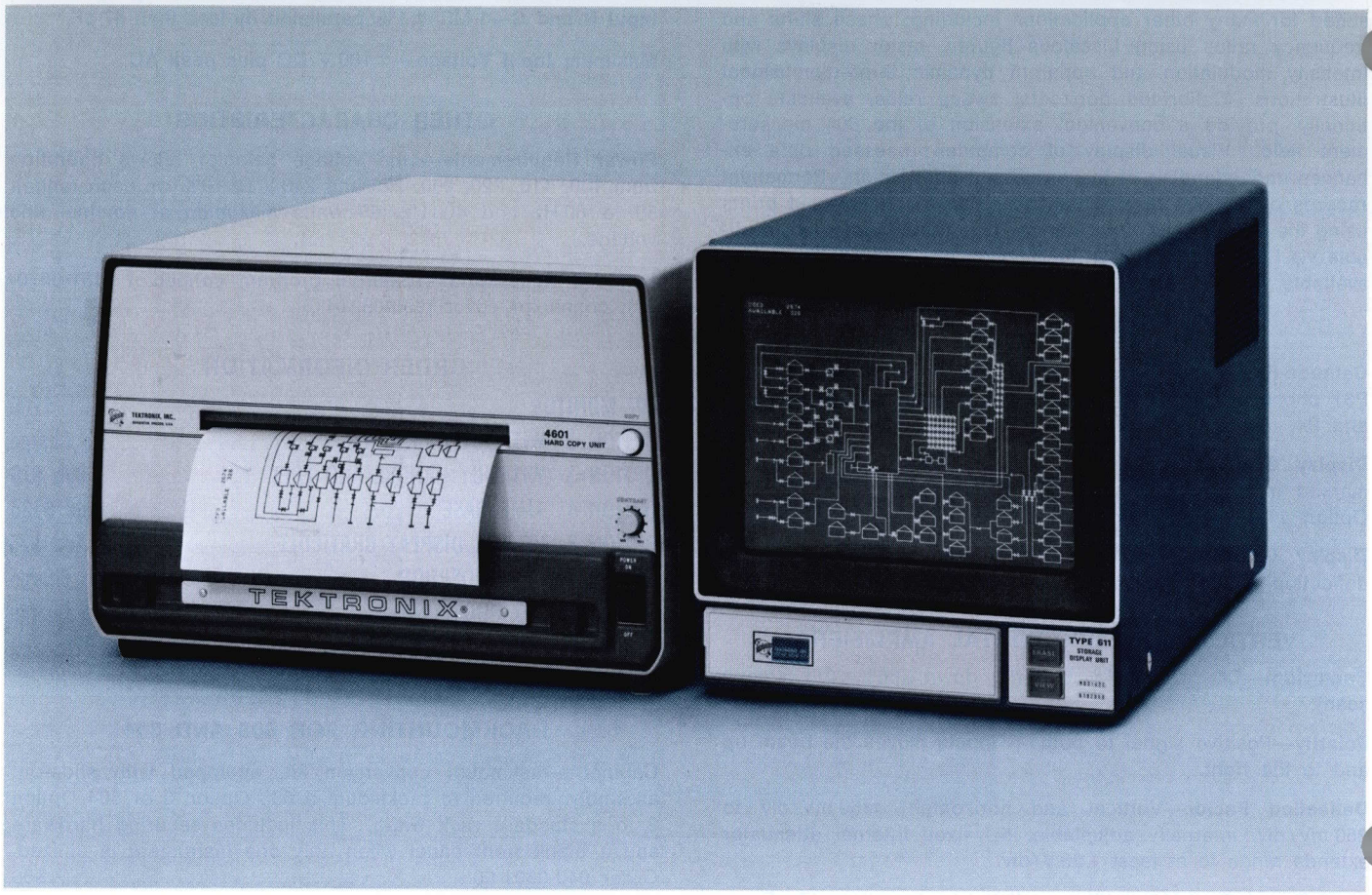
Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two 603 Option 3s or two 604 Option 3s side-by-side in a standard rack width.
Order 040-0600-00 ..... $44

Rackmount-to-cabinet conversion kit required to convert a rackmount 603 or 604 to a cabinet style.
Order 040-0602-00 ..... $22

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 603 or a 604 in a standard rack width.
Order 040-0624-00 ..... $44

603/604 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	6.0	15.25	5.25	13.5
Width	8.5	21.5	8.5	21.5
Length	20.0	50.9	19.0	48.0
Weights (approx)	lb	kg	lb	kg
Net	17.5	7.9	17.5	7.9
Domestic shipping	22.0	9.9	22.0	9.9
Export shipping	28.0	12.7	28.0	12.7



Type 611-2 Storage Display Unit with 4601 Hard Copy Unit.

- **HIGH-RESOLUTION ALPHANUMERIC AND GRAPHIC DISPLAYS**
- **FLICKER-FREE BISTABLE STORAGE**
- **ELIMINATES COSTLY MEMORY DEVICES**
- **HARD-COPY COMPATIBLE**
- **REMOTE PROGRAMMING OF DISPLAY FUNCTIONS**

The 611 Storage Display Unit provides stored displays of combined alphanumeric and graphic information from analog sources, digital computers and other data transmission systems. The TEKTRONIX-developed bistable storage CRT used in the 611 eliminates the need for costly memory devices for refreshing the information display and provides high information density without flicker or drift and with excellent resolution. The standard instrument provides a vertical format display area with the same aspect as a typewritten page. A horizontal display format is available in the 611-2.

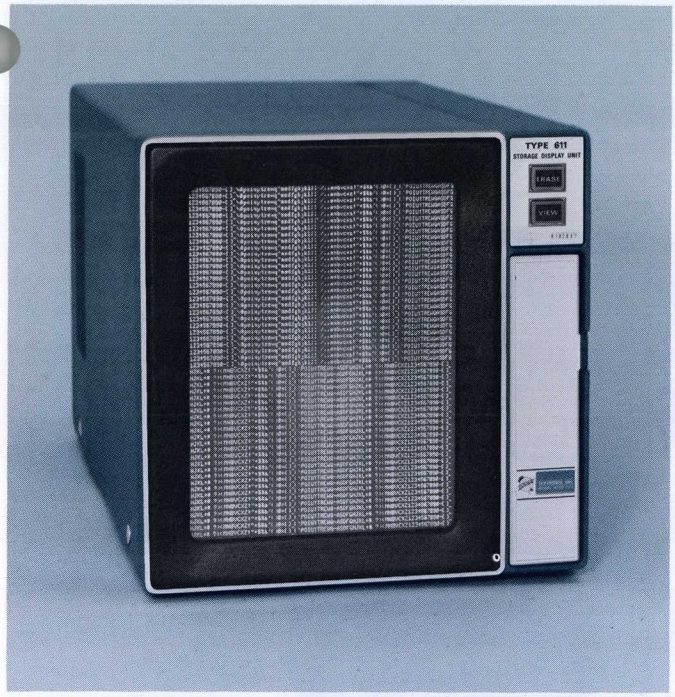
OPERATING FUNCTIONS

Operating functions are View, Erase, Non-Store, and Write-Thru. View and Erase are under manual or programmable control; Non-Store and Write-Thru are under programmable control. The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to "ready-to-write" mode. As new information is written, it is retained on the CRT in the "view" mode. Within 90 seconds after the display is written, the 611 will automatically switch to a "hold" mode. This holds data stored on the CRT at a low brightness to extend storage time. Pressing the VIEW switch while in the "hold" mode, returns the display to the "view" mode for at least 60 but not more than 90 seconds. The "view" mode may be programmed for continuous viewing.

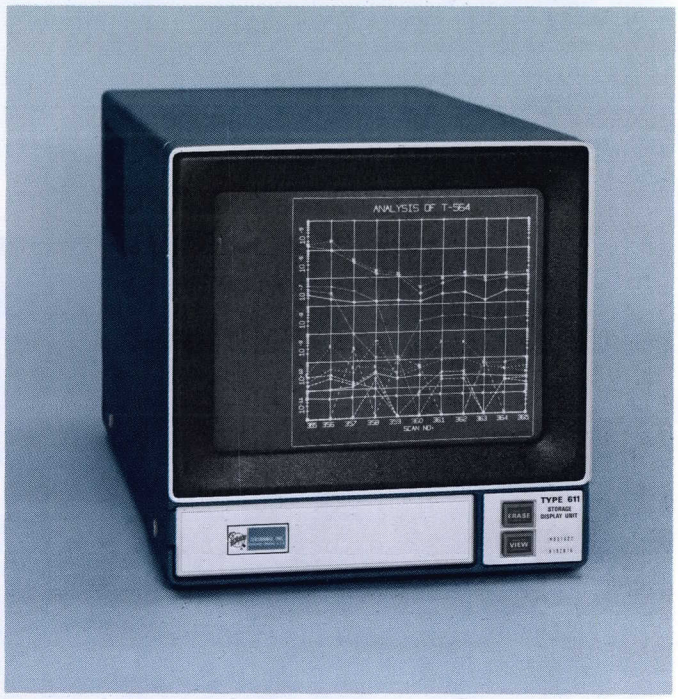
A special "write-thru" feature is provided for displaying additional information on a screen already containing stored information. In the "write-thru" mode the CRT beam is unblanked and a cursor, or any generated pattern, may be displayed without destroying previously stored data and without storing new data. This function is useful for positioning cursors and locating the CRT writing beam. In the "write-thru" and "non-store" modes the display remains on screen as long as it is refreshed.

The Intensity, Focus, Operating Level, Power Switch and Test Spiral controls are located behind a front-panel access door. Pushing the Test Spiral switch causes the instrument to complete an erase cycle and store a single-shot test pattern presentation. Pulling Test Spiral switch provides a "non-store" mode with repetitive test pattern for focusing and other tests.

The Erase, Non-Store, Write-Thru and View operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector. Manual control of Erase and View is provided on the front panel.



Type 611 features a vertical display format.



Type 611-2 features a horizontal display format.

CHARACTERISTICS

CRT DISPLAY AND STORAGE

Cathode Ray Tube—11-inch flat-faced bistable storage tube, phosphor similar to P1.

Display Size—Vertically: 21 cm. Horizontally: 16.2 cm.

Resolution— 4,000 characters based on a 90 x 70-mil matrix, clearly legible with good spacing. Equivalent to 400 vertical x 300 horizontal stored line pairs.

Viewing Time—At least 15 minutes without loss of resolution. Viewing time may be extended to one hour; however, several erasures may be required to fully remove previously stored data.

Dot Writing Time— 5 μs or less is required to write (store) one bit of information.

Erase Time— 500 ms or less.

VERTICAL AND HORIZONTAL AMPLIFIERS

Deflection Factor—Vertical: 1-V full scale (16.2 cm for square format or 21 cm for rectangular format), accuracy within 2%.

Horizontal: 1-V full scale (16.2 cm), accuracy within 2%.

Initial Beam Position—Any one of 9 initial beam positions can be selected by internal switches. Each position is adjustable.

Settling Time— 3.5 μs/cm + 5 μs, to within 1 spot diameter of final position.

Positional Drift— 0.16 mm (or less)/hour with 75-Ω source impedance at 20°C to 30°C. Within 1.6 mm/hour with 75-Ω source impedance at 10°C to 50°C, reference 25°C.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ shunted by approx 70 pF.

Z AXIS

Input—Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V or less.

Input R and C— 100 kΩ paralleled by approx 70 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

OTHER CHARACTERISTICS

Erase Interval Pulse—A negative-going erase pulse is provided at the rear connector to inhibit external equipment during an erase cycle. Amplitude change is approx +10 V to +0.3 V, source impedance approx 2 kΩ.

Remote Control—Contacts at the remote program connector on the rear panel provide remote control of the Erase, Non-Store, Write-Thru, and View operating functions.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 250 watts maximum at 115 V and 60 Hz. Rear panel selection provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights

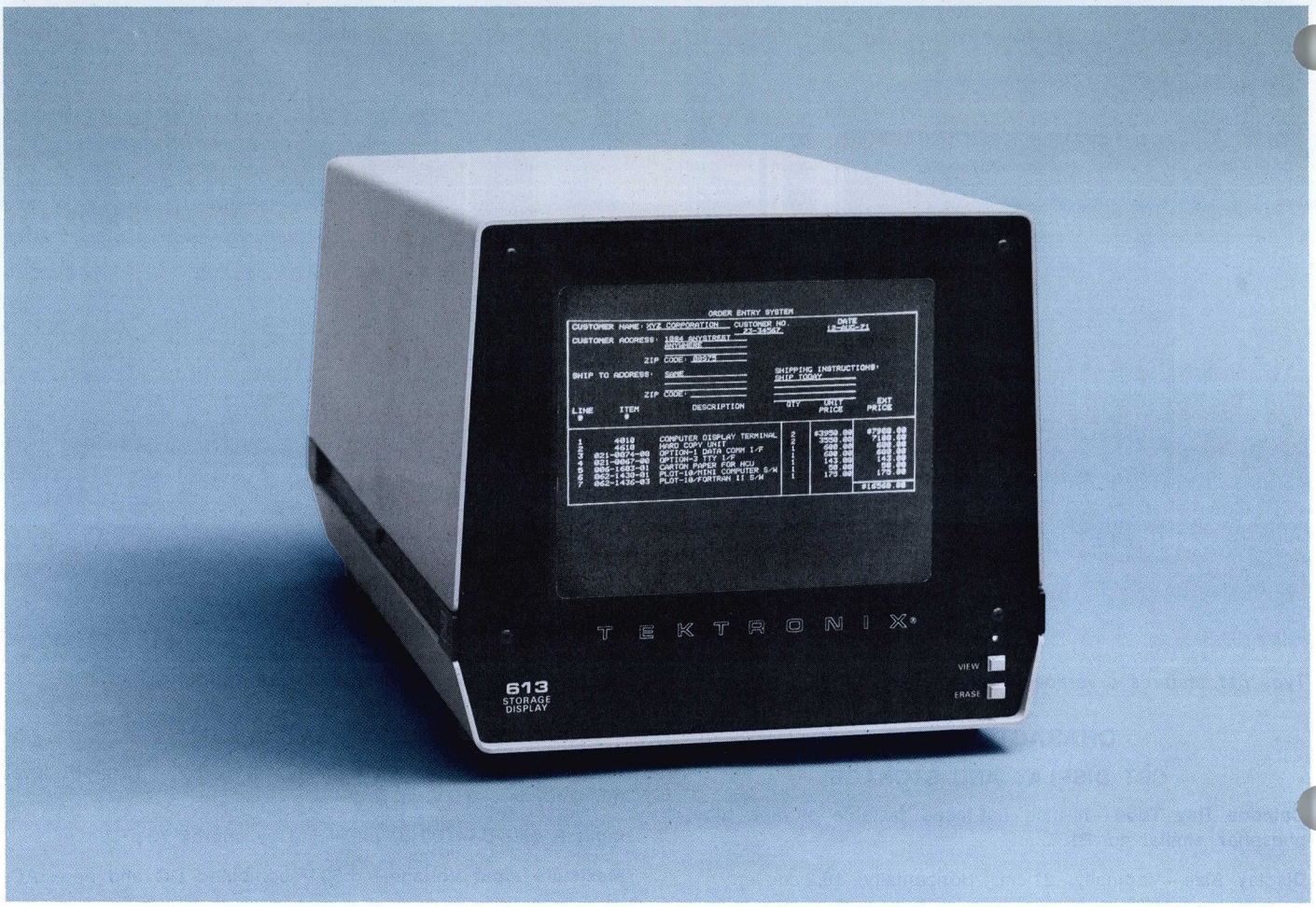
Height	11⅞ in	30.1 cm
Width	11⅝ in	29.5 cm
Depth	22⅜ in	56.8 cm
Net weight	≈51 lb	≈23.1 kg
Domestic shipping weight	≈62 lb	≈28.1 kg
Export-packed weight	≈72 lb	≈32.6 kg

Included Accessories—Program connector; connector cover, and maintenance manual.

ORDERING INFORMATION

611 STORAGE DISPLAY UNIT **$3175**

611-2 HORIZONTAL DISPLAY FORMAT **$3175**



- **BRIGHT FLICKER-FREE VIEWING**
- **LOW COST**
- **STORAGE ECONOMY**
- **HARD-COPY COMPATIBILITY**
- **REMOTE PROGRAMMING OF DISPLAY FUNCTIONS**

The 613 Storage Display is a bright, low cost, large screen data storage and display unit. Use includes any environment where a substantial amount of data is stored and presented in a single display.

Applications Versatility

The 613 Storage Display provides digital and analog displays in business, education, banking, electronic data processing, medicine, and process control.

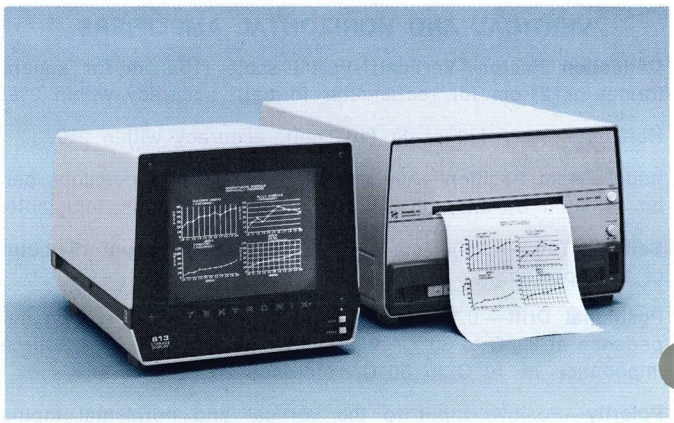
Use of a newly-designed storage cathode-ray tube provides a bright trace for easy viewing of high density alphanumeric and graphic displays in high ambient light conditions. The 613 Storage Display provides high information density without flicker.

Permanent hard copies of the displayed information are available by using the fully compatible 4610 Hard Copy Unit, which provides full-screen copies in eighteen seconds. Storage technology eliminates expensive components required in refreshed information display.

A 4610 Hard Copy Unit, Option 1 is available. This is a multiplex unit that allows from one to four 613's to operate into a single 4610 Hard Copy Unit thereby reducing copy costs.

Operating Functions

613 operating functions are View, Erase, Non-Store and Write Through. View and Erase are under manual or programmable control. Non-Store and Write Through are under programmable control only.



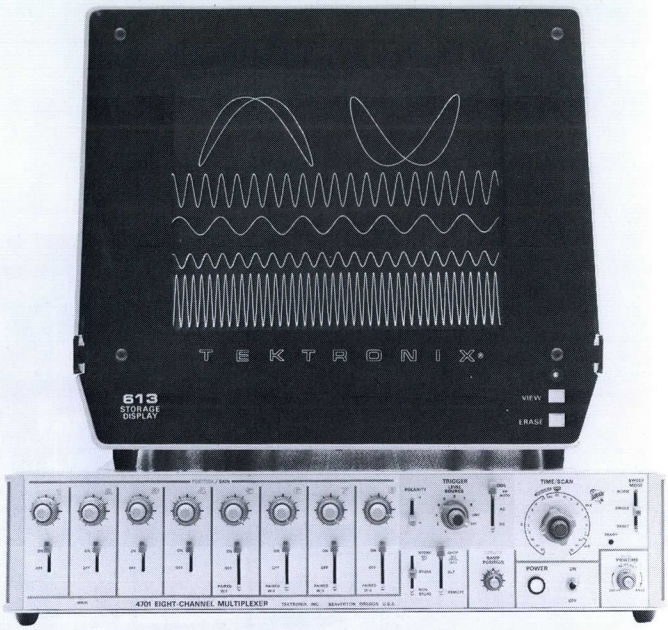
The 613 Storage Display is fully compatible with the 4610 Hard Copy Unit.

Remote programming of the 613 is achieved by grounding the appropriate program lines of a program connector on the rear panel.

The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to a "ready-to-write" mode. Within ninety seconds after the display is written, the 613 will automatically switch to a "Hold" mode, storing data on the CRT at a low brightness to extend the storage time. Pressing the VIEW switch while in the "Hold" mode returns the display to the "View" mode for at least 60, but not more than 90 seconds. The "View" mode may be programmed for continuous viewing.

In the "Non-Store" mode the display remains on the screen as long as it is refreshed.

The Intensity, Focus and Power switch controls are located on the rear panel. The View and Erase switches are located on the front panel. X, Y, and Z BNC connectors are available on the rear panel.



Bright, easily-viewed traces from as many as eight sources can be portrayed on the 613 Storage Display when used with the 4701 Eight-Channel Multiplexer.

CRT DISPLAY & STORAGE

Cathode-Ray Tube— 11-inch flat-faced storage tube.

Display Size—Vertically: 15 cm. Horizontally: 20 cm.

Resolution—Equivalent to 200 vertical x 266 horizontal stored line pairs.

Display Linearity—Full Scale—spot will settle within 1.5% of proper position along center axes for voltage applied.

Incremental—less than 15% difference between any 2 cm deflection, at any position in the display.

Viewing Time—Nominally 15 minutes. Longer viewing may require more than one erasure.

Dot Writing Time— 5 μs or less is required to write (store) one bit of information.

Erase Time—900 ms or less.

VERTICAL AND HORIZONTAL AMPLIFIERS

Deflection Factor—Horizontal: 1 V/20 cm rectangular format, accuracy within 2%. Vertical: 1 V/15 cm, within 2%. Either input driven differential or single ended.

Initial Beam Position—Any one of 9 initial beam positions may be selected by two internal connectors. Each position is adjustable ±10% of full scale vertically and horizontally.

Settling Time— 14.0 μs/cm plus 6 μs/cm up to 2 cm to within 1 spot diameter of final position.

Polarity—Positive input to the vertical moves beam up; positive input to the horizontal moves beam to the right.

Input R and C— 20 k minimum. Shunted by less than 60 pF.

Maximum Input Voltage— ±18 V DC plus peak AC.

Z AXIS

Input—At least +1 V turns beam on; +0.5 V or less turns beam off.

Input R and C— 10 k shunted by ≈50 pF.

OTHER CHARACTERISTICS

Remote Control—All 613 operating modes can be controlled by applying appropriate ground closures to the remote program connector. All control signal inputs are TTL compatible (2 TTL per input). Modes which may be controlled remotely are: Erase, View, Non-Store and Write-Through.

Power Requirements— 90 VAC to 132 VAC or 180 VAC to 264 VAC, 48-66 Hz. 180 watts maximum, 115 VAC, 60 Hz.

Dimensions and Weights

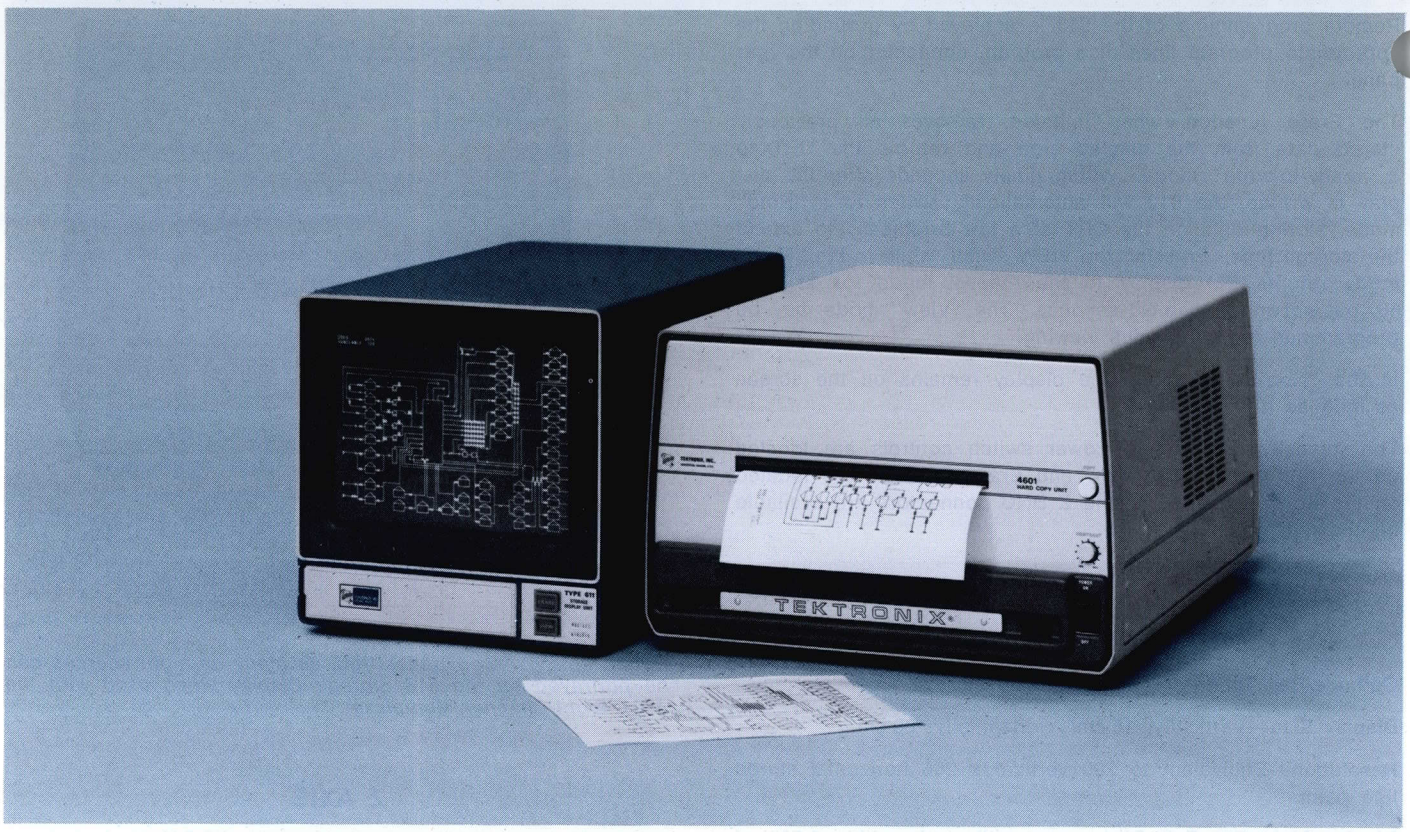
Height	11.100 in.	28.19 cm
Width	13.250 in.	33.65 cm
Depth	21.000 in.	53.34 cm
Weight	≈43 lbs.	≈19.5 kg

Included Accessories—Maintenance manual.

ORDERING INFORMATION

613 STORAGE DISPLAY **$2200**
Horizontal Display format

613-1 STORAGE DISPLAY **$2200**
Vertical display format



- **A NEW STANDARD OF USER CONVENIENCE**
- **PERMANENT COPIES OF STORED DISPLAYS**
- **COPY COSTS AS LOW AS 5 CENTS A COPY**
- **ACCURATE 8½" x 11" INFORMATION COPY**

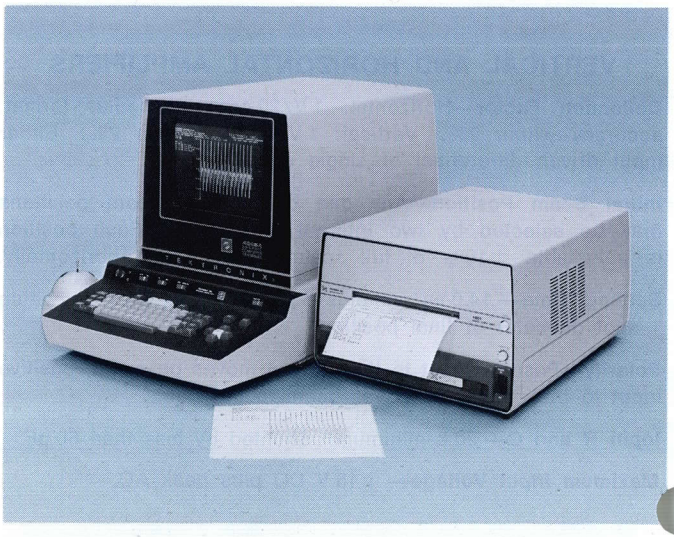
The 4601 Hard Copy Unit is a convenient, economical way of permanently copying alphanumeric and graphic displays. High resolution displays obtained on the 611 Storage Display or 4002A Graphic Computer Terminal are copied by the 4601, providing an accurate representation of the stored display on 3M Type 777 Dry-Silver Paper.

Installation and operation are quick and simple. Installation is just a matter of connection to the power line and the appropriate TEKTRONIX Display Unit. Copy command is initiated manually by pressing a front panel control, or by supplying an external command under program control.

THE COPY PROCESS

The signal source is "looped through" the 4601 to the TEKTRONIX display device. When the copy command is received, the signal source is automatically disconnected from the display device.

Hard Copy is produced by systematically scanning the target of the storage unit. Scanning ramps are generated by scan generators located in the Hard Copy Unit. An electrical signal is taken from the target electrode and fed to the Z axis of a line scan CRT. A fiber-optic faceplate couples the light output from the phosphor to the recording material. Heat development of the latent image takes place after this exposure. Hard Copy is available about 18 seconds after initiation of the copy command.



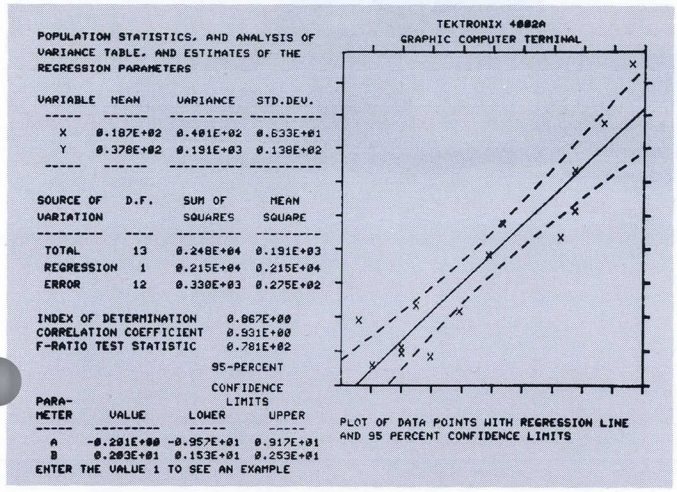
The 4601 Hard Copy Unit copies stored displays of the 4002A Graphic Computer Terminal and the 611 Storge Display Unit.

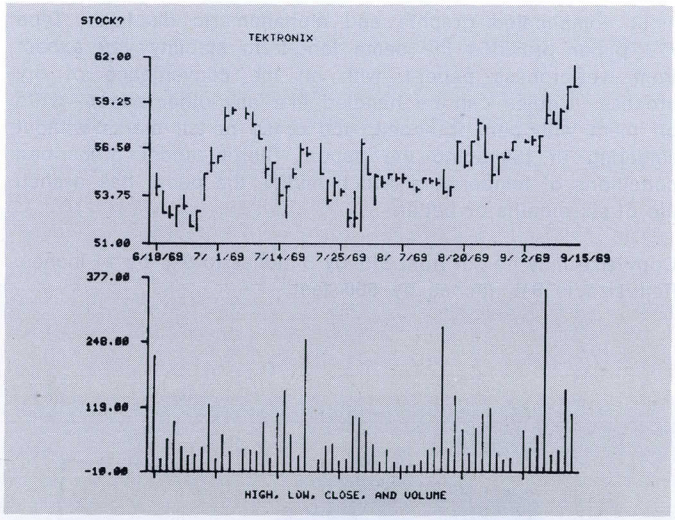
THE COPY MEDIUM

The processing unit in the 4601 uses 3M Brand Type 777 Dry-Silver Paper.

Type 777 Paper provides the high image contrast required for high-resolution copies of complex graphics and alphanumerics. It offers the stability normally associated with wet-process photosensitive paper, plus the convenience of dry print-out papers. Cost is low: 5 to 8 cents per 8½ by 11-inch copy, depending on quantity purchased. Further economies can be realized using smaller copies. Copy size may be set from 8½ by 6 inches to 8½ by 14 inches. Roll size is 8½ inches by 500 feet.

Dry-Silver prints can be handled much like any conventional paper. Records can be written upon with pencil or pen. Pencil marks are erasable. Shelf life for unexposed paper is six months, providing the paper is not removed from its protective wrapper and is stored at room temperatures.





The 4601 Hard Copy Unit provides permanent, 8½ x 11-inch copies of a wide range of alphanumeric and graphic displays as viewed on the TEKTRONIX 4002A Graphic Computer Terminal and 611 Storage Display Unit.

CHARACTERISTICS

Copy Size—Adjusted to 8½ x 11 inches at factory, variable between 8½ x 6 inches and 8½ x 14 inches.

Copy Time— 18 seconds for first copy.

Warmup Time— 20 minutes.

Remote Copy Command—Closure to ground for at least 5 μs.

Resolution (with 3M Brand Type 777 Paper)—Essentially the same as displayed on the 611 or 4002A Display Devices. Actual-size copies of a 4000-character display, based on a 90 x 70-mil matrix, are clearly legible.

Capability—Designed for use with TEKTRONIX 4002A Graphic Computer Terminal, and Type 611 Display Unit serial numbers B142240 and above. Type 611's below this serial number require a modification; contact your local TEKTRONIX Field Office for additional information.

Power Source (factory-wired options)— 90 to 136 VAC, 115 V nominal, 50 to 60 Hz. Maximum power consumption at 115 V, 60 Hz is 1450 W for first 40 seconds after turn on, 220 to 520 W for normal operation, 100 W standby.

Dimensions and Weights

Height	11 in	27.9 cm
Width	17 in	42.7 cm
Length	≈24 in	≈61 cm
Weight	≈69 lbs	≈31 kg

Included Accessories—Two 6-foot interconnecting cables; 8-foot detachable power cord.

ORDERING INFORMATION

4601 HARD COPY UNIT **$3750**
115 volt, 50-60 Hz power

4601-1 HARD COPY UNIT **$3750**
230 volt, 50-60 Hz power

The 4601 and 4601-1 have light tan cabinets and are setup for use with the TEKTRONIX 4002A Graphic Computer Terminal.

Option 1 BLUE CABINETS ..... **No Charge**

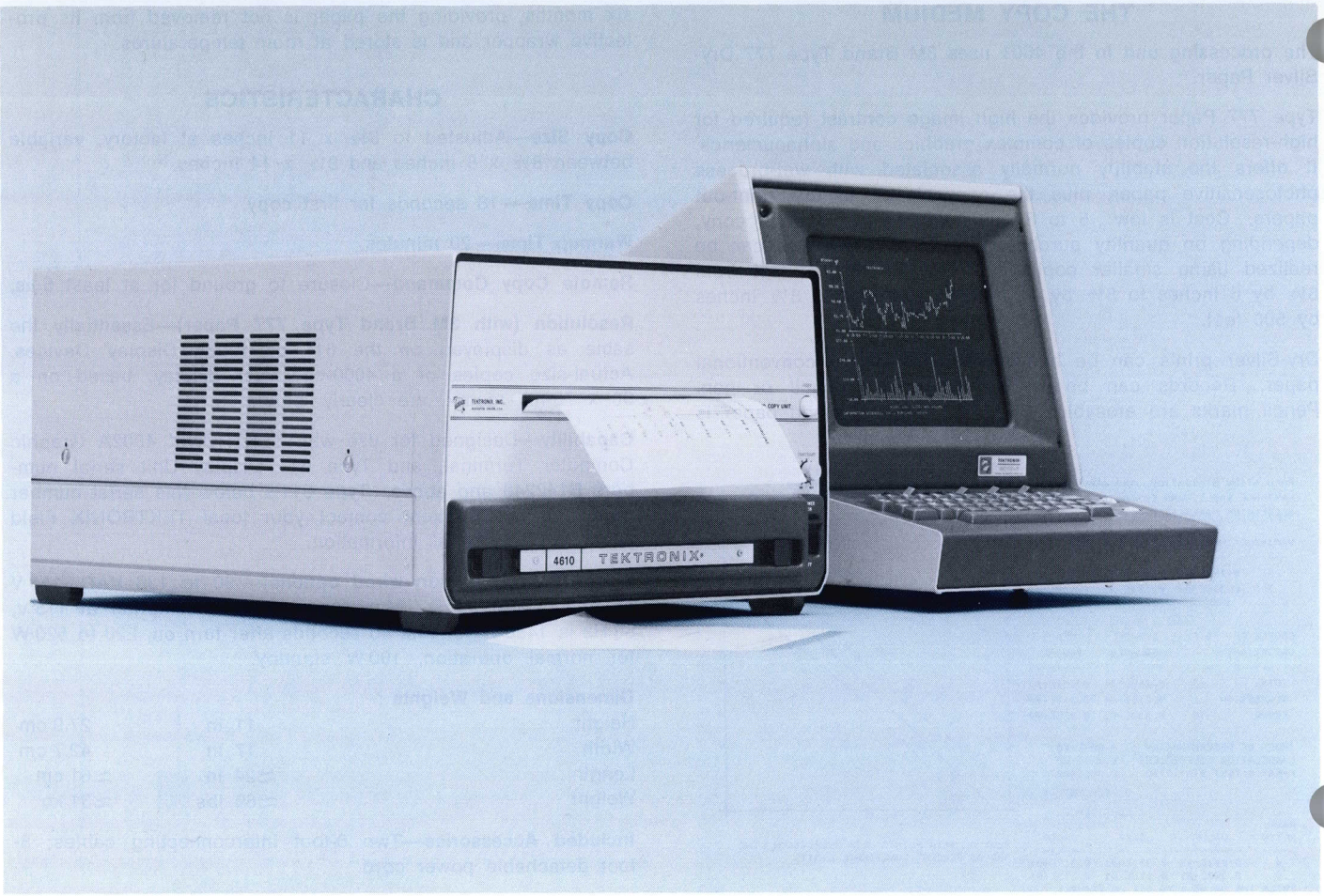
Instrument set up for use with the TEKTRONIX 611 Storage Display Unit.

OPTIONAL ACCESSORIES

Copy Catcher, order 016-0298-00 ..... **$95**

Paper—One roll is included with the 4601. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$ 40**
For one carton of 4 rolls, order 006-1603-01 ..... **$143**



- **DRY-PROCESS HARD COPY FROM GRAPHIC COMPUTER TERMINALS AND STORAGE DISPLAY UNITS**
- **SAME RESOLUTION AS STORAGE CRT**
- **COPIES IN ONLY 18 SECONDS**

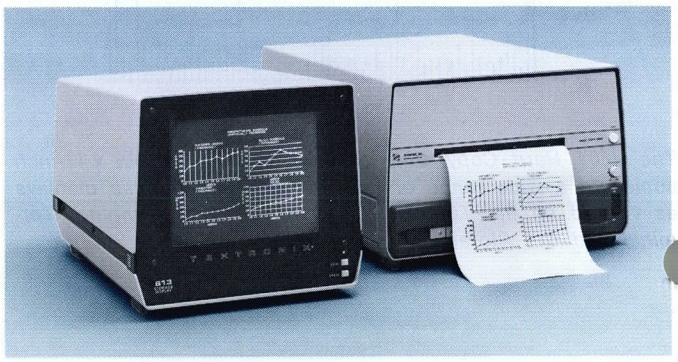
Sharp, permanent hard copies are made from the CRT display of the new 613 Storage Display, or any 4010-Family Computer Display Terminal by the 4610 Hard Copy Unit. And the 4610 can be multiplexed to provide a copying capability of from one to four Computer Display Terminals and/or 613 Storage Displays.

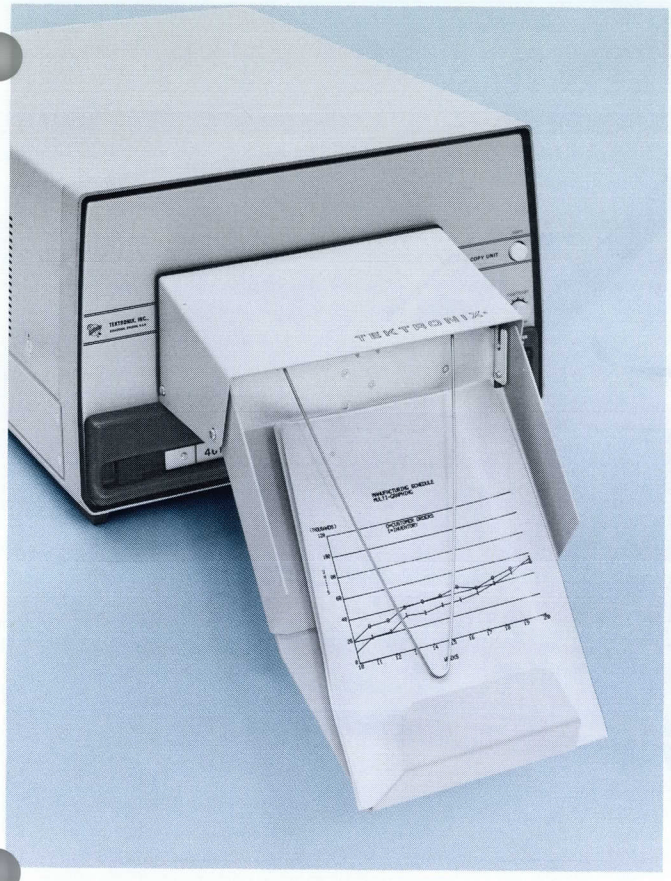
Operation is simple. A single pushbutton control on the 4610 front panel or a rocker switch on the computer terminal initiates copy-making manually, or program control will accomplish it from the computer.

Installation is equally simple—just a power line connection from the nearest 115-volt 60-Hz AC outlet, and one cable connection to the computer terminal or display unit.

The 4610 processor unit uses 3M Brand Type 777 Dry-Silver paper, which gives the high image-contrast needed for the most complicated graphic and alphanumeric displays. Type 777 paper provides the same long-term stability you expect from wet-process papers, with all the convenience of dry process. Copies can be handled like any other paper—write on them with pen or pencil, and erase pencil marks without smearing or damaging the paper. Stored under prescribed conditions of temperature and humidity, the paper has a shelf life of six months or better.

Copy size may be set from 8½ by 6 inches to 8½ by 14 inches. Roll size is 8½ inches by 500 feet.





The Copy Catcher pulls and stacks hard copies from all TEKTRONIX 4600-Series Hard Copy units.

CHARACTERISTICS

Copy Size—Adjusted to 8½ x 11 inches at factory, variable between 8½ x 6 inches and 8½ x 14 inches.

Copy Time— 18 seconds for first copy.

Warmup Time— 20 minutes.

Dimensions and Weights

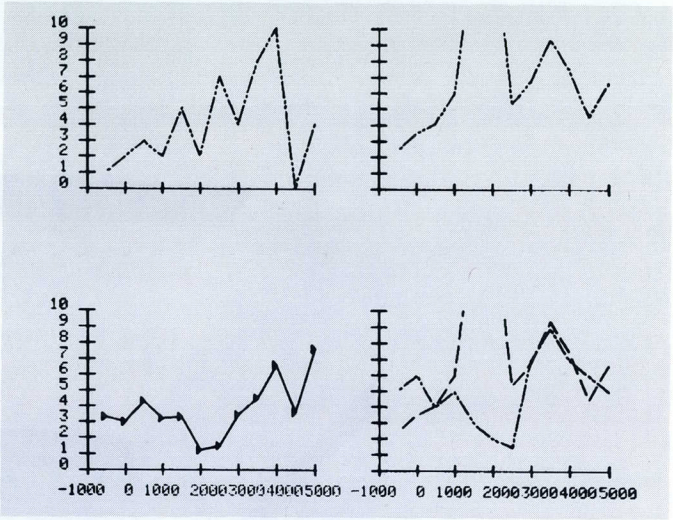
Height	11 in	27.9 cm
Width	17 in	42.7 cm
Length	24 in	61 cm
Weight	≈69 lbs	≈31 kg

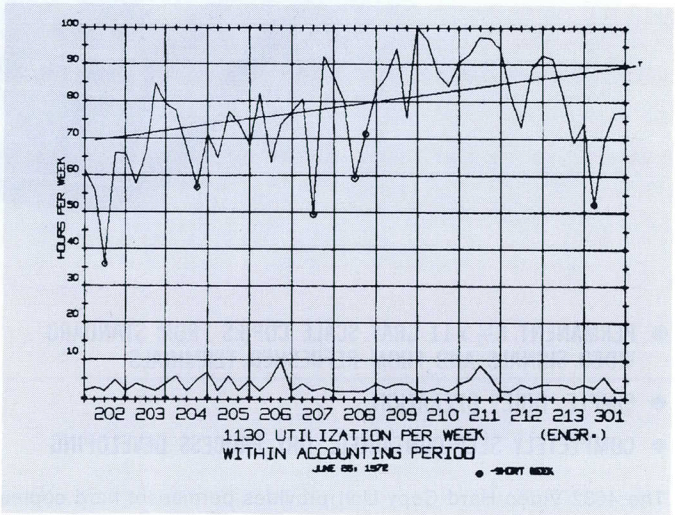
Resolution (with 3M brand Type 777 paper)—Essentially the same as the display.

Power Source (factory-wired options)—115 Volt nominal, 50 to 60 Hz. Maximum power consumption 1450 watts for first 40 seconds after turn-on, 220 to 520 watts for normal operation, and 100 watts standby.

Operating Ambient Temperature—Between +0°C and +35°C is recommended. If operation is necessary in extreme environmental conditions, see your TEKTRONIX Field Engineer or Application Engineer.

Included Accessories— 8-foot detachable power cord, interconnecting cable.





The 4610 provides clear copies of graphic and alphanumeric data.

ORDERING INFORMATION

4610 HARD COPY UNIT **$3550**

4610-1 HARD COPY UNIT **$3550**
Same as 4610 but modified to operate at 220 volts, 50 cycles.

Option 1 MULTIPLEXING CIRCUITRY ..... **Add $400**
Provides copying capability from one to four Computer Display Terminals. Applies to both 4610 and 4610-1.

OPTIONAL ACCESSORIES

Copy Catcher, order 016-0298-00 ..... **$95**

Paper—One roll is included with the 4610 or 4610-1. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$ 40**

For one carton of 4 rolls, order 006-1603-01 ..... **$143**

3M Type 777

New

- **PERMANENT 8½ x 11 GRAY SCALE COPIES FROM STANDARD VIDEO SIGNALS AND FROM REFRESHED TERMINALS**
- **SIMPLE, QUIET OPERATION**
- **COMPLETELY SELF CONTAINED. DRY PROCESS DEVELOPING**

The 4632 Video Hard Copy Unit provides permanent hard copies from standard composite video signals and from digital video signals of refreshed alphanumeric/graphic terminals. The 4632 provides both high contrast (black and white) or gray scale copies. The 4632 development is a dry process and is completely self-contained, lightweight and quiet. The 4632 is easily interfaced to a video system or refreshed terminal by a single cable. The operation of the control panel used to initiate a copy is extremely simplified. High quality copies are produced in seconds and exit, completely dry, into a built-in stacking tray.

CHARACTERISTICS

Input Signal Requirements—Input signals may be any one of three configurations. Configuration 1: Composite Video. Configuration 2: Video with horizontal drive and vertical drive. Configuration 3: Video with composite sync.

Input Video (composite video or video)—Amplitude; 0.3 V to 5 V. Impedance; 75-ohm loop-through. Return loss; ≥46 dB. Common mode rejection; ≥30 dB. Maximum input; 10 VDC plus peak AC.

Input Sync—Amplitude; 0.3 V to 8 V p-p. Impedance; 20 kΩ. Horizontal and Vertical drive; 0.3 V to 8 V p-p. Maximum input; 10 VDC plus peak AC.

Copy Size—Adjusted to 8½ x 11 inches for horizontal raster display (4:3 aspect ratio).

Copy Time—Approximately 18 seconds for first copy (typical 525 line, 60 Hz display). Additional copies of the same display take about 7 seconds each.

Warmup Time—20 minutes.

Power Source (factory-wired options)— 100-115 VAC, 50/60 Hz, 200-230 VAC 50/60 Hz.

Dimensions and Weights

Height	11 in	27.9 cm
Width	16 in	40.6 cm
Length	25.5 in	64.8 cm
Weight	65 lb	29 kg

Included Accessories—Users manual (070-1660-00), one roll 3M Type 777 dry silver paper (006-1603-00), one 75 ohm termination (011-0102-00).

ORDERING INFORMATION

4632 VIDEO HARD COPY UNIT **$2950**
Option 1 COPY COUNTER ..... **Add $35**
Option 2 4-Channel multiplexer ..... **Add $450**
Provides copying capability from one to four video sources.

OPTIONAL ACCESSORIES

Service Manual (mailed on request) ..... **No Charge**
25-foot 75-ohm BNC cable (012-0157-00) **$13.20**

Paper—One roll is included with the 4632. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$40**
For one carton of four rolls, order 006-1603-01 ..... **$143**

- **LINKS DATA AND SIGNAL SOURCES TO LARGE-SCREEN TV MONITORS**
- **STORE, INTEGRATE, DIFFERENTIATE, ADD, SUBTRACT, SCAN-CONVERT, DIGITIZE, COMPOSE AND SELECTIVELY ERASE**
- **GRAY SCALE STORAGE, VARIABLE PERSISTENCE, SELECTIVE ERASE, FRAME FREEZE**

The 4503 Scan converter is a high performance instrument with at least 500 lines resolution per picture height at 50% modulation. The primary application is to process digital and video signals with storage tube image writing and read-out.

The CRT target may be written by XY positioning the beam at random and writing at each point, or a series of points by staircase stepping. The beam may be scanned linearly, fast or slow, with modulation of the beam by a video signal or digital pulses. Analog waveforms may be written, preceded by a continuous erase bar.

CHARACTERISTICS

DISPLAY

Displayed Resolution—At least 500 lines at 50% modulation per picture height. (1000 lines optional).

Line Writing Time—25 microseconds.

Dot Writing Time— 25 nanoseconds.

Read Storage Time—At least 45 minutes (saturated signal). At least 15 minutes for full gray scale.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth— 1 MHz.

Deflection Factor—Vertical: 1 V full screen, Horizontal: 1 V full screen.

Input Resistance— 1 Megohm.

Input Capacitance— 100 pF or less.

Maximum Safe Input Voltage— 200 VDC.

Common Mode Rejection Ratio—minimum, 500:1 at 10 kHz, 100:1 at 1 MHz.

Z AXIS AMPLIFIER

Bandwidth— 30 MHz.

Input Amplitude— 1 V (beam full on).

Input Resistance— 1 Megohm (loop-through unterminated).

Input Capacitance— 100 pF or less.

Maximum Safe Input Voltage— 200 VDC.

Minimum Pulse Width— 40 nanoseconds with 1 V input.

Common Mode Signal Range—plus or minus 2 V.

Full Frame Z Signal—Composite Video 75 ohm (loop-through terminated).

TTL Z Signal—Logic "Lo" unblanks the writing beam.

OTHER CHARACTERISTICS

Power Requirements— 100 watts maximum at 115 V or 230 V, 50/60 Hz.

Composite Sync Out—Amplitude; 0 V to —4 V. Return loss; at least 30 dB.

Composite Video Output—Video information can be displayed at any TV line rate from 525 to 1225 lines. Instrument timing can be internally generated or externally synchronized.

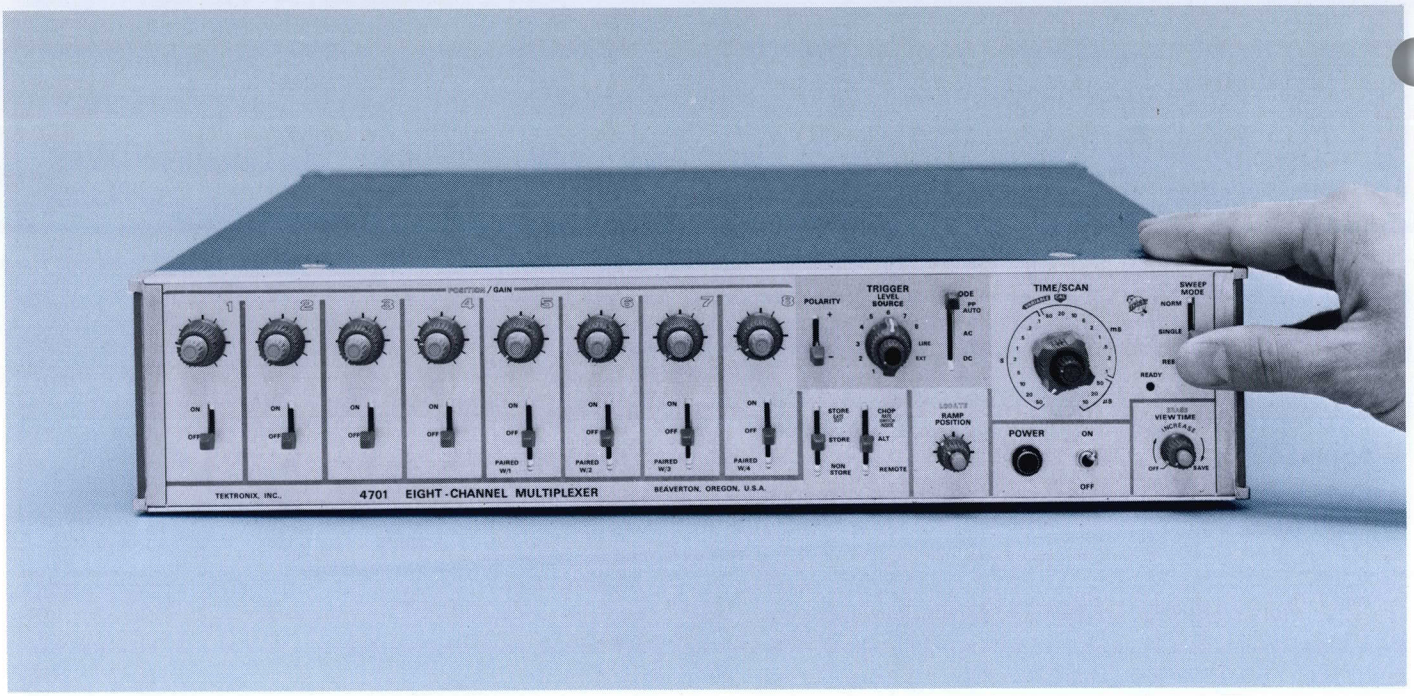
Composite Sync In—Amplitude; 0 V to —4 V. Return loss; at least 40 dB at 5 MHz. The external sync circuit will derive sync from a composite video waveform and will automatically phase lock to any TV line rate from 525 to 2048 lines.

Included Accessories— 75-ohm terminator; 25-pin connector, operator's manual.

ORDERING INFORMATION

4503 SCAN CONVERTER UNIT	$2950
R4503 SCAN CONVERTER UNIT (rackmount model)	$2950
Option 1 1000 LINE RESOLUTION	Add $500
Option 2 RF MODULATOR	Add $100

4701 *Eight-Channel Multiplexer*



- **DISPLAYS 8 CHANNELS Y-T or 4 CHANNELS X-Y**
- **REMOTE CHANNEL SELECTION**
- **CALIBRATED TIME BASE**

Display signals from as many as eight separate sources on a single screen with the 4701 Eight-Channel Multiplexer and a TEKTRONIX Display Unit. The 4701's calibrated Time Base makes possible as many as 8 simultaneous Y-T displays; up to four X-Y displays are possible using the channels in pairs; or a mixture of X-Y and Y-T displays can be selected.

Automatic erase for TEKTRONIX Storage Display Units is provided by the 4701. Operating modes for the 8 channels include Alternate, in Channel 1 through Channel 8 sequence; Chopped, with individual-channel viewing time selected according to the Display Unit in use; and Remote, as programmed from an external source.

INPUT CHARACTERISTICS

The eight channels have identical characteristics. Differential inputs provide for noise cancellation where long lines are used. This is an advantage in areas where the point of signal acquisition is at some distance from the 4701. Conventional 1-MΩ impedance minimizes circuit loading, and allows use of signal probes if further isolation or attenuation is desired. Front panel controls provide a continuously variable 10:1 attenuation.

APPLICATION AREAS

Medical

Operating Rooms and Intensive Care—Monitoring the level of anesthesia, blood pressure, heart rate and ECG signals.

Medical Schools—Monitoring actual and simulated ECG's, EDG's, EEG's, EMG's, etc. The 4701/611/4601 and 4701/4503/TV monitors fill needs here.

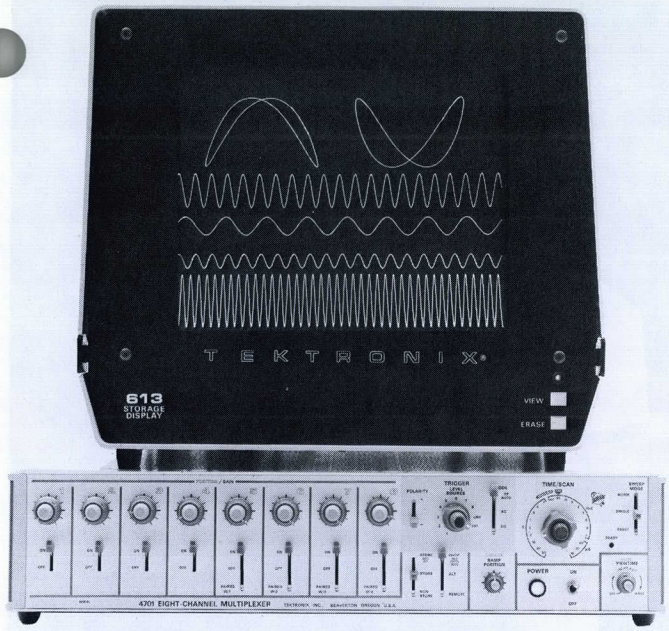
Medical Clinics—Multi-signal tests performed on blood and other biophysical elements.

Education

The 4701 finds a variety of uses in Engineering, Physics, Psychology, Veterinarian Departments and Technical Schools in lecture, labs and research applications.

Petroleum/Chemical

Research and refinery process control applications monitoring pressure, temperature, oxygen, etc. often occur in oil company and chemical plants. Auto erase and the externally-programmed channel selection features are particularly significant when used with computers. Hard copy capability is a plus in this environment.



The 4701 Eight-Channel Multiplexer and the 613 Storage Display comprise a system capable of portraying eight different signal sources.

CHARACTERISTICS

VERTICAL CHARACTERISTICS

Deflection Factor— 1 V to 10 V, continuously variable.

Bandwidth—DC to 1 MHz.

Input Impedance— 1 MΩ paralleled by ≈20 pF.

Common-Mode Rejection Ratio—at least 100:1.

Output— 1 V into 50 Ω with 1 V input.

Operating Modes—Alternate: in sequence 1 thru 8. Chopped: internal switch selects chopping rates of approximately 2.5 kHz, 30 kHz or 300 kHz. Remote: 3 lines of TTL compatible binary code select the output channel.

X-Y Plots—Selector switches on channels 5, 6, 7 and 8 select channels 1, 2, 3 and 4 respectively for their X displays.

TIME-BASE CHARACTERISTICS

Sweep—Provides full screen normal or single sweep displays at 20 different Time/Scan settings from 10 μs to 50 s in a 1, 2, 5 sequence. A non-calibrated mode is continuously variable between steps. Either repetitive or single sweeps can be selected.

Triggered Modes—Automatic peak-to-peak, AC coupled and DC coupled, plus and minus slope.

Trigger Inputs—Can be internal from each selected channel, external, or from the power line.

View Time—Provides automatic control of a TEKTRONIX storage display unit and permits the 4701 to retain the display in a view mode from .08 to 30 s, (continuously variable) after all channels are displayed.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 440 Hz, 21 watts maximum.

Dimensions and Weights—Height 3½ inches, width 16⅞ inches, depth 20⅛ inches, and weight approximately 15 pounds.

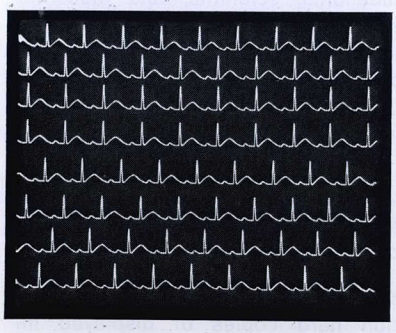
Included Accessories— 6-foot interconnecting cable; 25-pin male connector.

4701 EIGHT-CHANNEL MULTIPLEXER **$1500**

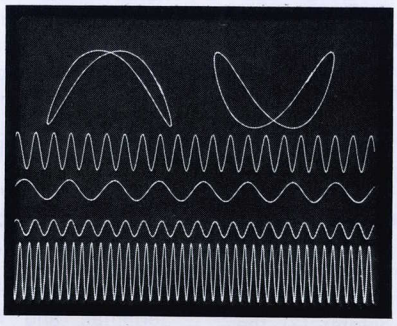
R4701 EIGHT-CHANNEL MULTIPLEXER **$1525**

613 STORAGE DISPLAY **$2200**
Horizontal display format

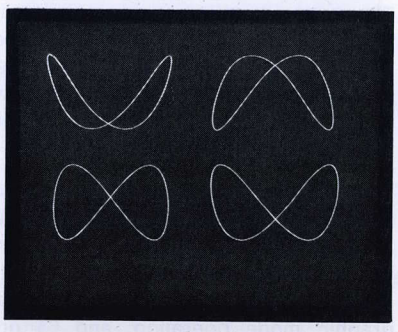
613-1 STORAGE DISPLAY **$2200**
Vertical display format



8-Channel Y-T Displays—Full-Screen normal or single sweep displays are swept at 10 μs to 50 s full scale, from a time base internal the 4701. Oscilloscope-type triggering also provided. Simulated ECG is shown.



MIXED X-Y and Y-T Displays—Simultaneous display of four frequencies versus time and two frequencies versus two other frequencies. Other display combinations include 1 X-Y with 6 Y-T displays and 3 X-Y with 2 Y-T displays.



4-CHANNEL X-Y Displays—Format can be horizontal or vertical, depending on the display unit ordered.

The above displays were photographed on a 611-2 Display Unit.

A GROWING FAMILY OF TERMINALS

Three new terminals add even greater variety and versatility to the successful TEKTRONIX line of Computer Display Terminals. Big screen storage combines with full ASCII and APL capability in the 4014 and 4015—newest members of the 4010 Family. The new 4023 refreshed alphanumeric terminal marks the first TEKTRONIX entry into this field.

The TEKTRONIX Terminal Family also includes (1) the 4002A, a general-purpose display terminal with both storage display and refreshed scratch pad (for on-line editing), a full 96-character ASCII set, and three distinct graphic modes; (2) the 4010, a low-priced terminal combining alphanumeric and graphic mode operation, and 64 printing characters; (3) the 4012, with Alphanumeric Display and Interactive Graphic operating modes, and the complete ASCII character set; and (4) the 4013, offering all of the features of the 4012, plus the complete APL character set. Additional information about each of these terminals is found on pages 271-275.

The PLOT-10 Software system makes the terminals useful for hundreds of business, educational, scientific, and industrial applications—and they can be interfaced with many different data communication systems and computer configurations. PLOT-10 is described on page 275.

COMPUTER TERMINAL FEATURES

The 4010-Family Terminals are designed in a convenient desk-height stand-alone pedestal configuration; excellent for use in any office, laboratory or industrial location.

A Hard Copy can be mated with each TEKTRONIX computer terminal, and high-resolution hard copies of displayed information obtained in seconds.

Further operational versatility is added to all TEKTRONIX terminals with a wide variety of optional accessories.

Price information on all accessories is found in this section.

- FULL SCREEN GRAPHING CAPABILITY
- STORAGE TUBE GRAPHICS WITH REFRESHED TUBE EDITING
- FULL ASCII CHARACTER SET
- HARD COPY COMPATIBILITY

The 4002A is a self-contained computer terminal which provides a high-resolution, flicker-free display of both complex graphics and high-density alphanumerics.

This graphic computer terminal provides benefits of both storage tube graphics and refreshed tube editing. A split screen, direct-view storage tube eliminates the need for a separate refreshed memory for the main display. This minimizes the information rate requirements of the data source. A one line refreshed scratch pad enhances editing. The full ASCII character set is provided, including 96 printing characters. Upper and lower case letters, as well as double size and italics can be displayed.

Three separate modes of graphic display are offered—Point Plot, Linear Interpolate, and Incremental Plot. In any of the graphic modes 1024 points can be addressed in either horizontal or vertical planes. 761 points can be viewed in the vertical plane, 1024 in the horizontal.

Added performance in graphics is provided by the use of the 4951 Joystick in combination with the 4901 or 4903 Interactive Graphic Units. The 4901 or 4903 fit directly into the 4002A, and generate a cross-hair cursor, which can be positioned to any point on the display screen by the Joystick. The Interactive Graphic Unit then digitizes the graphic address at the cross-hair intersection and sends the X and Y address components to the computer.

Hard copy output from the 4002A is furnished by the 4601 Hard Copy Unit. Specification and price information on the 4601 is found on pages 262 and 263.

CHARACTERISTICS

Display Medium—11-inch (diagonal) direct-view, bistable storage CRT with refreshed scratch pad area.

Display Area—8.3-inches horizontal by 6.1-inches vertical.

Alphanumeric Mode

Format— 39 lines of 85 normal or italic characters in main area, one line of 84 characters in scratch pad area.

Character Set— 96 upper and lower case printing characters (ASCII code).

Character Size—70 x 90 mils (approx) can be made double size.

Character Generation— 7 x 9 dot matrix.

Cursor—Pulsating 7 x 9 matrix.

Graphic Modes

Linear Interpolate, Incremental Plot, Point Plot. 1024 x 1024 addressable points, 1024 x 761 viewable points.

Graphic Input Mode—1024 (x), 761 (y) points. Joystick controlled. Cross-hair cursor.

Input Power—110/120 VAC with line voltage selector. HI, MED, or LOW line voltage switch selectable.

Operating Temperature—+10°C to +40°C.

Dimensions—19⅜ inches high, 19 inches wide, 34⅞ inches deep.

Weight— 130 pounds (approx).

4002A GRAPHIC COMPUTER TERMINAL, without Interface ... $8800

Graphic Computer Terminal Interfaces 4002A

INTERFACES FOR 4002A GRAPHIC COMPUTER TERMINAL

DATA COMMUNICATIONS INTERFACE FOR 4002A $600

021-0033-00 This interface transfers data in a serial asynchronous format either full-duplex or half-duplex mode. It conforms to EIA Standard RS-232-C and CCITT V24. Internal clocks or external timing signals may be used. Transmit and receive rates are independent of each other and easily selected on back panel switches. Standard selectable rates are 110, 150, 300, 600, 1200, 2400, 4800, 9600 bits/sec inclusive. Two positions of each switch are provided for user chosen rates.

TELETYPE PORT INTERFACE FOR 4002A $750

021-0034-00 DEC PDP-8/i, 8/L and 12
021-0035-00 Data General Computers
021-0036-00 HP 2100 Series & 2000A (12531 card)
021-0037-00 Varian 620/i, 620/L, 620/R
021-0038-00 Honeywell H316
021-0039-00 Interdata Computers and G. E. Process Computers with Teletype Control Card Type 32-062 F01
021-0039-01 Interdata Computers and G. E. Process Computers with Teletype Control Card Type 32-120 F01
021-0040-00 DEC PDP-11
021-0041-00 Varian 620F
021-0043-00 Raytheon 703, 704, 706
021-0044-00 DEC PDP-9
021-0045-00 DEC PDP-8 (S/N 150 & up)
021-0045-01 DEC PDP-8 (S/N 149 & below)
021-0046-00 DEC PDP-15
021-0047-00 DEC PDP-8/e with Module M865
021-0047-01 DEC PDP-8/e with Module M8650
021-0051-00 Honeywell DDP 516

4901 INTERACTIVE GRAPHIC UNIT $525
4903 INTERACTIVE GRAPHIC UNIT $1000
4951 JOYSTICK $300

4010, 4010-1 *Computer Display Terminal*

- SUPPORTS ALPHANUMERIC PLUS LOW-COST INTERACTIVE COMPUTER GRAPHICS
- CONVENIENT PEDESTAL DESIGN FOR USER ENVIRONMENTS
- FLICKER-FREE STORAGE DISPLAY
- COMPLETE SOFTWARE SUPPORT—PLOT-10

The 4010 Computer Display Terminal is a low-cost computer terminal for use in business, educational and scientific environments. Until recently, cost was a major barrier to the use of graphic terminals in many applications. The 4010 has broken the cost barrier, with complete interactive graphics and alphanumeric display at a new, economical price. Direct-view bistable storage makes the CRT display clear and flicker-free, with excellent resolution on all parts of the screen. Thumbwheel control of the cross-hair graphic cursor speeds and simplifies graphics input.

For alphanumeric operation, the full TTY ASCII character set of 64 printing characters is featured, with a format of 35 lines of 72 characters each—a total of 2520 characters maximum on the display screen.

For graphics, the 7.5 by 5.6-inch display area includes 1024 addressable points in both X and Y planes. Viewing limits are 1024 points in the X plane, and 780 in the Y plane.

Permanent hard copies can be made quickly and inexpensively by mating the 4010-1 version of the terminal with the 4610 Hard Copy Unit. Price and specification details for the 4610 are found on pages 264 and 265.

4010 CHARACTERISTICS

Display Medium—11-inch direct-view bistable storage CRT.

Display Area— 7.5 inches wide by 5.6 inches high.

Alphanumeric Mode

Format— 72 characters per line, 35 lines; 2520 characters per screen.

4010 Character Set— 64 printing characters (TTY ASCII Code).

4010 Cursor—Pulsating 5 x 7 dot matrix.

Graphic Mode—Vectors only. Vector drawing time 2.6 ms. 1024 x 1024 addressable points; 1024 x 780 viewable points.

Graphic Input Mode— 1024 (X), 780 (Y) points. Thumbwheel controlled cross-hair cursor.

4010 COMPUTER DISPLAY TERMINAL	$3950
4010-1 COMPUTER DISPLAY TERMINAL	$4250
ANY OPTIONAL INTERFACE	Add $300

4012 *Computer Display Terminal*

- LOW COST FULL RANGE PERFORMANCE
- UPPER AND LOWER CASE ALPHANUMERICS
- GRAPHIC CAPABILITY WITH HIGH RESOLUTION
- FULL ASCII CHARACTER SET

New operating versatility in low-cost computer graphics is offered by the 4012 Computer Display Terminal. TEKTRONIX direct-view bistable storage provides clear, flicker-free CRT display with excellent resolution on every part of the display screen. High-density alphanumeric and graphic displays contain as many as 2520 alphanumeric characters on 35 lines of 72 characters each. Addressable points for graphic operation are 1024 in X and 1024 in Y planes, with 780 in the Y plane and 1024 in the X viewable on screen.

Three modes of operation are provided. In addition to alphanumeric mode, Graphic Display (GRAF) and Interactive Graphics (GIN) can be used. The entire PLOT-10 Software System is available for use with the 4012, and interfaces can be arranged with a wide variety of data communication and computer systems.

The full ASCII character set of 96 printing characters is included, with both upper and lower case letters.

Hard copies of all 4012 displays can be made with the 4610 Hard Copy Unit mated to the terminal. See pages 264 and 265 for price and specification information on the 4610.

4012 COMPUTER DISPLAY TERMINAL	$4950
ANY OPTIONAL INTERFACE	Add $300

4013 *Computer Display Terminal*

- PROGRAMMING EASE FOR SCIENTISTS, MATHEMATICIANS, EDUCATORS
- APL CHARACTER CAPABILITY WITH HIGH RESOLUTION
- FULL ASCII CHARACTER SET

APL (A Programming Language) makes computer graphics a faster, more effective procedure and makes programming easier for scientists, mathematicians and educators. APL operation is a feature of the new 4013 Computer Display Terminal. This versatile new terminal, utilizing the TEKTRONIX direct-view bistable storage CRT, offers, in addition to the APL character set, the complete ASCII character set of 96 printing characters, including both upper and lower case letters.

The 4013 is an even more effective tool of data communication when used with the new TEKTRONIX PLOT-10 APL/Graph software or with the PLOT-10 software developed for the 4010-series Computer Display Terminals.

The 4013 offers high character density and exceptional display resolution. Up to 35 lines of 72 alphanumeric characters can be displayed simultaneously—and in the graphic modes, a 1024 by 1024-point matrix is addressable from the keyboard or from the computer. 1024 X addresses by 780 Y addresses are viewable on screen. All 4013 displays are flicker-free because of the TEKTRONIX storage CRT.

As with other TEKTRONIX Computer Display Terminals, hard copies of all displays can be made in seconds, and at minimum cost by using the 4013 with the 4610 Hard Copy Unit. Price and specification details for the 4610 are found on pages 26 and 265.

4013 COMPUTER DISPLAY TERMINAL	$5450
ANY OPTIONAL INTERFACE	Add $300

New — COMPUTER TERMINAL PRODUCTS
Computer Display Terminal 4014

- LARGE SCREEN DIRECT-VIEW STORAGE DISPLAY
- FOUR PROGRAM-SELECTABLE FORMATS IN ALPHANUMERIC MODE
- VECTOR AND DISCRETE-PLOT GRAPHIC MODES
- FIVE PROGRAM-SELECTABLE FORMATS IN GRAPHIC MODE

Storage display is presented on a big screen with the new 19-inch direct-view storage CRT in the 4014 Computer Display Terminal. Pictures, designs, graphs, procedures can all be presented in large, sharp, high-resolution displays. Any information on the screen can be copied on 8½ by 11-inch dry copies with a TEKTRONIX 4600-series Hard Copy Unit.

CHARACTERISTICS

Display Area—15 inches (≈381 mm) wide by 11 inches (≈279 mm) high.

Alphanumeric Mode—Four program-selectable formats from 74 characters per line with 35 lines per display, to 133 characters per line with 64 lines per display. 7 x 9 dot pulsating cursor. Full ASCII character set (94 printing characters).

Vector Mode—Vector drawing time: 5000 inches per second. Addressable Points: 1024(X) by 1024(Y), Displayable Points: 1024(X) by 780(Y).

Discrete Plot Mode—Incremental plot capability with 4096(X) by 3124 (Y) displayable points. Also allows program control of Z axis.

4014 COMPUTER DISPLAY TERMINAL **$8450**
ANY OPTIONAL INTERFACE ..... **Add $300**
DISCRETE PLOT OPTION (018-0073-00) ..... **Add $500**

New
Computer Display Terminal 4015

- FULL APL and ASCII CHARACTER SETS
- LARGE DIRECT-VIEW STORAGE CRT
- INTERACTIVE GRAPHICS CAPABILITY

The 4015 makes alphanumeric/graphic displays available on a large 15-inch by 11-inch viewing screen with storage capability. Included are the full ASCII and APL character sets (188 total printing characters), and a 7 x 9 dot pulsating cursor. Vector mode features 5000 inches per second vector drawing time.

The 4015 is compatible with all present APL systems, and makes use of all PLOT-10 software (see page 275). Pictures, designs, graphs, procedures can be displayed in a large, sharp, high-resolution, easily viewable size. As many as 8,512 alphanumeric characters can be displayed at one time. Permanent, dry-process hard copies of any information on the screen are made with a TEKTRONIX 4600-Series Hard Copy Unit.

4015 COMPUTER DISPLAY TERMINAL **$8950**
ANY OPTIONAL INTERFACE ..... **Add $300**
DISCRETE PLOT OPTION (018-0073-00) ..... **Add $500**

Computer Display Terminal Interfaces 4010-Family

(specify interface at time of order.)

ANY OPTIONAL INTERFACE ..... **Add $300**

Data Communication Interfaces

Standard	Standard Data Communication Interface included with the 4010 and 4010-1 is RS-232-C compatible. Strap selectable input/output data rates of 150, 300, 600, 1200, 2400, 4800 and 9600 bits/sec.
Option 1	Optional Data Communication Interfaces with convenient switch-selectable functions including: local-echo, full-duplex, half-duplex and independent transmit and receive rates of 110, 150, 300, 600, 1200, 2400, 4800 and 9600 bits/sec.

Teletype Interfaces

Option 2	DEC PDP-11 (Also see Option 16)
Option 3	DEC PDP-8/i, 8/L, 12, 15
Option 4	Data General Computers
Option 5	DEC PDP-8/e with Module M865 (Also see Option 17)
Option 6	HP 210 Series, 2000O (12531 card)
Option 7	Varian 620/i, 620/L, 620/R
Option 9	Raytheon 703, 704, 706
Option 10	DEC PDP-8 (S/N 150 & up), PDP-9 (Also see Option 18)
Option 11	Honeywell H316
Option 12	Honeywell DPD 516
Option 13	Interdata Computers and G.E. Process Computers with Teletype Control Card Type 32-062 FOI (Also see Option 19)
Option 14	Varian 620F
Option 15	APL 360
Option 16	DEC PDP-11 with D-11 Controller
Option 17	DEC PDP-8/e with Module M8650
Option 18	DEC PDP-8 (S/N 149 & below)
Option 19	Interdata Computers and G.E. Process Computers with Teletype Control Card Type 32-120 FOI

New

- **LOW COST REFRESHED VERSATILITY**
- **UPPER AND LOWER CASE CAPABILITY**
- **OPERATES AT THE SPEEDS YOU REQUIRE**

The newest member of the growing family of TEKTRONIX computer display terminals, the 4023 Refreshed Computer Display Terminal, for all of its low cost, is not a stripped-down version. It provides powerful editing and display formatting capabilities.

The 4023 keyboard provides selection of a full ASCII set of 94 printing characters, or the 63 character TTY upper case subset.

The memory (buffer) of the 4023 allows space for 24 lines with 80 characters each, providing a total of 1920 characters. Standard Terminal features permit the cursor to be addressed to any one of the 1920 character positions.

The 4023 can communicate directly with a computer, bypassing the buffer; or it can communicate via the buffer. Communicating directly to the computer is a character-by-character process; whereas, in buffered communications the data can be sent as one complete block.

Function Control and Numeric Pad—A cluster of 12 keys to the right of the keyboard that provides a dual purpose. Normally these keys provide control for editing, transmission, cursor movement, etc. However, pressing the NUM LOCK key located in the bottom right corner of the key cluster, enables the 12 keys to function as a numeric pad.

Editing Capabilities—Insert character and line, delete character and line, erase to end, erase input, and erase page. Editing is speeded by tab, back tab, and repeating character keys.

Field and Data Formatting—Displayed data can be arranged to resemble the source document. Forms information can then be rapidly retrieved, updated, edited, and entered. Visual field formats include: inverted, blinking, blanked, and dim fields. Logical formats include: transmittable, non-transmittable, protected, non-protected, and non-alpha fields.

Data Communications Interfacing—Provided by two data communications interfaces for telephone line connection. One is the standard Data Communications Interface supplied with the 4023 when no other interface is specified. Compatible with RS-2320, this interface provides switch-selectable input/output data rates of 110, 150, 300, 600, 1200, 4800, or 4600 baud. Local echo is also switch selectable.

CHARACTERISTICS

CRT— 12-inch diagonal.

Display Size— 9 inches wide by 5.5 inches high

Phosphor Type—P-4 (white)

Video—Composite Video, compatible with standard interlaced 525 line monitor

Refresh Rate— 60 Hz

Cursor Type— 7 by 10 dot matrix, non-destructive remote or local control

Character Generator— 5 x 7 dot matrix

Character Size— 80 mils by 120 mils (0.80 inch wide by 0.12 inch high)

Character Code— 128 ASCII, 94 printing upper and lower case characters.

Characters Per Line— 80

Lines Per Display— 24

Refreshed Buffer—MOS RAM

Intensity—Normal 30 foot lamberts, dim 15 foot lamberts for background identification

Keyboard— 64/96 ASCII upper and lower case, 2 key rollover, auto-repeat for any keys depressed over 0.3 second

Input/Output—Standard Data Communications Interface is RS-232C compatible, Full Duplex, Serial Asynchronous, Start/Stop, LSB first, Baud rate Transmit/Receive selectable 110-9600 with backpanel switch, Transmission code is 128 ASCII upper/lower case.

Power Requirements— 115/230 (hi, medium, lo) VAC, 50 to 400 Hz, nominal 220 watts

Physical—	Height	13 inches	≈33 cm
	Width	18 inches	≈46 cm
	Depth	23 inches	≈58 cm
	Net Weight	46 lbs.	≈21 kg
	Shipping Weight	67 lbs.	≈30 kg

ORDERING INFORMATION

4023 COMPUTER DISPLAY TERMINAL **$2995**

Option 1 OPTIONAL DATA COMMUNICATION INTERFACE Add $300

OPTIONAL ACCESSORIES

Audio Recorder Card, order 018-0086-00 ..... **$29**

Rulings Character Set, order 020-0085-00 ..... **$300**

- **SAVES MONEY AND TIME**
- **SAVES COMPUTER CORE**

Punched tape capability greatly expands the limited memory capacity of a mini-computer. With the 4911 Reader/Perforator Unit, programs that would otherwise consume valuable space in core storage are kept in permanent off-line form, ready to be read into the computer at 200 characters per second. Unprocessed data can be recorded in punched tape form and fed into the computer at convenient times.

With a 4911 Reader/Perforator Unit, the programs and data normally filed in a timesharing or in-house computer system can be converted to 8-channel punched tape and used for file maintenance through the 4010-Family Computer Display Terminal.

Tape loading and operation of both the reader and the perforator are quick and simple through convenient grouping of front panel pushbutton controls.

The 4911 Reader/Perforator Unit uses standard, easily-obtained one-inch paper, paper-mylar, or aluminum-mylar tapes with a thickness range of 0.0030 to 0.0043 inch.

ORDER INFORMATION

4911 READER/PERFORATOR UNIT **$2950**

SOFTWARE PRODUCTS

- **MOST EXTENSIVE GRAPHING SOFTWARE AVAILABLE ANYWHERE**
- **INTERFACES TO MORE THAN TWENTY MAJOR MINIS**
- **COMPATIBLE WITH MAJOR TIMESHARING SYSTEMS**
- **SOFTWARE ACCESSIBILITY TO 360/370 SYSTEMS**

Tektronix, Inc. has expanded its program of total software support to provide the most extensive graphing software ever offered. This graphing software is compatible with most timesharing systems, with IBM 360/370 O/S and TSO and with numerous mini-computers. PLOT-10 offers a series of modules from which can be selected those elements that best suit the operating environment and application. Now users can quickly and easily get computer data into a graphing form directly helpful to decision making.

PLOT-10/Mini-Computer

The PLOT-10/mini-computer package lets the operator easily use the TEKTRONIX terminals on his mini-system. PLOT-10 consists of assembly-language subroutines supporting graphics input/output and special functions of the terminal.

PLOT-10/360-370 Graphics Software

The PLOT-10/360/370 software module provides the capability to access TEKTRONIX terminals from within application programs. Written in assembler language using IBM's Execute Channel Program I/O facility, modules can be assessed from any of the IBM programming languages by subroutine calls. Special facilities are provided for PL/I compatibility. The module will handle multiple terminals, and operates under O/S MFT or MVT, or MVT with TSO.

Hardware connection between the S360/370 and the TEKTRONIX terminal is made through IBM's 270X series telecommunications control units. Varying speed capability, 300, 600, 1200, 2400, 4800 or 9600 baud, is available by replacing the IBM oscillator card in the IBM 2701 Control Unit with a TEKTRONIX oscillator card.

PLOT-10/Terminal Control System

This package sets a new standard for interactive graphics terminal software. It provides a comprehensive base of graphic software to support user application programs.

The software is written in FORTRAN IV. These routines allow all or part of your picture to be displayed on any region of the terminal screen. All clipping and scaling are automatic.

Routines are included for erasing the screen; making a hard copy; determining character size and font, plotting absolutely or relatively; handling and formatting alphanumeric output; and performing graphic input of screen points. Care has been taken to maximize transferability to any operating system that supports a FORTRAN IV compiler.

PLOT-10/Advanced Graphing—II

This set of routines allows the user to display data graphically without concerning himself with programming details. Alphanumeric data tables can be converted to graphs with a single subroutine call. Routines are included for data plotting in cartesian, semi-log, log-log, and polar-coordinate systems, with automatic or specified scaling. One curve or several curves can be drawn on the same set of coordinates.

PLOT-10/Decision Maker

PLOT-10/Decision Maker is an interactive system of FORTRAN IV subroutines which provide graphic analysis, forecasting, and report generation capabilities for a variety of business applications.

Two versions of PLOT-10/Decision Maker are available: (1) for Digital Equipment Corporation's PDP-10 with the standard DEC monitor; and (2) for IBM systems supporting TSO.

PLOT-10/APL Graph Software

APL/Graph is an integrated collection of user oriented APL functions adapted from the popular Terminal Control System and Advanced Graphing Routines. They are designed to allow highly interactive, easy to use computer graphics. The package includes functions to control all utilities of the terminal itself, including screen erasure, windowing, clipping, hard copy generation, and alphanumeric handling.

An extensive set of functions is also available to provide support for users in all facets of business, scientific, mathematical, and educational work. These include functions for creation of pie charts, histograms, time-series scales, and all types of X, Y plotting. Functions are also included to allow polynomial curve fitting. Normal X, Y plotting can be done on cartesian, semi-log, log-log, and polar coordinate systems with any number of curves drawn on the same set of coordinates.

Dataform

Dataform is a set of FORTRAN IV routines which allows the user to create, edit, save, and display forms in a TEKTRONIX 4023 refreshed terminal environment.

Included in the Dataform package is support of terminal functions such as erase, Hard Copy, cursor positioning, and others including the Ruling Character Set accessory for the 4023.

- **NATURAL MATHEMATICAL LANGUAGE**
- **POWERFUL PROGRAMMING ABILITY**
- **LESS EXPENSIVE**

NO MACHINE LANGUAGE NEEDED

Until now, programmable calculators have been unable to completely remove the machine language/rule barrier. Tektronix understands the problems this creates. That's why we designed our programmable calculators the other way around. From you and your mind back into the machine. Instead of you having to adapt to the machine, it has been adapted to you and the math language you grew up with.

The TEK 21 and TEK 31 are designed for easy interaction between you and your machine. There are no machine rules or languages to learn. Just natural, English-like programming keys and a simple keyboard that does math exactly the way you write it down.

Every function (and program) is clearly defined by the key sequence. For example, enter directly: $123.456 \times 10^{2} + 123=$. You get the answer, 1.24686×10^{4}, without having to modify the equation by special switches, or move it from register to register.

You can enter data in any mixture of notations. For example, enter directly: $23.40 \times 10^{-06} + .0000052=$. You get the answer, 2.86×10^{-05}, without having to convert the whole equation to one kind of notation.

The machine follows the same math hierarchy you do in working equations. Single variable operations, such as x^2 and $\sqrt{x}$ are performed first. Then, two-variable functions, like $|x|^a$ and $\sqrt{\Sigma x^2}$ are performed. Multiplication and division take place next, followed by addition and subtraction.

For example, enter directly $1 - 2 \times 3 + 8 - 4 =$. The correct answer, —1, will always result. You don't have to remember to key in unnecessary parentheses. More importantly, you don't have to remember to key in the equation in a special order.

There are over 30 math functions built into each TEKTRONIX calculator. So you don't have to spend additional funds to get the math functions you use frequently. You can solve equations containing exponents and trig functions directly from a single keyboard.

ADAPTABLE TO MANY REQUIREMENTS

With our calculator you can solve problems, even hyperbolic functions, right from the keyboard. You can store data in the calculator's memory and recall it by keystrokes. Or, put an entire problem in the program memory and have your calculator run programs, execute key commands, and recall data for you. Tektronix provides special software packages to make programming your calculator even easier. We are constantly developing new packages to meet your needs.

Memory capacity needs vary from one discipline to another. With our calculator, you can specify the amount of memory capability you require. If you need increases, the machine can be adapted internally, right in your office. The TEK 31 can be expanded to 8,192 program steps, 266 data registers, or 2,048 program steps, 1,010 data registers, or a combination of both.

In both TEKTRONIX calculators, program steps and data registers are separated. So you have no housekeeping details to worry about. You can add magnetic cards, cartridge tapes and plug-in PROM blocks also to expand memory or to perform specific functions. Input and output peripherals can be interfaced to further simplify your work, and take the tedium out of computation.

There's a user-definable overlay which makes the calculator more approachable, yet still maintains the machine's basic math capability. You custom label keys in your own language. For example, you might label a key standard deviation. Then, with a single keystroke, that function is executed. This feature allows even the inexperienced operator to use the machine, freeing the engineer from time spent entering data. The alphanumerics of the TEK 31 make interaction between you and the machine even easier.

COST EFFECTIVE

Through advanced design, based on unique concepts in MOS technology Tektronix is able to make a major price breakthrough with these calculators. The TEK 21 is only $1850, and the Tek 31 only $2850. They are built to Tektronix' high standards of technical excellence.

Built into both machines are many features you'd have to pay extra for on other calculators. For example, the full math capability, including trig and hyberbolic functions, user-definable keys, and peripheral control capability, just to mention a few.

COMPARE

Compare	Tek 21	Tek 31
PRICE for basic unit	**$1850**	**$2850**
NATURAL MATH LANGUAGE		
Follows math hierarchy	yes	yes
Data entry format	ordinary floating scientific floating mixed	ordinary floating scientific floating mixed
BUILT-IN FUNCTIONS		
Math functions	35	35
User-definable keys	8	24
MEMORY		
Data storage, standard	10 registers	74 registers
Optional		138, 202, 266, 458, 650 or 1,010 registers
Program, standard	128 steps	512 steps
Optional	256, 512 steps	1,024, 1,536, 2,048, 3,584, 5,120 or 8,192 steps
Program entry	Magnetic cards or Keyboard	Tape cartridge or Keyboard
PROGRAMMING POWER		
Conditional branching	yes	yes
Register arithmetic	Single keys	Single keys
Indirect addressing	yes	yes
Symbolic addressing or sub-routines		yes
Subroutine nesting		yes
Programmable flag		yes
English listing		yes
Editing	Step forward	Insert, delete, step forward, step back
OUTPUT		
Electronic display	12 digit (10 digit mantissa +2 digit exponent)	12 digit (10 digit mantissa +2 digit exponent)
Silent thermal printer (optional)	Numeric	Alphanumeric

- EASY TO READ DISPLAY
- FLASHING DISPLAY FOR ILLEGAL MATH OPERATIONS
- BUILT-IN MATH ROM WITH 35 BUILT-IN MATH FUNCTIONS
- MAGNETIC CARD FOR PROGRAM STORAGE
- FOLLOWS MATH HIERARCHY
- 10 DATA STORAGE REGISTERS
- 128 PROGRAM STEPS STANDARD
  256 AND 512 OPTIONAL
- INDIRECT REGISTER ADDRESSING
- INTERFACE WITH PERIPHERALS

No other calculator can do so much at such a modest price. The TEK 21 can free you from many of the time-consuming computations you must perform regularly. The keyboard looks deceptively simple. There's a lot more power behind it than you might suspect. In addition to 35 built-in math functions, there are 8 keys for functions you can define yourself. Customize a key to perform any sequence of keystrokes or other math functions you use frequently. Then when you need that sequence, all you do is push a single key labeled in your own language. The machine does the rest for you.

Enter data easily in the TEK 21. With any combination of ordinary floating, scientific floating or mixed decimal notation. The machine accepts information in whatever form you put it in, and deals with that information correctly.

MEMORY

Ten data registers, and 128 program steps standard, 256 and 512 steps optional.

Memory in the TEK 21 is separated into data storage and program memory. You don't have to worry about program steps and data registers overlapping. The calculator takes care of these details.

Data Storage Memory
Data is stored in ten registers, labeled K0 through K9. Each register can store any number shown in the display.

Storing a number is easy. For example, to store 146.73 in register K0 just press the keys: 146.73 = K0. Now the number is stored in K0.

Recalling data from the registers is done in the same simple way. For example: to add the contents of registers K0 and K1, and store the result in K2, simply press keys: K0 + K1 = K2. You have recalled and used the data in registers K0 and K1. The result is now in K2.

Program Memory

The basic program memory in the TEK 21 is organized in 8 blocks. In the standard machine, each block holds 16 program steps, or 128 total. With optional memory installed, this can be expanded to 256 or 512 steps. Access to the beginning of a program block is through the eight keys, f0 through f7.

You can use each of the eight blocks for a separate program, thus allowing eight individual programs to be put in memory. Or you can link these blocks, allowing longer programs to be written. For example, one program could take all eight blocks of memory.

With an overlay, you can label these keys in any way you want. Each key then addresses the beginning of a different block of memory. For example, f2 may address that part of memory programmed to calculate impedance. A single keystroke executes that sequence.

Magnetic cards are used to store or load in programs. They also can be used to expand the number of steps available.

PROGRAMMING

Programming the TEK 21 calculator is as simple as writing out your problem in ordinary math language, and then transferring that formula direct to the program memory.

For example: A + B X C = D

translates to K0 + K1 X K2 = K3 in the TEK 21.

To program this into memory, there are a few simple things you must tell the calculator. You must tell it where you want to start. So you press [GO TO] followed by the memory block you want to go to, [f2] for example. Next, you tell it you want it to remember. Press [DEFINE f∞ / LEARN]. The calculator is in the learn mode and ready to accept the information you want it to remember. Press the keystrokes you want it to learn: K0 + K1 X K2 = K3. If you want a printed copy of your result, press [PRINT DSPLY].

To tell the calculator that you have finished your program, press [END]. Now, tell the machine to stop remembering by pressing [DEFINE f∞ / LEARN]. This takes the calculator out of the learn mode.

To execute the program, simply press [f2].

Somewhere in the program you might want to direct the calculator to another point in memory. To unconditionally branch to that point, just press the key (f0 through f7) which identifies it. The calculator will go to that point and start execution there.

Decision making is easy in the TEK 21. Examine the contents of the display based on whether it is greater than or equal to zero (the default is, of course, less than zero). If the display is greater than zero the calculator will branch to where you tell it to go with the next keystroke (f0 through f7). If the condition is not met, the program continues without branching.

[STEP] and [LIST] keys are used for debugging and program documentation. Editing is also available in the TEK 21. The register arithmetic keys help eliminate keystrokes in your program and are useful in statistical applications.

Indirect addressing of data registers is possible in the simplest manner and shortens the number of program steps you need to do successive operations on a number of pieces of data.

OUTPUT

Operations and results are simple to read on the TEK 21. There's a large, bright display that flashes to tell you when the machine has exceeded its range or you've asked it to perform an illegal math operation. A silent numeric thermal printer gives you a hard copy of your results.

ORDERING INFORMATION

TEK 21 PROGRAMMABLE CALCULATOR	**$1850**
Option 01—THERMAL PRINTER	**$450**
Field Installation Package for Thermal Printer (Installation charge as quoted.)	**$500**
Option 02—MEMORY EXPANSION PACK—256	**$250**
Option 03—MEMORY EXPANSION PACK—512	**$400**

OPTIONAL ACCESSORIES

TEK 21 Statistics Program Library, Volume I	**$40**
TEK 21 Mathematics Program Library, Volume I	**$40**
Carrying Handle Kit, order 016-0575-00	**$25**
Magnetic Card Package, order 016-0576-00 (Package of 25 cards)	**$20**
Program Overlay Package, order 016-0577-00 (Package of 25 overlays)	**$10**
Thermal Printer Paper, order 006-1775-00 (Package of 5 Rolls)	**$10**

- EASY-TO-READ DISPLAY
- FLASHING DISPLAY FOR ILLEGAL MATH OPERATIONS
- 24 USER-DEFINABLE KEYS
- COMPLETE EDIT CAPABILITY
  INSERT, DELETE
  STEP FORWARD, STEP BACK
- FOLLOWS MATH HIERARCHY
- MEMORY EXPANDABILITY AND VERSATILITY
  512 PROGRAM STEPS STANDARD, EXPANDABLE TO 8192
  74 DATA REGISTERS, EXPANDABLE TO 1010
- INDIRECT REGISTER ADDRESSING
- INTERFACES WITH A WIDE VARIETY OF PERIPHERALS

The TEK 31 is an even more powerful machine with more memory than the TEK 21. And it can be customized to meet your particular needs. In addition to 35 built-in math functions, there are 24 keys which you can define to perform special functions you use frequently. A plug-in PROM (programmable read-only memory) can be loaded with your program which you define and find repeatedly useful in your own work. This makes the TEK 31 truly a personal calculating system. The TEK 31 has a cartridge tape unit to store programs and/or data.

Needs for memory capability and type vary. A statistician, for example, may have to deal with large quantities of data, while a theoretical physicist may need to solve complex problems involving only limited amounts of data. Most people need to work with both. Each of these requires a different mix of data storage and program memory. With the TEK 31, this is no problem. You specify and purchase only the amount and type of memory you need. If your need changes, you can expand the memory with a modification done in your office.

MEMORY

The TEK 31 has 512 program steps and 74 data registers in the standard model. The basic machine can be expanded in blocks of 512 program steps and 64 data registers up to 2,048 steps and 256 registers. Beyond that, you can expand program steps up to 8,192 or expand registers up to 1,010. Or you can add a combination of both. No matter what configuration you choose, program and data will always be stored separately. If your memory needs change, a simple operation in your office can restructure the machine.

Data Storage Memory

Storing a number in the TEK 31 is easy. In the basic machine, data is stored in the ten "K" registers (as in the TEK 21) plus the 64 "R" registers. For example, to store .25943 in register R52 just press the keys: .25943 = R52. The number is stored in R52. Recalling data is just that simple. For example: to multiply the contents of registers K0 and R33 and store the result in R14, simply press keys: K0 x R33 = R14. The data has been recalled, used and the result is now in R14.

Program Memory

In the TEK 31 there is one continuous memory, instead of the eight separate blocks in the TEK 21. In the basic machine this memory holds 512 program steps, and you can branch to any step. The versatility of the TEK 31 allows you to use an overlay to label 24 user-definable keys in your language. For example, if you're an electrical engineer dealing with complex variables, you may label keys magnitude, phase, real and imaginary. A single keystroke would give you any of these parameters. If you're dealing with statistics, you might choose to label some of the keys mean, variance, standard deviation, linear regression. While you're using the overlay in your language, you still maintain the full mathematical capability of the TEK 31.

A magnetic tape can also be used to store or load programs or data. And it can also be used to expand the number of steps or data registers available to you.

PROGRAMMING

In addition to conditional and unconditional branching, on the TEK 31 you have full editing capability, you can symbolically address and nest sub-routines, and alphanumerics are as simple as typing your name. With these features and the ease of programming, the computational power of a computer is available at your fingertips. And in a language you already understand.

For example, to enter a program into the TEK 31 program memory, simply tell the calculator the starting point of the program by using the GO TO key followed by the desired memory address. Then to tell the calculator to remember the keystrokes of your program press the LEARN key and enter your program. To print any result simply press the PRINT DSPLY key. To end the program and reset the calculator press the RESET key. Exit the learn mode by pressing the LEARN key.

Decision making within your program is a simple matter with the "if" condition keys (conditional branching). The number in the display may be tested for less than zero, equal to zero, or greater than or equal to zero. In addition, you can test the condition of a programmable flag and test to see if the calculator has overranged or attempted an illegal math operation (indicated by a flashing display). If the conditions are not met, the sequential program execution is interrupted and program control branches to the appropriate point in the program. In addition to these conditional branches, four types of unconditional branches are available.

If there is an error in programming, it's easy to examine the program, by pressing STEP or STEP keys to debug the program. The printer will list the program steps in English for you. Once you detect the error, you can insert, delete or overwrite a step. If necessary, the machine automatically renumbers the subsequent program steps.

Symbolically labeling a sub-routine allows you to call a subroutine by its name rather than by its location in memory. The calculator will remember the subroutine location. All you have to do is tell the calculator which subroutine you want. The calculator automatically finds the sub-routine, and executes it.

In order to return to the proper point in the program after branching to a sub-routine, the calculator automatically remembers the return address. This return address may be sequentially stored and recalled to permit nesting of sub-routines, or modified to alter the return address.

With the alpha capability in the TEK 31, the calculator actually communicates with the operator. Because the calculator can print instructions, ask for input and label results, an experienced operator is no longer a necessity. Any one who can press the start key can get the right answers.

OUTPUT

Reading the operations and results is easy in the large, bright display. Messages displayed tell you what mode you're in and if an error has been made. When you need hard copy, there's the silent alphanumeric thermal printer, optional on the TEK 31.

ORDERING INFORMATION

TEK 31 PROGRAMMABLE CALCULATOR	$2850
Option 01—THERMAL ALPHANUMERIC PRINTER	$700
Field Installation Package for Thermal Printer (Installation charge as quoted.)	$750
Option 02—1024 STEPS 128 REGISTERS	$400
Option 03—1536 STEPS 192 REGISTERS	$700
Option 04—2048 STEPS 256 REGISTERS	$1000
Option 05—2048 STEPS 640 REGISTERS	$2000
Option 06—3584 STEPS 448 REGISTERS	$2000
Option 07—5120 STEPS 256 REGISTERS	$2000
Option 08—2048 STEPS 1000 REGISTERS	$2800
Option 09—5120 STEPS 640 REGISTERS	$2800
Option 10—8192 STEPS 256 REGISTERS	$2800

OPTIONAL ACCESSORIES

TEK 31 Statistics Program Library, Volume I	$50
TEK 31 Mathematics Program Library, Volume I	$50
Carrying Handle, order 016-0575-00	$25
Magnetic Tape Cartridge, order 020-0082-00	$15
User Definable Overlay Package, order 016-0578-00 (Package of 10 overlays)	$20
Thermal Printer Paper, order 006-1775-00 (Package of 5 rolls)	$10

The new TEK 21 and 31 are powerful instruments fully capable of handling complex computations. However, in addition to the expandable memory capacity, a number of input and output peripherals can be interfaced to meet specified needs.

X-Y PLOTTER

The TEKTRONIX X-Y Plotter provides a precision X-Y recording capability for the TEK 21 and 31. Thus the possibilities for presentation of data and computational results for easy analysis are magnified many fold. Operation is simple and direct; this fast full digital X-Y recorder is under programming control, providing versatility and value for the simple and rapid graphical presentation of data computations.

4010 GRAPHIC TERMINAL

The 4010 terminal opens the world of graphics with alphanumerics and provides added dimensions to the TEK 31. Fast X-Y plots are as easy as specifying X-Y coordinates. And alphanumerics is as simple as typing your name. You can program alphanumerics into the calculator from either the 4010 or calculator keyboards. The 4010 will format and print alphanumerics and data output under full program control. Rapid presentation of data or calculated results as well as graphical presentation of information for analysis or decision making is well within the capability of this device. The TEK 31/4010 graphic terminal combination provides a powerful and versatile team for data analysis and presentation in the computational office or laboratory.

This is just the beginning of the input and output peripherals which will interface with the TEK 31. More will be introduced soon to help simplify your work and make the TEK 31 programmable calculator even more powerful.

AUTOMATED TEST EQUIPMENT
S-3260 System

New

- **128 ACTIVE PINS—64 INPUT, 64 OUTPUT**
- **FUNCTIONAL (TRUTH-TABLE) TESTS, DYNAMIC (TIMING) TESTS**
- **PARAMETRIC (DC) TESTS, GO NO-GO OR ANALYTICAL TESTS**
- **DATA-LOGGING, DATA-REDUCTION with COMPUTER-GRAPHICS DISPLAYS and optional HARD COPY CAPABILITY**

The TEKTRONIX S-3260 is an important, new automated test system. The results of years of test system design and manufacturing, it combines the most required test functions in a single product. The S-3260 is a major advance in state-of-the-art systems. It is built to perform GO NO-GO as well as engineering analysis testing of device measurements on all types of MOS, TTL, and ECL devices, circuit modules and printed circuit boards.

The S-3260 is basically a high speed (up to 20 MHz) function tester for up to 64 in/out (I/O) pin devices. In addition accurate DC current and voltage measurements may be made in either differential or single-ended modes. A time-measurement subsystem permits "one-shot" time measurements between the signals on any pin-pair of a device-under-test (DUT).

The S-3260 is an integrated system, each section being designed and used as an integral part, and not as stand-alone or add-on equipment.

The hub of the system is the 1803 test station. In order to perform 20-MHz function testing for each of up to 64 pins, drivers and comparators are placed as close as practical to the DUT. Critical Path™ Fixturing design has been used to provide optimum fast-risetime signal environments. All I/O circuitry is contained on plug-in cards. Cards are inserted in carrousel fashion (like spokes of a wheel) into the 1803.

Each sector card contains a DC to 20-MHz 1032-bit LSI buffer memory, two driver sample-and-hold (S/H) circuits, and a high-speed driver for input conditioning. In addition, output comparison circuitry consists of S/H circuits and a dual strobed comparator. Timing is provided by a high-speed clock generator which delivers seven independent signal phases. The start and duration of each phase can be programmed in 1-ns increments. Up to four of these clock phases may be used for DUT's requiring multiphase timing signals with the remaining phases used for data input driving and output data strobing. Note that each card may be programmed to different driver signal levels and different output comparator levels. This means that up to 64 different sets of input and output signal levels could be programmed.

Binary patterns determine the high/low or inhibit (high-impedance) state for each drive and set the high/low or mask (don't care) state for each comparator. These patterns are normally disk resident. They are buffered by core and LSI-memory to provide precise control of timing and word count at word rates to 20-MHz.

The DC and time-measurement subsystems, housed within the 1803, gain access to the DUT pins via a 2 x 64-pin 50-Ω switching matrix. This same matrix provides access for (optional) signal generators or waveform-digitizing oscilloscope.

A near-English, easily learned test language is provided for system control. Called TEKTEST III, it interacts with the operator to allow device-oriented programming. Test steps are easily interpreted—even without comments.

Executive—schedules the system tasks, controls foreground/background operation.

Text Editor—checks syntax, allows convenient test-program development.

Pattern Editors—allows binary patterns to be created manually or algorithmically.

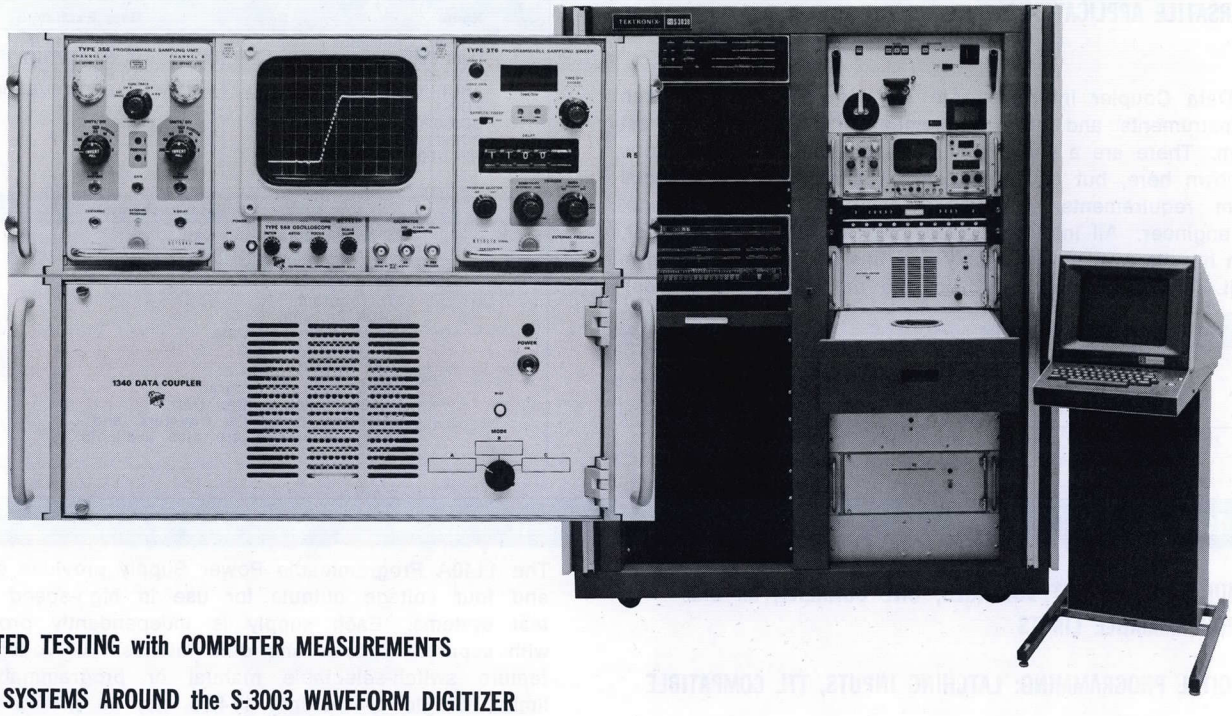
Translator—generates and stores machine-executable instructions.

Instruction Processor—controls system hardware from Translator output.

Data Reduction—processes data stored during testing to create graphic test-result displays.

Terminal Control—allows the operator to interact with the system *while testing* to debug test programs, characterize device failures, select test modes, or run system-maintenance programs.

The S-3260 will test a multitude of devices including yours with economy, thoroughness and high thru-put. To learn more about the S-3260 Test System check the appropriate box on the business reply card inside the front cover of this catalog.



- **AUTOMATED TESTING with COMPUTER MEASUREMENTS**
- **CUSTOM SYSTEMS AROUND the S-3003 WAVEFORM DIGITIZER**

The S-3000 Series with waveform digitizing and measurement software offers dynamic testing capabilities previously impractical. For example, measurements such as peak-to-peak, root-mean-square, averaging and multiplication are program calls. Others are only a matter of software rather than elaborate hardware modifications. Coupled with the extensive fixturing and stimuli available from Tektronix, Inc., a sophisticated system can easily be patterned to meet your testing requirements.

The S-3003 Waveform Digitizer is a complete measurement block that interfaces to your computer for measurement superiority and is available separately or integrated into your custom-built system. It consists of a R568 Programmable Sampling Oscilloscope and a 1340 Data Coupler. The 568 Oscilloscope contains a 3S6 Sampling and 3T6 Time-Base plug-in unit. The 1340 is configured, by plug-in circuit cards, to interface to the 568 Sampling Oscilloscope, the Waveform Digitizer Option, and a minicomputer. (A DEC PDP-11 is standard.)

The Waveform Digitizer interface processes a 10-division displayed waveform into a series of 1,000-10 bit words. At sweep rates of 1 ms/div and slower, the system operates in a real-time mode, and at faster rates automatically switches to equivalent-time sampling mode. One word is generated for each displayed dot on the sampling display. Since the sampler operates sequentially each dot is digitized in turn from left to right. The completed words are sent to the computer. This reduces the analog display to a binary image that can be processed with a computer. Measurements can then be made through the WAFORM™ software.

Used as a measurement package, the S-3003 brings the full power of the computer and software to testing. Typical applications include complex waveform analysis, linear device testing, processed data display, data storage for trend analysis, etc.

To support the S-3003, we offer a Software Operating System. Designed to operate in the PDP-11 Series of minicomputers, it assists Test System Engineers in building powerful and flexible programs easily. The kinds of measurements possible are limited only by the programmer's imagination.

By adding optional peripheral equipment to the S-3003, custom systems can be assembled to solve your measurement problems. Many types of programmable units, such as pulse and signal generators, power supplies, sophisticated fixtures and special measurement instruments are available. The many interfaces available for the 1340 Data Coupler include those for several different computers.

For more information, check the appropriate box on the business reply card inside the front of this catalog.

- **EASY INTERFACING**
- **VERSATILE APPLICATIONS**

The Data Coupler interfaces are for communication between the instruments and other equipment of an automated test system. There are a variety of interfaces for specific functions as shown here, but for interfaces to accomplish your special system requirements, please contact your local Tektronix field engineer. All interfaces plug into the 1340 Data Coupler, which has its own power supply and has access for 12 plug-in circuit cards (interfaces may be one or more circuit cards).

Special Purpose
Waveform Digitizer Reference Signals for auto-calibration with AUTOCAL software Programmable Clock

Control Name	General Purpose Data Exchange
PDP-8L Controller Data Logging IBM1826 Controller ASCII Data PDP-11 Controller BDX-6200 Controller PDP-11 for 2nd 1340 HP-2100 Controller	32 Bit Output 16 Bit IN/OUT 32 Bit Input 32 Bit OUT/ECHO

Specific Device Data Exchange
230/240 Program and Data Paper Tape (Remex Reader/Tally Punch) Paper Tape (Remex 3075 series) 3S6 Program 3T6 Program 1140A Program 230 Program and Data HP DMA Data Link 1840 Program **WAVETEK®** 157 Program S-3260 Station Control Unit **Interfaces to DMM's, Counters, and signal generators are also available.**

1140A *Programmable Power Supply*

- **FOUR INDEPENDENT VOLTAGES; ONE CURRENT; all with PROGRAMMABLE LIMITS**
- **DIGITAL PROGRAMMING: LATCHING INPUTS, TTL COMPATIBLE**
- **SAFE, CONTROLLED TRANSITIONS, and REMOTE SENSING**

The 1140A Programmable Power Supply provides one current and four voltage outputs for use in high-speed automated test systems. Each supply is independently programmable with separate strobes and data latches. All voltage supplies feature switch-selectable manual or programmable current limits. Single or multiple 1140's can be programmed by a 1340 Data Coupler. Options are available for programming the 1140A using the 1340 or user-supplied program unit.

286, 287, R288 *Sampling-Head Multiplexers*

- **1-4 HEADS MULTIPLEXED**
- **5-16 HEADS MULTIPLEXED**
- **17-64 HEADS MULTIPLEXED**

The sampling-head multiplexer system allows the signals from up to 64-test points to be measured by a two-input sampling unit. The measurements are made from a sampling head coupled to each test point. The signals sensed by these sampling heads are then multiplexed into the sampling unit, two signals at a time. Multiplexing is accomplished without affecting sampling-head risetime or input-impedance characteristics such as relay switching would do.

The 286 Sampling Head Multiplexer is the basic component in the multiplexed system, and it operates up to four sampling heads. Head selection commands are digital information that determine which sampling heads are operated.

A 286 can be installed in a 287 or R288, and in either case will then receive its head selection and signal data from these units.

A 287 holds and controls up to four 286's, allowing 16 heads to be multiplexed. An R288 along with up to three 287's may be used for multiplexing of up to 64 sampling heads.

241 *Programmer*

- **PROGRAMS UP TO 15 MEASUREMENTS**
- **AUTOMATIC OR MANUAL MEASUREMENT SEQUENCE**
- **AUTOMATIC TEST LIMITS STOP**
- **14 ADDITIONAL PROGRAM LINES**

The 241 Program Unit is designed to program the 568 Oscilloscope, 3T5 or 3T6, 3S5 or 3S6 programmable plug-ins, and 230 Digital Unit. It has 14 lines available for programming other equipment.

15 programmed measurements can be selected by front panel pushbuttons or external control lines actuated manually or automatically. In the automatic mode, an out-of-limits condition can stop the measurement sequence. Each measurement is programmed with quick-insertion diodes, making changing programs a quick and easy plug-in operation.

Where a group of identical measurements is repeated over a variety of DUT input/output connections, the 241 Program Resequencer may be added to extend test capacity to 150 with a single 241 or to 225 with two 241's.

For more information on the mentioned systems and components, please request the Automated Test Equipment catalog by checking the appropriate box on the business reply card in the front of this catalog.

Programmable Dual-Trace Sampling Units 3S5, 3S6

- **PROGRAMMABLE VOLTS/DIV and DC OFFSET**
- **CHOICE OF SAMPLING HEADS**

The 3S5 and 3S6 sampling units extend the automated measurement capability of the 568 Oscilloscope by allowing remote programming of deflection factor, DC offset, and smoothing.

External programming of the 3S5 can be accomplished by either a front- or rear-panel connector; signal inputs are on the front. The 3S6 has its program and signal inputs on the rear and can be used only in the 568 Oscilloscope.

Sampling heads* feature a choice of measurement capabilities and may be mixed or matched to meet specific needs. A front-panel control allows adjustment of the inter-channel time relationship to compensate for external delays.

Sampling heads may be plugged into the 3S5 or located remotely on the optional 3-ft or 6-ft sampling-head extenders. The 3S6 sampling heads are located remotely on an included 6-ft sampling-head extender that connects to the rear of the 568 Oscilloscope. 568 Oscilloscopes below serial number B110000 require a modification.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

*For complete descriptions refer to Sampling Head page 91 thru 94.

Programmable Time-Base Units 3T5, 3T6

- **PROGRAMMABLE TIME/DIV, SWEEP DELAY AND SAMPLES/SWEEP**
- **100 ps/DIV TO 500 ms/DIV CALIBRATED SWEEP RANGE**
- **EXTERNAL AUTOMATIC TRIGGER**

The 3T5 and 3T6 can be externally programmed to extend the automatic measurement capabilities of the 568 Oscilloscope configuration. The 3T5 can be externally programmed when used with the 561B or 564B Oscilloscopes. The 3T5 and 3T6 can also be used manually, using the front-panel controls.

Real-time sampling (1 ms/div to 500 ms/div) and digital delay are provided. An external automatic trigger mode eliminates the need for adjustments over a wide range of trigger signal characteristics.

S-3100-Series Systems

- **VARIED CAPABILITIES TO SUIT YOUR NEEDS**

The **S-3105** is versatile, low-budget measurement subsystem. It works with any computer and is programmed by strings of ASCII characters. The S-3105 can be used with any computer TTY port, which makes it easy to program and analyze returned results (no DOS or large core block needed). It can also be run by any time-sharing service, which makes it great for any dedicated job function where new programming must be kept to the minimum.

The **S-3110** and **S-3111** are dynamic measuring systems intended for checking the performance of active devices under simulated operating conditions. These systems can sequence to 15 measurements at high speeds. They contain a programmable oscilloscope and plug-ins, with digital unit, programmer, sampling heads, fixturing drawer or panel and appropriate cables. They can be configured to meet your needs, including special equipment.

The **S-3120** and **S-3130** Automated Test Systems are designed for testing and measuring active devices under simulated operating conditions. These systems have successfully tested such devices as diodes, transistors, integrated circuits, circuit modules, and subassemblies in preproduction, QC, and production. Each offers many varied possibilities for customer use. The S-3130 has programmable power supplies for testing devices of different families.

Both systems can make more than 100 measurements per second, and disc memory may access up to 1600 independent measurements, with sorting and classifying, too. Either system has provision for computer control to extend the range of activity of the system configured for your task. For more information check the appropriate box on the business reply card in the front of this catalog.

- **INEXPENSIVE MEASUREMENTS**
- **REDUCED ERRORS**

The 568/230 Bench-Test system is widely used wherever a flexible-inexpensive test package is required. It measures accurately with high repeatability, because all measurements are performed and displayed digitally. The operator is freed from display interpretation and measurement definition automatically. The same measurement uniformity may be carried to your production applications with a programmable version of the 568/230.

The Bench-Test system consists of the following equipment:

1 — 230 Digital Unit
1 — 568 Readout Oscilloscope
1 — 3S2 Dual-Trace Vertical Sampling Unit
1 — 3T2 Random Sampling Time Base Unit
2 — S-1 Sampling Heads*

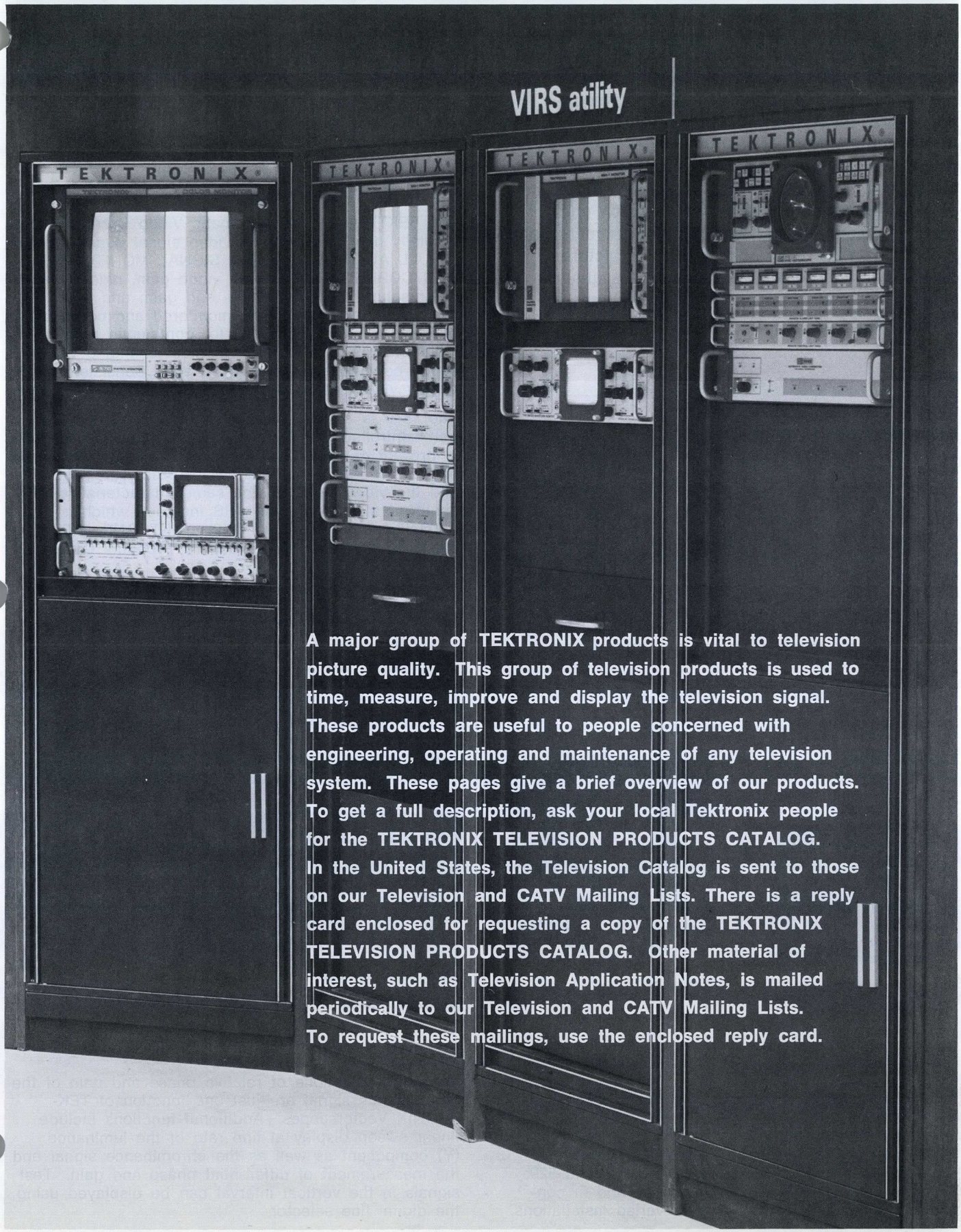
The Oscilloscope combination forms a dual-vertical-channel sampler with DC to 1-GHz bandpass (350-ps risetime using S-1 heads) with sensitivity from 2 mV/div to 200 mV/div in seven calibrated steps. DC offset, internal-trigger pickoff, and five display modes provide for a variety of operations. The time-base features random or sequential sampling operation. Random sampling permits the user to view the leading edge of a signal, without a delay line or pretrigger. The sweep time/div is displayed digitally in the TIME/DIV window and extends from 100 μs/div to 200 ps/div, expanding to 20 ps/div with X10 DISPLAY MAGNIFIER control. Versatile display and trigger modes extend the capabilities of the package.

The 230 Digital Unit presents oscilloscope measurements in alphanumeric form. The instrument can be used to measure any desired time or voltage parameter associated with the display on the 568 CRT. Voltage measurements are made on either Channel A or B, or between the two channels.

Measurement results are displayed on four digits with units of measure, decimal point and polarity information. Limit controls provide for upper- and lower-measurement limits. These function automatically for each digital reading and illuminate one of three lamps. Thus a measurement can be repeated many times, with the operator proceeding on the basis of the limit lights rather than the digital reading.

Complete specifications for the Bench-Test system components may be found in the Automated Test Equipment catalog. Request your copy by checking the appropriate box on the business reply card in the front of this catalog

*Any of the sampling heads described on page 91 thru 94 may be used.



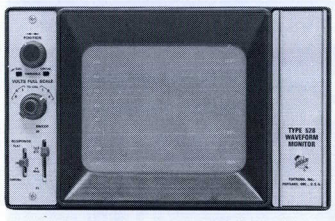
A major group of TEKTRONIX products is vital to television picture quality. This group of television products is used to time, measure, improve and display the television signal. These products are useful to people concerned with engineering, operating and maintenance of any television system. These pages give a brief overview of our products. To get a full description, ask your local Tektronix people for the TEKTRONIX TELEVISION PRODUCTS CATALOG. In the United States, the Television Catalog is sent to those on our Television and CATV Mailing Lists. There is a reply card enclosed for requesting a copy of the TEKTRONIX TELEVISION PRODUCTS CATALOG. Other material of interest, such as Television Application Notes, is mailed periodically to our Television and CATV Mailing Lists. To request these mailings, use the enclosed reply card.

TELEVISION PRODUCTS SUMMARY—NTSC, PAL, SECAM

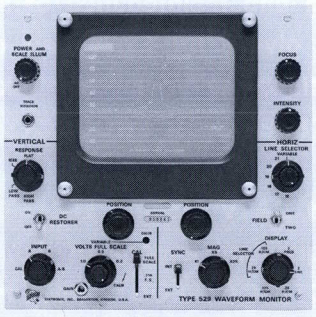
For more than twenty years, Tektronix, Inc. has produced products used in detecting and measuring television signal distortions. TEKTRONIX Television Products have led the way to better signal quality. Our waveform monitors, vectorscopes, test signal and synchronizing generators and picture monitors are in constant use at almost every point in world-wide television broadcasting systems. Our engineering and marketing people play an active part within the television engineering community developing measurements and techniques that help make the color picture a quality color picture. Tektronix means quality among the world community of television professionals.

TEST SIGNAL, SYNC AND COLOR STANDARD GENERATORS

The 140-Series Signal Generators are compact sources of high-quality television test, drive and convergence signals. All signals needed to time and accurately test, evaluate and adjust both standard broadcast and closed circuit color video equipment are provided. Each test signal conforms with industry standards, and provides additional refinements to enhance both the accuracy and range of measurements which can be made. See page 290 for signals available. Complete information will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.



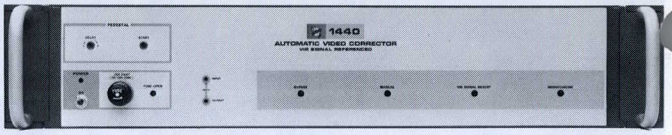
528 Waveform Monitor



529 Waveform Monitor

WAVEFORM MONITORS

A television waveform monitor is a specialized oscilloscope with vertical amplifier characteristics and time-base features tailored to display and measure television signal waveforms. Tektronix, Inc. makes two families of waveform monitors, the 528 and 529. Versions are available for all standards and in configurations suitable for inclusion in varied installations.



1440 Automatic Video Corrector

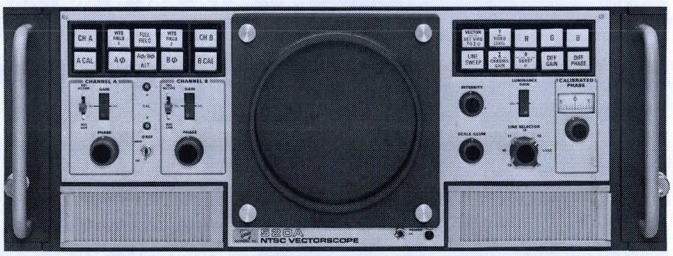
VIRSatility Products for Automatic Video Signal Correction

The TEKTRONIX 1440 Automatic Video Corrector adds a totally new dimension to video signal quality control —FULL AUTOMATIC VIDEO SIGNAL MONITORING AND CORRECTION. Overall video gain, black level, color saturation, burst phase and gain, and sync level may be automatically monitored and corrected by the 1440. The necessity for continuous readjustment of proc amp controls to meet changing video signal conditions is done away with. Consistent, high quality video signals are the result.

The 1440 is a VIRS (Vertical Interval Reference Signal) controlled video processing amplifier. When VIRS is present on the video signal, the 1440 samples VIRS and, if necessary, automatically corrects the VIRS and the video signal to the same characteristics achieved at the point of VIRS insertion which is normally program origin. Other TEKTRONIX VIRSatility products are described in our TV Products Catalog.

1478 CALIBRATED CHROMINANCE LEVEL CORRECTOR

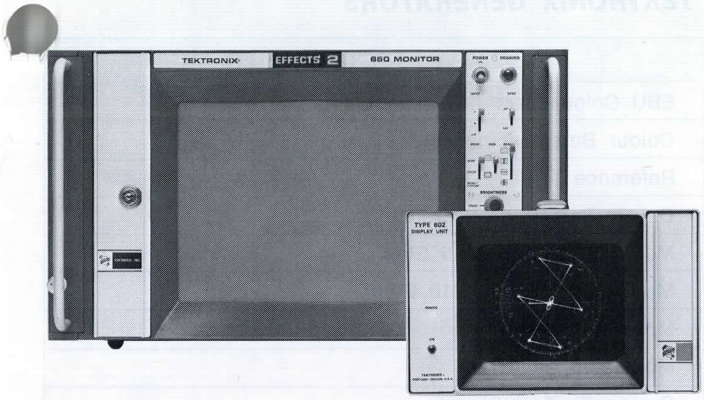
The 1478 is an in-line manual chrominance corrector designed for use with NTSC, PAL and PAL M color video signals. Used with the 12.5 T or 20 T modulated sine-squared pulses, the 1478 is used to manually correct relative chrominance/luminance gain errors which are usually caused by frequency response deficiencies in a video system.



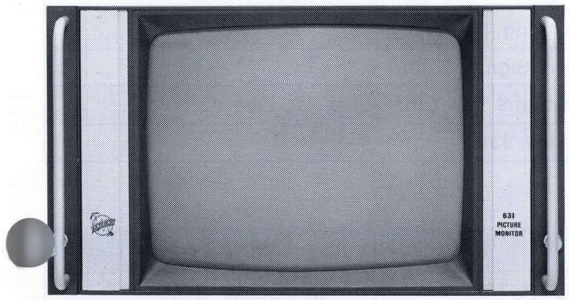
R520A Vectorscope (rackmount)

VECTORSCOPES

Vector presentations of relative phase and gain of the chrominance signal are just one function of TEKTRONIX Vectorscopes. Additional functions include linear sweep display at line rate of the luminance (Y) component as well as the chrominance signal and the measurement of differential phase and gain. Test signals in the vertical interval can be displayed using the digital line selector.

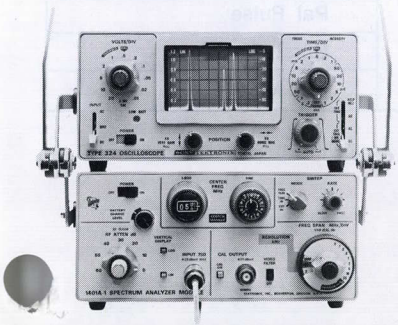


650 Series Monitor with 602 Option 5

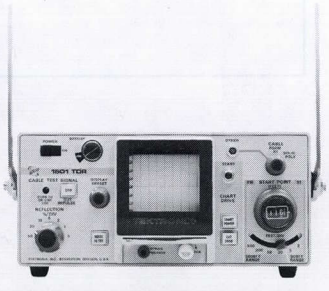


631 Monochrome Picture Monitor

There are other TEKTRONIX products that are of interest to people concerned with the television signal. These products are described in full on pages preceding and following this section. The following products are of particular interest: Spectrum Analyzers, Time Domain Reflectometers (cable fault-finding); and 7B53A Option 5 and 465 Option 5 Oscilloscopes. We also suggest that you review the 7000-Series listings of mainframes and plug-ins for information on specialized applications.



1401A-1 Portable Spectrum Analyzer shown with a 324 Option 76 Oscilloscope (P7 phosphor).



1501 Time Domain Reflectometer (Cable fault locator)

COLOR PICTURE MONITORS

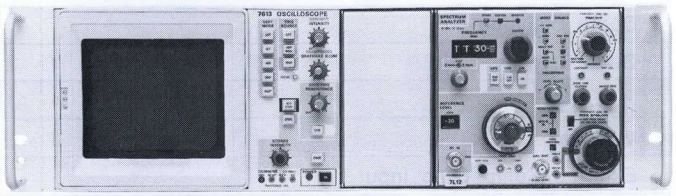
TEKTRONIX 650-Series and 670-Series Color Picture Monitors have the features and accuracy to reliably assess picture quality. There are now versions of the 650 and 670 Series for use in the scanning standard and color system appropriate to your location. A specially-manufactured Sony Trinitron*, with its simplicity of convergence and its adaptability to multi-standard usage, is the heart of each monitor. The construction of the monitor allows us to economically produce monitors for any standard used anywhere in the world. All versions maintain a uniform quality of performance previously unavailable.

The 650-Series Color Picture Monitors are particularly adaptable to precisely determine signal quality, since they feature differential (A-B) inputs. Differential inputs are very useful in matching systems for cable length delays. The 670-Series Monitors have many of the features of the 650 Series and are excellent for applications requiring a larger picture.

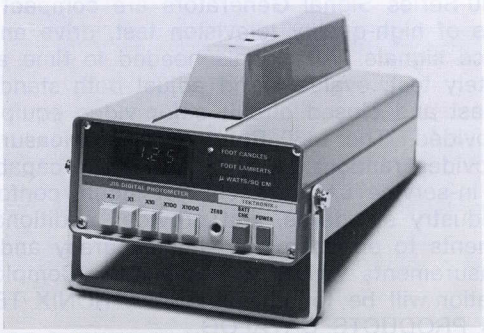
MONOCHROME PICTURE MONITORS

TEKTRONIX Monochrome Picture Monitors are designed for measurement and qualitative evaluation of 525/60 and 625/50 standards. The monitors have many features such as a choice of D6500 or W9300 K phosphors. High resolution is maintained at full drive. Bandwidth is 6 MHz within 0.5 dB with 100% white amplitude. The monitors are all solid-state (except kinescope). A rectangular kinescope with 3:4 aspect ratio is used.

*Registered Trademark Sony Corporation.



7L12 Plug-in Spectrum Analyzer shown in a R7613 Variable Persistence Oscilloscope



DIGITAL PHOTOMETER-RADIOMETER

The J16, with appropriate accessories, provides a simple, accurate method for adjustment of monitor screen color temperatures. The primary colors can be measured and adjusted individually to produce white color temperature balance and standardization.

SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

NTSC TEST SIGNALS
Vertical Interval Reference Signal (VIRS)
EIA Color Bar
Color Bar Luminance Signal
Full-Field Color Bar
Modulated 5 Step Staircase
Modulated 10 Step Staircase
Modulated Ramp
Modulated Pedestal
Composite Test Signal
Convergence Pattern
Full Amplitude Multiburst
Sin^2 Pulse & Bar
Sin^2 Pulse & Window
Field Square Wave
Noise Measuring Capability
Flat Field (Variable Level)
Flat-Field Bouncing APL
Mixed Test Signal

PAL TEST SIGNALS
EBU Colour Bars
Colour Bars/Luminance
Reference
Colour Bars/Red Reference
Modulated Staircase 5 Step
Modulated Staircase 10 Step
Modulated Ramp
Modulated Pedestal
Composite Test Signal
Multiburst
Sin^2 Pulse & Window
Field Square Wave
Flat Field
APL Bounce
Noise Measuring Capability
Convergence Signal
ITS, International Per EBU—Line 17, Line 18,
Line 330, Line 331

NTSC SYNC and TIMING
Gen-lock Input
Comp Sync
Subcarrier
Comp Blanking
Burst Flag
H Drive
V Drive
External Comp Sync Input
External Subcarrier Input

PAL SYNC and TIMING	
SIGNAL OUTPUTS	Composite Sync
	Composite Blanking
	Subcarrier
	Burst Flag
	PAL Burst
	Line Drive
	Field Drive
	1 MHz Reference
	25 Hz
	12.5 Hz
SIGNAL INPUTS	Gen-lock Input
	External Sync Input
	External Subcarrier Input
	Pal Pulse
	Burst Flag
	4.43 MHz

The 140-Series Signal Generators are compact sources of high-quality television test, drive and convergence signals. All signals needed to time and accurately test, evaluate and adjust both standard broadcast and closed circuit color video equipment are provided. The 1430 Random Noise Measuring Set provides random noise measurement capabilities on an in-service basis. Each test signal conforms with industry standards, and provides additional refinements to enhance both the accuracy and range of measurements which can be made. Complete information will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.

Tektronix, Inc. offers a wide variety of probes to help accomplish a wide variety of measurements. In the process of selecting a probe for your applications, a few general concepts should be kept in mind.

1. 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 two orders of magnitude greater than the circuit source impedance. For higher frequencies, the importance of the capacitance increases drastically and will eventually be the prime consideration.
2. For risetime 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-ohm source environment.
3. For many circuits, the loading of the circuit by the probe may cause unnatural performance. For this consideration, probe capacitance is of prime importance at high frequencies (greater than about 30 MHz) and resistance at low frequencies (less than 5 MHz).
4. The best general-purpose probe is the active probe which contains the best obtainable combination of high probe resistance and low capacitance.

CURRENT PROBES

TYPE	USEFUL BANDWIDTH Hz to MHz		CURRENT/DIV SCOPE AT 50 mV/DIV	SATURATION DC	SATURATION AMP ms PRODUCT	MAXIMUM CURRENT MAX RMS	MAXIMUM CURRENT PEAK PULSE	MAXIMUM CURRENT DERATE BELOW	MAXIMUM CURRENT DERATE ABOVE	PRICE	PAGE
P6021 with Term	120	50	.1 A to .5 A	.5 A	.5	5.3 A	250 A	300 Hz	5 MHz	**$ 140.00**	301
with 134	12	35	1 mA to 1 A	.5 A	.5	5.3 A	15 A	230 Hz	5 MHz	**$ 365.00**	301
P6022 with Term	8.5 k	100	50 mA or .5 A	.2 A	.009	2.1 A	100 A	3 kHz	10 MHz	**$ 175.00**	301
with 134	100	60	1 mA to 1 A	.2 A	.009	2.1 A	15 A	1.3 kHz	10 MHz	**$ 395.00**	301
P6042	DC	50	1 mA to 1 A	10 A	—	10 A	10 A	—	1 MHz	**$ 795.00**	304
CT-1 with P6040	30 k	1000	10 mA	.2 A	.001	.5 A	100 A			**$ 55.00**	302
CT-2 with P6041	1.2 k	85	50 mA	.2 A	.05	2.5 A	100 A			**$ 70.00**	303
CT-3	30 k	1000	10 mA	.2 A	.001	.5 A	100 A			**$ 41.80**	309
CT-5 with P6021/134	12 k	20	20 mA to 1 kA	20 A	500	700 A	15 kA	230 Hz	1.2 kHz	**$ 840.00**	302
with P6042	.5 k	20	20 mA to 10 kA	20 A	8000	700 A	10 kA	20 Hz	1.2 kHz	**$1270.00**	304
CT-5 with P6021 Passive Termination	120	20	1 A to 500 A	20 A	500	700 A	50 kA	300 Hz	1.2 kHz	**$ 615.00**	303

VOLTAGE PROBES for 50 Ω inputs, or 1 MΩ inputs

TYPE	ATTEN	LENGTH IN FEET	PACKAGE NUMBER	LOADING		RISETIME IN NS	INPUT LIMITS MAX. DC + PK. AC	INPUT LIMITS LINEAR DYNAMIC RANGE	INPUT LIMITS DC OFFSET RANGE	READ-OUT	PRICE	PAGE
P6045 FET	1X	6.0	010-0204-00*	10 M	5.5 pF	1.5	±100 V	±.5 V	±1 V	NO	**$365.00***	297
	10X				2.5		±100 V	±5 V	±10 V			
	100X				1.8		±100 V	±50 V	±100 V			
P6046 DIFF/AMP	1X	6.0	010-0213-00*	1 M	10 pF	3.5	±25 V	±10 Div		NO	**$470.00***	297
	10X			10 M	3		±16 V	±10 Div				
P6051 FET	Obsolete, use P6201 and GR Adapter											
P6056[1]	10X	6.0	010-6056-03	500 Ω	1 pF	0.1	±16 V	±16 V		YES	**$ 50.00**	299
		9.0	010-6056-05								**$ 50.00**	
P6057[1]	100X	6.0	010-6057-03	5 KΩ	1 pF	0.25	±50 V	±50 V		YES	**$ 50.00**	299
		9.0	010-6057-05								**$ 50.00**	
P6201 FET	1X	6.0	010-6201-01	100 K	3.0 pF	0.4	±100 V	±.6 V	±5.6 V	YES	**$395.00**	294
	10X				1		±200 V	±6 V	±56 V			
	100X				1		±200 V	±60 V	±200 V			

*Without Power Supply

[1]Must be shunted by 50 Ω (011-0049-01) on a 1-MΩ system.

VOLTAGE PROBES for 1 MΩ inputs

TYPE	ATTEN	LENGTH IN FEET	PACKAGE NUMBER	LOADING		USEFUL BW MHz	DC MAX	SCOPE C IN pF	READ OUT	PRICE	PAGE
P6006[1]	10X	3.5	010-0127-00	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	NO	**$ 32.00**	294
		6	010-0160-00		8.5	25				**32.00**	
		9	010-0146-00		11	25				**32.00**	
		12	010-0148-00		13	12				**32.00**	
P6007[1]	100X	3.5	010-0150-00	10 MΩ	2 pF[2]	25	1.5 kV	15 to 55	NO	**$ 38.00**	294
		6	010-0165-00		2.2	20				**38.00**	
		9	010-0152-00		2.4	15				**38.00**	
		12	010-0154-00		2.6	13				**38.00**	
P6008	10X	3.5	010-0129-00	10 MΩ	7.5 pF[2]	100	600 V	12 to 47	NO	**$ 60.00**	295
		6	010-0129-01	ENVIRONMENTALIZED —50°C to +150°C						**90.00**	
P6009	100X	9	010-0170-00	10 MΩ	2.5 pF[2]	120	1.5 kV	12 to 47	NO	**$ 72.00**	295
		9	010-0264-01		2.5 pF	100			YES	**72.00**	
P6010	10X	3.5		Furnished with S-5 (Page 80) For other uses see P6054A or P6065							
P6011	1X	3.5	010-0193-00	1 MΩ	48 pF[2]	17	600 V	ANY	NO	**$ 25.00**	295
		6	010-0190-00		68	10				**25.00**	
		9	010-0229-00		95	7				**25.00**	
P6012	10X	3.5	010-0203-00	10 MΩ	11.5 pF	35	500 V	15 to 47	NO	**$ 44.00**	295
		6	010-0209-00		14.5	30				**44.00**	
		9	010-0231-00		17.5	22				**44.00**	
P6013A	1000X	10	010-0177-01	100 MΩ	3 pF	80	12 kV	15 to 55	NO	**$220.00**	296
		25	010-0175-01		3.5	13				**220.00**	
P6015[1]	1000X	10	010-0172-00	100 MΩ	3 pF	75	20 kV	12 to 47	NO	**$275.00**	296
P6027[1]	1X			SAME AS P6028 BUT WITH UHF CONNECTORS						**$ 20.00**	296
P6028	1X	3.5	010-0074-00	1 MΩ	50 pF[2]	17	600 V	ANY	NO	**$ 22.00**	296
		6	010-0075-00		67	10				**22.00**	
		9	010-0076-00		90	7				**22.00**	
		12	010-0077-00		112	4				**22.00**	
P6047	10X		Obsolescent	SEE P6054A							
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	**$ 75.00**	298
P6049A	10X	3.5	010-6049-01	10 MΩ	13.5 pF	20	500 V	43 to 66	NO	**$ 40.00**	298
P6052	10X or 1X	3.5	010-0241-00	10 MΩ	14 pF	20	500 V	15 to 55	YES	**$ 60.00**	298
				1 MΩ	113	3				**60.00**	
	10X or 1X	6	010-0243-00	10 MΩ	15.5	15				**60.00**	
				1 MΩ	134	2				**60.00**	
P6053B	10X	3.5	010-6053-11	10 MΩ	9.5 pF	250	500 V	15 to 24	YES	**$ 60.00**	298
		6	010-6053-13		12.5	250				**60.00**	
		9	010-6053-15		13.5	88				**60.00**	
P6054A	10X	3.5	010-6054-11	10 MΩ	9.5 pF	250	500 V	15 to 24	NO	**$ 55.00**	299
		6	010-6054-13		12.5	250				**55.00**	
		9	010-6054-15		13.5	88				**55.00**	
P6055[3]	10X	3.5	010-6055-01	1 MΩ	10 pF[2]	60	500 V	20 to 47	YES	**$ 85.00**	299
P6058			010-0260-00	SEE 7D13 and DM 501 Plug-in Units						**$ 65.00**	
P6060[3]	10X	3.5	010-6060-01	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	YES[4]	**$ 36.00**	300
		6	010-6060-03		8.5	25				**36.00**	
P6061	10X	3.5	010-6061-01	10 MΩ	9.5 pF	60	500 V	18 to 22	YES[4]	**$ 40.00**	300
		6	010-6061-03		12	60				**40.00**	
		9	010-6061-05		13.5	60				**40.00**	
P6065A	10X	6	010-6065-13	10 MΩ	12.5	100	500 V	18 to 25	YES	**$ 45.00**	300
		9	010-6065-15		13.5						
P6075A	10X	6	010-6075-13	10 MΩ	12.5	200	500 V	18 to 22	YES	**$ 48.00**	300

[1]Available with UHF connectors.

[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.

7000-SERIES
OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART

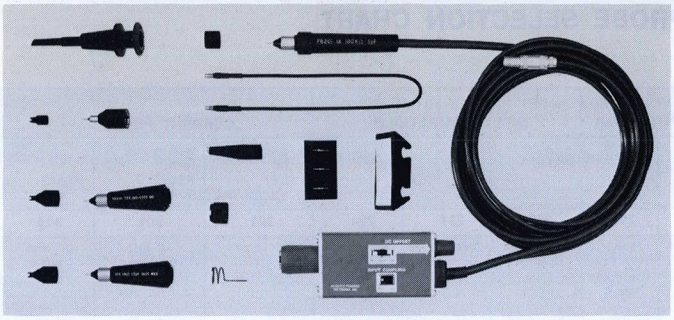
			PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE					PASS. VOLTAGE 50 Ω INPUT COMP.		FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE			**P6011 3.5′**	**P6053B 3.5′**	**P6055 3.5′**	**P6009**	**P6015 10′**	**P6056**	**P6057**	**P6045**	**P6046**	**P6201**	**w/passive term P6021 5′ 10 mV/ma**	**w/passive term P6022 5′ 10 mV/ma**	**P6042**
PAGE			**295**	**298**	**299**	**295**	**296**	**299**	**299**	**296**	**297**	**294**	**301**	**301**	**304**
FEATURES			**Miniature Probe**	**Fastest Probe Compatible with 1-MHz Input**	**Adj. Attenuation for Differential Use**	**1.5 kV Compatibility**	**40 kV Compatibility**	**Fastest 10X Passive Probe low C**	**Fastest 100X Passive Probe low C**	**10-MΩ Input Impedance**	**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**	**10X**	**100X**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**
	7A11	Freq.*	NC	NC	NC	NC	NC						55 MHz	150 MHz	45 MHz
	7A12	Freq.	20 MHz	115 MHz		95 MHz	70 MHz			105 MHz	75 MHz	115 MHz	50 MHz	100 MHz	45 MHz
	7A13	Freq.	20 MHz	105 MHz	65 MHz	85 MHz	65 MHz			90 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A14	Freq.	NC	NC	NC	NC	NC			NC	NC	NC	55 MHz	120 MHz	NC
	7A15A/AN	Freq.	20 MHz	75 MHz		70 MHz	60 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	Freq.	20 MHz	200 MHz		130 MHz	80 MHz			160 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
7904	**7A17**	Freq.	20 MHz	140 MHz		105 MHz	75 MHz			120 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
	7A18/N	Freq.	20 MHz	75 MHz		70 MHz	60 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	Freq.	NC	NC	NC	NC	NC	500 MHz	480 MHz	200 MHz	95 MHz	430 MHz	NC	NC	50 MHz
	7A22	Freq.	1 MHz	NC	1 MHz								1 MHz	1 MHz	1 MHz
	7A24	Freq.	NC	NC		NC	NC	350 MHz	350 MHz	180 MHz	90 MHz	310 MHz	NC	NC	45 MHz
	7A26	Freq.	20 MHz	175 MHz		125 MHz	75 MHz			145 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
	7A11	Freq.	NC	NC	NC	NC	NC						55 MHz	125 MHz	45 MHz
	7A12	Freq.	20 MHz	100 MHz		85 MHz	65 MHz			90 MHz	70 MHz	100 MHz	50 MHz	90 MHz	45 MHz
	7A13	Freq.	20 MHz	100 MHz	65 MHz	85 MHz	65 MHz			85 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A14	Freq.	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	50 MHz	105 MHz	NC
	7A15A/AN	Freq.	20 MHz	70 MHz		65 MHz	55 MHz			70 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
7704A	**7A16A**	Freq.	20 MHz	145 MHz		115 MHz	75 MHz			125 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A17	Freq.	20 MHz	140 MHz		105 MHz	75 MHz			120 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
	7A18/N	Freq.	20 MHz	75 MHz		70 MHz	60 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19**	Freq.	NC	NC	NC	NC	NC	250 MHz	250 MHz	155 MHz	85 MHz	215 MHz	NC	NC	45 MHz
	7A22	Freq.	1 MHz	NC	1 MHz								1 MHz	1 MHz	1 MHz
	7A24	Freq.	NC	NC		NC	NC	200 MHz	200 MHz	145 MHz	80 MHz	180 MHz	NC	NC	45 MHz
	7A26	Freq.	20 MHz	140 MHz		105 MHz	75 MHz			120 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
	7A11	Freq.	NC	NC	NC	NC	NC						50 MHz	85 MHz	40 MHz
	7A12	Freq.	20 MHz	75 MHz		70 MHz	60 MHz			70 MHz	60 MHz		45 MHz	70 MHz	40 MHz
	7A13	Freq.	20 MHz	75 MHz	55 MHz	60 MHz	55 MHz			70 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A14	Freq.	NC	NC	NC	NC	NC			NC	NC	NC	50 MHz	80 MHz	NC
7600	**7A15A/AN**	Freq.	20 MHz	60 MHz		55 MHz	50 MHz			60 MHz	50 MHz		40 MHz	60 MHz	35 MHz
FAMILY	**7A16A**	Freq.	20 MHz	95 MHz		85 MHz	65 MHz			85 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A17	Freq.	20 MHz	95 MHz		85 MHz	65 MHz			85 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18/N	Freq.	20 MHz	70 MHz		65 MHz	55 MHz			70 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	Freq.	1 MHz	NC	1 MHz								1 MHz	1 MHz	1 MHz
	7A26	Freq.	20 MHz	95 MHz		85 MHz	65 MHz			85 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A11	Freq.	NC	NC	NC	NC	NC						40 MHz	55 MHz	35 MHz
	7A12	Freq.	20 MHz	50 MHz		50 MHz	45 MHz			50 MHz	45 MHz		40 MHz	50 MHz	35 MHz
	7A13	Freq.	20 MHz	55 MHz	45 MHz	50 MHz	45 MHz			50 MHz	45 MHz		40 MHz	50 MHz	35 MHz
	7A14	Freq.	NC	NC	NC	NC	NC			NC	NC		40 MHz	55 MHz	NC
7400	**7A15A/AN**	Freq.	20 MHz	45 MHz		45 MHz	40 MHz			45 MHz	40 MHz		35 MHz	45 MHz	35 MHz
FAMILY	**7A16A**	Freq.	20 MHz	55 MHz		55 MHz	45 MHz			55 MHz	50 MHz		40 MHz	55 MHz	35 MHz
	7A17	Freq.	20 MHz	45 MHz		45 MHz	40 MHz			45 MHz	40 MHz		35 MHz	45 MHz	35 MHz
	7A18/N	Freq.	20 MHz	45 MHz		45 MHz	40 MHz			45 MHz	40 MHz		35 MHz	45 MHz	35 MHz
	7A22	Freq.	1 MHz		1 MHz								1 MHz	1 MHz	1 MHz
	7A26	Freq.	20 MHz	55 MHz		55 MHz	45 MHz			55 MHz	50 MHz		40 MHz	55 MHz	35 MHz

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

** = Option 9 Mainframe

NC = Not Compatible

P6201 DC to 900 MHz 1X



The P6201 from Tektronix, Inc. is an active (FET) probe providing unity gain and DC to 900-MHz bandwidth. The P6201 is the best general-purpose probe within its voltage range from the standpoint of electrical performance. The very low input capacitance of the probe permits acquisition of high frequency signals with minimum loading of circuits under test while the high input resistance minimizes low frequency and DC loading. Plug-on attenuator heads provide higher input resistance and reduced input capacitance.

The P6201 will maintain excellent risetime and pulse fidelity in higher source impedance circuits, due to low input capacitance when compared to other general-purpose probes.

The P6201 provides a DC offset feature to bias out a voltage level and allow observation of signals riding atop a carrier. This allows the signal to be brought within the linear input window of the probe. AC or DC coupling selection is also available. When AC coupled, the DC voltage component, which could otherwise saturate an active probe, is blocked, allowing viewing of the superimposed signal.

The P6201 is designed primarily for use with TEKTRONIX 7900 and 7700 Series, 475 and 485 Oscilloscopes due to its direct compatibility with the probe power available on these instruments. The P6201 is valuable for use in the 50 Ω and 1 MΩ input real-time oscilloscope systems and also with sampling systems, spectrum analyzers and counters where high performance and minimum signal source loading is desired.

The probe includes a locking-type BNC connector which provides scale-factor readout information to instruments having readout capability, while maintaining compatibility with those instruments without readout. The 10X and 100X attenuator heads couple readout information to the instrument via the output connector.

The 1101 Accessory Power Supply is available to power the P6201 for use with instrumentation not supplying probe power.

Bandwidth (—3 dB) DC to 900 MHz, **Risetime** is 0.4 ns or less. **Probe Gain** is 1X within 3%. **Attenuator Accuracy** ≤4% with probe (10X or 100X). **Input Impedance** (probe only) is 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** is at least ±600 mV; extends to ±6 V with 10X attenuator; ±60 V with 100X attenuator. **DC Offset Range** is at least —5.6 V to +5.6 V (with respect to tip of probe without attenuator head). Effective offset is extended by 10X and 100X attenuation heads to ±56 V and ±200 V respectively. **Noise** (Tangential) is 300 μV or less at output. **Maximum Input Voltage** is ±100 V. Probe only and ±200 V with attenuation heads, derating with frequency. **LF Response** (—3 dB) (AC Coupled) is 10 Hz or lower; 10X attenuator extends LF response to ≤1 Hz; with 100X attenuator, LF response is ≤10 Hz.

P6201 6-FT PROBE, order 010-6201-01 ..... **$395**
Included accessories as shown, see Accessory page 305.

OPTIONAL ACCESSORIES

Accessory Power Supply, for powering up to four P6201 or P6051 Probes. Order 1101 Power Supply $300

P6006 DC to 35 MHz 10X

The P6006 is a general-purpose probe designed for use with TEKTRONIX DC-to-33 MHz oscilloscopes. The probe can be compensated to match all TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ. This probe is more rugged and has a higher voltage rating than the miniature probes.

Attenuation is 10X; **Input Resistance** is 10 MΩ; **Input Capacitance** for standard length probe is approximately 7.5 pF when used with an instrument having a 20-pF input capacitance; 8.5 pF for the 6-ft version, 11 pF for the 9-ft version, 13 pF for the 12-ft version; **Probe Risetime** is approximately 5 ns; **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 12 ns; **Voltage Rating** is 600 V DC, AC peak, or DC and AC peak combined;*

P6006 3.5-FT PROBE, order 010-0127-00 BNC or 010-0125-00 UHF **$32**

P6006 6-FT PROBE, order 010-0160-00 BNC or 010-0158-00 UHF **$32**

P6006 9-FT PROBE, order 010-0146-00 BNC or 010-0142-00 UHF **$32**

P6006 12-FT PROBE, order 010-0148-00 BNC **$32**

*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.

P6007 DC to 25 MHz 100X

The P6007 low input-capacitance, high-voltage (1.5-kV) probe is designed for use with TEKTRONIX DC-to-33-MHz oscilloscopes. The probe can be compensated to match all TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

Attenuation is 100X; **Input Resistance** is 10 MΩ; **Input Capacitance** for 3.5-ft probe is approximately 2.0 pF when used with an instrument having a 20-pF input capacitance; 2.2 pF for the 6-ft version, 2.4 pF for the 9-ft version, 2.6 pF for the 12-ft version; **Probe Risetime** is approximately 7 ns; **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is approx 12.5 ns; **Voltage Rating** is 1.5 kV DC or AC RMS, 4.2 kV AC peak to peak.*

P6007 3.5-FT PROBE, order 010-0150-00 BNC or ~~010-0134-00 UHF~~ No Longer Avail **$38**

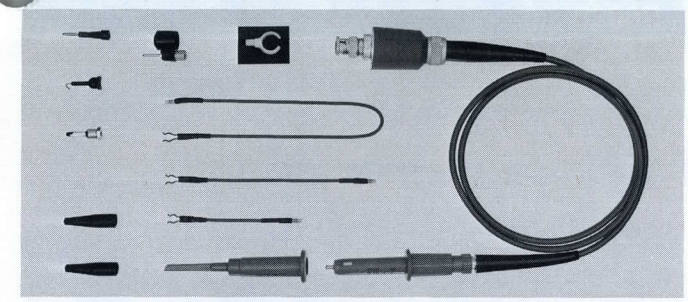
P6007 6-FT PROBE, order 010-0165-00 BNC or ~~010-0162-00 UHF~~ No Longer Avail **$38**

P6007 9-FT PROBE, order 010-0152-00 BNC or ~~010-0136-00 UHF~~ No Longer Avail **$38**

P6007 12-FT PROBE, order 010-0154-00 BNC or ~~010-0138-00 UHF~~ No Longer Avail **$3**

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 200 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

P6008 DC to 100 MHz 10X



ENVIRONMENTAL PROBE

The P6008 Environmental probe is designed to operate over −50°C to +150°C, for the probe body and tip, the compensation box operates from −15°C to +55°C. Input capacitance is 9.0 pF when used with an instrument having a 15 pF input capacitance. Probe risetime is less than 4 ns, all other characteristics are the same as for the standard probe.

The P6008 standard probe is designed to use with TEKTRONIX DC-to-100 MHz oscilloscopes. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

Attenuation is 10X; **Input Resistance** is 10 MΩ; **Input Capacitance** is approximately 7.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Risetime** is less than 3 ns; **Typical Risetime** of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.6 ns; **Voltage Rating** is 600 V DC, AC peak, or DC and AC peak combined.*

P6008 6-FT ENVIRONMENTALIZED PROBE, order 010-0129-01 .. **$90**

Includes: banana plug (134-0013-00); miniature alligator clip (344-0045-00); 12.5-inch ground lead (175-0925-00); probe holder (352-0068-00); retractable hook tip (013-0071-01).

P6008 3.5-FT PROBE (Nonenvironmentalized), order 010-0129-00 . **$60**

Included accessories as shown, see Accessory page 305.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 20 MHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 300 V.

P6009 DC to 120 MHz 100X

The P6009 low input capacitance, high-voltage (1.5-kV) probe is designed for use with TEKTRONIX DC-to-150 MHz oscilloscopes. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides CRT READOUT information when used with plug-in units and mainframes that have these features. The readout connector is not compatible with most standard non-readout BNC connectors.

Attenuation is 100X. **Input Resistance** is 10 MΩ. **Input Capacitance** is approximately 2.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Risetime** is approximately 2 ns; **Typical Risetime** of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.1 ns. **Voltage Rating** is 1.5 kV DC or AC RMS, 4 kV AC peak to peak*. **Cable** is 9 ft long, terminated with a BNC connector; **Net Weight** is approx 16 oz.

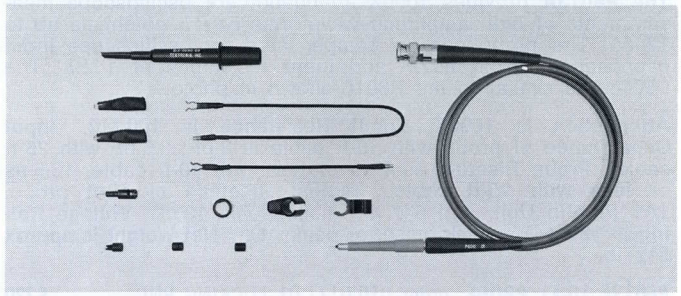
P6009 PROBE (with readout connector), order 010-0264-01 ... **$72**

P6009 PROBE, order 010-0170-00 ..... **$72**

Included accessories as shown with P6008, see Accessory page 305.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 200 kHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 425 V.

P6011 DC to 17 MHz



The P6011 1X Passive Probe can be used with all TEKTRONIX general-purpose oscilloscopes. The small size of the probe body makes it ideal for working on compact circuitry.

Attenuation is 1X. **Input Resistance** is 1 MΩ, instrument input R included. **Input Capacitance** for the 3.5-ft probe is approx 28 pF; 48 pF for the 6-ft version, instrument excluded. For total input capacitance of the system add input C of the instruments. **Probe Risetime** for the 3.5-ft length is less than 12 ns into 15 pF or less than 15 ns into 20 pF. The probe risetime of the 6-ft version is less than 15 ns into 15 pF or less than 17 ns into 20 pF. The probe risetime of the 9-ft version is less than 23 ns into 15 pF or less than 25 ns into 20 pF. **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 16 ns. **Voltage Rating** is 600 V DC, AC peak, or DC and AC peak combined.*

P6011 3.5-FT PROBE, order 010-0193-00 ..... **$25**

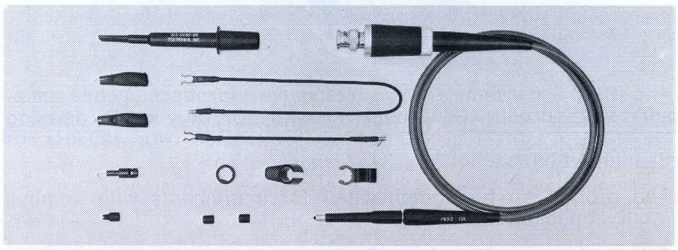
P6011 6-FT PROBE, order 010-0190-00 ..... **$25**

P6011 9-FT PROBE, order 010-0229-00 ..... **$25**

Included accessories as shown, see Accessory page 305.

*Peak voltage derating is necessary for CW frequencies higher than 0.5 MHz. When the probe is used with a plug-in having an input C of 20 pF, the maximum allowable peak voltage at 1 MHz is 510 V. At 5 MHz, the maximum is 100 V; 46 V at 10 MHz.

P6012 DC to 35 MHz 10X



The P6012 is a miniature general-purpose probe designed for use with TEKTRONIX oscilloscopes having bandwidths up to 33 MHz. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 to 47 pF and input resistance of 1 MΩ.

Attenuation is 10X. **Input Resistance** is approximately 10 MΩ. **Input Capacitance** of probe with 3.5-ft cable is 11.5 pF or less; 14.5 pF or less for the 6-ft version; 17.5 pF or less for the 9-ft version. **Probe Risetime** is 5 ns or less with 3.5-ft cable, 6 ns or less with 6-ft cable, 6.5 ns or less with the 9-ft cable. **Typical Risetime** of the 3.5-ft probe and 422 is 24 ns. **Voltage Rating** is 500 V DC and AC peak combined*.

P6012 3.5-FT PROBE, order 010-0203-00 ..... **$44**

P6012 6-FT PROBE, order 010-0209-00 ..... **$44**

P6012 9-FT PROBE, order 010-0231-00 ..... **$44**

Included accessories as shown, see Accessory page 305.

*Peak voltage derating is necessary for CW frequencies higher than 4 MHz. At 15 MHz the maximum allowable peak voltage is 210 V; 95 V at 33 MHz.

P6013A 12 kV 1000X

The P6013A provides 1000X attenuation for oscilloscope measurements of high amplitude waveforms or DC potentials up to 12 kV. The probe can be compensated for oscilloscope input capacitance up to 60 pF and input resistance of 1 MΩ. The P6013A is similar to the P6015 shown in photo.

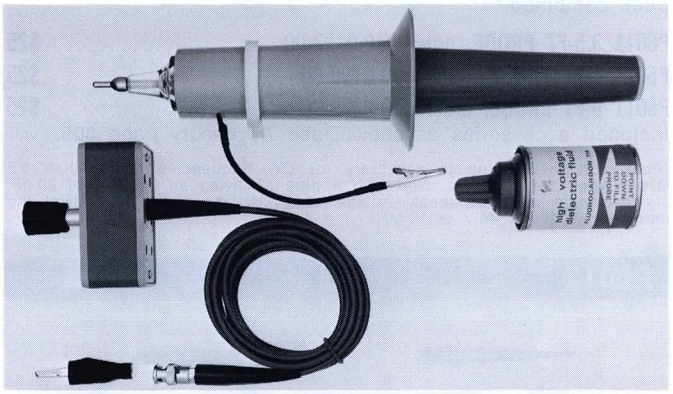
Attenuation is 1000X. **Input Resistance** is 100 MΩ. **Input Capacitance** of probe with 10-ft cable is 3 pF; 3.5 pF with 25-ft cable. **Probe Risetime** is 7 ns or less with 10-ft cable, 13.5 ns or less with 25-ft cable. **Typical Risetime** of 10-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 13 ns. **Voltage Rating** is 12 kV DC, peak pulse, or peak AC.* **Net Weight is approx 5½ lb.**

P6013A 10-FT PROBE, order 010-0177-01 LOCKING BNC **$220**
Includes: compensating box (015-0083-00 BNC); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00).

P6013A 25-FT PROBE, order 010-0175-01 LOCKING BNC **$220**
Includes: compensating box (015-0084-00 BNC) or alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00).

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 1 MHz, the maximum allowable peak-to-peak voltage is 5.5 kV.

P6015 40 kV 1000X



The P6015 provides 1000X attenuation for oscilloscope measurements up to 40-kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF.

Attenuation is 1000X. **Input Resistance** is 100 MΩ. **Input Capacitance** is approximately 3 pF. **Probe Risetime** is approximately 4 ns. **Typical Risetime** of the probe, 1A1 Plug-In Unit and 547 Oscilloscope is 8 ns. **Temperature Range** is 10°C to 55°C **Voltage Rating** is 40 kV peak AC or pulse, 20 kV DC or RMS continuous at 25°C*.

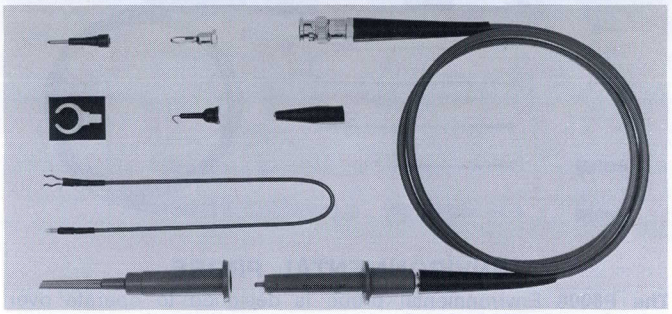
P6015 10-FT PROBE, order 010-0172-00 LOCKING BNC or ~~010-0132-00 UHF~~ no longer avail. **$275**
Includes: compensating box (015-0049-00 BNC) or (015-0039-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); can of high-voltage dielectric fluid (252-0120-00); silica-gel† (256-0570-00); carrying case† (016-0128-00).

†not shown.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 13 kV.

use w/ 103-0015-00

P6027 DC to 17 MHz 1X
P6028 DC to 17 MHz 1X



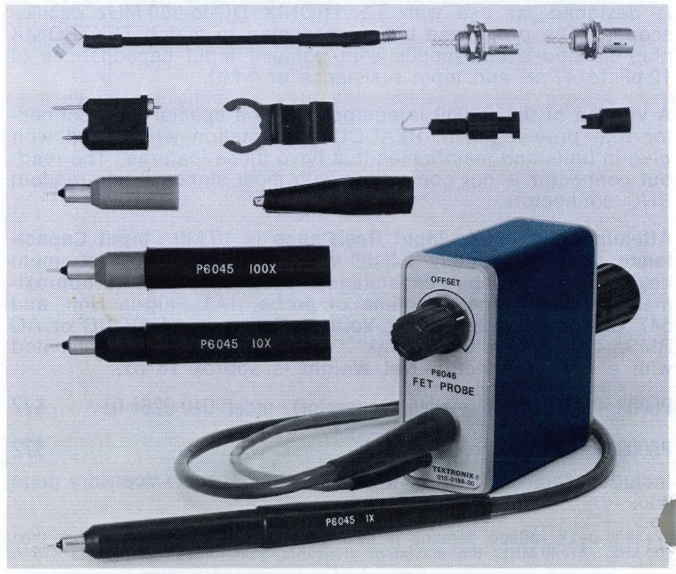
The P6028 is a general-purpose 1X voltage probe designed for use with TEKTRONIX oscilloscopes that have BNC input connectors. **The P6027** is identical to the P6028 except for the UHF connector.

Attenuation is 1X. **Input Resistance** is 1 MΩ, instrument input R included. **Input Capacitance** for 3.5-ft version is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument. **Probe Risetime** is approximately 10 ns. **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 15 ns. **Voltage Rating** is 600 V DC or AC peak to peak*.

P6028 3.5-FT PROBE, BNC Connector, order 010-0074-00 ..... **$22**
P6028 6-FT PROBE, BNC Connector, order 010-0075-00 ..... **$22**
P6028 9-FT PROBE, BNC Connector, order 010-0076-00 ..... **$22**
P6028 12-FT PROBE, BNC Connector, order 010-0077-00 ..... **$22**
Included accessories as shown, see Accessory page 305.
P6027 3.5-FT PROBE, UHF Connector, order 010-0070-00 ..... **$22**
P6027 6-FT PROBE, UHF Connector, order 010-0071-00 ..... **$22**
P6027 9-FT PROBE, UHF Connector, order 010-0072-00 ..... **$22**
Included accessories as shown, see Accessory page 305.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.

P6045 DC to 230 MHz 1X



The P6045 is an active (FET) probe providing unity gain* and DC to 230-MHz bandwidth. The low input-capacitance of the probe permits coupling of high-frequency signals to an oscilloscope input with minimum loading on the circuit under test. Plug-on attenuator heads provide higher input resistance, reduced input capacitance, and attenuation of the signal. Effective DC offset range is also increased when using an attenuator head.

The P6045 is designed primarily for use with conventional oscilloscopes (with 1-MΩ input resistance). The internal 50-Ω termination may be switched in or out to adapt the probe output to either 1-MΩ or 50-Ω inputs.

The P6045 may be powered from the probe power output of the oscilloscope, or by the Accessory Power Supply.

Bandwidth (—3 dB) DC to 230 MHz, **Risetime** is 1.5 ns or less. **Probe Gain** is 1X, 10X to 100X. **Input Impedance** is 10 MΩ shunted by 5.5 pF. **Attenuator Input** C 10X 2.5 pF, 100X 1.8 pF. **Dynamic (Signal) Range** is at least 500 mV. **DC Offset Range** is at least —1 V to +1 V (with respect to tip of probe without attenuator head). **Effective Offset** is extended 10X and 100X by attenuator heads. **Noise** (Tangential) is 600 μV or less at output. **Maximum Input Voltage** (probe only) is 12 V, derated with frequency. **LF Response** (—3 dB) (AC Coupled) is 16 Hz or lower.

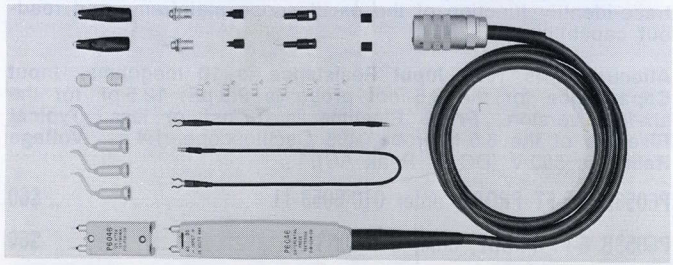
P6045 PROBE WITH ACCESSORY POWER SUPPLY, order 010-0205-00 ..... **$500**

P6045 PROBE, order 010-0204-00 ..... **$365**
Includes: 10X attenuator head (010-0357-02); 100X attenuator head (010-0358-01); AC-coupling capacitor head (010-0360-00); 2.5-inch ground lead (175-0249-00); bayonet ground adapter (013-0085-00); hook tip (206-0114-00); alligator clip (344-0046-00); two test jacks (131-0258-00); probe holder (352-0090-00); carrying case (016-0090-01).

POWER SUPPLY, order 015-0073-00 ..... **$135**
Power Supply includes: power cord (161-0025-01).

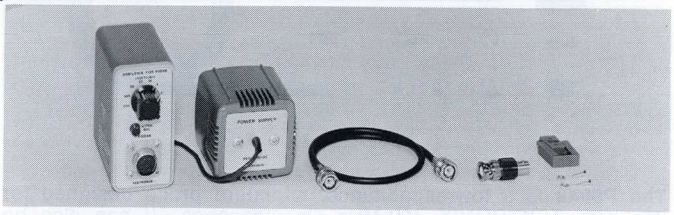
*Peak-to-peak voltage derating is necessary for CW frequencies higher than 18 MHz. Maximum input voltage at 230 MHz is 20 V.

P6046 — DC to 100 MHz with 1000:1 CMRR AT 50 MHz



The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities when used with all TEKTRONIX oscilloscopes. With this probe system, the differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 Probe and Amplifier provides DC-to-100 MHz single-ended and differential measurements. The CMRR of the P6046 and amplifier is 1000:1 at 50 MHz.

A switch on the probe selects AC or DC input coupling. Accessories include a plug-on 10X attenuator for extending the differential input voltage range, and a ground tip for applications requiring single-ended input. Unique swivel tips provide variable spacing to accommodate varying distance between test points.



The P6046 Amplifier mounts conveniently on the side of the oscilloscope and features a calibrated 1-mV/div to 200-mV/div (2 V/div with 10X attenuator) deflection factor (oscilloscope deflection factor set at 10 mV/div). The output impedance of the amplifier is 50 Ω. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems.

The P6046 Differential Probe may be used with the 1A5 Differential Amplifier with TEKTRONIX 540 and 550 Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the 1A5 to 45 MHz. (CMRR is 1,000:1 at 50 MHz.) The 1A5 supplies both probe power and amplification.

CHARACTERISTICS

Probe and Amplifier

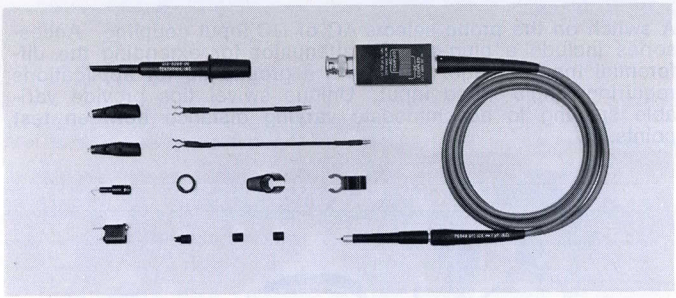
Deflection Factor is 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Bandwidth** is DC-to-100 MHz at 3-dB down. **Risetime** is 3.5 ns or less. **Common-Mode Rejection Ratios** with deflection factors of 1 mV/div to 20 mV/div are at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, 1,000:1 from 10 MHz to 20 MHz, and 500:1 at 50 MHz. **Common-Mode Linear Dynamic Range** is ±5 V. **Input RC** is 1 MΩ paralleled by 10 pF or less. **Input Coupling** is AC or DC, selected by a switch on the probe. Low-frequency response AC-coupled is 3-dB down at 20 Hz, 2 Hz with 10X attenuator. **Displayed Noise** is 280 μV or less (tangentially measured). **Maximum Input Voltage** is ±25 V (DC + peak AC), ±250 V with 10X attenuator. **Output Impedance** is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems. **Probe Cable** is 6 feet long, terminated with a special nine-pin connector. **Amplifier Power Requirements** are 10 watts maximum, 48 to 400 Hz. Factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V-to-250 V (234 V nominal). Instrument can be ordered factory wired for 210 V-to-250 V operation.

P6046 PROBE/AMPLIFIER, order 010-0232-00 ..... **$890**
Includes: P6046 Probe Package (010-0213-00); Amplifier for P6046 and Power Supply (015-0106-00).

AMPLIFIER FOR P6046, order 015-0106-00 ..... **$420**
Includes: Amplifier for P6046 and Power Supply; hanger assembly (014-0029-00); 50-Ω cable (012-0076-00); 50-Ω termination (011-0049-01).

P6046 PROBE, order 010-0213-00 ..... **$470**
Included accessories as shown, see Accessory page 305.

P6048 DC to 100 MHz 10X

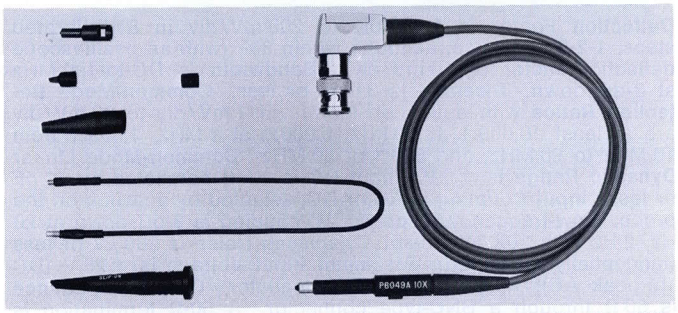


The P6048 is a low-capacitance, miniature probe designed for use with TEKTRONIX 100-MHz Oscilloscopes. It can also be compensated for use with other instruments that have a nominal input capacitance of 15 to 20 pF and inputs resistance of 1 MΩ. The P6048 offers a new level of high-frequency measurement performance with its low 1-pF input capacitance. Its small size makes it easy to use, particularly for applications involving compact circuitry.

ATTENUATION is 10X. **Input Resistance** is 1 kΩ. **Input Capacitance** is 1 pF or less. **Bandwidth** 100 MHz. AC-coupled low-frequency response is 7 kHz or less. **Voltage Rating** DC coupled is 20 V (DC plus peak AC); AC coupled is 200 V DC.

P6048 6-FT PROBE, order 010-0215-00 ..... **$75**
Included accessories as shown, see Accessory page 305.

P6049A DC to 10 MHz 10X



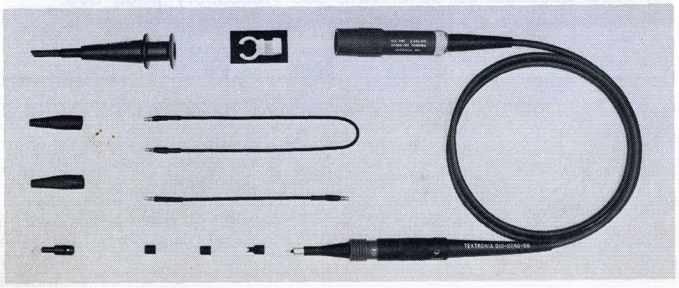
The P6049A is a miniaturized, 10X probe, for use with the 323, 324 and 326 Portable Oscilloscopes. The probes compensating box and cable is at right angles to the BNC connector to allow for compactness and easy use. The probe will compensate to oscilloscopes with input capacitance of 47 pF to 62 pF and input resistance of 1 MΩ.

Attenuation is 10X. **Input Resistance** is 10 MΩ. **Input Capacitance** is 13.5 pF or less. **Voltage Rating** is 500 V DC + Peak AC*.

P6049A 3.5 FT. PROBE, order 010-6049-01 ..... **$40.00**

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 3 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 190 V.

P6052 DC to 20 MHz 1X, 10X Selectable Attenuation



The P6052 is a passive dual-attenuation probe designed for TEKTRONIX low-frequency oscilloscopes that feature CR READOUT and trace-identification functions. A sliding colla on the barrel of the probe selects 1X or 10X attenuation; a push button actuates the trace-identify function. A coding ring on the probe BNC output connector couples the control signals to the mainframe. The P6052 can be compensated for use with instruments having a nominal input capacitance of 15 to 55 pF.

Attenuation 10X. **Input Resistance:** 1X position, 1 megohm; 10X position, 10 megohms. **Input Capacitance** for the 3.5-foot probe is 113 pF in the 1X position, 14 pF in the 10X position. For the six-foot version the input capacitance in the 1X position is 134 pF, the 10X position 16 pF. **Probe Risetime** for the 3.5-foot probe is ≤60 ns in the 1X position, ≤9 ns in the 10X position. For the six-foot version: 1X position ≤75 ns, 10X position ≤11 ns. **Typical Risetime** of the 3.5-foot probe, 7403 Oscilloscope, and 7A18 Amplifier is 11 ns. **Voltage Rating** is 500 V (DC + Peak AC)*.

P6052 3.5-FT PROBE, order 010-0241-00 ..... **$60**

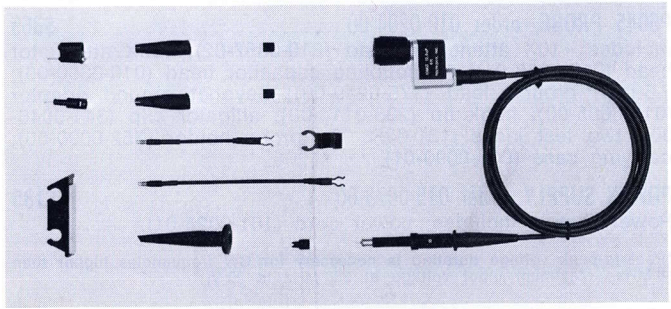
P6052 6-FT PROBE, order 010-0243-00 ..... **$60**
Note the readout connector is not compatible with a standard BNC connector.

P6052 3.5-FT PROBE, (without readout function)
order 010-0241-01 ..... **$60**

P6052 6-FT PROBE, (without readout function)
order 010-0243-01 ..... **$60**
Included accessories as shown, see Accessory page 305.

*Peak voltage derating is necessary for CW frequencies higher than 500 kHz in the 1X position and above 5 MHz in the 10X position. At 44 MHz the maximum allowable peak voltage is approximately 35 V in the 1X position and approximately 60 V in the 10X position.

P6053B DC to 250 MHz 10X



The P6053B is a miniature fast-rise 10X probe designed for TEKTRONIX instruments having a nominal input capacitance of 15 to 24 pF. The probe has a push button for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

Attenuation is 10X. **Input Resistance** is 10 megohms. **Input Capacitance** for the 3.5-foot probe is 9.5 pF; 12.5 pF for the six-foot version. **Probe Risetime** is 0.7 ns† or less. **Typical Risetime** of the 3.5-ft probe, 485 Oscilloscope, 1.4 ns. **Voltage Rating** is 500 V (DC + Peak AC).*

P6053B 3.5-FT PROBE, order 010-6053-11 ..... **$60**

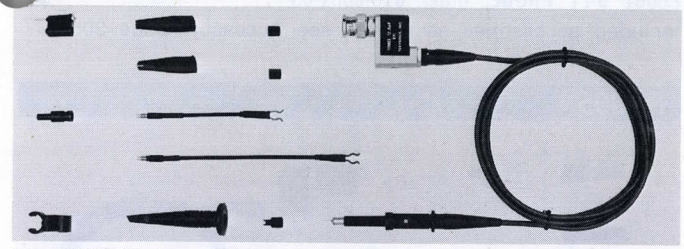
P6053B 6-FT PROBE, order 010-6053-13 ..... **$60**

P6053B 9-FT PROBE, order 010-6053-15 ..... **$60**
Included accessories as shown, see Accessory page 305.

†Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system.

*Peak voltage derating is necessary for CW frequencies higher than 5.5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

P6054A DC to 250 MHz 10X



The P6054A is a miniature, fast-rise, 10X probe designed for use in conjunction with TEKTRONIX oscilloscopes having a nominal input capacitance of 15 to 24 pF. The probe does not incorporate CRT READOUT/trace-identify functions but does have a ground reference button in hand.

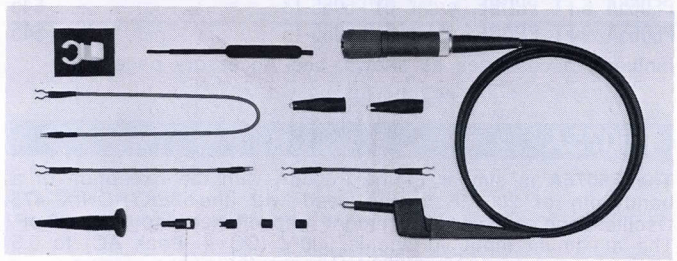
Attenuation is 10X. **Input Resistance** is 10 megohms. **Input Capacitance** for the 3.5-ft probe is 9.5 pF; for the 6-foot version 12.5-pF; for the 9-foot version 13.5 pF. **Probe Risetime** for 3.5-ft or 6-ft probe is 0.7 ns* or less, the 9-ft probe is 2 ns or less. **Typical Risetime** of 3.5-ft probe with 454A Oscilloscope is 2.4 ns. **Voltage Rating** is 500 V (DC + Peak AC).†

P6054A 3.5-FT PROBE, order 010-6054-11 ..... **$55**
P6054A 6-FT PROBE, order 010-6054-13 ..... **$55**
P6054A 9-FT PROBE, order 010-6054-15 ..... **$55**
Included accessories as shown, see Accessory page 305.

*Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system.

†Peak voltage derating is necessary for CW frequencies higher than 6 MHz. At 10 MHz the maximum allowable peak voltage is 300 V; 25 V at 100 MHz, 22 V at 150 MHz. Values for 3.5-ft probe only.

P6055 20,000:1 CMRR



The P6055 is a miniature low-capacitance, 10X Probe designed for use with TEKTRONIX differential amplifiers having nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the CMRR of the system.

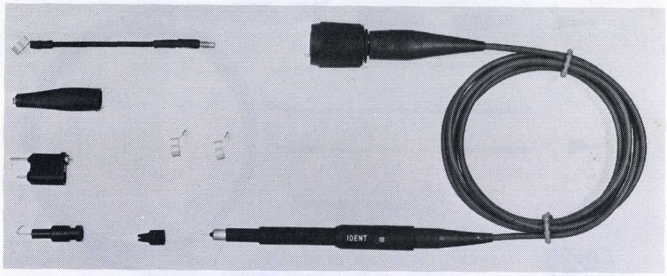
CMRR is 20,000:1 from DC to 1 kHz derating to 100:1 at 20 MHz, measured at probe tip using probe pair with 7A13 or 1A5.

Attenuation is adjustable to 10X. **Input Resistance** is 1 MΩ ±0.5%. **Input Capacitance** is approx 10 pF when used with an instrument having 20 pF input capacitance; 12.5 pF when used with an instrument having 47 pF input capacitance. **Typical Risetime** of the probe with 7A13 and 7704 Oscilloscope is ns. **Voltage Rating** is 500 V (DC + peak AC).*

P6055 3.5-FT PROBE, order 010-6055-01 ..... **$85**
Included accessories as shown, see Accessory page 305.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 12 MHz. At 70 MHz, the maximum allowable peak-to-peak voltage is 100 V.

P6056 DC to 3.5 GHz 10X



The P6056 is a miniature low-capacitance probe for use with 50 Ω, wide-band oscilloscopes. Bandwidth DC to 3.5 GHz. This probe can also be used with 50-Ω sampling systems, with an appropriate BNC adapter.

The P6056 is equipped with a special BNC connector that provides trace identification and CRT READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

Attenuation is 10X. **Input Resistance** is 500 Ω at DC and approx 300 Ω at 1 GHz. **Input Capacitance** is 1.0 pF. **Risetime** is less than 100 ps, Probe only. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. **Bandwidth** is 3.5 GHz probe only DC to 500 MHz with 7A19 and 7904. **Maximum Input Voltage** RF (CW) 22 volts DC 16 volts. **Maximum Power Dissipation** is 0.5 watt. **Transit Time variation** from probe to probe is less than 70 ps.

P6056 6-FT PROBE, order 010-6056-03 ..... **$50**
P6056 9-FT PROBE, order 010-6056-05 ..... **$50**
Included accessories as shown, see Accessory page 305.

P6057 DC to 1.4 GHz 100X

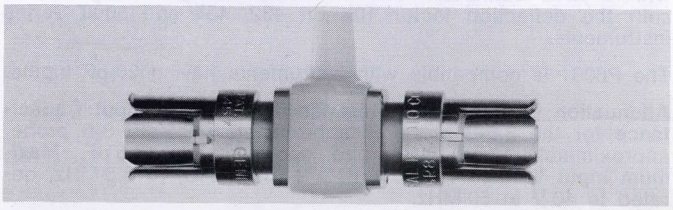
The P6057 is a miniature low-capacitance probe for use with 50 Ω, wide-band oscilloscopes. Bandwidth DC to 1.7 GHz. This probe can also be used with 50-Ω sampling systems, with an appropriate BNC male adapter (017-0063-00).

The P6057 is equipped with a special BNC connector that provides trace identification and CRT READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

Attenuation is 100X. **Input Resistance** is 5000 Ω at DC and approx 1500 Ω at 1 GHz. **Input Capacitance** is 1.0 pF. **Risetime** is less than 250 ps probe only. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. **Bandwidth** is 1.4 GHz probe only DC to 480 MHz with 7A19 and 7904. **Maximum Input Voltage** 50 V DC or RMS to 500 MHz decreasing to 21 volts at 1 GHz. **Transit Time variation** from probe to probe is less than 70 ps.

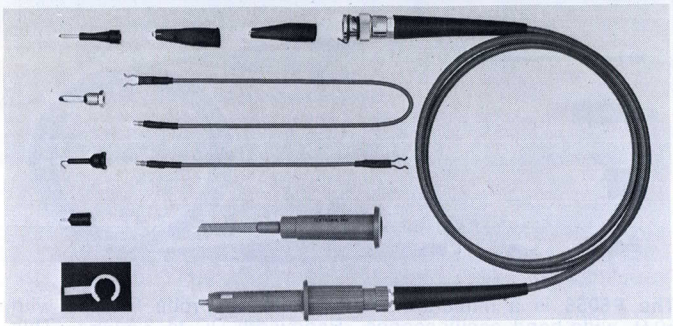
P6057 6-FT PROBE, order 010-6057-03 ..... **$50**
P6057 9-FT PROBE, order 010-6057-05 ..... **$50**
Included accessories, same as P6056.

OPTIONAL ACCESSORIES



The VP-1 50-Ω "T" pickoff allows signal pickoff from a closed 50-Ω system with minimum disturbance of the system's characteristics. The VP-1 is used with the P6056 and P6057 probes in a closed, 50-Ω coaxial system with minimum disturbance.
Order 017-0073-01 ..... **$35.00**

P6060 DC to 35 MHz 10X



The P6060 is a precision passive probe with 10X attenuation, for use with TEKTRONIX low- and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 MΩ.

The BNC-type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5000-Series Oscilloscopes.

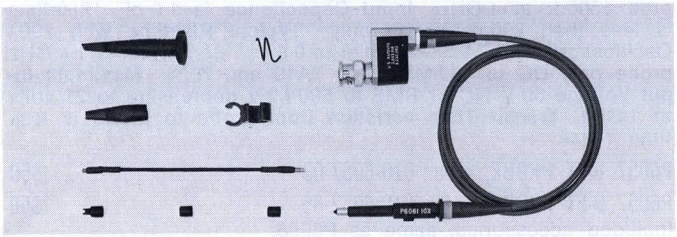
Attenuation is 10X. Accuracy when used with a 1 MΩ ±0.15% instrument input will be within ±0.4%. When used with a 1 MΩ ±2% instrument input the accuracy will be within ±2%. **Input Resistance** is 10 MΩ within ±0.25% with a 1 MΩ ±0.15% instrument input; 10 MΩ within ±0.4% when used with a 1 MΩ ±2% instrument input. **Input Capacitance** for 15 pF instruments is ≈6.0 pF with 3.5-ft probe and ≈7.7 pF with 6 ft. On 55 pF we have ≈9.5 pF with the 3.5 ft, ≈11.5 pF for the 6 ft. **CMRR (Probe Pair)**—At least 400:1 (with 5A20N or 5A21N) DC to 30 kHz. **Bandwidth**— 3.5-foot probe at least 40 MHz (with 453A; 20 mV/div to 10 V/div). 6-foot probe at least 30 MHz (with 453A; 20 mV/div to 10 V/div. **Maximum Input Voltage**— 600 V (DC + Peak AC).*

P6060 3.5-FT PROBE, order 010-6060-01 ..... **$36**
P6060 6-FT PROBE, order 010-6060-03 ..... **$36**

Included accessories as shown, see Accessory page 305.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 3 MHz. Maximum input voltage at 50 MHz is 50 V.

P6061 DC to 60 MHz 10X



The P6061 is a miniature 10X attenuation probe designed for use with 60 MHz Oscilloscopes. The probe is terminated with a BNC connector that has a special grounding clip to shift the deflection factor 10X on 432, 434 and 5000 Series instruments.

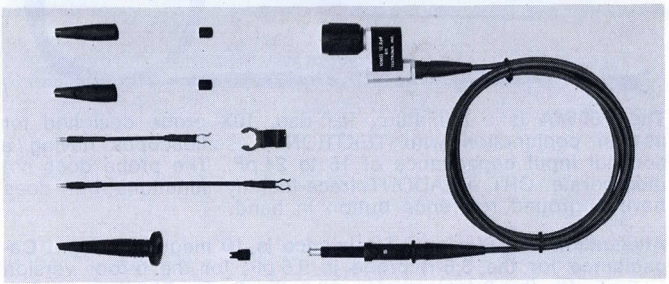
The P6061 is compatible with instruments having 20-pF inputs.

Attenuation is 10X. **Input Resistance** is 10 MΩ. **Input Capacitance** for the 3.5-ft probe is approximately 9.5 pF; 6-ft probe, approximately 12 pF; 9-ft probe, approximately 13.5 pF. **Maximum Input Voltage** is 500 V (DC + peak AC) to 3.5 MHz, derated to 40 V at 60 MHz.

P6061 3.5-FT PROBE, order 010-6061-01 ..... **$40**
P6061 6-FT PROBE, order 010-6061-03 ..... **$**
P6061 9-FT PROBE, order 010-6061-05 ..... **$**

Included accessories as shown, see Accessory page 305.

P6065A DC to 100 MHz 10X



The P6065A is a miniature passive probe with precise 10X attenuation for use with the TEKTRONIX 465 Oscilloscope. When used with the 465 Oscilloscope, the bandwidth will be 100 MHz. When compensated to other 20-24 pF input capacitance instruments the bandwidth will be at least 75 MHz.

The probe provides both ground reference and readout features. The ground reference push button, on the probe body, when depressed provides a ground reference signal which can also be used to identify which probe is in use on a multi-channel instrument.

Attenuation is 10X within 0.4% when used with a 1 MΩ ±0.15% instrument input and within ±2% when used with a 1 MΩ ±2% instrument input. **Input Resistance** is 10 MΩ within ±0.25% with a 1 MΩ ±2% instrument input. **Input Capacitance** is 12.5 pF. **Bandwidth** is 100 MHz when used on the 465 Oscilloscope. **Maximum Input Voltage** is 500 V (DC + peak AC) to 3.5 MHz derated to 35 V at 100 MHz.

P6065A 6-FT PROBE, order 010-6065-13 ..... **$45**
P6065A 9-FT PROBE, order 010-6065-15 ..... **$45**

Included accessories as shown, see Accessory page 305.

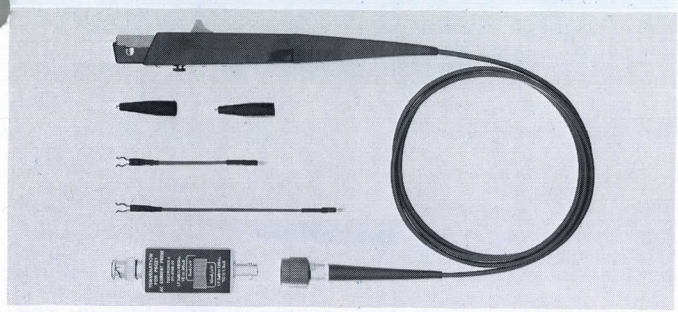
P6075A DC to 200 MHz 10X

The P6075A is similar to the P6065A with the exception of a bandwidth of 200 MHz when used with the TEKTRONIX 475 Oscilloscope and an instrument capacitance input of 20 pF. The maximum input voltage is 500 V (DC + Peak AC) to 0.5 MHz, derated to 30 V at 200 MHz.

P6075A 6-FT PROBE, order 010-6075-13 ..... **$48**

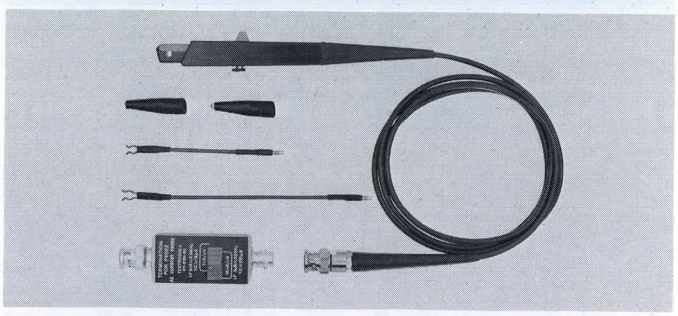
Included accessories as shown, see Accessory page 305.

P6021 120 Hz to 60 MHz—AC Current Probes



The P6021 and P6022 are AC current probes, the P6021 has 125 turns and the P6022 has 50 turns. The probes are designed for use with real-time oscilloscopes. Neither the termination nor the amplifier are required to use the probes with the TEKTRONIX 5A21N and 7A14 Plug-in Amplifiers. Both probes provide the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Just open the spring-loaded slide, place the conductor (up to 0.150 inches with P6021 and 0.100 inches with P6022) in the probe slot and release the slide. No electrical connection is required.

P6022 935 Hz to 150 MHz—AC Current Probes



The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. For general-purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The extra-small size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits. Both probes, low-frequency capabilities and sensitivity can be expanded using the 134 Current Probe Amplifier. Either probe, with passive termination or with the amplifier, can be used with oscilloscopes having input resistance of 1 MΩ or greater.

PERFORMANCE CHARACTERISTICS

		P6021 & P6022 PROBE WITH PASSIVE TERMINATION				P6021 & P6022 PROBE WITH 134 AMPLIFIER	
SENSITIVITY	P6021	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.				Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.	
	P6022	1 mA/mV or 10 mA/mV, selected by termination switch. Accuracy ±3%.					
SYSTEM BANDWIDTH†/RISETIME Oscilloscope Bandwidth		Bandwidth		Risetime		Bandwidth	Risetime
P6021	50 MHz	39 MHz		9.0 ns		30 MHz	11.6 ns
	75 MHz	48 MHz		7.3 ns		35 MHz	10.0 ns
	100 MHz	52 MHz		6.7 ns		36 MHz	9.6 ns
P6022		1 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	Bandwidth	Risetime
	50 MHz	47 MHz	48 MHz	7.45 ns	7.2 ns	40 MHz	8.8 ns
	75 MHz	65 MHz	70 MHz	5.35 ns	5.0 ns	50 MHz	7.0 ns
	100 MHz	80 MHz	90 MHz	4.36 ns	3.9 ns	54 MHz	6.4 ns
	150 MHz	100 MHz	120 MHz	3.50 ns	2.9 ns	59 MHz	5.9 ns
LOW FREQUENCY RESPONSE		P6021 ≤450 Hz at 2 mA/mV ≤120 Hz at 10 mA/mV		P6022 ≤8.5 kHz at 1 mA/mV ≤935 Hz at 10 mA/mV		P6021 ≤12 Hz	P6022 ≤100 Hz
NOISE P6021 & P6022						≤150 μA	
MAXIMUM CURRENT (CW)*	P6021	15 A peak-to-peak sinewave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV				15 A peak-to-peak sinewave between 230 Hz and 5 MHz	
	P6022	6 A peak-to-peak sinewave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV				6 A peak-to-peak sinewave between 1.3 kHz and 10 MHz	
MAXIMUM CURRENT (PULSE)*	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	
MAXIMUM VOLTAGE		600 V (DC + peak AC)				600 V (DC + peak AC)	
NET WEIGHT		≈1 lb				≈5 lb	

*Decrease oscilloscope sensitivity to make these measurements.

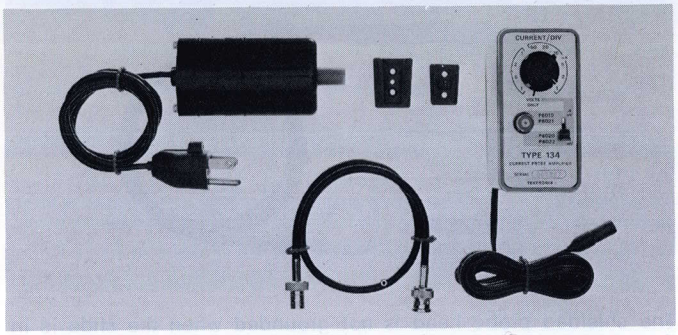
†All bandwidths stated are —3 dB.

P6021 5-FT PROBE, order 010-0237-02 ..... **$100**
P6021 9-FT PROBE, order 010-0244-02 ..... **$100**

P6022 5-FT PROBE, order 010-0238-00 ..... **$130**
P6022 9-FT PROBE, order 010-0238-02 ..... **$130**

Additional information on following page.

134 AC Current Probe Amplifier



The 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div).

The 134 can also be used as an auxiliary voltage amplifier by placing the current/div switch in the VOLTS position.

Linear Deflection: ±15 A Peak at 1 A/div. **Impedance:** (input) approx 50 Ω, AC-coupled. **Bandwidth:** 8 Hz to 50 MHz at a gain of 50; 10 Hz to 30 MHz at a gain of 125 (3-dB down). **Net Weight:** approx 4 lb.

134 AMPLIFIER ONLY order 015-0057-01 ..... **$265**

POWER SUPPLY ONLY, 115 V order 015-0058-01 ..... **$45**

POWER SUPPLY ONLY, 230 V order 015-0059-01 ..... **$45**

ORDERING INFORMATION

P6021

P6021 5-FT PROBE WITH PASSIVE TERMINATION order 015-0140-02 ..... **$140**

P6021 9-FT PROBE WITH PASSIVE TERMINATION order 015-0140-03 ..... **$140**

P6021 5-FT PROBE order 010-0237-02 ..... **$100**

P6021 9-FT PROBE order 010-0244-02 ..... **$100**

P6021 PASSIVE TERMINATION order 011-0105-00 ..... **$45**

P6022

P6022 5-FT PROBE WITH PASSIVE TERMINATION order 015-0135-00 ..... **$175**

P6022 9-FT PROBE WITH PASSIVE TERMINATION order 015-0135-01 ..... **$175**

P6022 5-FT PROBE order 010-0238-00 ..... **$130**

P6022 9-FT PROBE order 010-0238-02 ..... **$130**

P6022 PASSIVE TERMINATION order 011-0106-00 ..... **$54**

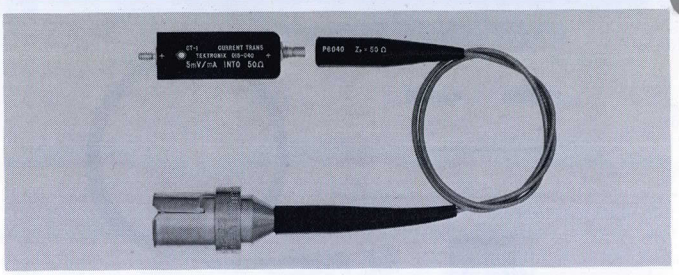
OPTIONAL ACCESSORIES for P6021 and P6022

CALIBRATOR ADAPTER, BNC order 013-0092-00 ..... $5.50

ADAPTER, BNC to UHF order 103-0015-00 ..... $2.50

Carrying case for P6021 or P6022 and a 134 amplifier order 016-0087-00 ..... $9.90

P6040/CT-1 1 GHz AC CURRENT PROBE



The P6040/CT-1 Current Probe is designed for use with TEKTRONIX 50-Ω sampling units. With the use of a 50-Ω termination the P6040/CT-1 can be used with wideband, nonsampling oscilloscopes for making fast-risetime current measurements.

Several CT-1 current transformers may be placed throughout the circuit and monitored by one or more P6040 Probes. For a longer length probe, additional 50-Ω cable can be used in series with the probe. Conductor sizes up to 0.065 inches in diameter can be monitored. (Note the CT-1 permanently inserted into a 50-Ω circuit will not change the 50-Ω environment.)

P6040 PROBE

The P6040 Probe is an interconnecting cable for the CT-1, used between the transformer and oscilloscope input.

If several CT-1 Transformers are in a circuit, the P6040 Probe can be used to monitor any one of them.

The P6040 can be used with other test-point connectors, such as Amphenol series 27 Sub-Minax or Sealectro Sub-Miniature RF.

Impedance is 50 Ω. **Attenuation** is 1X. **Output Connector** is a GR type. **Cable Length** is 18 inches. Additional 50-Ω cable can be used in series with the probe. RG213/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

CT-1 CURRENT TRANSFORMER

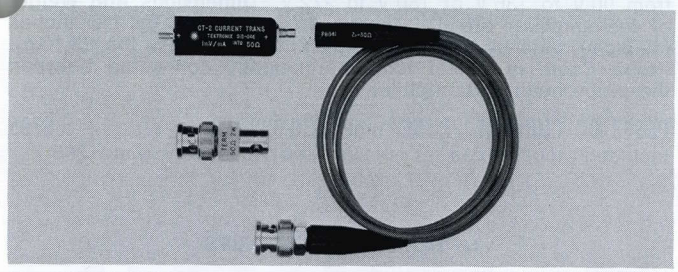
Sensitivity is 5 mV/mA into a 50-Ω load. Accuracy is ±3%. **Decay Time Constant** is 5 μs, approximated by 1% per 50 ns; limit, 1 μs. **Risetime** is less than 350 ps. **Frequency Response** is 35 kHz to 1 GHz (3 dB down). **Insertion Impedance with a** 50-Ω termination is 1 Ω shunted by approximately 5 μH; 2 Ω shunted by approximately 5 μH without a 50-Ω termination. **Capacitance Loading** to a bare wire passing through the CT-1 transformer is typically 1.5 pF for #14 gauge, 0.6 pF for #20 gauge. **Maximum Voltage of Circuit Under Test** is 1000 V DC. **Direct Current** reduces the L/R time constant by a factor of 2 at 0.6 A. **Pulse Current Rating** is 100 A peak, with a max amp-second product of 1 A-μs. **RMS Current Rating** is 500 mA maximum. **Temperature Rating** is −25°C to +65°C. **Physical Dimensions** are 3/8 x 9/16 x 1-13/16 inches plus #6-32 x 1/4-inch mounting stud.

P6040/CT-1 CURRENT PROBE, order 015-0041-00 ..... **$55**

CT-1 CURRENT TRANSFORMER, order 015-0040-00 ..... **$33**

P6040 PROBE, order 010-0133-00 ..... **$25**

P6041/CT-2 AC CURRENT PROBE



The P6041/CT-2 Current Probe is designed for use with TEKTRONIX DC-to-100 MHz Oscilloscopes. A 50-Ω termination is used in conjunction with the P6041/CT-2 for terminating the probe at the input of the oscilloscope.

The insulated case of the CT-2 Current Transformer is convenient to use in applications where limited circuit space exists. Several CT-2 Transformers may be placed throughout the circuit and monitored by one or more P6041 Probes. Conductor sizes up to 0.050 inches in diameter can be monitored.

P6041 PROBE

The P6041 Probe serves as an interconnecting cable between the CT-2 Transformer and the oscilloscope input. A 50-Ω termination is used in conjunction with the P6041 for terminating the probe at the high impedance input of the oscilloscope used.

Although designed for use with the CT-2, the P6041 Probe can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

Impedance is 50 Ω. **Attenuation** is 1X. **Output Connector** is BNC type. **Cable Length** is 42 inches. Additional 50-Ω cable can be used in series with the probe. RG213/U or RG58A/U cable is recommended to preserve the high-frequency response.

CT-2 CURRENT TRANSFORMER

Sensitivity is 1 mV/mA into a 50-Ω load. Accuracy is ±3%. **Decay Time Constant** is 125 μs, approximated by 1% per 1.25 μs; limit, 25 μs. **Risetime** is approx 0.5 ns. **Frequency Response** is 30% down at 1.2 kHz, 7% down at 200 MHz. **Insertion impedance** with a 50-Ω termination is 0.04 Ω shunted approx 5 μH; 0.08 Ω shunted by approx 5 μH without a 50-Ω termination. **Capacitive Loading** to a bare wire passing through the CT-2 Transformer is typically 2.1 pF for #16 gauge, 0.7 pF for #22 gauge. **Maximum Voltage of Circuit Under Test** is 1000 V DC. **Direct Current** reduces the L/R time constant by a factor of 2 at 0.5 A. **Pulse Current Rating** is 100 A peak, with a max amp-second product of 50 A-μs. **RMS Current Rating** is 2.5 A maximum. **Temperature Rating** is −25°C to +65°C.

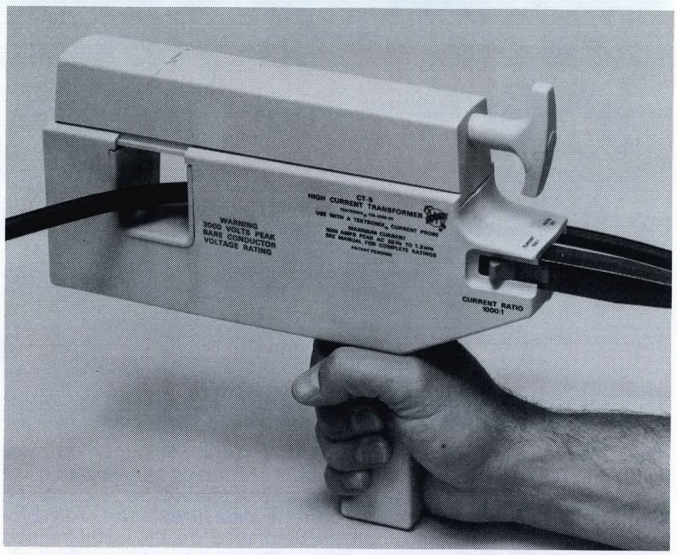
P6041/CT-2 CURRENT PROBE, order 015-0047-00 ..... **$70**
Includes: 50-Ω termination (011-0049-01).

CT-2 CURRENT TRANSFORMER, order 015-0046-00 .... **$35**

P6041 Probe, order 010-0164-00 ..... **$22**

50-Ω TERMINATION, order 011-0049-01 ..... **$15**

CT-5 1000 A C W CURRENT



The CT-5 is a clip-on High-Current Transformer designed to extend the measurement capability of TEKTRONIX clip-on current probes. Maximum low-frequency performance is obtained using the P6042 DC Current Probe. Maximum pulse current up to 50,000 A may be measured provided the 8 A-sec rating is not exceeded. It may also be used with the P6021 (not compatible with P6022) in conjunction with a current probe amplifier for measurements at normal power line frequency and above.

The CT-5 has receptacles for insertion of a current probe in either 20:1 or 1000:1 step-down ratios. The 1.5-inch square opening makes it possible to clip onto large conductors to make current measurements without breaking the circuit under test.

The core and shield assembly is insulated from the windings and the handle. This allows measurements to be made on bare conductors to 3000 volts, and to 10 kV RMS on insulated conductors or by use of a high-voltage bushing.

Use of an optional DC bucking coil assembly, which slips over the front of the CT-5, allows up to 300 amps of DC to be tolerated without appreciably degrading the measurements to be made. This is very useful for measuring AC signals riding on top of DC.

CHARACTERISTICS

Bandwidth—with CT-5/P6042 is 0.5 Hz to 20 MHz; CT-5/P6021/134 is 12 Hz to 20 MHz; CT-5/P6042/DC Bucking Coil is 1 Hz to 1 MHz.

The following are characteristics of the CT-5 using either the P6042 or P6021/134 combination.

Risetime is 17.5 ns or less. **Insertion Impedance** is 20 μΩ or less at 60 Hz, increasing to 20 MΩ at 1 MHz. **Current Range** is 20 mA/div to 20 A/div (20:1 step-down ratio); 1 A/div to 1000 A/div (1000:1 step-down ratio). Accuracy is within 4%. **Maximum Current** is 1000 A Peak CW.* **Amp-Second Product** is 8 A-s. **Maximum Voltage** of circuit under test is 3000 V (bare conductor). **Maximum DC Bucking Current** is 300 mA to buck out 300 A DC (using optional DC bucking coil). **Dimensions and Weight**—the length is 10½ inches, width is 2¼ inches, height is 9½ inches, net weight is approx 4 lb.

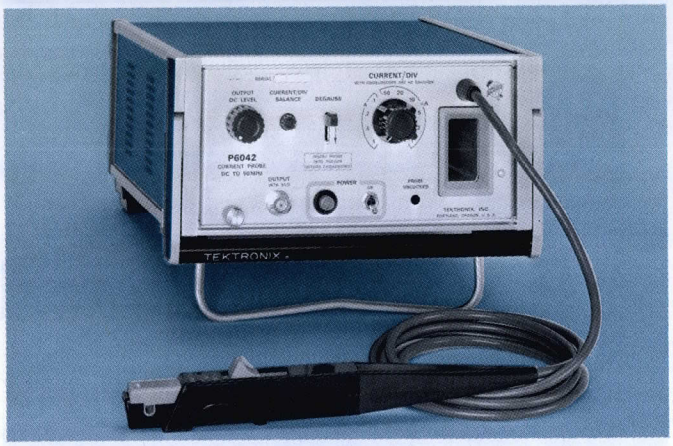
CT-5 HIGH-CURRENT TRANSFORMER, order 015-0189-00 ..... **$475**
Includes carrying case (016-0191-00); high-voltage bushing, 10 inches (015-0194-00).

OPTIONAL ACCESSORIES

DC Bucking Coil, order 015-0190-00 ..... $150
High-Voltage Bushing, 4 ft long, inside dia is 1 inch, order 015-0194-01 ..... $15

*Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.

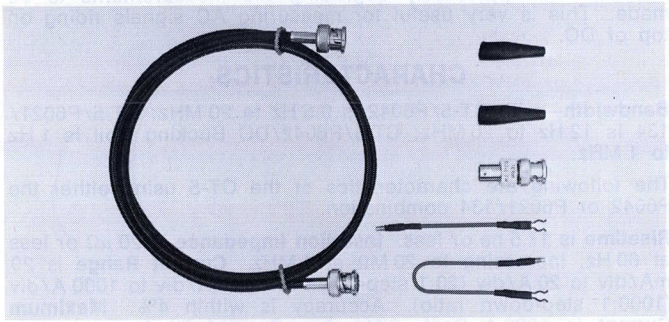
P6042 DC to 50 MHz CURRENT PROBE



The P6042 is a DC-to-50 MHz current probe designed for use with all TEKTRONIX Oscilloscopes. Utilizing a variation of the Hall effect, the P6042 offers new capabilities for making both high-frequency and DC current measurements. AC Signals with DC components can be displayed on the oscilloscope with true waveform presentation. The probe is particularly useful for evaluating the performance of semiconductor circuits where a wide range of parameters exist. Fast switching transients, low-frequency response, and DC level can all be displayed simultaneously.

The probe can also be used to measure the sums or differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, the sum is displayed. By reversing one of the wires, the difference is displayed. For increasing sensitivity, several loops can be placed through the probe, increasing the sensitivity by the number of loops.

The P6042 consists of an amplifier with built-in power supply, 6-foot probe cable, and probe head. The probe is easy to use. Simply place the conductor (Up to 0.150-inch diameter) in the slot of the probe head and close the spring-loaded slide . . . no need to break the circuit under test. A warning light on the front panel of the amplifier indicates when the slide is in the unlocked position. A compartment is provided in the front panel for use in degaussing, and for convenient storage of the probe head when the system is not in use.



CHARACTERISTICS

Probe and Amplifier

Sensitivity is 1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 50 mV/div). **Bandwidth** is DC to 50 MHz at 3-dB down. **Risetime** is 7 ns or less. **Dynamic Range** is + and − 10 divisions of display. **Noise** (periodic and random deviation) is 0.5 mA or less, plus 0.2 or less major divisions of display. Random trace shift is 1.5 mA or less. **Thermal Drift** is 2 mA/°C or less, plus 0.2 or less major division of display per °C. **Maximum Input Current** is 10 A (DC plus Peak AC).* **Maximum Voltage of Circuit Under Test** is 600 V (DC plus Peak AC). **Output Impedance** is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the probe for use with 1-MΩ systems.

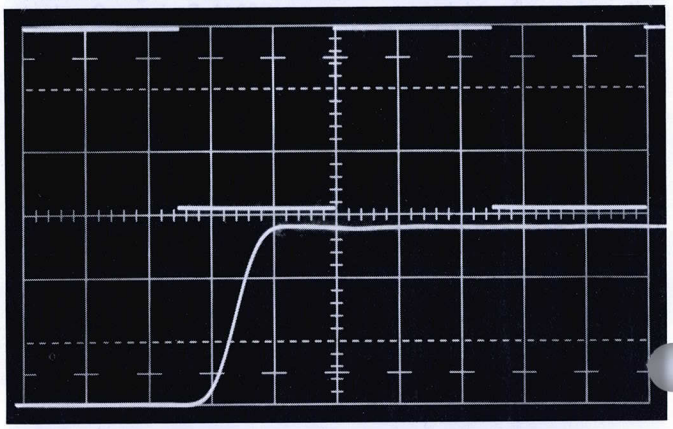
Amplifier Power Requirement is approximately 20 W, 50 Hz to 400 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V. **Dimensions And Weight** of the amplifier are 4½ inches (11.4 cm) high by 7½ inches (19.2 cm) wide by 9¾ inches (24.8 cm) deep; 6½ lbs. (3.1 kg). **Probe Cable** is 6 feet long, permanently connected between the probe head and amplifier.

P6042 DC CURRENT PROBE, order 010-0207-00 ..... **$795**
Included accessories as shown, see Accessory page 305.

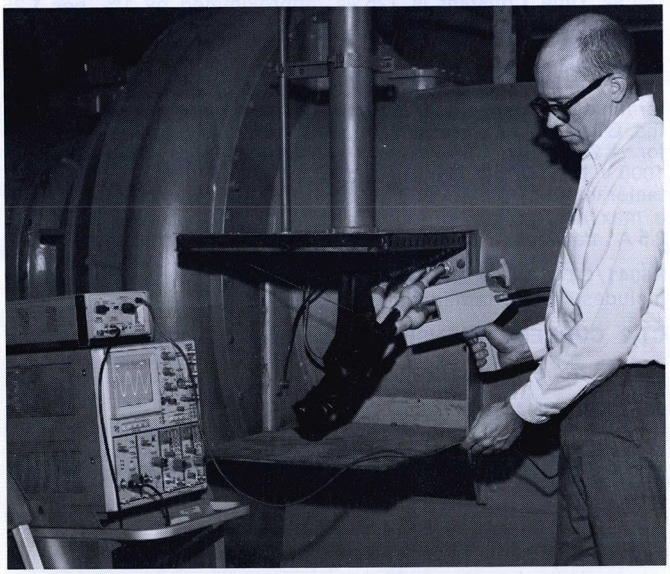
OPTIONAL ACCESSORIES

The CT-5 High-Current Transformer extends the maximum measurement capability of the P6042 at bandwidths from 1 Hz to 20 MHz.
Order 015-0189-00 ..... $475

*Peak-to-peak current derating is necessary for CW frequencies higher than 1 MHz. At 50 MHz, the maximum allowable current is 2 A.



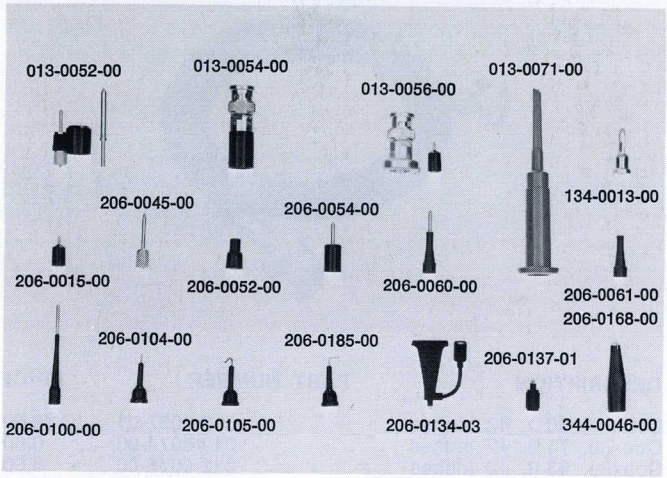
Upper display is a 60-Hz squarewave demonstrating the DC response of the P6042. The lower display is the same waveform at 10 ns/div. Double exposure photograph.



Typical application of the CT-5 clip-on high-current transformer, P6042 DC current probe and 7000-Series Oscilloscope measuring the running current of a 1500 hp delta-connected induction motor.

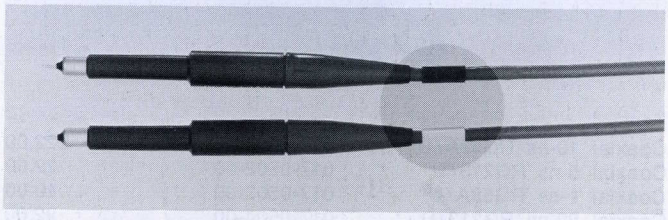
#6-32 PROBE TIPS AND ACCESSORIES

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, P6027, P6028 and P6060 Probes.



DESCRIPTION	PART NUMBER	PRICE
Bayonet ground assembly (for P6006, P6007, P6008, P6009)	013-0052-00	$2.75
Probe tip to BNC adapter (for P6006, P6007, P6008, P6009)	013-0054-00	4.00
Probe tip to BNC adapter (for P6027, P6028)	013-0056-00	3.85
Probe retractable hook tip (for P6006, P6007, P6008, P6009, P6027, P6028)	013-0071-00	2.20
Probe banana tip	134-0013-00	.25
Probe straight tip (0.055 inch dia)	206-0015-00	.35
Probe straight tip (0.080 inch dia)	206-0045-00	.95
Probe recessed tip (accepts 0.065 inch dia recessed pin)	206-0052-00	.50
Probe straight tip (0.086 inch dia)	206-0054-00	.95
Probe spring tip (0.080 inch dia)	206-0060-00	.60
Probe spring tip (accepts 0.065 inch dia pin)	206-0061-00	.55
Probe calibration tip (0.063 inch dia)	206-0100-00	2.50
Probe long straight tip (0.032 inch dia)	206-0104-00	.35
Probe hook tip	206-0105-00	.35
Probe pin tip (accepts 0.025 inch square pin)	206-0134-03	1.95
Probe ground lead adapter (#6-32 to 0.025 inch x 0.025 inch dia pin)	206-0137-01	1.20
Probe spring tip (accepts 0.068 inch dia pin)	206-0168-00	.55
Probe right angle hook tip	206-0185-00	.35
Miniature alligator clip	344-0046-00	.30

IDENTIFICATION TAGS

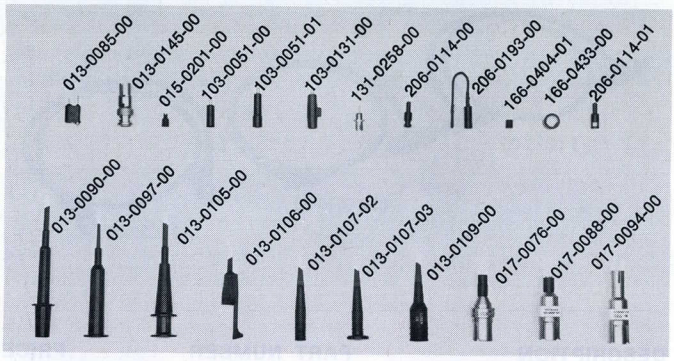


Probe identification tags for multi-probe applications help locate correlating probe ends quickly. The P6006, P6007, P6008, P6009, P6027, P6028 and P6060 have 3/16-inch cable. The P6011, P6012, P6048, P6052, P6053A, P6054, P6055, P6056, P6057 and P6061 have an 1/8-inch cable. One package contains two each of ten colors.

DESCRIPTION	PART NUMBER	PRICE
For 1/8 inch dia cable	016-0130-00	$1.20
For 3/16 inch dia cable	016-0127-00	1.20

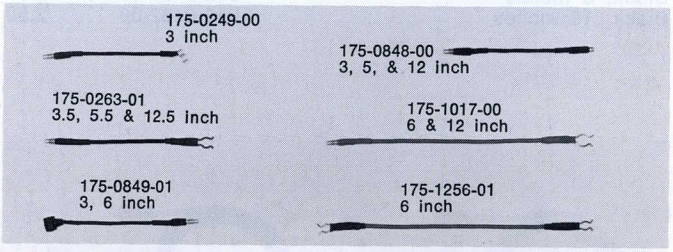
SLIP-ON PROBE TIPS AND ADAPTERS

The following tips and adapters are designed for use with TEKTRONIX Miniature Probes that accept a slip-on tip.



DESCRIPTION	PART NUMBER	PRICE
Probe tip to BNC adapter (not shown)	013-0084-01	$ 5.85
Bayonet ground assembly	013-0085-00	3.05
Retractable hook tip (for P6010, P6011, P6012, P6048, P6049)	013-0090-00	2.40
Retractable hook tip (for S-3A, P6045)	013-0097-00	2.40
Retractable hook tip (for P6052)	013-0105-00	2.40
Retractable hook tip (for 7A11)	013-0106-00	3.60
Retractable hook tip	013-0107-02	2.20
Retractable hook tip (for P6053B, P6054A, P6055, P6061, P6065A, P6075A)	013-0107-03	2.20
Retractable hook tip (for P6051)	013-0109-00	4.95
P6201 Probe tip to BNC adapter	013-0145-00	6.50
Probe tip cover	015-0201-00	.10
Probe tip to GR adapter	017-0076-00	12.00
Probe tip to GR 50-Ω termination Adapter	017-0088-00	27.50
P6201 probe tip to GR 50-Ω termination adapter	017-0094-00	25.85
Miniature Probe to #6-32 adapter	103-0051-00	1.30
Miniature Probe to #6-32 adapter	103-0051-01	1.20
Miniature Probe to #6-32 adapter	103-0131-00	3.05
Chassis mount test jack	131-0258-00	1.65
Probe tip ground cover, insulating sleeve	166-0404-01	.15
Probe tip ground cover, insulating sleeve	166-0433-00	.35
Probe tip hook	206-0114-00	1.00
Probe tip straight	206-0114-01	1.00
Probe tip flexible for .025 sq. pin	206-0193-00	2.40

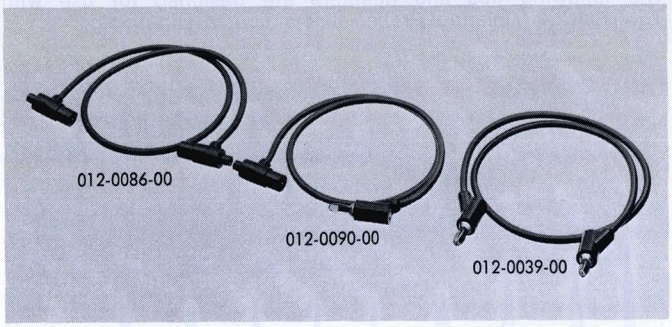
PROBE GROUND LEADS



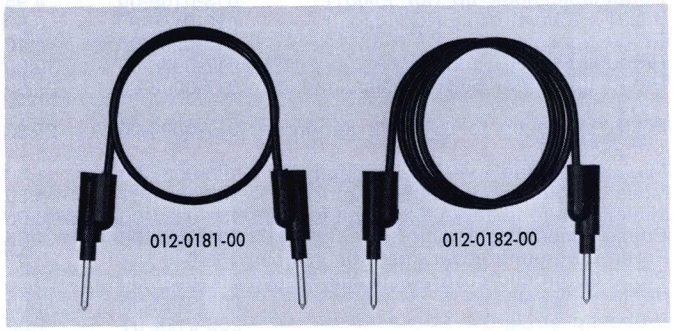
The following Ground Leads have a #6-32 thread size.

DESCRIPTION		PART NUMBER	PRICE
Ground lead	5.5-inch	175-0124-01	$ .40
Ground lead	12.5-inch	175-0125-01	.70
Ground lead for P6034, P6035, P6045, S-3A, P6056, P6057:	3-inch	175-0249-00	1.20
Ground lead	3.5-inch	175-0263-01	.65
Ground leads for P6051, P6052, P6053, P6054:	3-inch	175-0848-00	.65
	5-inch	175-0848-01	.65
	12-inch	175-0848-02	.65
Ground leads for P6051:	3-inch	175-0849-00	1.00
	6-inch	175-0849-01	1.00
Ground lead for P6055:	6-inch	175-1256-00	.75
Ground lead for S-3A:	6-inch	175-1017-00	.75
	12-inch	175-1018-00	.75

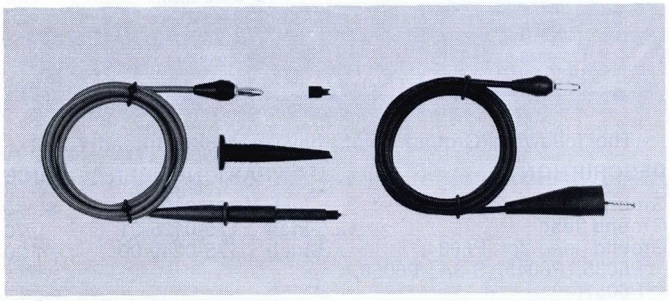
TEST LEADS



DESCRIPTION	PART NUMBER	PRICE
BNC to BNC, 18 inches		
Red	012-0087-00	$1.80
Black	012-0086-00	1.80
BNC to banana plug-jack, 18 inches		
Red	012-0091-00	1.80
Black	012-0090-00	1.80
Banana plug-jack to banana plug-jack, 18 inches		
Red	012-0031-00	1.80
Black	012-0039-00	1.80



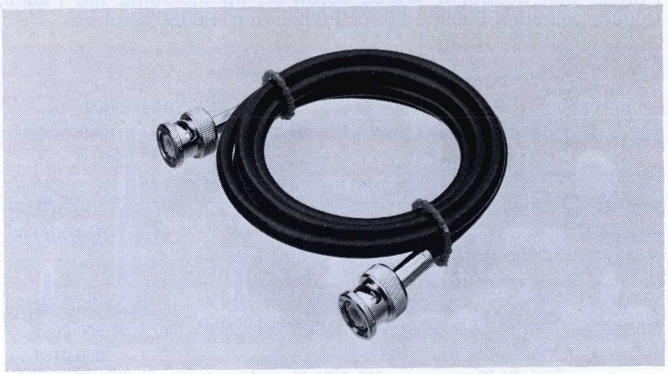
Pin-jack to pin-jack, 0.08 inches dia pin		
Red, 8 inches	012-0179-00	$2.50
Red, 18 inches	012-0180-00	2.50
Black, 8 inches	012-0181-00	2.50
Black, 18 inches	012-0182-00	2.50



Test leads	012-0427-00	$10.00

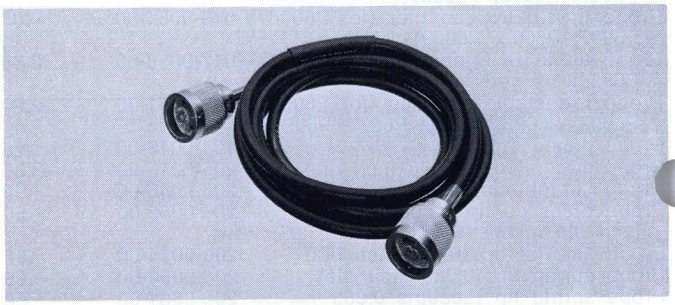
COAXIAL CABLES

BNC Connectors



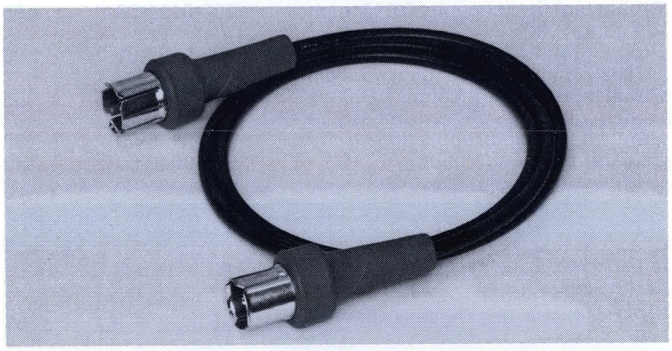
DESCRIPTION	PART NUMBER	PRICE
Coaxial, 50 Ω, 42 inches	012-0057-01	$6.60
Coaxial, 75 Ω, 42 inches	012-0074-00	6.60
Coaxial, 93 Ω, 42 inches	012-0075-00	6.60
Coaxial, 50 Ω, 18 inches	012-0076-00	6.60

N Connectors 50 Ω



Coaxial N connectors, 6 feet	012-0114-00	$11.00

GR Connectors 50 Ω

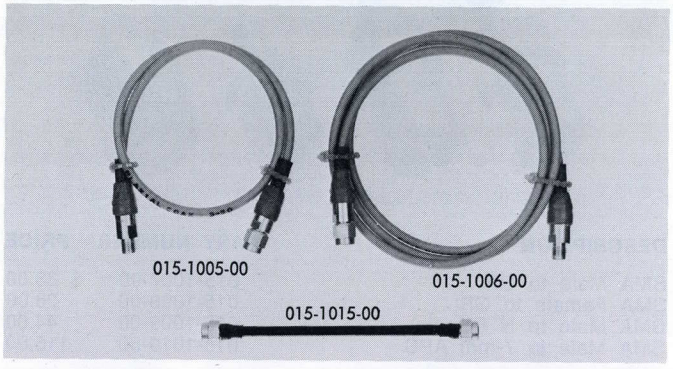


Coaxial 10-ns RG58A/U	017-0501-00	$22.00
Coaxial 5-ns RG213/U	017-0502-00	22.00
Coaxial 1-ns RG58A/U*	017-0503-00	10.00
Coaxial 20-ns RG213/U	017-0504-00	22.00
Coaxial 2-ns RG58A/U	017-0505-00	22.00
Coaxial 5-ns RG58A/U	017-0512-00	22.00
Coaxial 10-inch RG213/U	017-0513-00	22.00
Coaxial 20-inch RG213/U	017-0515-00	22.00

*Connector on one end only.

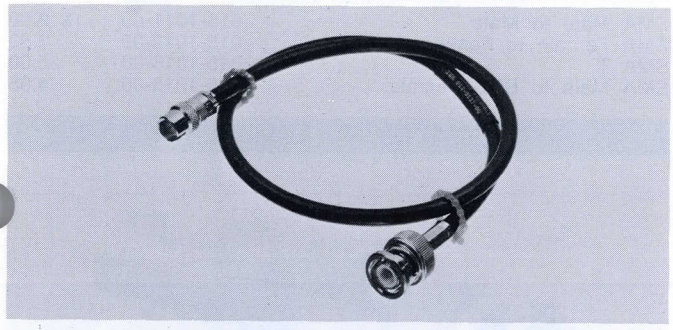
50-Ω CABLES

SMA (3 MM) Connectors 50 Ω



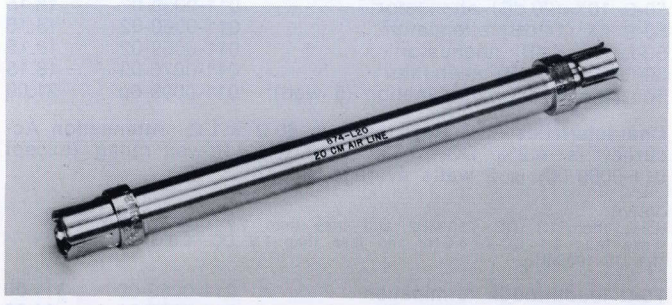
DESCRIPTION	PART NUMBER	PRICE
Coaxial 2 ns	015-1005-00	$44.00
Coaxial 5 ns	015-1006-00	50.00
Coaxial semirigid 500 ps	015-1015-00	26.40
Coaxial semirigid 750 ps	015-1017-00	26.40
Coaxial 1 ns	015-1019-00	30.00

BNC to BSM Connectors 50 Ω



Coaxial, 10 inches, RG58 BSM Female to BNC Male	012-0128-00	$8.25
Coaxial, 18 inches, RG58 BSM Female to BNC Male	012-0127-00	8.25

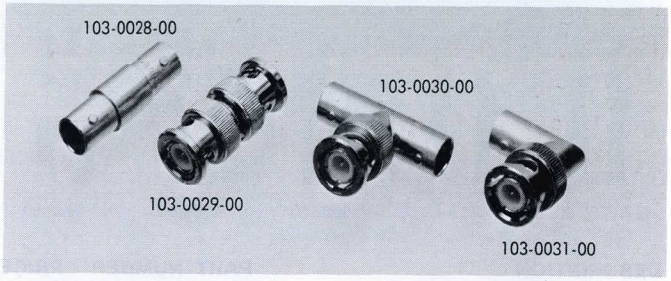
50-Ω AIR LINE



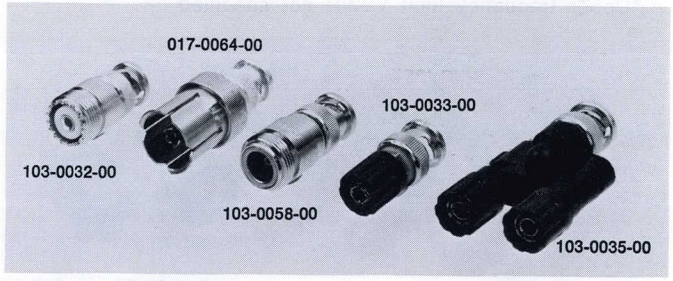
The 20-cm 50-Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50-Ω Air Line	017-0084-00	$22.00

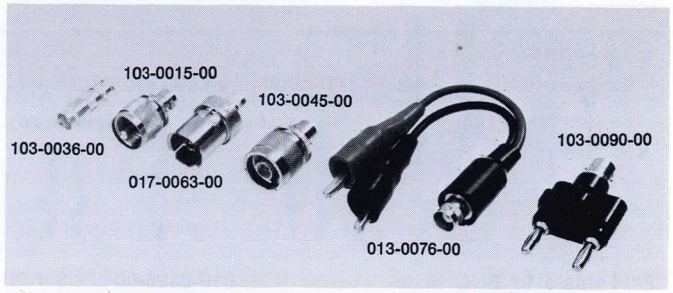
ADAPTERS



DESCRIPTION	PART NUMBER	PRICE
BNC Female to BNC Female	103-0028-00	$2.50
BNC Male to BNC Male	103-0029-00	4.40
BNC T	103-0030-00	4.40
BNC Elbow Male to Female	103-0031-00	3.30



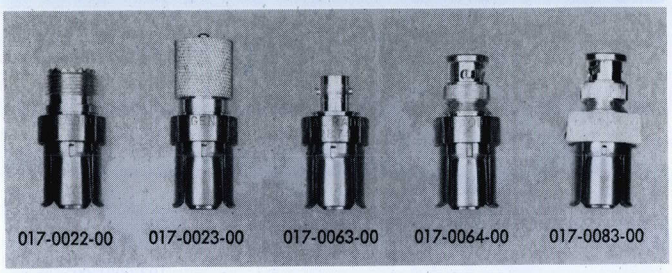
BNC Male to GR	017-0064-00	$12.00
BNC Male to UHF Female	103-0032-00	2.50
BNC Male to Binding Post	103-0033-00	2.40
BNC Male to Dual Binding Post	103-0035-00	7.50
BNC Male to N Female	103-0058-00	3.05



BNC Female to clip leads	013-0076-00	$6.05
BNC Female to GR	017-0063-00	9.00
BNC Female to UHF Male	103-0015-00	2.50
BNC Female to BSM Male	103-0036-00	6.05
BNC Female to N Male	103-0045-00	2.65
BNC Female to Dual Banana	103-0090-00	3.85

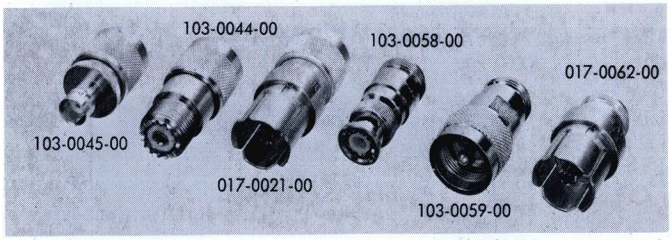
GR to N Male	017-0021-00	$10.00
GR to C Male	017-0027-00	12.00
GR to N Female	017-0062-00	10.00
GR to C Female	017-0065-00	11.50

ADAPTERS

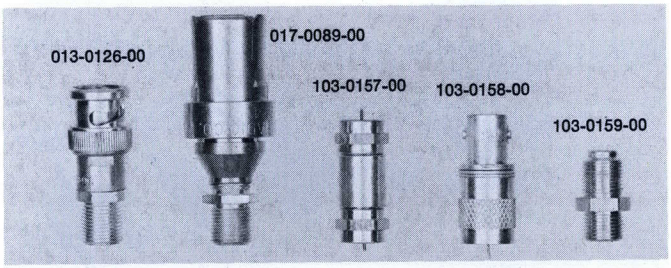


DESCRIPTION	PART NUMBER	PRICE
GR to UHF Female	017-0022-00	$10.00
GR to UHF Male	017-0023-00	10.00
GR to BNC Female	017-0063-00	9.00
GR to BNC Male	017-0064-00	12.00
50-Ω termination, thru-line *(GR to BNC Male)	017-0083-00	36.85

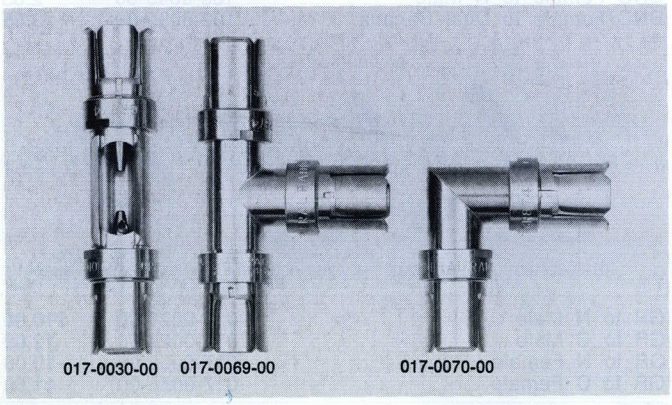
*Upper frequency limit VSWR not specified



N Male to GR	017-0021-00	$10.00
N Female to GR	017-0062-00	10.00
N Male to UHF Female	103-0044-00	4.70
N Male to BNC Female	103-0045-00	2.65
N Female to BNC Male	103-0058-00	3.05
N Female to UHF Male	103-0059-00	2.75

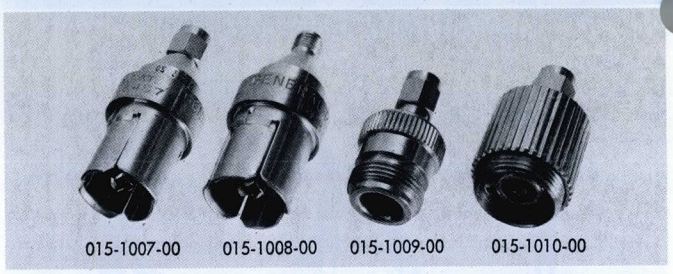


"F" Female to BNC Male	013-0126-00	$ 6.90
"F" Female to GR874	017-0089-00	11.00
"F" Male to "F" Male	103-0157-00	6.90
"F" Male to BNC Female	103-0158-00	6.90
"F" Female to "F" Female	103-0159-00	6.90

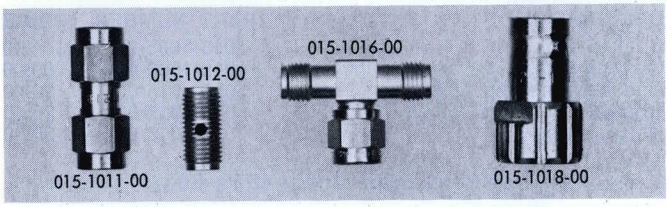


GR Insertion Unit	017-0030-00	25.00
GR T	017-0069-00	25.00
GR Elbow	017-0070-00	20.00

ADAPTERS

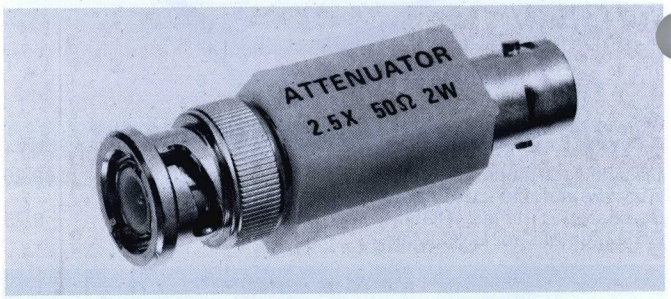


DESCRIPTION	PART NUMBER	PRICE
SMA Male to GR	015-1007-00	$ 33.00
SMA Female to GR	015-1008-00	26.00
SMA Male to N Female	015-1009-00	44.00
SMA Male to 7-mm APC	015-1010-00	115.00



SMA Male to Male	015-1011-00	$ 9.00
SMA Female to Female	015-1012-00	7.50
SMA T	015-1016-00	25.00
SMA Male to BNC Female	015-1018-00	4.95

ATTENUATORS—TERMINATIONS



50-Ω feedthrough termination[1]	011-0049-01	$15.00
50-Ω 10X (20 dB) attenuator[2]	011-0059-02	18.15
50-Ω 5X (14 dB) attenuator[2]	011-0060-02	18.15
50-Ω 2X (6 dB) attenuator[2]	011-0069-02	18.15
50-Ω 2.5X (8 dB) attenuator[2]	011-0076-02	18.15
50-Ω feedthrough termination (5 watt)[3]	011-0099-00	21.00

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 watts 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	$11.00
93-Ω feedthrough termination	011-0056-00	11.00
50-Ω to 75-Ω min loss attenuator	011-0057-00	15.00
50-Ω to 93-Ω min loss attenuator	011-0058-00	15.00
75-Ω 10X attenuator	011-0061-00	13.20
93-Ω 10X attenuator	011-0062-00	13.20
600-Ω feedthrough termination (1 watt, DC to 1 MHz)	011-0092-00	19.80
75-Ω to 50-Ω min loss attenuator (AC coupled)	011-0112-00	27.50

CHARACTERISTICS

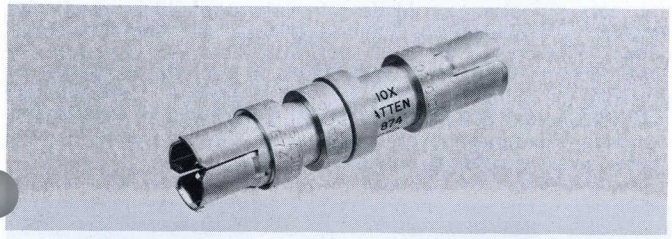
Accuracy of Indicated Attenuation Ratio is ±2% at DC. Power Rating of attenuators is ½ watt and terminations 1 watt. Voltage Standing Wave Ratio (VSWR) not specified.

50-OHM ATTENUATORS

Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

DESCRIPTION	PART NUMBER	PRICE
10-dB attenuator	011-0085-00	$49.50
20-dB attenuator	011-0086-00	49.50
40-dB attenuator	011-0087-00	60.50

ATTENUATORS—TERMINATIONS

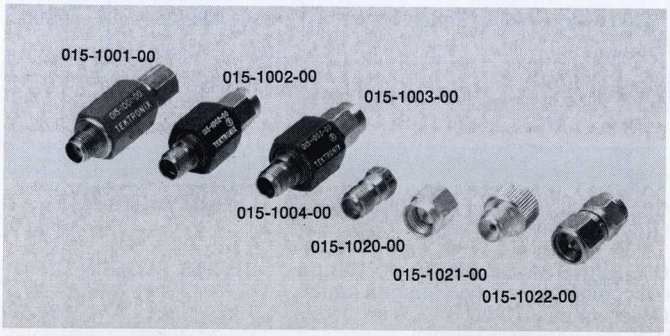


125-Ω min loss	017-0052-00	$40.00
50-Ω 10X attenuator	017-0078-00	49.00
50-Ω 5X attenuator	017-0079-00	49.00
50-Ω 2X attenuator	017-0080-00	49.00
50-Ω termination, end-line	017-0081-00	39.00

CHARACTERISTICS

Accuracy of indicated attenuation ratio is ±2% at DC, ±3% at 1 GHz. Voltage standing wave ratio (VSWR) is less than 1.1 up to 1 GHz. Power Rating is 1 watt.

ATTENUATORS—TERMINATIONS

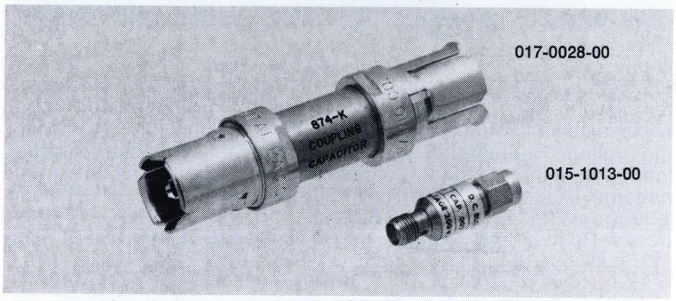


50-Ω 2X attenuator	015-1001-00	$ 90.00
50-Ω 5X attenuator	015-1002-00	120.00
50-Ω 10X attenuator	015-1003-00	80.00
50-Ω termination Female	015-1004-00	44.00
Short-Circuit termination Male	015-1020-00	7.25
Short-Circuit termination Female	015-1021-00	7.25
50-Ω termination Male (Not Pictured)	015-1022-00	30.25

CHARACTERISTICS

	DC — 12.40 GHz		12.41 — 18.00 GHz		
	Attenuation Accuracy	VSWR	Attenuation Accuracy	VSWR	Continuous Power
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	± .75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W

50-Ω COUPLING CAPACITOR



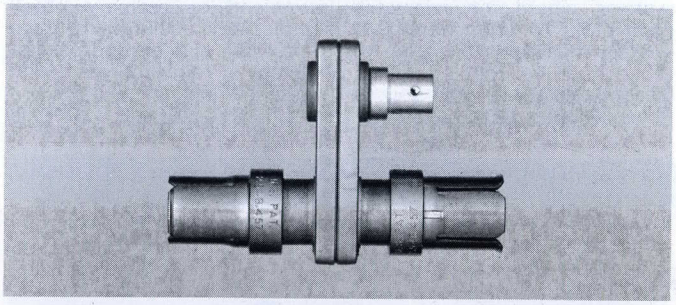
The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150-ps TDR system), maximum is 0.03. Voltage rating is 200 Volts.

Coupling Capacitor SMA (3 MM) 015-1013-00 $82.50

The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but DC and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor GR 017-0028-00 $20.00

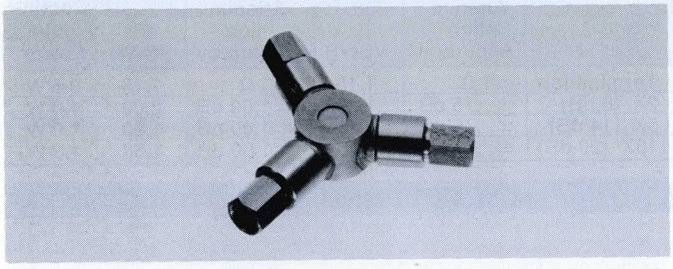
CT-3 SIGNAL PICKOFF



Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50-ohm system. Used with any of the TEKTRONIX sampling instruments, the CT-3 provides the link for use as a trigger source. **Sensitivity** is 10% of the voltage under test, into a 50-ohm load. **Decay Time Constant** is 4.5 μs at 0 DC current. **Risetime** is less than 0.4 ns. **Frequency Response** is 50 kHz to 875 MHz at 0 DC current. **Insertion Impedance** with a 50-ohm termination is 1 ohm shunted by 4.5 μH; 2 ohms shunted by 4.5 μH without a 50-ohm termination. **VSWR** is less than 1.2 at 1.5 GHz. **Voltage Rating** at 0 V DC is 25 V RMS, 1-kV pulse peak. The volts-second product is 100 Vμs. If exceeded, the L/R decay will decay rapidly toward zero.

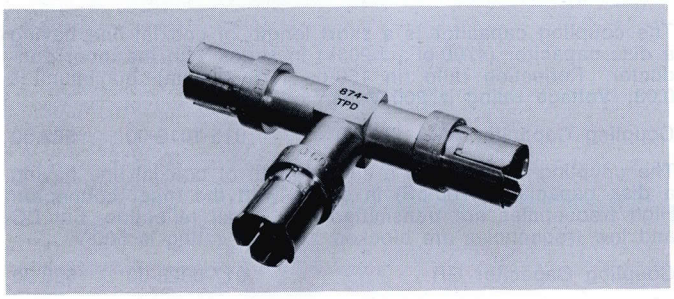
Order 017-0061-00 ..... **$41.80**

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). Maximum VSWR is 1.50 from DC to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

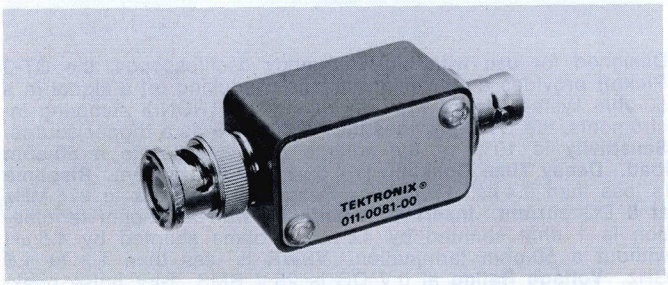
Power Divider SMA (3 MM) 015-1014-00 $115.00



This coaxial tee has a 16.67-ohm resistor in each leg, connected so that the tee looks like 50 ohm if two legs are terminated in 50 ohm. It is designed for use in broad-band 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider GR 017-0082-00 $110.00

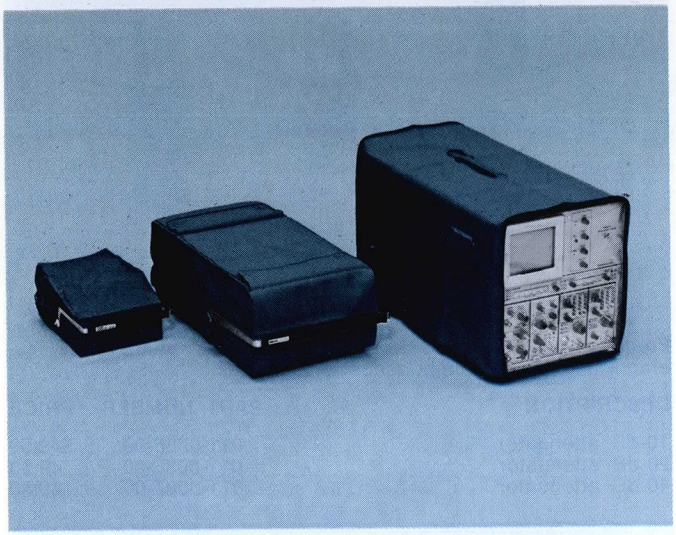
ACCESSORY HOUSING



Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing 011-0081-00 $8.80

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, 5100 and 7000 Series Laboratory Oscilloscopes have clear vinyl frontal areas. The cover for all portable instruments, except the small portables like the 323 and 1401A, has a pocket for carrying the manual. The 4002A Computer Terminal Cover is similar to the laboratory oscilloscope cover except tan in color.

INSTRUMENT	PART NUMBER	PRICE
323, 324, 1401A, 1401A-1, 1501	016-0112-00	$11.00
422 (with battery pack)	016-0075-00	11.00
422 (without battery pack)	016-0076-00	11.00
453A, 454A, 491	016-0074-01	11.00
465, 475	016-0554-00	11.00
529 (with field case)	016-0085-00	11.00
560 Series (except 565, 567, 568)	016-0067-00	11.00
565, 567, 568	016-0069-00	11.00
540 Series	016-0068-00	11.00
5000 Series	016-0544-00	11.00
7300, 7400, 7600 Series	016-0192-00	11.00
7704A, 7900	016-0531-00	11.00
4002A	016-0194-00	30.00

PLUG-IN UNIT CARRYING CASES

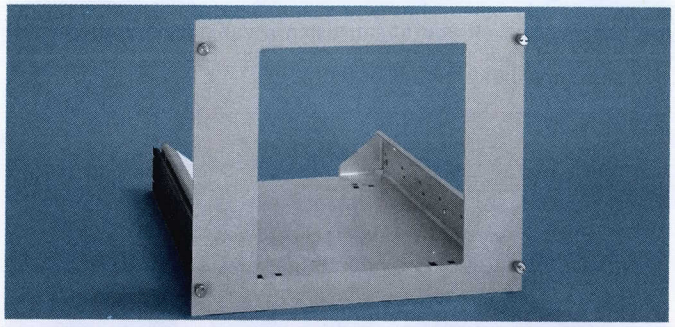
CARRYING CASE FOR 7000-SERIES PLUG-IN UNITS
Order 437-0106-00 ..... $33.00

CARRYING CASE FOR 2, 3, 10 and 11-SERIES PLUG-IN UNITS—accommodates two plug-in units.
Order 437-0070-00 ..... $33.00

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 ..... $24.20

Plain Cover for 7300/7400/7600 Series mill
Kit kit 7613/7623

RACK ADAPTERS



For rackmounting the 7500 and 7700-Series Oscilloscopes and 611 in a standard 19-inch wide rack. Rack adapter includes slide-out assemblies. 7500 and 7700-Series mask finish is light gray, 611 mask finish is black.

For 7503, rack height is 15¾ inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0555-00 ..... $105.00

For 7504, 7514, 7704, and 7904, rack height is 15¾ inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0554-00 ..... $105.00

For 611, rack height is 14 inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0551-00 ..... $105.00

RACK ADAPTERS

For rackmounting most TEKTRONIX generators in a standard 19-inch wide rack. The rack height is 5¼ inches, rack depth is 19¾ inches. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and blank panels are provided to cover the unused openings. Mounting kits must be ordered separately for each instrument to be mounted.

Rack Adapter includes half-rack width blank panel (333-1384-00).
Order 016-0268-00 ..... $250.00

284 Mounting Kit includes quarter-rack width blank panel (016-0109-00).
Order 016-0187-00 ..... $27.00

106, 114, 115, and 191 Mounting Kits.
Order 016-0186-00 ..... $15.00

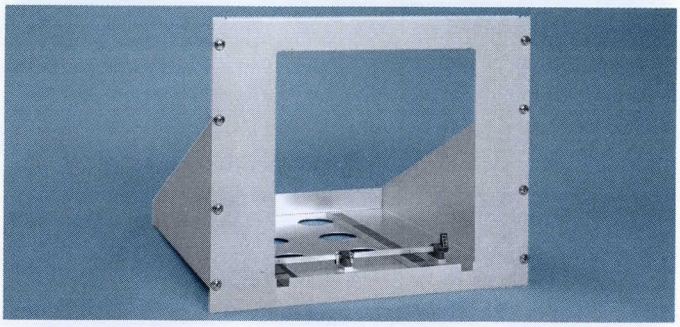
2101 and 2901 Mounting Kits.
Order 016-0188-00 ..... $7.50

286 Mounting Kit.
Order 016-0190-00 ..... $12.50

For rackmounting two TM 503s
Order 040-0616-00 ..... $44.00

For rackmounting one TM 503
Order 040-0617-00 ..... $66.00

CRADLE MOUNTS



For rackmounting 500, 7500 and 7700-Series cabinet-type oscilloscopes in a standard 19-inch wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, 7500 and 7700-Series mask finish is light gray.

For 7504, 7514, and 7704A, rack height is 15¾ inches, rack depth is 22 inches, shipping weight is approx 16 lb.
Order 040-0560-00 ..... $37.95

For 540 Series and 575, rack height is 17½ inches, rack depth is 21-9/16 inches, shipping weight is approx 16 lb.
Order 040-0281-00 ..... $37.95

For 561B and 564B, rack height is 15¾ inches, rack depth is 21-9/16 inches, shipping weight is approx 17 lb.
Order 040-0321-01 ..... $37.95

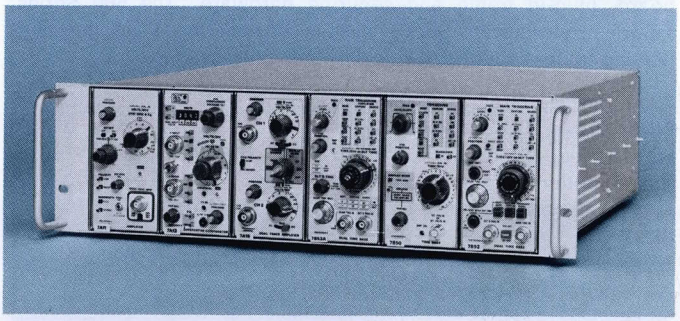
REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19-inch backless rack. Shipping weight is approx 3 lb.

For R561B, R564B, and R647A.
Order 040-0344-00 ..... $11.00

For RM565 and R567.
Order 040-0346-00 ..... $11.00

STORAGE CABINETS

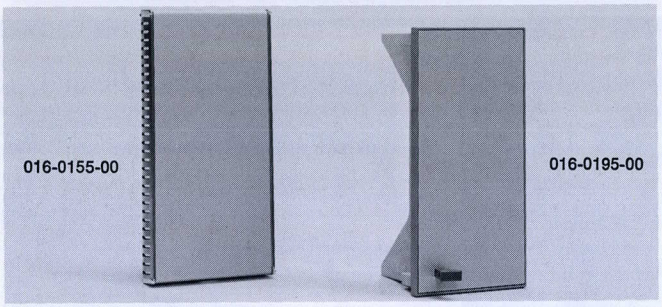


For 7000-Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19-inch rack, 5¼ inches high.
Order 437-0126-01 ..... $140.00

For 1-Series and Letter-Series Plug-In Units—Holds 3 plug-in units. Measures 19 inches wide, 8¾ inches high, 9⅜ inches deep. Net weight is approx 9 lb.
Order 437-0031-00 ..... $30.25

For 2 and 3-Series Plug-In Units—holds 4 plug-in units. Measures 19 inches wide, 7 inches high, 13-5/16 inches deep. Net weight is approx 10 lb.
Order 437-0071-00 ..... $36.30

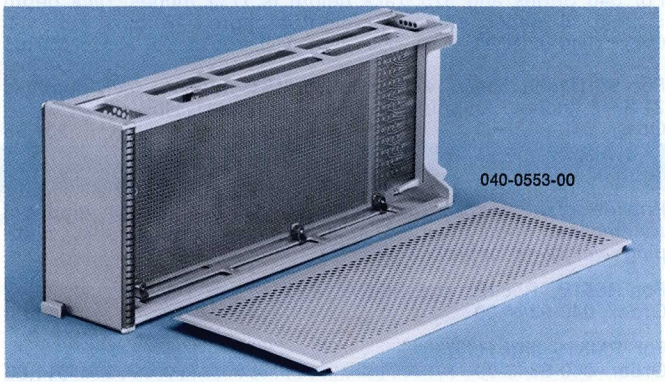
BLANK PLUG-IN PANEL



Blank Plug-in 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 plug-in panel may be used to cover unused compartment. The panel for the 7000 Series is also good for EMI shielding.

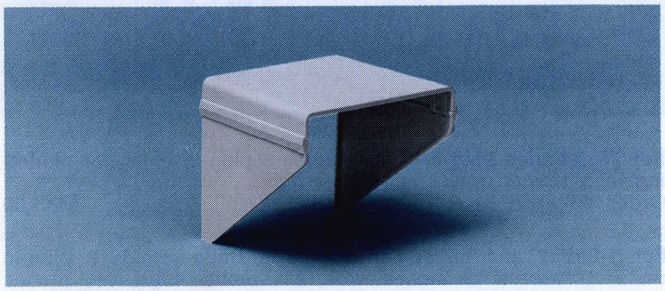
7000 Series, 2600 Series, Order 016-0155-00 ..... $7.50
5000 Series, ~~TM 500 Series~~, Order 016-0195-00 ..... $4.40

BLANK PLUG-IN CHASSIS



Blank Plug-in Chassis—are available for all Tektronix mainframes. The 7000 and 5000 Series provide 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 040-0553-00 ..... $50.60
~~5000~~ Series, Order 040-0652-00 ..... $13.75
560 Series, Order 040-0245-00 ..... $30.25
1 and Letter Series, Order 040-0065-00 ..... $30.25



View Hood (folding)—for 211, 212, 214, 323, 324, 326, 576, 577, 5000 and 7000-Series Oscilloscopes.

For 576, order 016-0259-00 ..... $8.80
For 577, 5000 and 7000 Series, order 016-0260-00 .... $8.80
For 211 and 212 (not pictured), order 016-0199-01 ..... $2.50
For 323 and 324 (not pictured), order 016-0247-01 ..... $3.30
For 326 (not pictured), order 016-0297-00 ..... $1.30

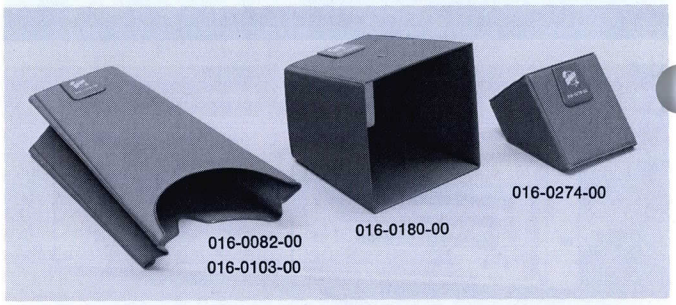
VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.

Polarized Viewers—For TEKTRONIX 5-inch Oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

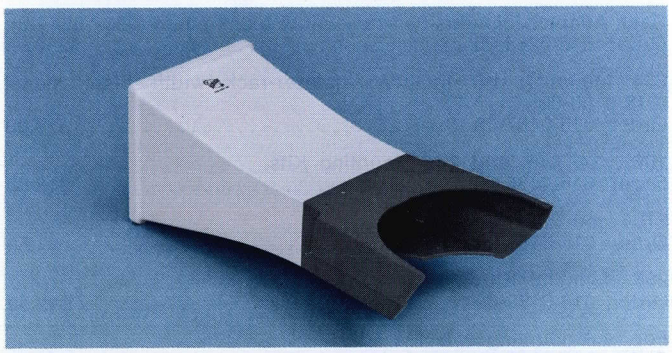
Rectangular Viewer, order 016-0039-00 ..... $13.20
Plastic Round Viewer, order 016-0053-00 ..... $13.20

Viewing Hood—For TEKTRONIX 5-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 ..... $10.00



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 ..... $9.90
For 422, 453A, 454A, 485, 491, order 016-0274-00 ..... $6.60
For 561B, 564B, 565, 568, order 016-0103-00 ..... $9.90

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 465, 475, order 016-0180-00 ..... $12.00



Viewing Hood—for 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

For 576, order 016-0153-00 ..... $10.45
For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577, order 016-0154-00 ..... $10.45

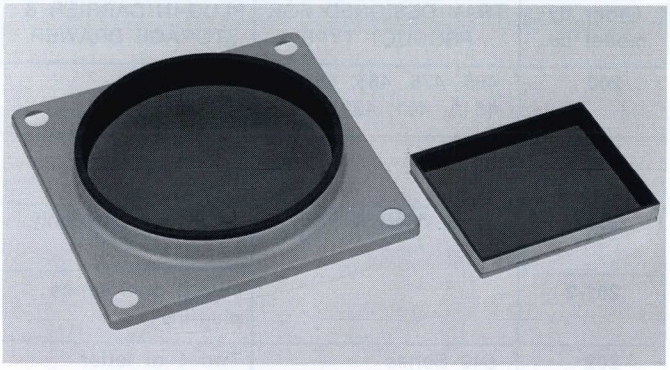
CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
323, 324	Smoke-gray	426-0403-00	$2.30
	Blue†	426-0512-00	2.30
	Amber	426-0513-00	2.30
326	Blue†	406-0811-00	4.60
422, 491, 453A, 454A	Smoke-gray	378-0549-00	1.00
	Green	378-0557-00	1.00
	Blue†	378-0664-00	.70
	Amber	378-0559-00	1.00
465, 475	Blue	337-1674-00	1.75
	Clear	337-1674-01	1.75
540-, 550-Series, 565, 575	Smoke-gray†	378-0567-00	1.75
	Green	378-0568-00	1.75
	Blue	378-0569-00	1.75
	Amber	378-0570-00	1.75
529, 561B, 567, 568	Smoke-gray†	378-0560-00	1.50
	Green	378-0561-00	1.50
	Blue	378-0562-00	1.50
	Amber	378-0563-00	1.50
520A, 521A, 522A	Smoke-gray†	378-0581-00	1.00
576	Blue†	378-0616-00	1.75
	Amber	378-0616-01	1.75
602	Smoke-gray†	378-0586-00	1.65
	Amber	378-0595-00	4.50
7904, 7313, 7700-Series, 7613, 7623	Blue†	378-0625-00	1.75
	Amber	378-0625-01	1.75
	Gray	378-0625-02	1.75
	Green	378-0625-03	1.75
	Gray TV Graticule CCIR	378-0625-05	3.30
	Gray TV Graticule NTSC	378-0625-06	3.30
	Clear Implosion Shield With Spectrum Analyzer Graticule	337-1159-02	1.65
7613 & 7623 (only)	Spectrum Analyzer	378-0625-07	1.75
	Green (UV)	378-0625-08	1.75
	TV Graticule CCIR	378-0625-09	1.75
	TV Graticule NTSC	378-0625-10	1.75
7403N, 7603	Blue	378-0684-00	2.20
	Amber	378-0684-01	2.10
	Gray	378-0684-02	2.10
	Green	378-0684-03	2.10
	Gray TV Graticule CCIR	378-0684-04	3.85
	Gray TV Graticule NTSC	378-0684-05	3.85
	Clear Implosion Shield With Spectrum Analyzer Graticule	337-1439-01	1.65
	Blue Implosion Shield†	337-1700-01	1.75
	Clear Implosion Shield	337-1700-04	1.75
5100 and 5400 Series	Clear	337-1440-00	1.05
	Green	337-1440-01	1.05
	Amber	337-1440-02	1.05
	Blue	337-1440-03	1.05
	Gray	337-1440-04	1.05
5100, 5400, 603, 604	Amber	378-0705-00	1.65
	Green	378-0704-00	1.65
432, 434	Clear	378-0677-00	1.75

*For both cabinet and rackmount instruments unless rackmount version is listed.

†Standard filter supplied with instrument.

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
323, 324	378-0596-00	$16.50
432, 434	378-0682-00	16.50
422, 491, 453A, 454A	378-0648-00	16.50
465, 475	378-0726-01	15.00
540-Series, 565	378-0572-00	19.80
529, 561B, 564B, 568	378-0575-00	19.80
7400	378-0696-00	19.80
7500, 7700-Series	378-0603-00	19.80

*For both cabinet and rackmount instruments.

SCOPE-MOBILE Usage Chart

Order by model no.	TRAY DESIGNED FOR PRODUCT TYPE	PLUG-IN CARRIER & STORAGE DRAWER	SCOPE LOCK-DOWN	TOP TRAY DIMENSIONS*	BOTTOM SHELF DIMENSIONS**	NET WEIGHT APPROX	PRICE
200	465, 475, 485, 453A, 454A, 491, 432, 434	None	No	11½ x 16½ in	12 x 12 x ¾ in deep	19 lb	**$120**
200-2	422	None	No	9¼ x 15 in	12 x 12 ¾ in deep	19 lb	**$120**
201-1	561B, 564B & 577	Storage drawer only	No	10½ x 18½ in	15½ x 25 in	37 lb	**$165**
201-2		Two 2 or 3 series plug-ins	No	10½ x 18½ in	15½ x 25 in	39 lb	**$185**
202	540 Series	Two 1 or letter series plug-ins	No	14 x 21 in	15½ x 25 in	43 lb	**$185**
202-1	540 Series, 507, 576	Storage drawer only	No	14 x 21 in	15½ x 25 in	41 lb	**$165**
202D	DPO Digital Processing Oscilloscope	Storage drawer only	Yes	14¾ x 25 in	18½ x 25 in with a mount for 5¼ x 19 in minicomputer	44 lb	**$350**
203	7403N, 7313, 7613, 7623, 7603, 5100 & 5400 Series	Holds four 5 or 7 series plug-ins	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	**$195**
203 Opt. 1		Holds four 5 or 7 series plug-ins and TM 503	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	**$195**
204	7704A, 7904	Holds five 7 series plug-ins	Yes	14 x 21 in	17½ x 26⅞ in	48 lb	**$225**
204 Opt: 1		Holds five 7 series plug-ins and TM 503	Yes	14 x 21 in	17½ x 26⅞ in	48 lb	**$225**
204 Opt. 2	7704A, 7904, 576	No storage drawer or plug-in carrier	No	14 x 21 in	17½ x 26⅞ in	45 lb	**$195**
205	520A, 521A, 522A, 556, 565, 568 & rack-mount instruments	Storage drawer only	No	17¾ x 22⅜ in	18½ x 25 in	46 lb	**$190**
206	Computer Terminals and portable instruments	Two flat shelves	No	16 x 27 in	16 x 27 in	34 lb	**$ 90**

*Overall length bottom of tray, includes rear radius bend and front stops.
**Usable dimensions may be limited by height required.

● A SCOPE-MOBILE® Cart for Every Oscilloscope

There is a SCOPE-MOBILE Cart for every TEKTRONIX Oscilloscope that needs one. The cart is designed for "ease of use", tilting the oscilloscope to various degrees. The top tray on the models 200 and 200-2 has friction locks which will adjust from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting. The top tray on the other SCOPE-MOBILE Cart models 201 through 205 has tilt locks in 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

All SCOPE-MOBILE Carts feature sturdy aluminum construction, and a linoleum-covered steel plate for the bottom shelf. The 206 has two flat trays. The carts are equipped with rubber wheels and locking brakes on the front wheels.

The carts, with the exception of the 200 and 206, have three AC receptacles located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.

The 200 SCOPE-MOBILE® Cart is especially designed for the 432, 434, 453A, 454A, 465, 475 and 485 Portable Oscilloscopes and the 491 Spectrum Analyzer. A separate version, the 200-2, is designed for use with the 422 Portable Oscilloscope.

These oscilloscope carts occupy less than 18 inches of aisle space. With their large wheels and unique design, they can easily be moved up and down stairs. Friction locks on the oscilloscope tray permit the instrument to be positioned at any angle for convenient viewing. Storage space is provided at the base of the cart for accessories or associated instruments.

Adjustable tray friction-locks in any position from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting.

Mechanical features include cast-aluminum construction with six-inch rubber wheels in the rear and two-inch swivel castors in front.

Overall dimensions are approximately 29 inches high by 17 inches wide by 19 inches deep. Storage area in the base measures 12 inches by 12 inches and ¾ inch deep.

Pricing information is on page 314.

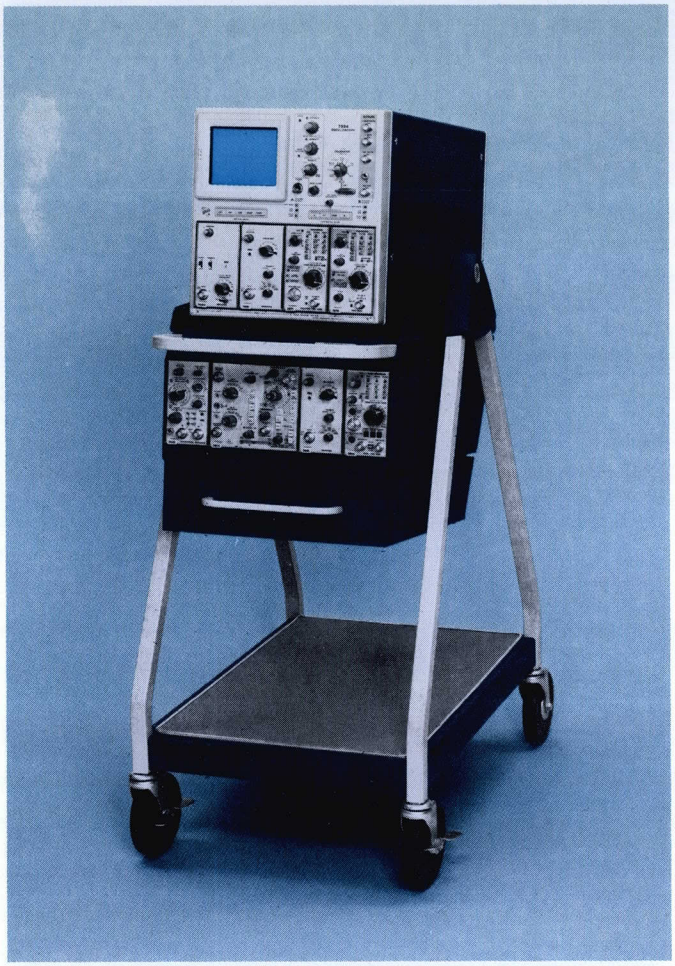
The 203 and 203 Option 1 SCOPE-MOBILE® Carts hold any of the TEKTRONIX 5000 or 7000 Series three plug-in mainframes. The 203 Option 1 SCOPE-MOBILE® Cart replaces the storage drawer of the 203 with brackets to hold the TM 503 Power Module. (The TM 503 Power Module is ordered separately.) The 203 Option 1 then becomes a versatile test station.

The 203 or the Option 1 can store four additional plug-ins for later use. The Carts have three AC receptacles located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and linoleum-topped steel shelf at the bottom.

Pricing information is on page 314.



The 204 and the 204 Option 1 SCOPE-MOBILE® Cart features tilt-locking in any of nine tray positions. The 204 is equipped with a large storage drawer for holding accessory items and a plug-in carrier for storing plug-ins. Three AC receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.

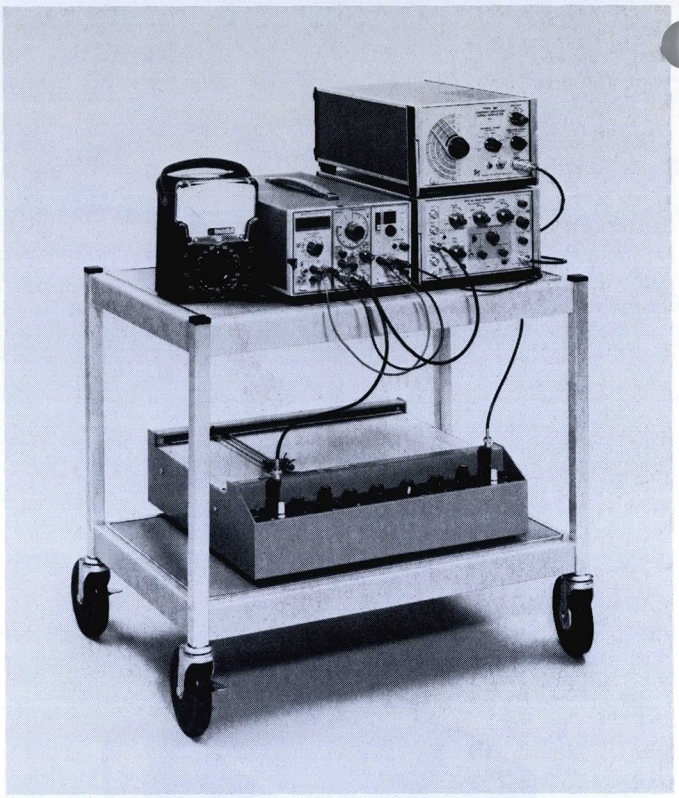
The 204 Option 1 SCOPE-MOBILE® Cart replaces the storage drawer of the 204 with brackets to hold the TM 503 Power Module. (The TM 503 Power Module is ordered separately.) The 204 Option 1 then becomes a versatile test station.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes, a linoleum-topped steel shelf at the bottom. A latch-operated hold-down device insures that the oscilloscope is firmly secured to the adjustable tray.

Overall dimensions are approximately 36 inches high by 19½ inches wide by 29 inches deep.

Pricing information is on page 314.



The 206 Instrument Cart is a versatile mobile table. The 206 Cart provides a base for a portable test instrumentation setup. It may be used as added table space or for transport.

Portability may also be given to the computer terminal with the lower shelf being used for a hard-copy unit. The 5-inch rubber wheels (two wheels lock) allow easy pushing over carpeted areas and entrance ways. The low profile cart has two linoleum covered steel shelves attached to a sturdy aluminum frame. The shelves are 16 x 27 inches with an overall height of 25 inches.

Pricing information is on page 314.

The instruments described on these pages are in limited demand, but represent a desirable choice in a few specialized cases. As such, they are available for you who have a need for them.

453A PORTABLE OSCILLOSCOPE

The 465 is the recommended replacement.

The 453A is a portable oscilloscope with a bandwidth of DC to 60 MHz, risetime of 5.8 ns, vertical deflection factors from 5 mV/div to 10 V/div, and horizontal sweep speeds of 0.1 μs/div to 5 s/div.

Order 453A OSCILLOSCOPE $2050
Order R453A OSCILLOSCOPE (Rackmount) $2135

For specific information on different models, contact your local Tektronix Field Office.

454A PORTABLE OSCILLOSCOPE

The 475 is the recommended replacement.

The 454A is a portable oscilloscope with a bandwidth of DC to 150 MHz, risetime of 2.4 ns, vertical deflection factors from 2 mV/div to 5 V/div, and horizontal sweep speeds of 20 ns/div to 5 s/div.

Order 454A OSCILLOSCOPE $3200
Order R454A OSCILLOSCOPE (Rackmount) $3285

507 OSCILLOSCOPE

The TEKTRONIX 507 is a specialized oscilloscope, designed primarily for high-voltage surge testing of power transformers, high-voltage insulators, lightning arrestors, etc. Careful design of circuitry grounding points ensures minimum sensitivity to extraneous disturbances caused by large voltage transients often introduced into the grounding system.

Order 507 OSCILLOSCOPE $4300

547 50-MHz OSCILLOSCOPES

For replacement of 547 see TEKTRONIX 7000-Series Oscilloscopes.

The 547 is designed for use with all TEKTRONIX Letter-Series and 1-Series Plug-in Units. Features include: bandwidth DC to 50 MHz, full bandwidth triggering, dual time base, delayed sweep, and horizontal display switching.

Order 547 OSCILLOSCOPE, without plug-in units $2350

647A and R647A OSCILLOSCOPES
10A2A DUAL-TRACE AMPLIFIER
11B2A DELAYED SWEEP TIME BASE

The TEKTRONIX 7603N Option 11S is recommended as a replacement for the 647A, R647A, 10A2A, and 11B2A.

The 647A, R647A, 10A2A, and 11B2A are built for severe environments. Bandwidth and triggering are from DC to 100 MHz.

The 10A2A is a dual-trace amplifier with two identical channels, with deflection factors from 10 mV/div to 20 V/div. They may be added algebraically, or operated dual trace with alternate or chopped switching.

The 11B2A is a delayed sweep time base with sweep speeds from 10 ns/div to 5 s/div. Two separate time-base generators and a calibrated delayed sweep are provided.

Order 647A OSCILLOSCOPE, without plug-in units $1925
Order R647A OSCILLOSCOPE, without plug-in units $2050
Order 10A2A DUAL-TRACE AMPLIFIER $985
Order 11B2A TIME BASE $1070

601 STORAGE DISPLAY UNIT

The 603 is recommended as a replacement for the 601.

The 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. The TEKTRONIX-developed bistable Storage CRT used in the 601 eliminates the need for costly memory devices for refreshing the information display. The built-in vertical and horizontal differential amplifiers permit Y versus T plots up to 100 kHz for remote storage monitor applications. All solid-state modular circuit design insures long-term stable performance.

Order 601 STORAGE DISPLAY UNIT $1400

7A12 DUAL-TRACE AMPLIFIER

The 7A26 Dual-Trace Amplifier is recommended as a replacement for the 7A12.

The 7A12 Dual-Trace Plug-in features a bandwidth of DC-to-120 MHz in the 7900-Family mainframes. It also has 5 operating modes, trigger source selectivity, trace offset with ± 1000-div range, color keyed control grouping and trace identify function.

Order 7A12 AMPLIFIER $900

1A2 DUAL-TRACE AMPLIFIER

The 1A1 Dual-Trace Amplifier is recommended as a replacement for the 1A2 Plug-in Unit.

The 1A2 Plug-in Unit provides dual-trace displays in 530, 540, 550, and 580 (Type 81A Adapter required) Series Oscilloscopes. The unit has two identical channels with deflection factors from 50 mV/div to 20 V/div. Bandwidth is DC to 50 MHz when used in the 556 Oscilloscope.

Order 1A2 PLUG-IN UNIT $460

3S2 DUAL-TRACE SAMPLING UNIT

The 5S14/7S14 Samplers are recommended as replacements for the 3S2 Plug-in.

The Type 3S2 Dual-Trace Sampling Unit is designed for use in the Type 561B, 564B or 568 Oscilloscope. The unit can be used with 3T2 Sampling Sweep Unit. It can also be used with real-time units. In the 568 Oscilloscope, information can be presented in digital as well as analog form.

The Type 3S2 accepts two Sampling Heads than can be inserted directly or located remotely with an optional extender. Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.

Five display modes provide for a variety of single-trace, dual-trace or X-Y displays. The 3S2 can also be operated with only one head, for applications not presently requiring dual-trace displays.

Order 3S2 DUAL-TRACE SAMPLING UNIT, without sampling heads $700

3T2 RANDOM SAMPLING SWEEP UNIT

The 5S14/7S14 Samplers are recommended as replacements for the 3T2 Plug-in.

The 3T2 Random Sampling Sweep Unit provides a unique advancement in measurement capabilities. This unit may be used in a 561B, 564B or 568 Oscilloscope, in conjunction with the 3S2 Vertical Dual-Trace Sampling Unit.

Random sampling permits observation of the leading edge (or other portions) of signals even when used with vertical units that have no delay lines and without a pretrigger. Random sampling is especially useful with the 3S2 Sampling Unit with S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Heads.

A front-panel switch (START POINT) selects either conventional, sequentially-stepped sampling or random sampling modes of operation.

SWEEP TIME/DIV

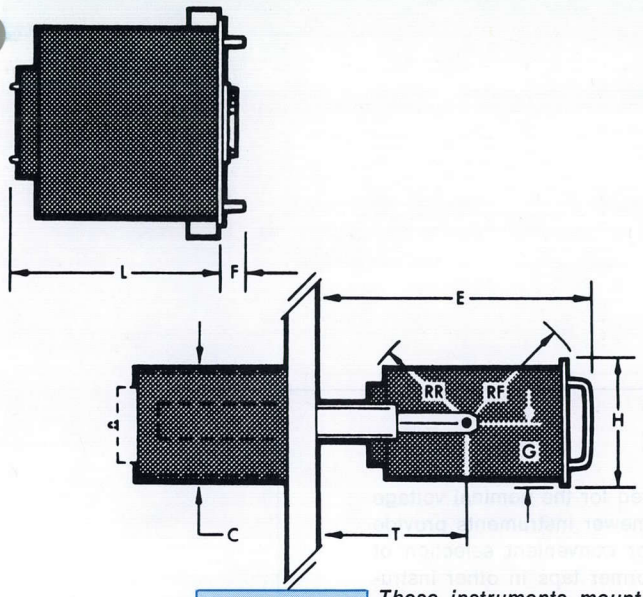
100 μs/div to 200 ps/div, 1-2-5 sequence extending to 20 ps/div with X10 DISPLAY MAGNIFIER. Accurate within 3% from 100 μs/div to 2 ns/div, within 5% from 1 ns/div to 200 ps/div. TIME/DIV is a resultant of the combined settings of TIME POSITION RANGE, TIME MAGNIFIER, and DISPLAY MAG. The sweep rate is displayed (digitally) in the TIME/DIV "window" for all combinations of these controls.

Order 3T2 RANDOM SAMPLING SWEEP UNIT $800

129 POWER SUPPLY

The TEKTRONIX 129 provides a regulated power supply for 2- and 3-Series Amplifiers and Time-Base Units in a wide variety of low-frequency instrumentation systems. With this power supply, the amplifiers can be used to drive recording equipment, X-Y plotters, oscilloscopes or other indicators. The unit is designed for a 19-inch rack. With a cathode follower output card installed, bandwidth is DC to 1 MHz; bandwidth with a passive-divider output card is DC to 100 kHz.

Order 129 RACKMOUNT PLUG-IN UNIT POWER SUPPLY, without plug-in units or circuit cards $1100



RACK MOUNT INSTRUMENTS EXCLUSIVE OF PLUG-IN UNITS AND PROBES		
Symbol	**Description**	**Definition**
H	Height	Height of front panel.
L	Length	Rack front to rearmost permanent fixture excluding cables.
F	Forward Clearance	Back of front panel to foremost protrusion.
G	Vertical Axis	Bottom of front panel to horizontal plane of rotation.
E	Extended Inst.	Maximum forward clearance with instrument out and horizontal.
RF	Radius — Front	Front radius of rotation.
RR	Radius — Rear	Rear radius of rotation.
T	Track	Rack front to pivot point.
C	Cabinet	Cabinet height.

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

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

MOUNTING DIMENSIONS

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
D54R	5.3	13.3	17.8	45.1	1.8	4.5	—	—	—	—	—	—	—	—	—	—	5.3	13.3
R140, R141A, R142 R144, R146, R147A, R148, R149A, 145	3.5	8.8	18.5	47.1	1.6	4.1	—	—	24.1	61.3	—	—	—	—	—	—	3.0	7.6
R230, R240, R241, R250, R287, R288	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
R422	7.0	17.8	12.5	31.8	1.8	4.6	3.5	8.9	16.6	42.3	—	—	—	—	—	—	6.8	17.2
R432, R434	5.3	13.3	18.0	45.7	1.6	4.1	—	—	—	—	—	—	—	—	—	—	5.3	13.2
R453A, R454A,	7.0	17.8	17.4	44.2	1.8	4.6	3.5	8.9	20.7	52.6	11.6	29.5	7.9	20.0	9.3	23.7	6.8	17.2
R465, R475	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	20.0	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	50.6	10.9	27.6	7.9	20.2	9.3	23.7	6.8	17.2
R491	7.0	17.8	17.4	44.2	2.1	5.2	3.5	8.9	21.1	53.5	11.9	30.4	8.5	21.6	9.3	23.7	6.8	17.3
R520A, R521A, R522A	7.0	17.8	18.0	45.8	2.0	5.1	—	—	23.0	58.4	—	—	—	—	—	—	7.0	17.8
R556	14.0	35.6	22.8	57.9	1.8	4.5	8.1	20.7	30.3	77.0	13.1	33.3	14.3	36.2	18.5	57.0	13.9	35.2
R561B, R564B	7.0	17.8	18.6	47.3	1.8	4.5	2.4	6.1	24.3	60.8	13.8	34.9	7.9	20.0	11.0	27.9	6.8	17.2
R568	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
1140A, R1340	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
R2601	7.0	17.8	15.5	39.4	2.1	5.2	—	—	—	—	—	—	—	—	—	—	7.0	17.8
R5103N, R5403	5.3	13.3	19.0	48.3	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
R7403N	5.3	13.3	22.2	55.5	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3
R7704	7.0	17.8	22.4	56.0	2.3	5.8	1.8	4.4	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	13.3	22.3	55.6	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3
R7903	5.3	13.3	22.5	57.2	2.3	5.8	—	—	25.3	64.3	—	—	—	—	—	—	5.3	13.3
R7912	5.3	13.3	26.9	68.3	1.8	4.5	—	—	26.9	68.3	—	—	—	—	—	—	5.3	13.3
RM529	5.3	13.3	18.3	46.4	1.8	4.5	2.4	6.1	21.3	54.1	12.1	30.8	8.4	21.5	9.4	23.8	5.1	13.1
RM565	12.3	31.1	22.2	56.4	1.8	4.6	2.4	6.1	30.5	77.4	15.2	30.8	13.1	33.2	16.6	42.2	12.2	31.0
S54AR	5.3	13.3	17.8	45.1	—	—	—	—	—	—	—	—	—	—	—	—	5.3	13.3
129	10.5	26.6	21.6	55.0	2.0	5.1	1.8	4.5	29.5	74.9	17.6	44.8	11.1	28.3	13.3	33.7	10.5	26.8
650 Series	10.5	26.7	12.2	31.0	1.7	4.9	4.9	12.7	21.5	54.7	—	—	—	—	—	—	10.5	26.7
670	15.7	39.9	19.6	49.8	2.1	5.3	8.1	20.6	27.7	70.4	—	—	—	—	—	—	15.8	40.1
1440	3.5	8.9	18.0	45.7	2.1	5.3	—	—	17.4	44.2	—	—	—	—	—	—	3.5	8.9
1441, 1478	1.7	4.3	18.1	45.9	1.3	3.3	—	—	17.4	44.2	—	—	—	—	—	—	1.7	4.3
016-0115-02	5.3	13.3	16.3	41.4	0.3	0.9	—	—	—	—	—	—	—	—	—	—	5.3	13.3
016-0268-00	5.3	13.3	19.8	50.2	1.8	4.6	—	—	—	—	—	—	—	—	—	—	5.2	13.2
016-0525-00	12.3	31.1	21.4	54.3	1.0	2.6	—	—	26.0	66.1	—	—	—	—	—	—	—	—
040-0551-00	14.0	35.6	22.4	57.1	0.6	1.5	—	—	30.9	78.6	—	—	—	—	—	—	—	—
040-0554-00	15.8	40.0	21.5	54.7	1.9	4.9	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0555-00	15.8	40.0	22.6	57.6	1.9	4.9	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0616-00	5.3	13.3	16.5	41.9	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
040-0617-00	5.3	13.3	16.5	41.9	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
437-0031-00	8.8	22.2	9.5	24.2	0.3	0.7	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0071-00	7.0	17.8	13.4	34.0	1.4	4.0	—	—	—	—	—	—	—	—	—	—	6.6	16.8
437-0126-00	5.3	13.3	22.3	55.6	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3

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

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

TEKTRONIX instruments are equipped with either a three-conductor attached power cord, or a three-terminal power cord receptacle. The third wire, or terminal, is connected directly to the instrument frame, and is intended to ground the instrument to protect operating personnel, as recommended by national and international safety codes. Color coding of the power cord conductors follows the National Electrical Code ANSI C1-1971): the line conductor is black; the neutral is white; the safety earth or ground is green with a yellow stripe.

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

FIELD ENGINEERS

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

COMMUNICATIONS

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

ORDERING

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

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

OPERATION

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

FACTORY TRAINING

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

APPLICATIONS

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

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.

TRACEABILITY

The reference standards of measurement of Tektronix, Inc., 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 instruments 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).

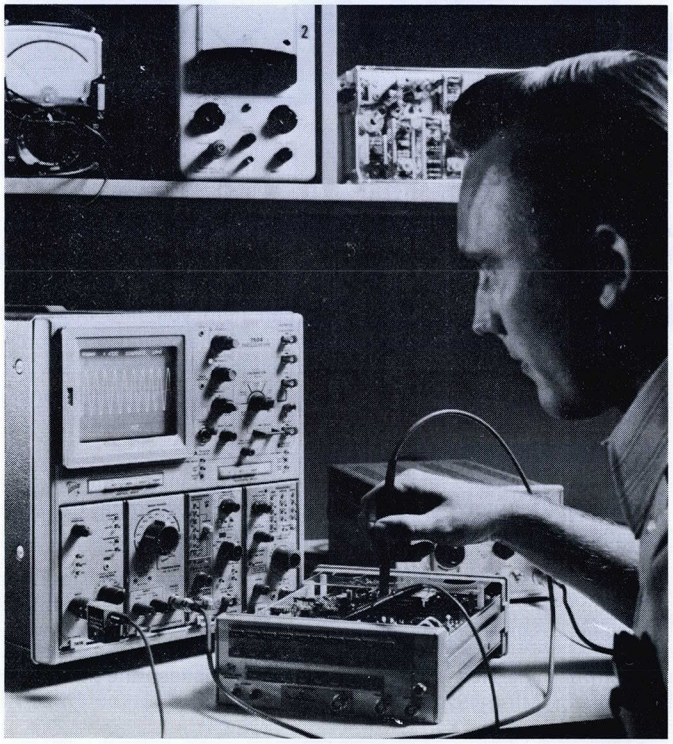
CERTIFICATES AVAILABLE

Certificate of Calibration

Includes model and serial numbers, date of test, signature, and current NBS numbers. (The fee for this service will be listed in the current Price Schedule for Calibration and Readings.) If you ask for this service after the unit has been shipped, you must return the unit to the factory or local service center for recalibration, transportation prepaid.

Certificate of Compliance

Includes a statement that the particular instrument being shipped conforms to its published (or quoted) specifications. Signature and date will normally be provided. There is no charge for this service when requests accompany the order.



MAINTENANCE

Tektronix, Inc. willingly assumes much of the responsibility for continued efficient operation of the instruments 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 instrument 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.

PRODUCT SERVICE—RECONDITIONING

To help assure adequate product service and maintenance facilities for our customers, Tektronix, Inc. has established Field Engineering Offices and Service Centers at strategic points throughout the United States and overseas. Contact your Field Engineer for details concerning • Warranty • Emergency Repairs • Repair Parts • Scheduled Maintenance • Reconditioning and Overhaul • Pick up and Delivery • Maintenance Contracts • On Site Service for Fixed Installations • Other Services available through these local offices and centers.

EMERGENCY REPAIR

This service will help you in situations where products require immediate attention. If your TEKTRONIX product malfunctions, or if you want a particular characteristic optimized, just bring it to your local service center. Work starts when you arrive. In most cases we will solve the problem immediately and get you on your way in a matter of minutes.

Should your oscilloscope need emergency attention during field trips, please contact any of our service centers, they will be glad to assist you with repairs and get you on your way—without costly delays.

REPAIR PARTS

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

SCHEDULED MAINTENANCE, RECONDITIONING AND OVERHAUL

Proper, scheduled maintenance will enable your TEKTRONIX products to deliver many years of dependable service.

Your older TEKTRONIX Products can be reconditioned or completely overhauled, restoring them to catalog specifications. Our service centers are equipped to clean and completely overhaul, both electrically and mechanically, all TEKTRONIX Products.

Want detailed information?
Contact your nearest Tektronix Field Office.

Tektronix, Inc.

P. O. Box 500, Beaverton, Oregon 97005

Telephone: (503) 644-0161 Telex: 36-0485 Cable: TEKTRONIX

FIELD ENGINEERING OFFICES

ALABAMA

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

ARIZONA

***Phoenix** 85034
2643 E. University Drive
Suite 113
Phone (602)244-9795, Telex 66-7401
Tucson Area: Enterprise 383

CALIFORNIA

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

***Irvine** 92705
16601 Hale Avenue
Phone (714) 556-8680, Telex
From Los Angeles: (213) 778-5225

†**Santa Ana** 92705
Suite E, 1420 So. Village Way
Phone (714)541-4162

Palo Alto 94303
3750 Fabian Way
Phone (415)326-8500, Telex 34-8411
(Info. Disp. Prod. 415-321-7728)

†**Mountain View Service Center**
2133B Leghorn Street
Mountain View 94040
Phone (415)967-2863

***San Diego** 92111
6841 Convoy Court
Phone (714)292-7330, Telex 69-5025

San Jose
Suite 1B, 280 Martin Avenue
Santa Clara 95050
Phone (408)296-3010, Telex 34-6439

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

COLORADO

***Denver**
6801 So. Yosemite St.
Englewood 80110
Phone (303)771-8012, Telex 4-5798

CONNECTICUT

***Milford** 06460
#20 Commerce Park Road
Phone (203)877-1494, Telex 9-9338

FLORIDA

***Fort Lauderdale** 33311
1871 West Oakland Park Blvd.
Phone (305)731-1220, Telex 51-4474
Also serves Puerto Rico and U.S. Virgin Islands
From Miami: 944-6948

***Orlando** 32803
1040 Woodcock Road
Phone (305)894-3911, Telex 56-4465
From the Cape Kennedy Area: 636-0343

Pensacola 32503
Suite 130, 4900 Bayou Blvd
Phone (904)476-1897, Telex 70-2430

GEORGIA

***Atlanta** 30341
Suite 3, 2251 Perimeter Park
Phone (404)451-7241, Telex 54-9508

ILLINOIS

Chicago
1541 Elmhurst Rd.
Elk Grove Village 60007
Phone (312)593-2830, Telex 72-6347

†**Chicago Service Center**
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175 Randall Rd.
Elk Grove Village 60007
Phone (312)956-1774
Telex 28-2577

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***Indianapolis** 46219
6121 East 30th Street
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KANSAS

***Kansas City**
Suite 101, 6025 Lamar
Mission 66202
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MARYLAND

***Baltimore**
1526 York Road
Lutherville 21093
Phone (301)825-9000, Telex 87-804
From Harrisburg, Lancaster and York Area call: ENterprise 1-0631
(Info. Disp. Prod. 301-821-9390)

***Rockville** 20850
1335 Piccard Drive
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MASSACHUSETTS

***Boston**
244 Second Avenue
Waltham 02154
Phone (617)890-4550, Telex 92-3446
From Providence: (401)739-4771
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***Detroit**
22132 West Nine Mile Road
Southfield 48075
Phone (313)358-3122, Telex 23-0692

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

MISSOURI

***St. Louis**
11331 Natural Bridge Road
Bridgeton 63044
Phone (314)731-4696, 7, Telex 44-851

NEW JERSEY

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

NEW MEXICO

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

NEW YORK

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

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

***Endicott**
3214 Watson Blvd.
Endwell 13760
Phone (607)748-8291, Telex 932-421

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

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

***Syracuse** 13211
1 Northern Concourse
North Syracuse 13212
Phone (315)455-6661, Telex 937-239

NORTH CAROLINA

***Greensboro** 27405
1011 Homeland Avenue
P.O. Box 6526
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5689 Pearl Road
Phone (216)884-6558, Telex 98-5217

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Worthington 43085
Phone (614)888-4040, Telex 24-5497

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501 Progress Road
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***Oklahoma City** 73105
Suite 201
800 N.E. 63rd
Phone (405)848-3361, Telex 74-7227

OREGON

Portland
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Tigard 97223
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Tektronix Industrial Park
Beaverton 97005
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Norristown 19401
Phone (215)539-5540, Telex 84-6482

***Pittsburgh**
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Monroeville 15146
Phone (412)351-3345, Telex 86-761

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

***Houston** 77036
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Suite 217
Phone (713)783-1910, Telex 77-5494

San Antonio 78228
Suite 100, 4415 Piedras St., West
Phone (512)736-2641 2, Telex 76-7456
From Austin Area:
ENterprise 9915

UTAH

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

VIRGINIA

Hampton 23366
1929 Coliseum Drive
Phone (703)826-4020, Telex 82-3409

WASHINGTON

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

***Field Office/Service Center**

†**Service Center**

GENERAL TERMS OF SALE AND WARRANTY

Orders should be placed with your Tektronix Field Engineering Office listed on page 323.

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 Field Engineer.

NET 30 DAYS

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

EXTENDED TERMS OF SALE

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

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 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.

Certain Information Display Products are available under an operating lease program. The minimum fixed term of this lease is 12 months and is available on a declining rate basis during the next succeeding two years of renewal. Equipment leased on this program is maintained by Tektronix, Inc. during the term of the agreement.

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

CONDITIONAL SALES CONTRACT

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.

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Conditional Sales Contract. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30 or 36 months. Minimum balance amounts may be financed, ranging from $200 for six months to $2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more the $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.

WARRANTY

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

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

SHIPMENT

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

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

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

INTERNATIONAL FIELD OFFICES

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Cable: TEKTRONIX Australia

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Adelaide, South Australia 5000
Phone 23-2811

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

AUSTRIA
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Prinz Eugen Strasse 70
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Phone Vienna 653704, Telex 13933

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Cable: TEKTROBEL

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Cable: TEKANADA

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Don Mills 403, Ontario
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91401 Orsay
Phone 907 78 27
Telex TEKFRANS 69 332 F
Cable: TEKFRANS Orsay

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166, Avenue Berthelot
69007 Lyon 7e
Phone (78)72.00.70,
Telex TEKLYON 30 150 F

Centre Regional de Nancy
16, rue de la Cote
54000 Nancy
Phone (28)27.24.88
Telex TEKNANCY 86 802 F

Centre Regional de Nice
16, avenue de la Mer
06270 Villeneuve-Loubet-Plage
Phone (93)31.29.84,
Telex TEKNICE 46 663 F

Centre Regional de Rennes
6 bis, avenue Louis Barthou
35000 Rennes
Phone (99)30.05.30,
Telex TEKTREN 74 829 F

Centre Regional de Toulouse
284, route Saint-Simon
31300 Toulouse
Phone (61)42.04.50,
Telex TEKTOULS 57 791 F

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Cable: SONYTEK Tokyo

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530
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8 Hijle-cho-2 Nakamura-ku
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Lamadrid 188
Cordoba
Phone 2 3707

Alberdi 939
Rosario
Phone 3 1348

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ZC-29
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Phone: 264-7406
Cable: RAIOCARDIO Rio de Janeiro

Rua Tupi 535
Sao Paulo
Phone 52-7806 & 51-0912
Cable: RAIOCARDIO Sao Paulo

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

Rua Contria, 578-6° and.
Belo Horizonte
Phone 35-4500

CEYLON
Maurice Roche Limited
P.O. Box 61
Colombo
Cable: LAXAPANA Colombo

CHILE
Equipos Industriales S.A.C.I.
Moneda 812 - Of. 912
(Casilla 13550)
Santiago
Phone 716 882 & 382 942

COLOMBIA
Manuel Trujillo Venegas e Hijo Ltda.
Carrera 20 No. 37-33.
Apartado Aereo 53747
Bogota 2, D.E.
Phone 32-06-79 & 45-23-04
Cable: TRUVEHIJO Bogota

ECUADOR
Proteco Coasin Cia Ltda.
Apartado 228A
Quito
Phone 52-6759

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Cable: EMCEEKOREA Seoul

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Petaling Jaya
Phone 53570, 53478

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Av Universidad 3335 Norte
Monterrey, N.L.
Phone 51-13-60, Telex 038865

Calz. J. Gonzales Gallo 383
Guadalajara, Jal.
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Telex 068710

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Glen Innes
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Auckland
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Cable: KOSFY Auckland

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

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

PERU
Importaciones y Representaciones Electronicas, S.A.
Franklin D. Roosevelt 105
Lima
Phone 27-2076
Cable: IREING, Lima

PHILIPPINES
Philippine Electronic Industries, Inc.
2129 Pasong Tamo Street
(P.O. Box 498)
Makati Commercial Center
Makati, Rizal
Phone 80-72-41/42/43/44
Cable: PHILECTRON, Makati

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Mechanical & Combustion Engineering Co. Pty. Ltd.
No. 12 Jalan Kilang
Redhill Industrial Estate
(P.O. Box 46, Alexandra Post Office)
Singapore 3
Phone 647151
Cable: MECOMB

TAIWAN
Heighten Trading Co. Ltd.
(P.O. Box 1408)
Taipei
Republic of China
Phone 518324, 518372, 517517
Cable: HEIGHTEN Taipei

THAILAND
G. Simon Radio Co. Ltd.
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Phone 30991-3
Cable: SIMONCO Bangkok

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Cerrito 617-4°
Montevideo
Phone 9-79-78
Cable: COAUR Montevideo

VENEZUELA
Coasin C.A.
Edificio Eguski
Avenida Havana Y Valparaiso Los Caobos
Apartado Postal 50939
Caracas 105
Phone 728662 Y 72311
Cable: INSTRUVEN, Caracas

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands
Telephone: Guernsey 26411 (eight lines), Telex: 41193

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

ANGOLA

Equipamentos Tecnicos, Lda.

Rua Serpa Pinto 39
(P.O. Box 6319)
Luanda
Phone 6917
Telex 3147 EQUIPAL LUANDA
Cable: EQUIPAL

EAST AFRICA (Kenya, Tanzania and Uganda)

Engineering & Sales Co., Ltd.

Bankhouse, Government Road
(P.O. Box 46658)
Nairobi, Kenya
Phone 26815

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5000 **Koeln** 1
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Telex 888-5417
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8 **Muenchen** 2
Dachauer Strasse 109
Phone (0811) 52 10 41
Telex 0 522 953
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FINLAND

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11, **Meritullinkatu**
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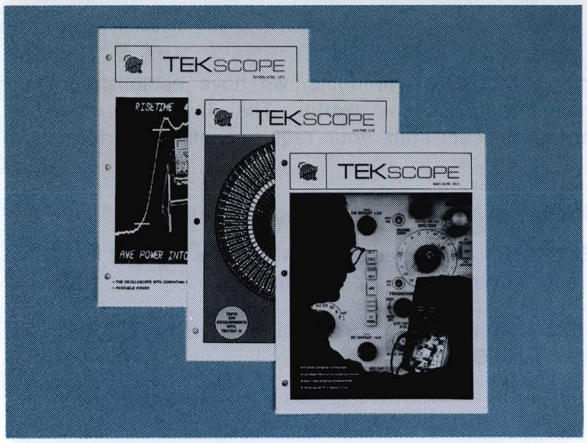

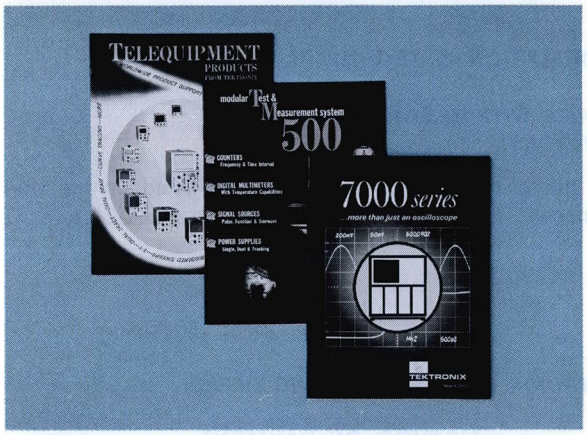

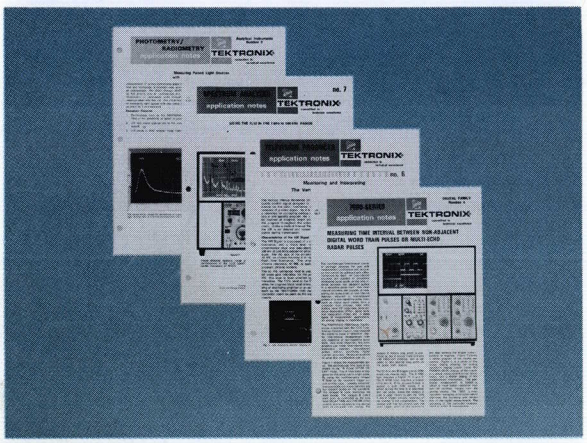

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A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques.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

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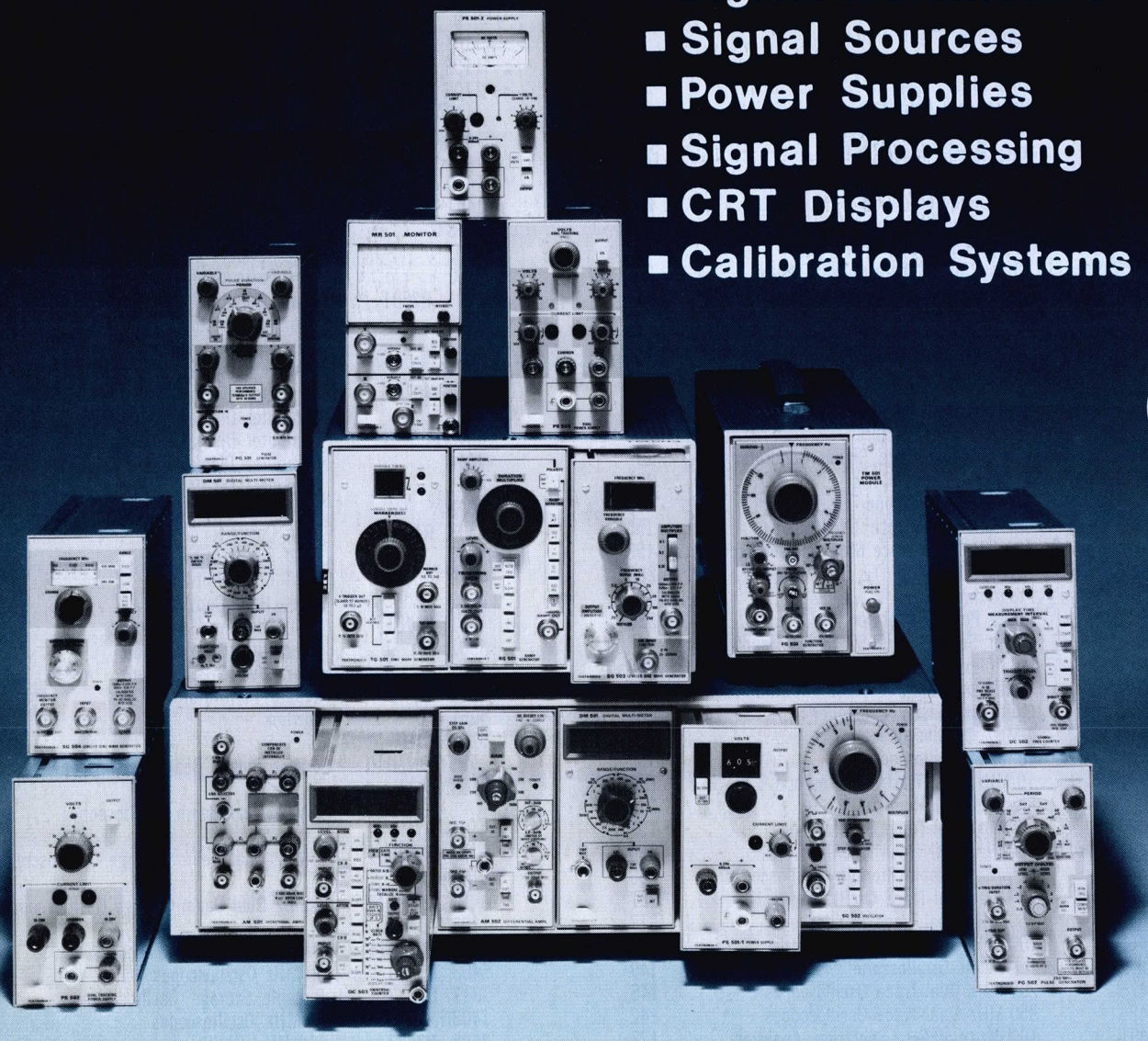
New ways to think of Tektronix

- Counters
- Digital Multimeters
- Signal Sources
- Power Supplies
- Signal Processing
- CRT Displays
- Calibration Systems



the TM 500 Series puts it all together

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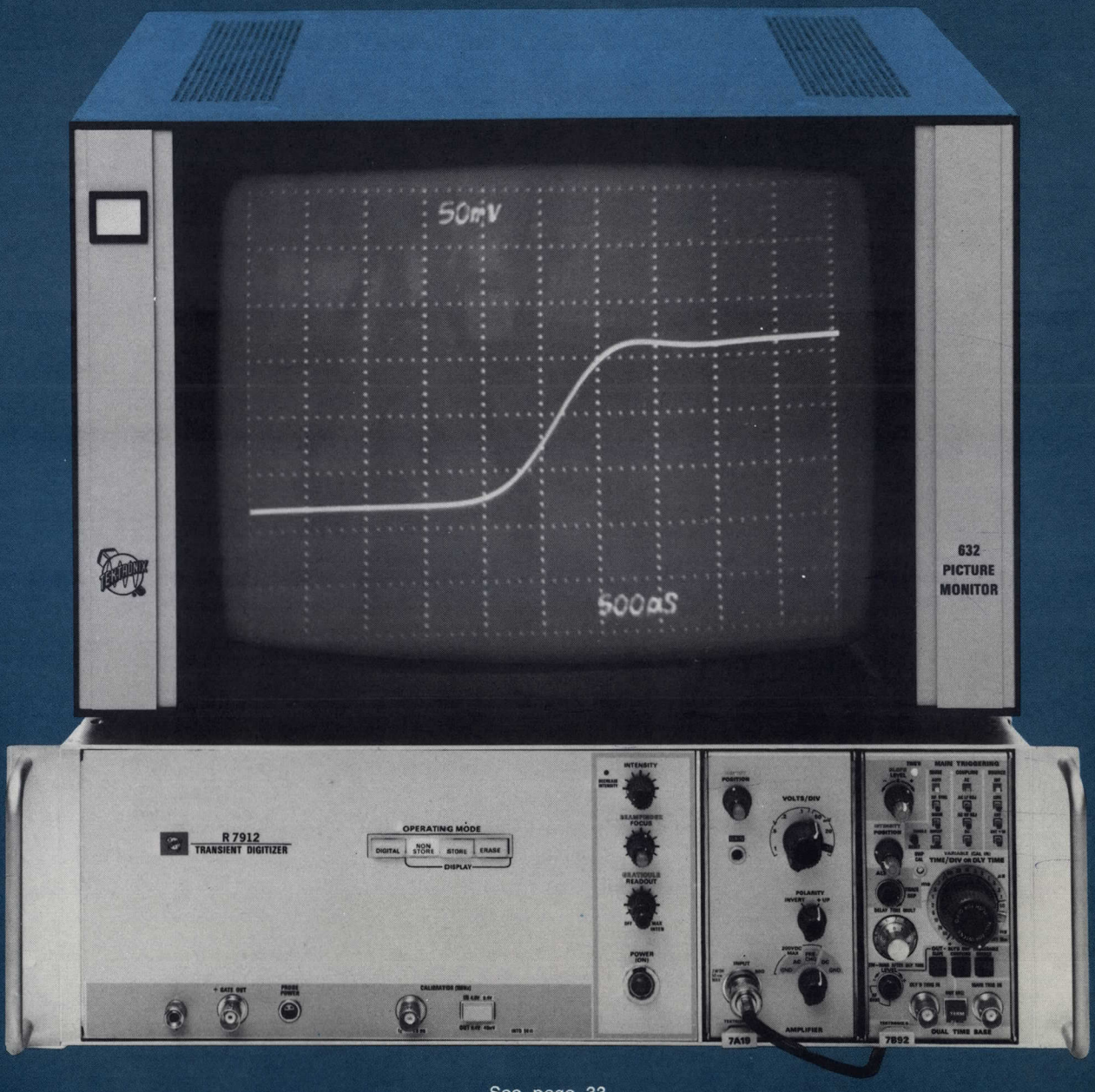
A new way to look at waveforms

- 5 ns Time Window Transient Storage
- Subnanosecond Rise Time Digitizing
- 30,000 div/µs Storage Writing Rate
- Fast Transient TV Viewing



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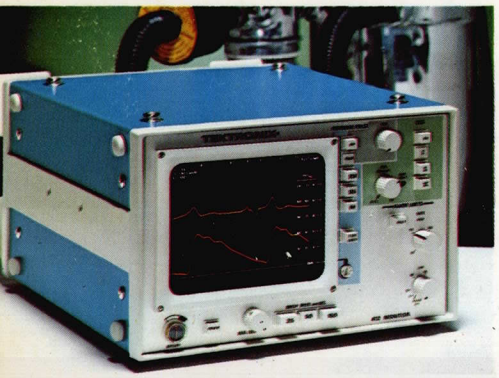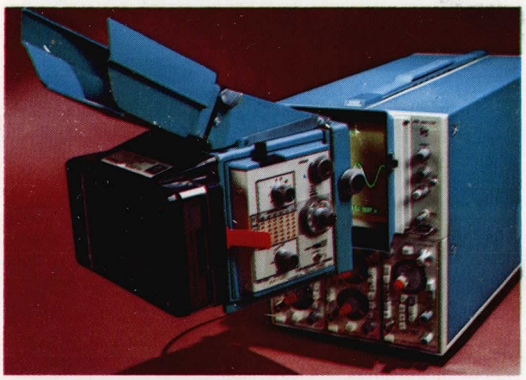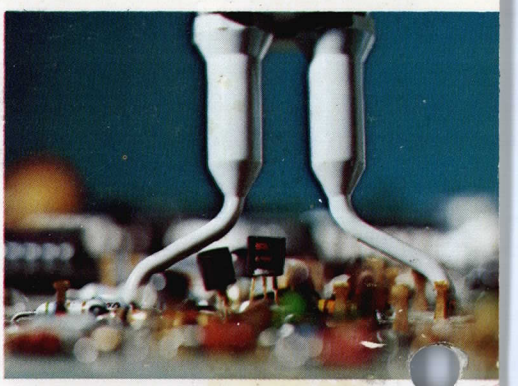
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