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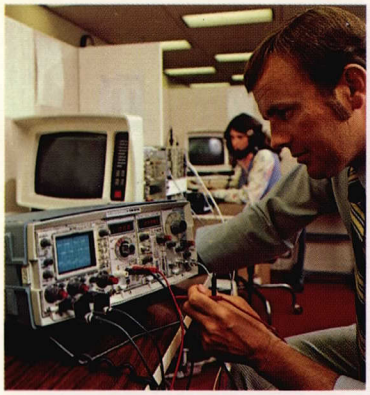
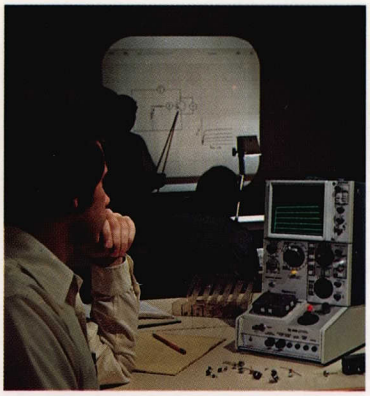
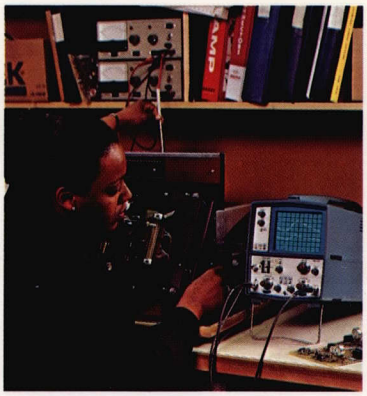
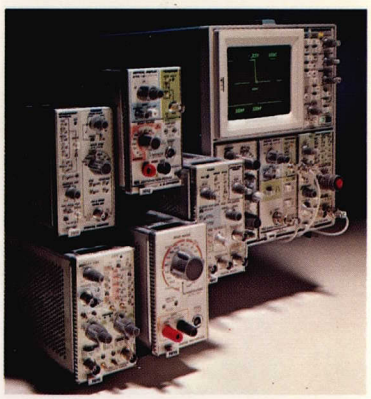
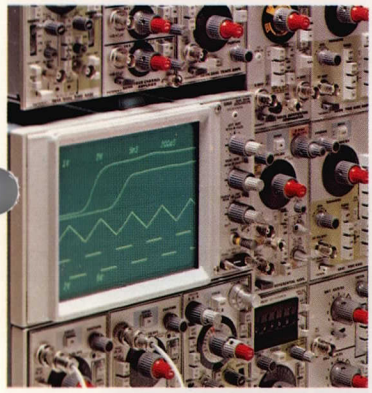
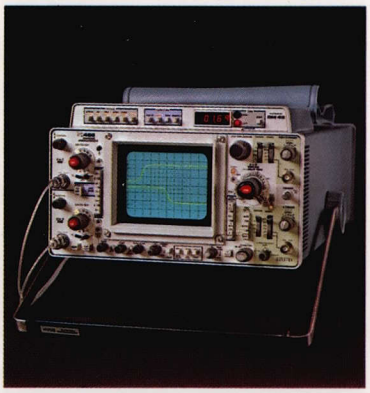
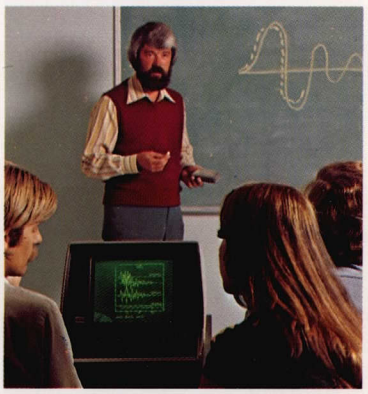
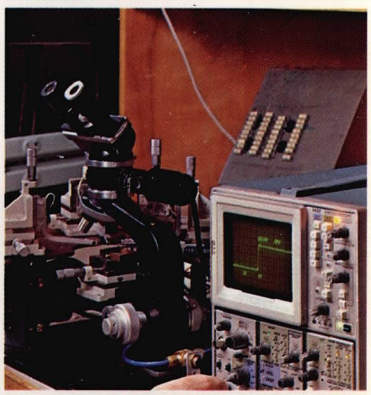

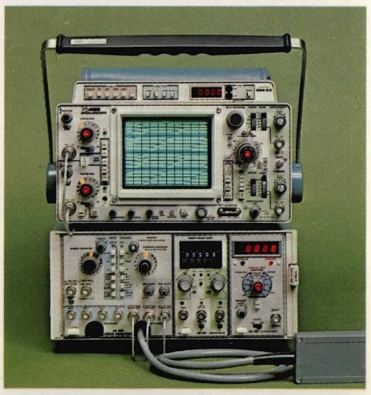
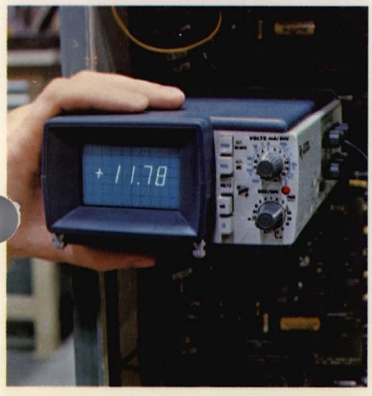

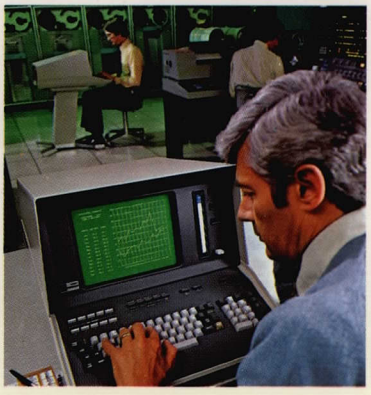

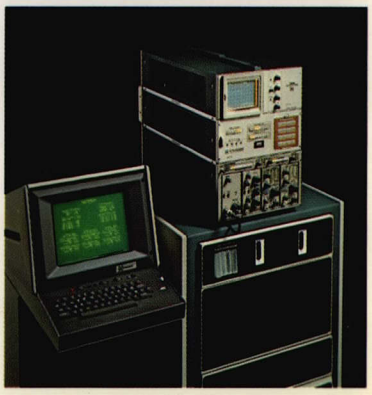

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WHAT WE CAN DO FOR YOU

Whether you're designing, using, or servicing electronic equipment, operating data processing systems, or performing any other measurement or computational task, you'll probably need to call on a variety of supporting electronic devices. Our purpose at Tektronix is to supply you with the best possible electronic tools for examining and working with electronic signals and computational data.

From our original product, a pioneering laboratory oscilloscope, to the hundreds of products listed in this catalog, our objective has been to see that everything we offer reflects our commitment to engineering excellence, quality manufacture, and unexcelled customer support.

To you personally, Tektronix can also mean individual assistance with your unique measurement problems. Our field staff invites you to give the Tektronix office near you a call.

WE'RE READY AND WILLING TO HELP

If you wish help in selecting a Tektronix product, or just need a recommendation on how we can help solve your measurement problem, please feel free to contact your nearest Tektronix Field Office. You'll find a complete list on pages 260-261. In cases where further advice is needed, local Tektronix personnel can also arrange for additional help from our home office, or put you directly in touch with a specialist in a particular product or application area.

Besides sales advice, your local Tektronix field staff member can also arrange for training, service, special orders, and maintenance. Through our Field Service Centers, we're ready to solve repair problems on our products from calibration through complete instrument reconditioning. Alternately, we will furnish parts if you wish to do the work yourself. And any one of our many offices will be glad to provide you with more detailed catalogs, specification sheets, application notes, and support materials. A request card for this purpose is provided inside the back cover of the catalog.

INTERNATIONAL SALES AND SERVICE

Besides our network throughout the United States, Tektronix, Inc. also maintains field offices in 11 other countries. Distributors and representatives provide additional support for over 40 countries around the world. For a list of these offices, see pages 260 and 261.

NEW PRODUCTS SUMMARY

A brief discussion of new products introduced during the past year, including:

T900 Series Oscilloscopes — Five models in a new, moderately-priced line.

Portable Oscilloscopes — Five new models including a **DMM** Oscilloscope.

Digital Service Products — A versatile 16-channel logic analyzer.

TM500 Series — New power module and four significant new plug-ins.

5000-Series Products — Dual Beam Oscilloscope and two new time bases including digital delay.

7000-Series Products—Two new time bases feature differential delay.

Spectrum Analyzer Products — A 5-MHz analyzer, two tracking generators, attenuators, sweep generator, and preamplifier.

TDR Cable Testers — Two new ruggedized portables.

Digital Processing Oscilloscope — A low-priced starting package for restricted budgets.

Computer Terminal Products — Desktop graphic computing system, low-cost terminal, hard copy unit, and digital tape reader.

TELEQUIPMENT Products — A dual-trace, battery operated portable.

Cameras and Scope Carts — An inexpensive camera and a new versatile scope cart.

Television Products—NTSC television sideband adapter.

Medical Monitor — Dual trace display of ECG and blood pressure or peripheral pulse.

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3a

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CORPORATE OFFICES AND PRINCIPAL PLANT LOCATED AT TEKTRONIX INDUSTRIAL PARK
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OUR NEWEST PRODUCTS

T900 SERIES OSCILLOSCOPES

T900-Series Oscilloscopes are an entirely new line designed for cost savings without sacrifice of basic performance. They offer the quality, reliability, and support traditionally associated with TEKTRONIX Oscilloscopes—all at a moderate price.

This new line includes:
T921-Dc to 15 MHz; single trace, mono time base,

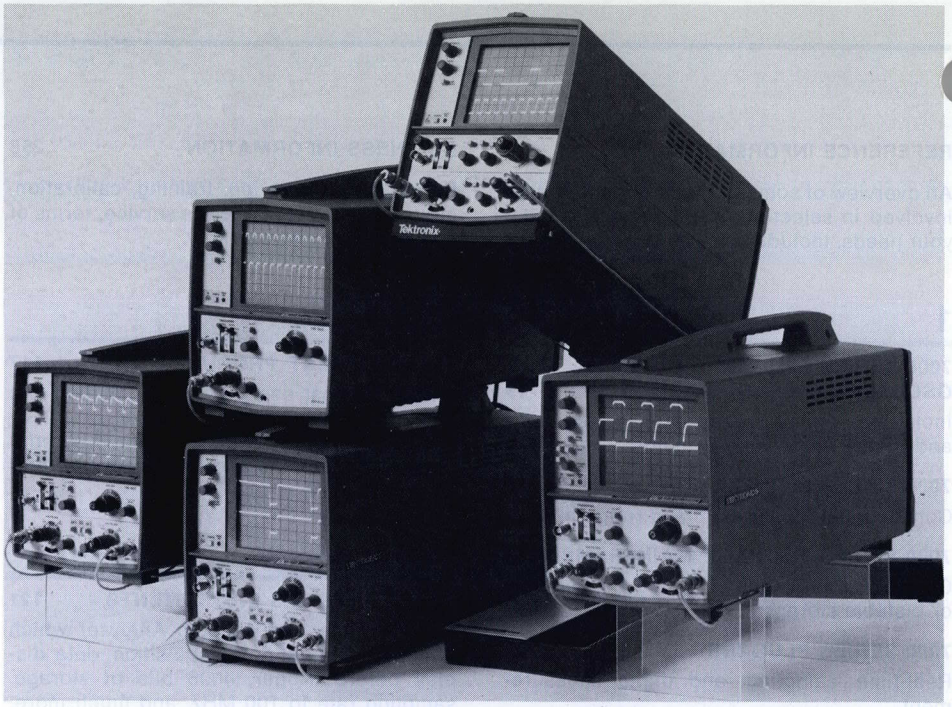
T922-Dc to 15 MHz; dual trace, mono time base,

T932-Dc to 35 MHz; dual trace, mono time base,

T935-Dc to 35 MHz; dual trace, dual time base with delayed sweep,

T912-Dc to 10 MHz; dual trace, mono time base, bistable storage.

All of the T900s have a large (8 x 10 cm) screen with internal graticule. The four non-storage models use a 12 kV accelerating voltage in a post-accelerator crt, providing bright displays of low-rep-rate signals, even under adverse lighting conditions.



Stored writing speed of the T912 extends up to 250 cm/ms.

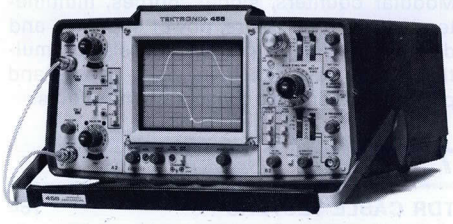
For further information on the T900 Series see page 116.

PORTABLE OSCILLOSCOPES

The Unique TEKTRONIX 213 DMM/Oscilloscope offers a distinct advantage to the serviceman who has had to carry both a DMM and oscilloscope, or make do with only one. With this precise, full function, 3½ digit multimeter and 1 MHz oscilloscope in one compact (3.7 lb, 3.0 x 5.2 x 8.9 inches) instrument, more repairs can be performed on site, on the first call. The small, lightweight 213 can be easily carried to the site in a briefcase or tool kit. In operation it can be hand held, rested on the equipment under test, or even carried on a convenient neck strap.

DMM or oscilloscope operation is easily selected with a single pushbutton. A second pushbutton selects dc or true rms operation. The remaining three pushbuttons provide quick selection of voltage, current, or resistance measurements. Scale factor (volts, mA, or ohms) for both DMM and oscilloscope modes is selected with one clearly labeled dial. A second dial is used to select time/division for the oscilloscope mode.

For further information on the 213 see page 115.



The 455 Portable Oscilloscope combines 50 MHz bandwidth, dual traces, and delayed sweep in a rugged, value-leading package that provides a cost-effective means of bringing needed performance features and accuracy to field service applications and to many production applications as well.

The 455 offers features designed to make measurements faster, easier, and more error free. These include: lighted deflection factor indicators, trigger view, variable trigger holdoff, color-coded modular probes, modular construction for easy serviceability, and an easily understood color-coded control panel. To further enhance its use in service and industrial environments, the 455 is housed in a rugged, shock resistant plastic case. Optional battery operation frees the 455 from dependence on ac lines.

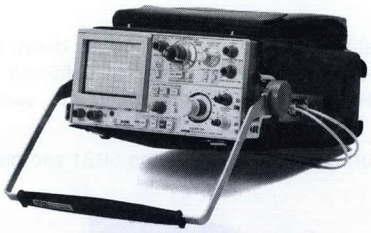
The 455 is an ideal choice for servicing small to medium scale computers, computer peripherals, industrial control equipment, military or commercial communications gear, office machines, and point-of-sale terminals.

For further information on the 455 see page 103.

The SONY/TEKTRONIX 314 Portable Storage Oscilloscope provides dual trace storage with 4-hour viewing time and 1 mV/div sensitivity at 10 MHz, all in a compact, rugged package with less than one-half the weight of most other storage oscilloscopes.

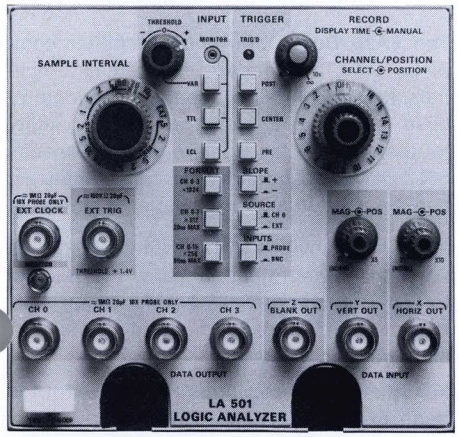
Lightweight (10.5 lb), small size (4.4 x 9.3 x 13.6 inches), and ac or dc operation mean that the 314 will go wherever storage measurements must be made. It is particularly well suited to measurements in production, and servicing of industrial control systems, biophysical instrumentation, computer terminals, point-of-sale terminals, computer peripherals, and communication systems.

For further information on the 314 see page 111.



The SONY/TEKTRONIX 335 Portable Oscilloscope provides the fundamental capabilites (35 MHz bandwidth, dual traces, and delayed sweep) for a quite sophisticated level of digital and analog servicing. And these capabilities are housed in an easy-to-carry, 10.5 lb package. The 335 is ruggedly constructed to withstand the hard use of industrial and field applications.

DIGITAL ANALYZING INSTRUMENTS



The LA 501 Logic Analyzer is a 4096 bit digital storage unit designed as a 2-wide TM 500 Series Plug-in providing flexible test package configurations for the engineering lab, manufacturing area, and field service applications.

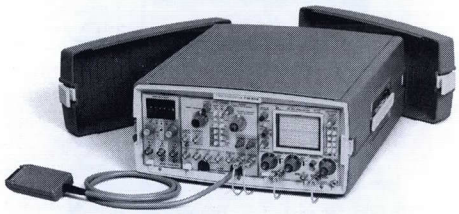
The 4096 bit memory is easily formatted via front panel pushbuttons into data acquisition of 4, 8, or 16 channels, maximizing resolution, speed, and memory width vs length for a wide range of applications. Captured multiline data can be displayed on any X-Y monitor or scope, in a timing diagram format, or without a monitor it can be connected to any data collecting unit such as mass storage, modem, etc., via the data output connector and appropriate level translator.

A choice of pre-trigger, center-trigger, or post-trigger modes allows the operator to select where the displayed block of data falls with respect to a trigger taken from his system.

The LA 501 can be clocked internally or externally and will handle TTL, ECL, or other logic families with fixed or variable single threshold level controls.

For further information on the LA 501 see page 122.

TM 500 SERIES PRODUCTS



The TM 515 Traveler Mainframe and SC 502 Oscilloscope Plug-in, in combination with the rest of the TM 500 family of plug-in instruments, offer a new concept in portable instrumentation.

The TM 515 accommodates five plug-ins, or modules, and is electrically similar to other TM 500 Mainframes. However, its design has been optimized for portability. It is lightweight, rugged, and attractive. With end covers on, it has the appearance of quality luggage. The covers provide protection for the instrument front panels and the ventilating fan, and serve as storage compartments for the bail and power cord. Accessories or tools can also be stored in the covers.

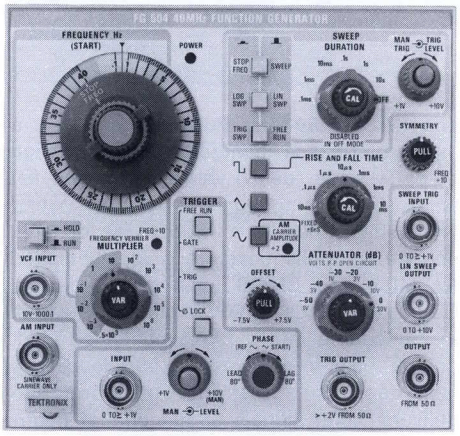
The SC 502 is a two-compartment wide, dual trace oscilloscope that offers a combination of features not found on any other oscilloscope. Bandwidth is 15 MHz from 20V/DIV to 5 mV/DIV, 10 MHz at 2 mV/DIV, and 5 MHz at 1 mV/DIV. The rise time is 23 ns.

For complete description of the TM 515 and SC 502 see pages 153 and 158.

The SG 504 Leveled Sine Wave Generator is primarily intended to extend the capability of the TEKTRONIX Oscilloscope Calibration Package to 1050 MHz. It provides a constant amplitude sine-wave output over the frequency range of 245 MHz to 1050 MHz in two ranges. A reference frequency of either 50 kHz or 6 MHz (selected internally) is activated by a front-panel pushbutton, enabling you to quickly check the reference level setting without changing the dial.

The output amplitude can be set over the range of 0.5V to 4.0V peak-to-peak by a front-panel, five-turn, calibrated control. A frequency monitor output provides a convenient means to more precisely determine the output frequency by use of a counter. Provision is made to frequency modulate the output signal over the range of dc to 100 kHz using an external source. Since this input is dc-coupled, it can also be used for remote fine frequency control.

For complete description of the SG 504 see page 146.



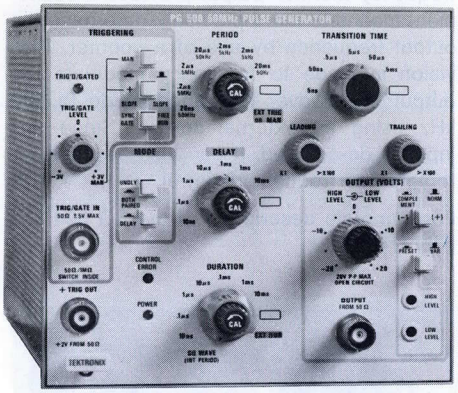
The FG 504 Function Generator provides high-quality, low-distortion sine, square, triangle, ramp, and pulse waveforms. The frequency range is from 0.001 Hz to 40 MHz over ten decades (0.001 Hz to nominally 4 MHz for waveforms requiring use of variable symmetry control). An additional position for a user-determined frequency range is provided.

The instrument can be swept between the START and STOP dial settings at either a linear or logarithmic rate. The output may be phase locked, gated, or triggered. A step attenuator and variable amplitude adjustment control the output amplitude over a range of 0 to 30 V peak-to-peak into an open circuit. An output offset control is provided.

For complete description of the FG 504 see page 143.

TM 500 SERIES PRODUCTS

(Continued from previous page)

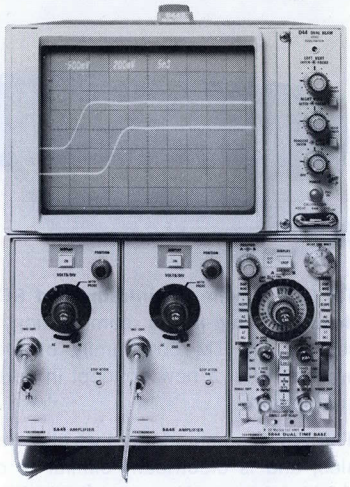


The PG 508 50-MHz Pulse Generator is a high-performance generator featuring high output voltage, delay, variable rise and fall times, 1 megohm trigger input, and gating capability to handle a wide range of logic and other applications. It is ideally suited for MOS and CMOS logic circuit design. Output amplitude is 20V peak-to-peak from a 50Ω source into a high impedance load, or 10V peak-to-peak into a 50Ω load. The low-reactance 50Ω source impedance delivers clean signals at the end of unterminated cables, eliminating the need to terminate the pulse generator output. Variable rise and fall times from <6 ns over a range of 100:1 remain constant with changes in pulse output amplitude, thereby reducing set-up time.

A front-panel control-error light tells the operator when he has selected illegal modes, or when timing conflicts exist. The PG 508 occupies two compartments in a TM 500 Mainframe allowing space for companion instruments.

For complete description of the PG 508 see page 139.

5000 SERIES PRODUCTS

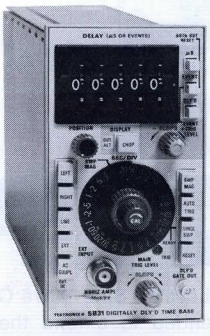


The 5444 Dual Beam Oscilloscope, used with the 5B44 Dual Time Base Plug-in and two plug-in vertical amplifiers, is virtually two oscilloscopes in one. Both beams can write anywhere on the 8 by 10 division screen. This scope has a 60 MHz bandwidth and sweep rates as fast as 5 ns/div.

The 5444 will display a one-shot signal at two sweep speeds or two one-shot signals at any sweep speed, four repetitive waveforms in the alternate or chopped mode, or up to 8 at reduced bandwidth. Four single-shot events may be displayed at sweep speeds up to 100 μs/div in the chopped mode.

The crt provides a bright display, with readout that automatically documents the sweep speed and vertical deflection factor for each beam. (A user-addressable readout option allows you to write up to two 10-character words of your choice to identify the photograph, the device under test, etc.)

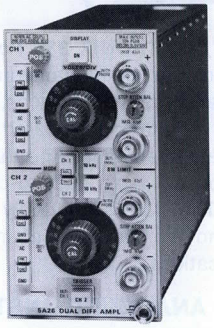
For complete description of the 5444 see page 74.



The 5B31 Digitally Delayed Time Base, a new plug-in in the 5400-Series Oscilloscope line, brings new measurement accuracy and operating convenience to many delaying sweep applications. The delay system—a crystal-controlled clock, a digital counter, and a unique circuit that eliminates one-count ambiguity in the counter—replaces the usual delaying sweep.

It features two delaying modes, delay by events and delay by time, in addition to 60 MHz triggering and 20 ns/div sweep rate.

For further information on the 5B31 see page 79.

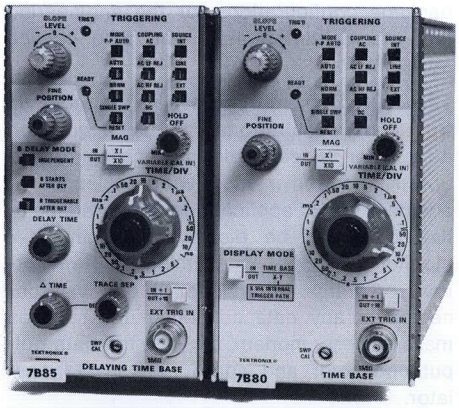


The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. It adds "no compromise" differential measurement capability to the line of low-cost, high-performance 5000-Series Laboratory Oscilloscopes. It may be used in any 5000-Series Mainframe.

The 5A26 provides 50 μV/div at 1 MHz, high common-mode rejection ratio, crt readout in any standard 5400-Series Mainframe, trigger-source selection, and bandwidth limit on each channel.

For complete description of the 5A26 see page 87.

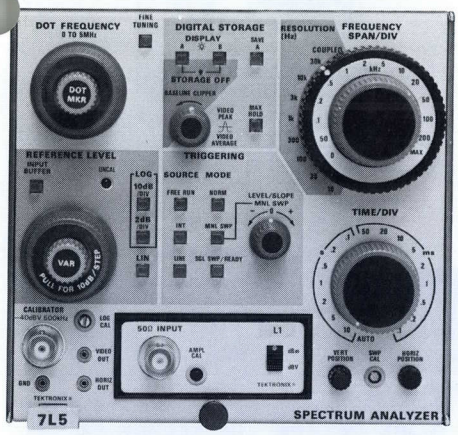
7000 SERIES PRODUCTS



The 7B85/7B80 combination of plug-in time bases for the 7000 Series adds new capability in oscilloscope timing measurements—the time difference between selected points is computed and digitally displayed on the crt. Other features you'll like include 1 ns/div sweep rate, 400 MHz triggering, and variable trigger hold-off.

For complete description of the 7B85/7B80 see page 55.

SPECTRUM ANALYZER PRODUCTS

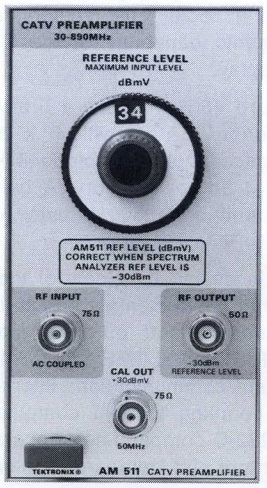


The 7L5 5-MHz Spectrum Analyzer combines synthesizer and digital technology to achieve exceptional frequency accuracy, stability, and 6 digit resolution. Operation is easy with crt readout of display parameters and with sweep time and resolution automatically optimized for each span position.

Performance characteristics include: 80-dB on-screen dynamic range, 10-Hz resolution, and absolute calibration in dBm, dBV, or volts. Reference level is set and read out in 1-dB steps over the range of −128 dBm to +21 dBm (with the L1 50Ω plug-in module).

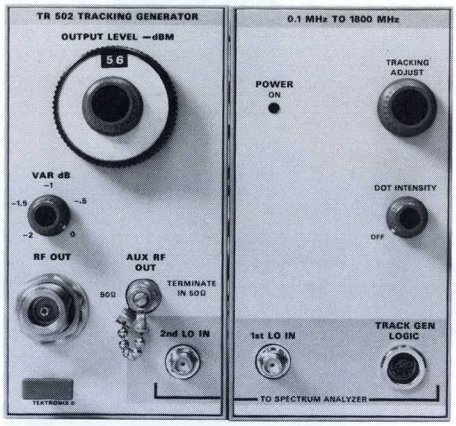
Digital storage in the 7L5 provides clean, easy-to-see, easy-to-photograph displays with any 7000-Series crt readout mainframe.

For further information on the 7L5 see page 190.



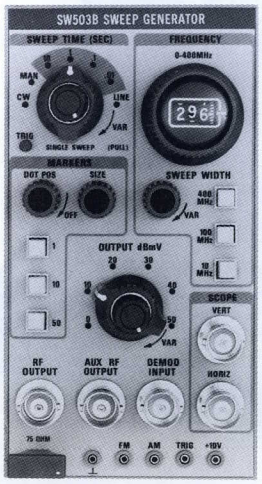
The AM 511 Preamplifier is designed for spectrum analyzer applications where extra sensitivity is required. The AM 511 fits into the TM 500 Modular Series power supplies. The amplifier is tailored to the CATV and field intensity measurement markets providing a 75Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifier well suited for signal-to-noise and low level radiation measurements.

For further information on the AM 511 see page 152.



The TR 501 and TR 502 Tracking Generators, designed to work with the 7L12 or 7L13 Spectrum Analyzers, provide highly stable, leveled signals over the range of 100 kHz to 1.8 GHz. The stability of the Spectrum Analyzer/Tracking Generator system is determined by the analyzer with which it is used. Signal output level is calibrated and adjustable from 0 dBm to −59 dBm in 1 dB steps (0 dBm to −11 dBm for the TR 501) with a variable control providing an additional −2 dB of range. The stability and high resolution of the 7L13/TR 502 system yields dynamic range greater than −110 dB. An auxiliary rf output is provided so that a counter can be used with the spectrum analyzer for high sensitivity measurements.

For further information on the TR 501 and TR 502 see pages 188-189.



The SW 503 Sweep Generator is a small compact unit, which incorporates most of the features associated with larger laboratory type sweep generators, and is designed to operate in a TM 500 Series Power Module. The instrument covers a frequency range of 1 to 400 MHz. It has a variable sweep rate, step attenuator, 20 dB vernier attenuator, and a crystal controlled marker generator which provides comb type markers at 1, 10, and 50 MHz.

A unique feature of the SW 503 when used in conjunction with a DC 502 Option 7 Digital Counter is its ability to provide a variable marker over the entire 1 to 400 MHz frequency range with the marker frequency read directly on the digital counter.

For further information on the SW 503 see pages 144-145.

The 2701 and 2703 Step Attenuators are small, laboratory-quality, wideband benchtop instruments for attenuating large value radio- and video-frequency signals. The 2701 is a 50 ohm attenuator particularly useful in making receiver sensitivity and distortion measurements. Its range of attenuation is 0 to 79 dB, in 1 dB steps.

The 2703 75Ω Step Attenuator is tailored for television, CATV, telephone, and radio applications. A front-panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity.

For further information on the 2701/2703 see page 195.

TDR CABLE TESTERS

The 1502 and 1503 TDR Cable Testers are small, portable, rugged (qualifed to MIL-T-28800, Type 11, class 2, style A) battery-powered units designed to test any type cable, from lamp cord to coax, under virtually any conditions. The 1502 tests cables up to 2000 feet with resolution to a fraction of an inch, while the 1503 tests cables up to 50,000 feet with a resolution of 3 feet.

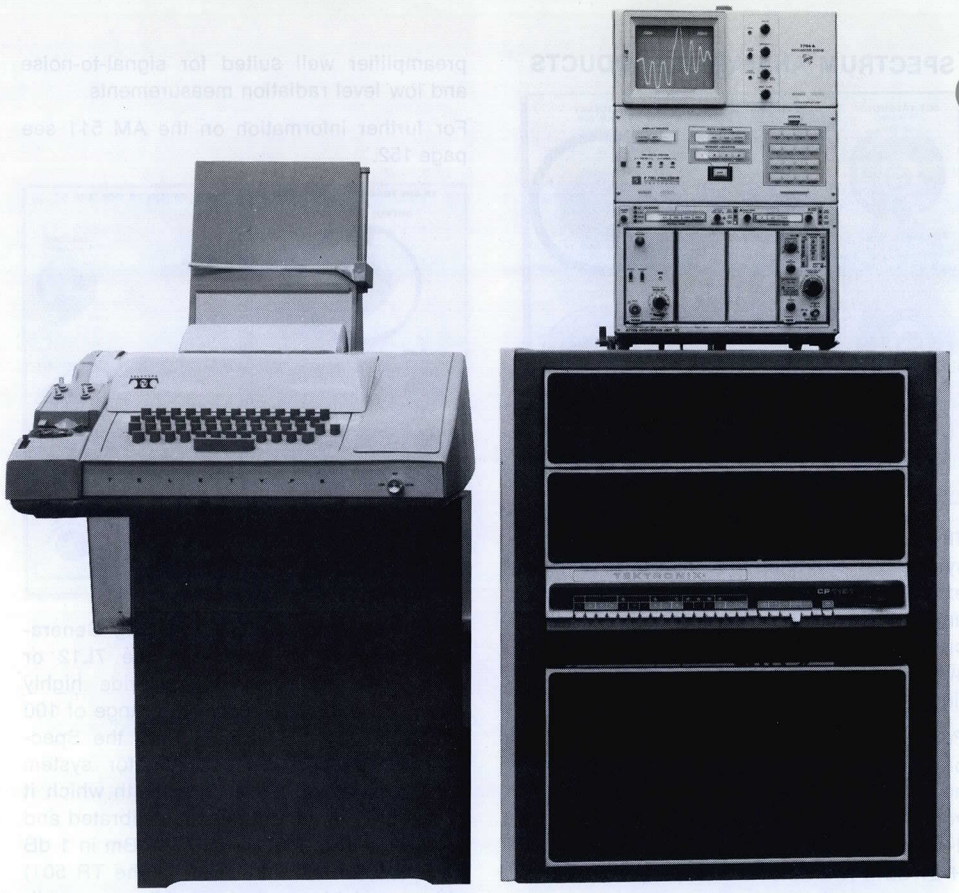
For further information on the 1502/1503 see page 164.

DIGITAL PROCESSING OSCILLOSCOPES

The WP 1205 DPO is a low-priced starting package for customers with a restricted budget. The package includes one 7A16 vertical plug-in, one 7B70 time base plug-in, a CP1151 controller with a 16 k memory, a modified ASR-33 teletype, and paper tape DPO TEK BASIC software.

The WP 1205 has an internal 1 k memory, adequate to acquire and display one waveform with scale factors. To store four waveforms, a 4 k DPO memory option is available. The software, DPO TEK BASIC, is written to allow specific routines to be selected at loading. This provides the CP1151 controller (16 k) with adequate program space for most user applications.

For further information on the WP 1200 Series see page 31.



COMPUTER TERMINAL PRODUCTS

The 4051 BASIC Graphic Computing System is a compact data system that combines high-level BASIC-language interaction, built-in computing, local tape memory, and the unique graphic capability of the Tektronix storage display.

The standard 4051 includes a firmware implementation of BASIC with 8 k bytes of working space. Options include 8 k, 16 k, and 24 k of add-on memory. A built-in 3M mag tape unit adds 300 k bytes of local storage.

The 4051 is designed to control the operation of other instruments through the new standardized, general purpose, interfacing system (GPIB) called IEEE Std 488-1975. An optional data communications interface provides for coupling to host computers, and other RS-232-C compatible peripherals such as line-printers and keyboard terminals.

For further information on the 4051 see page 202.

The 4006-1 Computer Display Terminal brings graphic display capability right to your desk top at a new low cost. The 11 inch storage tube provides crisp, clear displays with 800,000 viewable points (1024 X by 780 Y). It has an on-screen capacity of 2590 alphanumeric characters. You can transmit or receive data at selectable rates of 75 to 4800 baud.

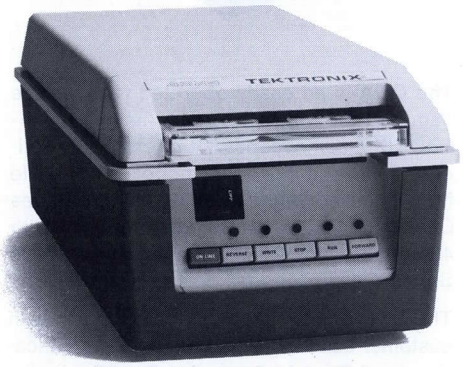
The 4006-1 is supported by extensive software products and is compatible with the 4631 Hard Copy Unit for dry, high-quality, 8½ x 11 inch copies of any information displayed on the 4006-1 screen. The 4923 Digital Cartridge Tape Recorder, a low-cost off-line data storage device, is also compatible with the 4006-1. For more complete details on the 4006-1 use the reply card accompanying the catalog.

The 4631 Hard Copy Unit is plug-to-plug compatible with the entire TEKTRONIX 4010 Series of computer graphics terminals, as well as with the 613 Storage Display Unit. The 4631 is designed as a direct replacement for the TEKTRONIX 4610 Hard Copy Unit.

Among its many features is the advantage of being able to copy either the 11 inch or 19 inch storage tubes of the TEKTRONIX 4010-1, 4012, 4013, 4014-1, or 4015-1 terminals. The 4631 is plug-to-plug compatible with all these, whereas the 4610 required a special option for the larger 4014-1 and 4015-1 terminals.

The 4631 uses 3M Type 777 dry silver paper and requires 18 seconds for the first copy and only 8 seconds for subsequent copies. The clean dry-copying process is self-contained in the unit and requires no external equipment to print or develop copies. A built-in paper stacking tray eliminates any need for additional accessories to remove or stack the copies. The 4631 weighs only 65 pounds.

For further information on the 4631 see page 205.



The 4923 Digital Tape Reader is the perfect storage device to team up with the TEKTRONIX 4010 family of Computer Display Terminals or the 4023 Terminal. In fact, any product using RS-232-C data communications lines can be used with the 4923 Option 1.

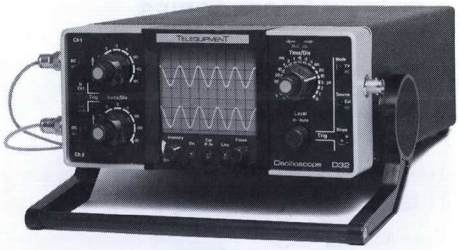
Information is stored on a DC300A 3M Data Cartridge with a data capacity of 200,000 8-bit bytes. Data format is 128 8-bit byte records with variable length files. The standard model operates up to 10 k baud, depending on the terminal environment. Option 1 lets you select a baud rate from 110 to 9600.

Operating the 4923 is as simple as one, two, three. You have front panel controls for Reverse, Write, Stop, Run, and Forward.

The computer can access START READ (DC1) and STOP READ (DC3). During a READ operation the 4923 provides a line-turn-around character if a DC3 is encountered in the data. Once a DC3 is read, the following stored character is read and sent, and the unit stops.

For further information on the 4923 see page 205.

TELEQUIPMENT PRODUCTS



The TELEQUIPMENT D32 is one of the smallest and least expensive dual trace, battery operated, 10 MHz oscilloscopes available today. The TELEQUIPMENT line of TEKTRONIX Oscilloscopes combine low prices with a number of features not usually found in other oscilloscopes of the same price range. Features such as calibrated sweep rate and vertical step attenuators, triggered sweep, probe-calibrator output, and TV-field or line triggering, make this instrument easy to use.

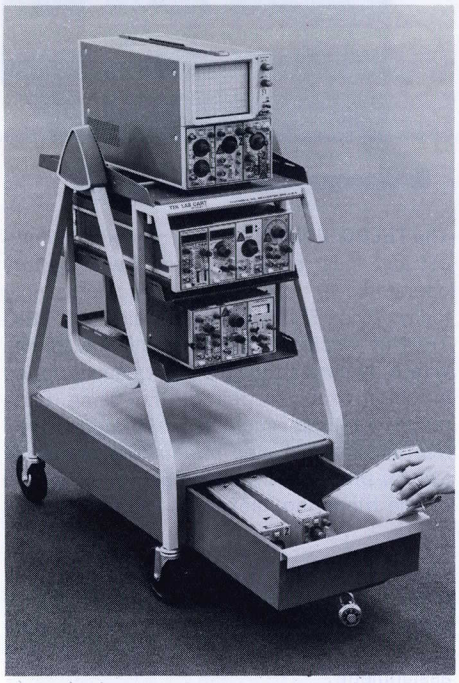
The D32 measures 4 x 9 x 11 inches, weighs only 10 pounds, and has an adjustable carrying handle which also serves as a tilt bail. It can be carried comfortably on any assignment.

Packed into a small frame are features normally associated with instruments several times its size. The D32 offers 10-MHz bandwidth at 10 mV/div sensitivity; automatic selection of chopped or alternate modes; and the choice of ac line or battery operations with up to four hours continuous operation working from its rechargeable batteries.

Calibrated sweeps range from 500 ns/div to 500 ms/div in 19 steps, with an X5 magnifier extending the fastest range to approximately 100 ns/div.

For further information on the D32 see pages 118-120.

CAMERAS, SCOPE CARTS, AND ACCESSORIES



The Tek Lab Cart Model 3 introduces a new line of versatile, general purpose oscilloscope carts. Its top tray accommodates all three and four plug-in mainframes of 5100, 5400, and 7000 Series Oscilloscopes. It can also accommodate TM 503 or TM 504 Mainframes, portable oscilloscopes, 576, and 577 instruments. The cart includes a large drawer in the base with provision for padlock, brakes on front casters, 15 ft power cord with plug strip, and safety belt.

A framework attached to the underside of the tilting top tray accepts one or more shelves (one of which is standard) at any one of ten positions to permit the use of various configurations of instruments such as the TM 500 Series.

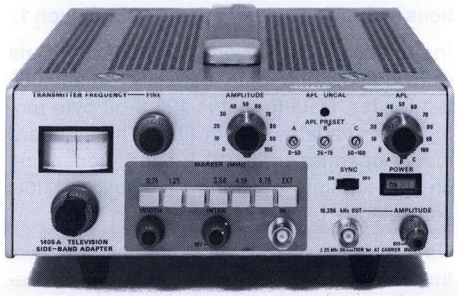
For further information on Tek Lab Carts see pages 254-256.

The C-5A is an easily operated inexpensive camera that will fit a broad range of TEKTRONIX Oscilloscopes. It offers both graticule flash and nonflash models. Graticule flash is used with T900 and 5100 Series Oscilloscopes, and nonflash models with 434, 455, 464, 465, 466, 475, and 7000 Series Oscilloscopes.

The f/16 lens system has a fixed focus, with customer-selectable 0.67 or 0.85 magnification for 9.76 x 12.2 cm and 8 x 10 cm displays.

For further information on the C-5A see page 228.

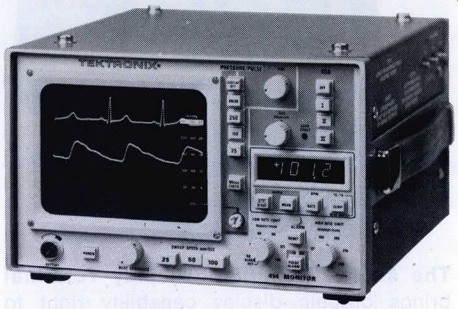
TELEVISION PRODUCTS



The 1405 NTSC Television Sideband Adapter is used with a spectrum analyzer, such as the 7L12 or 7L13, to analyze the video output of television transmitters. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sinusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. The 1405/Spectrum Analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Complete specifications and prices are available in the Television Products Catalog.

MEDICAL MONITORS



The 414 Portable Patient Monitor is a dual-trace monitor designed to simultaneously display ECG and blood pressure or peripheral pulse. Heart rate, systolic/diastolic blood pressures, mean blood pressure, or temperature are digitally displayed for increased accuracy and convenience. Rate alarm limits are also set digitally. Because an internal battery pack permits portable operation, the 414 can be as easily used for cardiac catheterization as for surgery and recovery. All of this monitoring capability is built into a small portable package weighing only twelve pounds.

For further information on the 414 see pages 197-198.

Reference Information

USING THIS REFERENCE SECTION

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

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

REFERENCE SECTION CONTENTS

Configuration: Two Basic Approaches 10

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

Portability **12**

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

Environmental Factors **12**

Information about how to interpret environmental specifications.

Power Source Considerations **12**

Material on what kind of power sources TEKTRONIX instruments can handle.

Storage **14**

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

Key Specifications and Features For Oscilloscopes and Related Equipment 16

Factors presented are:

Rise Time and Bandwidth

Sensitivity (Deflection Factor)

Time Bases
Sweep Rates, and Sweep Types

Fast Sweep, High Frequencies, and Rise Times

Delaying/Delayed Time Bases

Multiple Inputs

Two Techniques: Dual Beam and Dual Trace
Differential, Balanced, or Push-Pull Inputs

Sampling

Cathode-Ray Tube Phosphor Data .. **18**

A section on phosphors and human eye response, and one on phosphor protection. Chart of common phosphor types and their characteristics.

CONFIGURATION

TWO BASIC APPROACHES

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

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

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

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

The flexibility and expandability provided by modular design are particularly important in general instrumentation, since they allow you to keep up with changes and advances in your field without requiring total replacement which might be required with monolithic instruments.

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

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

OUR MODULAR LINES

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

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

INTEGRATED AND MONOLITHIC DEVICES

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

Many oscilloscopes of this type are particularly designed for portable use, with rugged cases, environmental protection, and internal or external battery power.

Other TEKTRONIX one-piece instruments include TDR/Cable Testers, Portable Patient Monitors, Spectrum Analyzers, and some graphic and computation products. Each performs its specialized task economically yet fully because it is deliberately designed for a specific type of use.

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

MONOLITHIC INSTRUMENTS

NOT INCLUDING PORTABLE LISTED ON PAGE 92

OSCILLOSCOPES

Model Number	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Page	Price
T935	35 MHz	2 mV/div at BW	X	10 ns/div	X	116 f	1250
T932	35 MHz	2 mV/div at BW	X	10 ns/div		116 g	1050
T922	15 MHz	2 mV/div at BW	X	20 ns/div		116 d	850
T921	15 MHz	2 mV/div at BW		20 ns/div		116 e	695
T912	10 MHz	2 mV/div at BW	X	500 ns/div		116 c	1195
TELEQUIPMENT D61A	10 MHz	10 mV/div at BW	X	100 ns/div		119	on request
TELEQUIPMENT S51B	3 MHz	100 mV/div at BW		≈500 ns/div		120	325

OTHER TEKTRONIX INTEGRATED (ONE-PIECE) DEVICES

TEKTRONIX offers one-piece products designed to be used alone or as elements of larger systems in the following areas:

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Tv Products	199
Programmable Calculators	208
Graphic Terminals	201
Display Monitors	210

MODULAR INSTRUMENTS

MAINFRAME AND PLUG-IN OSCILLOSCOPES

Model Number	Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Maximum Sweep Rate	Sweep Delayed	Page	Price*
7904 R7903	500 MHz†	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	34	4100 3650
7844	400 MHz†	20 mV/div at BW 10 μV/div 1 mA/div	up to 4 Dual Beam	1 ns/div	X	36	6100
7704A opt 9	250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	38	2900
7704A	200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	38	2900
7603	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	40	1800
5444 New	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual Beam	5 ns/div	X	74	3300
5440	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	5 ns/div	X	75	1350
5112	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual Beam	100 ns/div	X	82	1100
5110	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	X	81	625
7603N opt 11S	Ruggedized oscilloscope system [meets or exceeds MIL-O-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	41	3450

*Price does not include plug-ins.

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

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

TM 500 MODULAR TEST AND MEASUREMENT LINE **158-163**

Over 30 plug-in instruments and 5 mainframes, including portable, rackmount, desktop, and cart-mounted configurations.

OTHER TEKTRONIX MODULAR DEVICES

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Curve Tracers	170
Spectrum Analyzers	183
Digital Processing Oscilloscopes	29
Waveform Digitizing Instruments	27

PORTABILITY

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

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

For many applications, internal battery power is often essential. On the other hand, the weight of internal batteries can be a disadvantage if they are rarely needed. In some applications power is always available, since it must be provided to the equipment being tested. TEKTRONIX portable oscilloscopes cover the full range of power options. The 200 Series has internal batteries. High performance portables, like the TEKTRONIX 400 Series, are line operated, though external battery packs are available as accessories.

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

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

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

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

ENVIRONMENTAL CHARACTERISTICS

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

The specifications for humidity, vibration, shock, and transportation are intended to be beyond what can be expected in use, and operation at these extremes may cause minor physical deterioration. Such operation, however, should not cause electrical performance to deteriorate outside specifications.

The specifications for temperature and altitude are such that continual use at the limits will not cause significant short-term deterioration. Naturally, higher temperature operation can be expected to reduce long-term reliability and should be avoided if possible. The emc test is completely nondestructive.

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

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

POWER SOURCE CONSIDERATIONS

In general, instruments are factory wired for the nominal voltage of the country of manufacture. Most Tektronix instruments provide wide-range regulated supplies, or quick change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order. 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 multi-phase system or across the legs of a single-phase three-wire system (220 V).

Except for some double-insulated instruments, most Tektronix instruments are equipped with either a three-conductor attached power cord or a three-terminal power-cord receptacle. The third wire or terminal is connected directly to the instrument chassis to protect operating personnel.

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

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

PORTABLE INSTRUMENTS

OSCILLOSCOPES

Model Number	Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Page	Price
485	350 MHz	5 mV/div at BW	X	1 ns/div	X	94	4550
475	200 MHz	2 mV/div at BW	X	1 ns/div	X	98	2900
465	100 MHz	5 mV/div at BW	X	5 ns/div	X	98	2095
455 New	50 MHz	5 mV/div at BW	X	5 ns/div	X	103	1695
335 New	35 MHz	1 mV/div 10 mV/div at BW	X	20 ns/div	X	107	1825
326	10 MHz	10 mV/div at BW 1 mV/div	X	100 ns/div		108	1825
221	5 MHz	5 mV/div at BW	X	100 ns/div		112	825
323	4 MHz	10 mV/div at BW 1 mV/div		500 ns/div		109	1200
214	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		113	1200
212	500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		113	875
213 New	1 MHz	20 mV/div at BW 5 mV/div		400 ns/div		114	1200
TELEQUIPMENT D32	10 MHz	10 mV/div at BW	X	100 ns/div		118	1050

TM 500 MODULAR TEST AND MEASUREMENT LINE **158-163**

All of the more than 30 TM 500 plug-ins are portable when used with portable TM 500 Mainframes.

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

Portable Mainframes: TM 515 5-compartment Traveller Mainframe.

TM 503 3-compartment Mainframe with carrying case or protective cover.

TM 504 4-compartment Mainframe with carrying case or protective cover.

OTHER TEKTRONIX PORTABLE DEVICES

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Spectrum Analyzers	183
TDR — Cable Testers	164
Portable Patient Monitors	197
Logic Analyzer*	121

*In TM 500 Portable Mainframe.

STORAGE

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

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

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

TYPES OF STORAGE

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

Although storage writing speeds are not quite as fast as conventional crt speeds yet, they are catching up: recent developments in transmission storage tubes at Tektronix have resulted in a fast stored writing speed of 3000 div/μs (1350 cm/μs).

BISTABLE

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

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

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

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

VARIABLE PERSISTENCE

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

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

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

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

FAST TRANSFER

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

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

DIGITAL

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

CRT STORAGE INSTRUMENTS

OSCILLOSCOPES

Model Number	Maximum Stored Writing Rate	Maximum View Time	Type of Storage	Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Delayed Sweep	Plug-in	Page	Price*
466	3000 div/μs	††15 s	Fast	100 MHz	5 mV/div at BW	up to 2	X		101	$4300
	3 div/μs	††15 s	Variable Persistence							
7633	2200 div/μs	††30 s	Fast Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	44	4200
	400 div/μs	until erased	Fast Bistable							
	3 div/μs	††30 s	Variable Persistence							
	2 div/μs	until erased	Bistable							
7623A	150 div/μs	††30 s	Fast Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	44	3500
	50 div/μs	until erased	Fast Bistable							
	0.5 div/μs	††30 s	Variable Persistence							
	0.03 div/μs	until erased	Bistable							
464	110 div/μs	††15 s	Fast	100 MHz	5 mV/div at BW	up to 2	X		102	3600
	0.5 div/μs	††15 s	Variable Persistence							
7613	5 div/μs	1 hr	Variable Persistence	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	46	2850
5441	5 div/μs	1 hr	Variable Persistence	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	76	2475
7313	5 div/μs	4 hrs	Bistable Split Screen	25 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	48	2400
434	5 div/μs	4 hrs	Bistable Split Screen	25 MHz	10 mV/div at BW 1 mV/div	up to 2			105	2850
5115	0.8 div/μs	10 hrs	Bistable Split Screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	81	1350
5113	0.2 div/μs	10 hrs	Bistable Dual-Beam Split Screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	82	1650
5111	0.02 div/μs	10 hrs	Bistable Split Screen	2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	X	X	81	1250
214	0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			113	1200
T912 New	0.4 div/μs	4 hrs	Bistable	10 MHz	1 mV/div at BW	up to 2			116C	1195
314 New	0.250 div/μs	4 hrs	Bistable	10 MHz	2 mV/div at BW	up to 2			110	1995

*Price does not include plug-ins.

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

††View times are at full stored display intensity. They may be increased by using reduced intensity in the save display mode.

OTHER TEKTRONIX STORAGE DEVICES

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Display Monitors:	210	Curve Tracer:	170
Large-Screen Monitors:	207	Graphic Terminals:	202
Basic Graphic System:	202		

KEY SPECIFICATIONS AND FEATURES

for oscilloscopes and related equipment

RISE TIME AND BANDWIDTH

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

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

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

Most oscilloscope designs make use of gradual roll-offs at the high-frequency end, so in many cases a scope will be useful far beyond its specified bandwidth. Compensation will have to be made for any measured value, however.

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

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

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

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

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

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

SENSITIVITY (DEFLECTION FACTORS)

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

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

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

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

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

TIME BASES

SWEEP RATES AND SWEEP TYPES

Except in special cases, oscilloscopes have built-in sawtooth sweep generators for producing constant-speed horizontal beam deflection. In early scopes, these generators ran continuously, and horizontal calibration was based on their repetition **frequency.** In most modern 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."

This technique permits:

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

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

A major graticule division may be an inch, centimeter, or some other length. Some instruments have different distance-units for the vertical and horizontal scales. Graticules often have small markings which subdivide the major divisions to assist in making accurate measurements. Such subdivisions should **not** be interpreted as the distance unit in a specification.

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

SWEEP SPEEDS, HIGH FREQUENCIES, AND RISE TIMES

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

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

DELAYING/DELAYED TIME BASES

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

You can make delay and interval time measurements with digital ease on several TEKTRONIX oscilloscopes. The DM40/43 option for the 400 Series allows you to read the delay time or interval right from an LED readout, with no calculation or interpolation required. The 7B85 and 7B80 plugins for 7000-Series Oscilloscopes provide dual-delayed sweep measurements. With this feature, both ends of the selected interval which can be independently positioned on the trace are shown by intensified regions. The time interval between those points is shown on the screen using the 7000-Series crt-readout capability.

MULTIPLE INPUTS

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

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

TWO TECHNIQUES: DUAL BEAM AND DUAL TRACE

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

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

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

DIFFERENTIAL, BALANCED, OR PUSH-PULL INPUTS

Differential or balanced amplifiers provide a feature beyond mere accommodation of push-pull signals: they have the ability to cancel or reject, to a high degree, any signal components equal in amplitude and phase that appear at both inputs. Such amplifiers provide a simple and accurate means of measuring the difference between two signals. They also provide a means of rejecting most unwanted signal components common to both inputs, such as power line "hum."

SAMPLING

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

The sampling method, however, provides a means 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 less than 5 mV of peak amplitude.

A variation in sampling techniques is the random sampler. The random sampler constructs a display of a repetitive waveform in a manner much like a conventinal sampling oscilloscope; however, it incorporates 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 afforded by this feature are:

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

CATHODE-RAY TUBE PHOSPHOR DATA

HUMAN EYE RESPONSE

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wavelength from deep red to violet. The human eye is most sensitive to the yellow-green region; however, its responsiveness diminishes on either side in the orange-yellow area and the blue-violet region. The eye is not very receptive to deep blue or red.

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

The term **luminance** is the photometric equivalent of brightness. It is based on measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The SI (international metric standard) units for luminance are candelas per meter squared, but the English footlamberts are still used extensively in the U.S. One footlambert = 0.2919 candelas/m^2. The term **luminance** implies that data has been measured or corrected to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de L'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful **only** when the phosphor is being **viewed.**

PHOSPHOR PROTECTION

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

The two most important and controllable factors affecting the occurrence of burning are **beam-current density** (controllable with the Intensity, Focus, and Astigmatism controls) and the length of **time** the beam excites a given section of the phosphor (controllable with the Time/Div control). Of the total energy from the beam, 90% is converted to heat and 10% to light. A phosphor must radiate the light and dissipate the heat, or like any other substance, it will burn. Remember, burning is a function of intensity and time. Keeping the intensity down or the time short will save the screen.

SELECTING A PHOSPHOR

The catalog description of each oscilloscope indicates the phosphor normally supplied or offered as an option. Special phosphors are available for applications which require different characteristics. For example, P11 is excellent for waveform photography but due to its short persistence it is not well suited for applications requiring visual observation of low-speed phenomena. For more specific information regarding the best-suited phosphor for your particular applications, please confer with your Tektronix Field Engineer, Representative, or Distributor. He or she will know the factors that must be considered in selection of a phosphor for any given application.

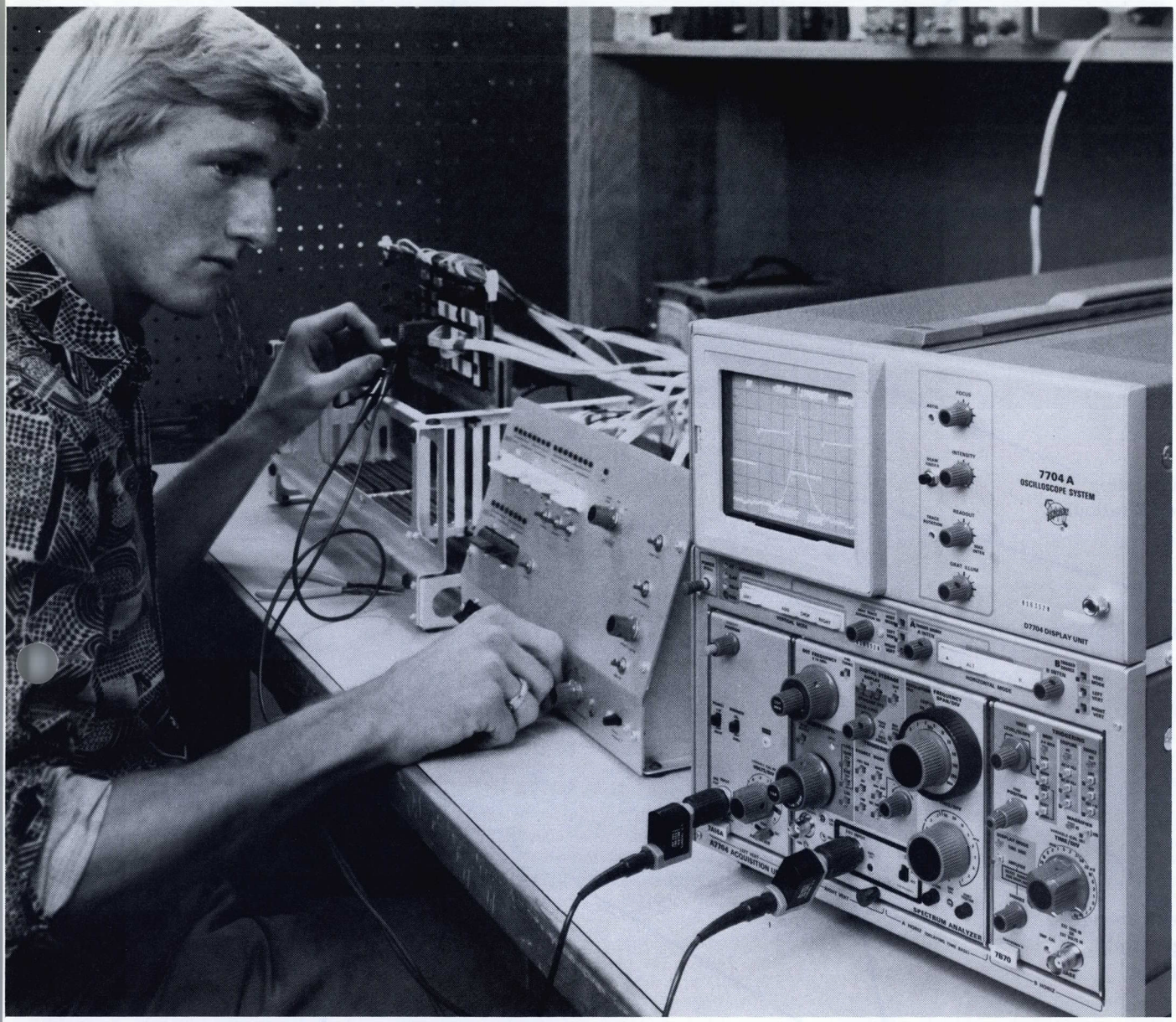
Phosphors are rated in several parameters, such as color of fluorescence or phosphorescence, decay, etc. The following table describes the more commonly used phosphors.

PHOSPHOR DATA CHART

Phosphor	Fluorescence	Phosphorescence Where Different from Fluorescence	Relative Luminance[1]	Relative Photographic Writing Speed[2]	Decay to 10%	Decay to 1%	Decay to 0.1% (in ms)	Relative Burn Resistance	Comments	Ordering Information Option
P1	Yellowish-green	—	50%	20%	24 ms	48 ms	95	Medium	Replaced by P31 in most applications	Special order
P2	Bluish-green	Yellowish-green	55%	40%	75 μs	—	120[3]	Medium high	Good compromise for high- and low-speed applications	Special order
P4	White	—	50%	40%	60 μs	470 μs	20	Medium high	Television displays	74
P7	Blue	Yellowish-green	35%	75%	0.3 s	3 s	1500[3]	Medium	Long decay, double-layer screen	76
P11	Purplish-blue	—	15%	100%	80 μs	—	20	Medium	For photographic applications	78
P31	Yellowish-green	—	100%	50%	38 μs	250 μs	32	High	General 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.

7000-Series Instruments



Pick a Plug-in Scope for

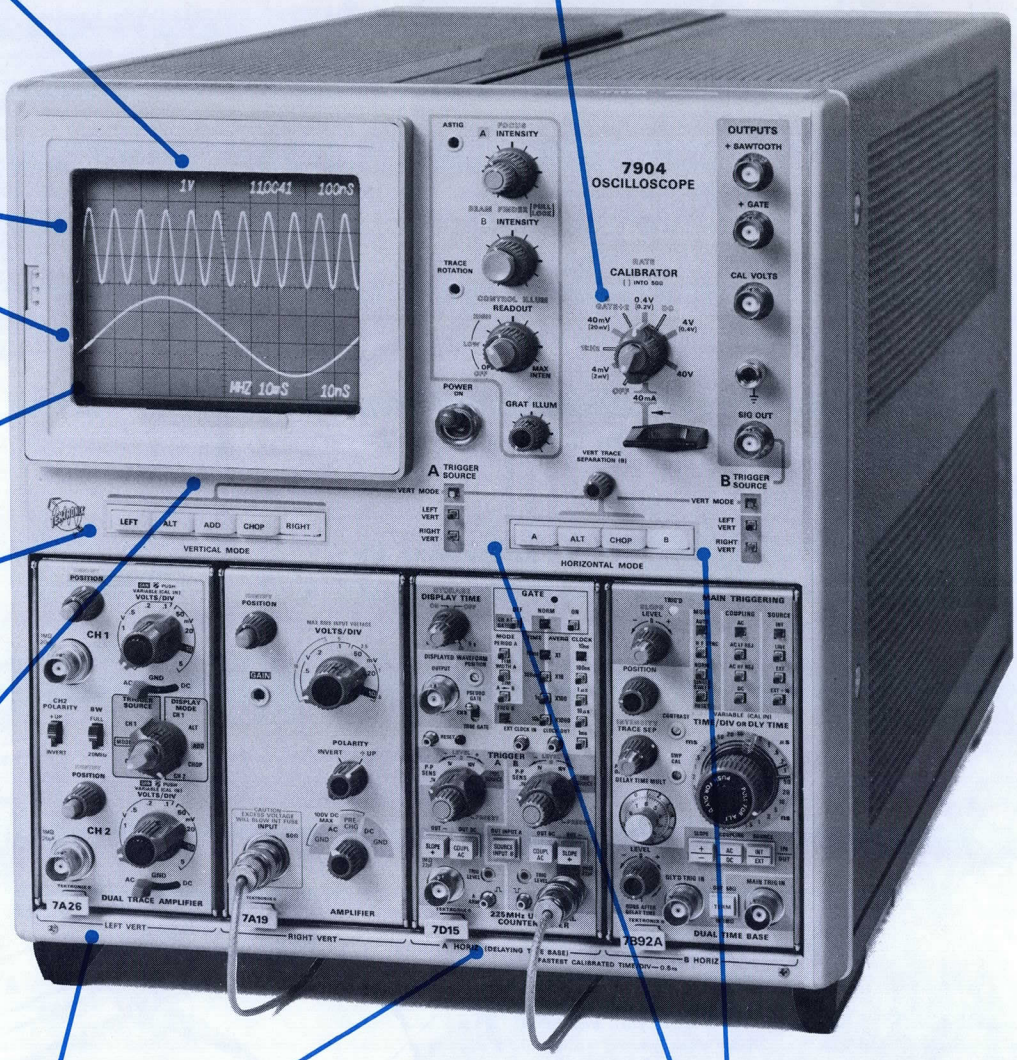
Superior Performance. The 7000 Series of plug-in laboratory instruments embodies more state-of-the-art performance features than any other oscilloscope-based measurement system.

Flexibility. The 7000 Series offers a choice in measurement parameters, ranges, and techniques which allow you to tailor the optimum system for your specific needs.

Expandability. The 7000 Series is a growing family of mainframes and plug-ins which continues to develop new capabilities and techniques, thereby reducing the likelihood that your instruments will become obsolete.

The 7000 Series...more than an oscilloscope.

7000 Series...more than an oscilloscope



Crt Readout

Calibration Standard

Bright Traces

Large No Parallax Illuminated Graticules

Easy Display Selection

Convenient Camera Mountings And Connections

Plug-In Flexibility

Pick The Trigger Source

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

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

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

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

Crt Readout

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

Bright Traces

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

Large Illuminated Graticules Eliminate Parallax

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

Convenient Camera Mountings and Connections

A standard bezel connector matches most TEKTRONIX oscilloscope cameras to 7000 Series mainframes.

Independent Intensity Controls

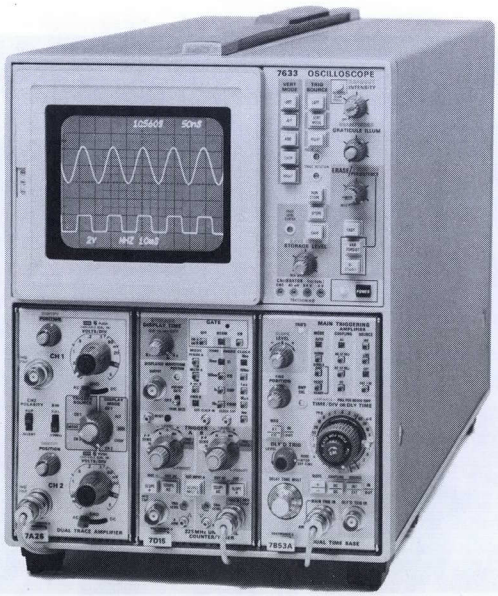
Separate intensity controls allow for independent adjustment of A sweep, B sweep, and character readout brightness. The intensity of each sweep may be adjusted to a level that suits your application.

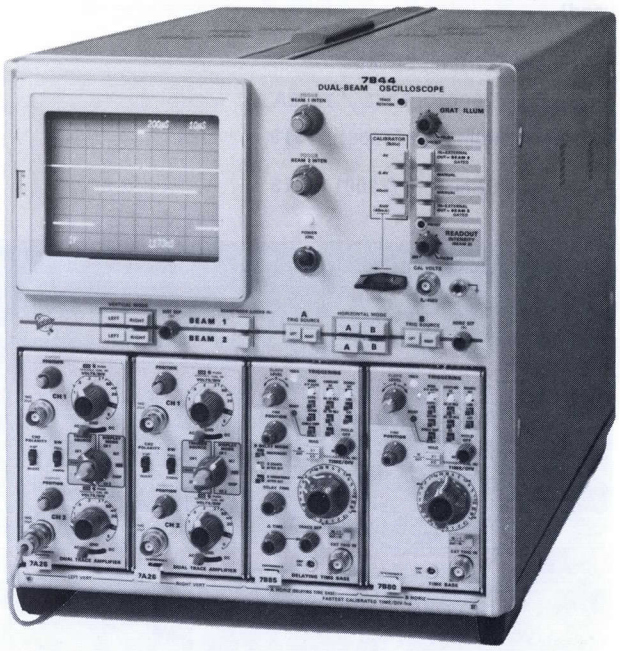
Auto-focus

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

Adjustable Graticule Illumination

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





Plug-Ins

Flexible Measurement Systems

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

Analog/Digital Synergism

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

Mainframes

Calibration Standard

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

Trigger Source Flexibility

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

Easy Display Selection

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

Mainframe Flexibility

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

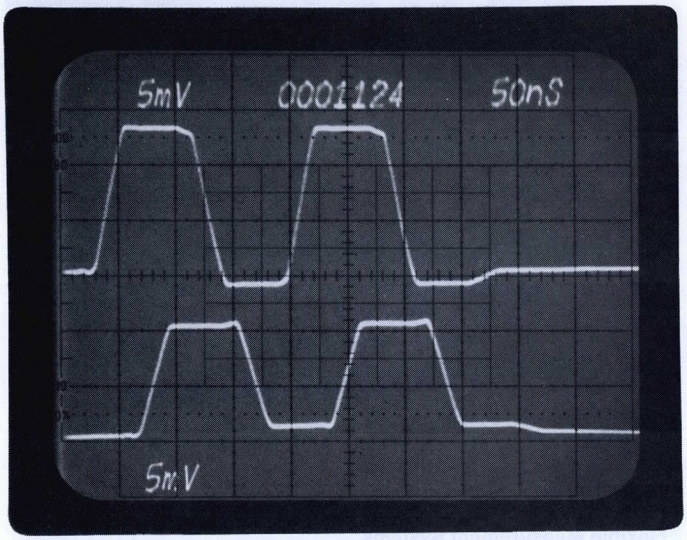
STORAGE

Readout Stored With The Waveform, (dual-trace vertical amplifier used)

Fast Stored Writing Speeds

Multimode (7600) 7633 / 7623A

Variable Persistence (7600) 7613
Or
Split Screen Bistable (7300) 7313

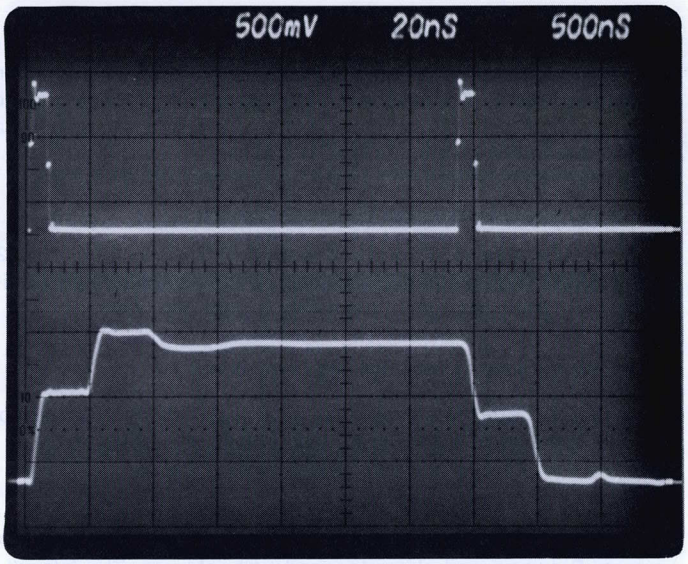


DUAL BEAM

400 MHz Bandwidth

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

Full overlap on 8 x 10 cm Display



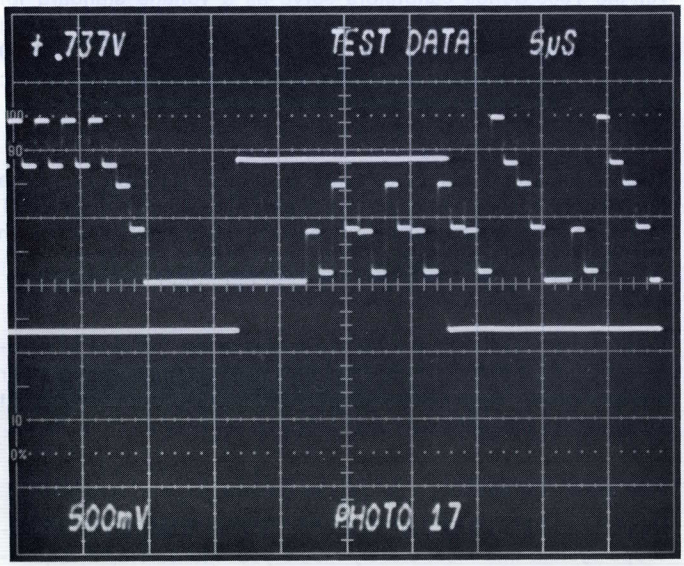
DIGITAL

Sample And Hold DVM Measures Difference Voltage Between Two Points On Complex Waveform, (gate waveform indicates two points—leading and trailing edges—where voltage difference is made— +.737V)

Readout Unit Identifies This Waveform As TEST DATA-PHOTO 17

Counter/timer Measurement With Analog Display

Compare Digital Measurement With Analog Display



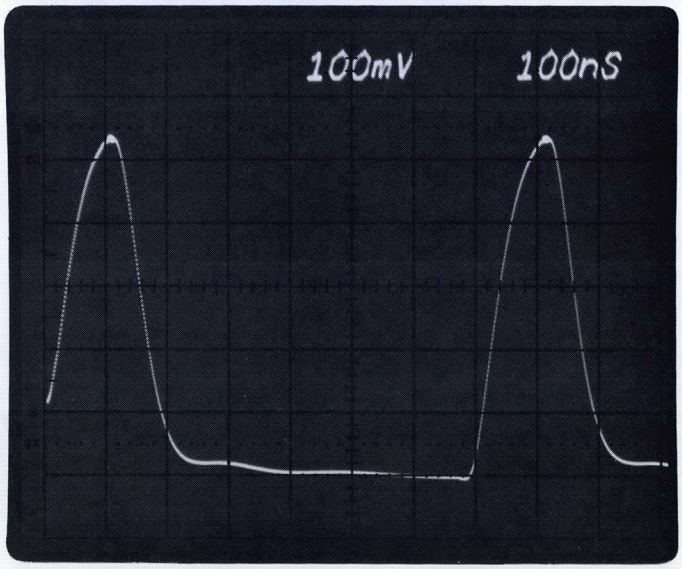
SAMPLING

Two-Dot Time Measurement

Calibrated Delayed Sweep

Simultaneous Sampling & Conventional Displays

Operational Ease Of A Conventional Oscilloscope



7000 Series Storage Oscilloscopes

Storage, as it applies to most instruments in the TEKTRONIX 7000 Series, involves techniques for capturing and retaining signals within the cathode-ray tube itself. (Systems for digitally reconstructing signals, sometimes included under the broad umbrella of storage, are discussed on pages 43 through 48.)

Why store?

While capturing an event for detailed analysis is perhaps the most obvious application for a storage crt, numerous other situations call for the unique advantages of storage. Some examples of potential benefit include observing changes in a signal, both unintentional and intentional—such as adjusting a circuit; comparing two or more signals—such as an unknown against a standard; observing the entire display of a slowly occurring signal; increasing the brightness of a repetitive signal so that you can view, in normal ambient light, a signal that would otherwise be too dim to view; reducing the brightness of random noise on a repetitive signal; babysitting, that is unattended monitoring while waiting to capture a transient; enhancing other recording techniques such as photography; and reducing the flicker annoyance on low repetition rate signals.

Storage features

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

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

Characteristics of individual 7000 Series mainframes employing storage techniques are listed on pages 19 through 22. A review, though, of storage concepts should prepare the reader to evaluate the various alternatives more knowledgeably.

Bistable

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

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

Bright Bistable

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

Variable Persistence

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

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

Fast Multimode

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

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

As the name implies, fast provides increased storage writing speed. For example, in the reduced scan display mode, the variable persistence writing speed of 2.7 cm/μs is increased to 1000 cm/μs by selecting fast variable persistence. The 1000 cm/μs writing speed is fast enough to capture a single event equivalent to the 7633's 100-MHz bandwidth or a 3.5-ns rise time.

400 MHz Dual Beam

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

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

Digitals

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

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

Sampling

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

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

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A15A	7A16A	7A17	7A18	7A19	7A21N	7A22	7A24	7A26
PAGE			50	52	50	50	51	53	51	51	52	53	53
PERFORMANCE FEATURE			Low-Capacitance FET Probe Amplifier	Differential Dc Offset, High-Freq Cmrr Amplifier	Low-Cost Conventional Input Amplifier	Wide-Bandwidth Conventional Input Amplifier	Low Cost Easy to Customize Amplifier	Dual-Channel Amplifier	Wide-Bandwidth 50-Ω Input Amplifier	Direct Crt Access	Dc-Coupled, High-Gain Differential Amplifier	Dual-Channel 50-Ω Amplifier	Dual-Channel Amplifier
MIN DEFL FACTOR			5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)[2]	5 mV/div	50 mV/div	5 mV/div	10 mV/div	<4 V/div	10μV/div	5 mV/div	5 mV/div
ACCURACY[1] WITHOUT PROBE			2% (integral)	1.5%	2%	2%	——	2%	3%	——	2%	2%	2%
7900 FAMILY (0°C to 30°C)	7904 R7903 R7912[6]	BW	250 MHz	105 MHz P6053B 65 MHz P6055	80 MHz	225 MHz	150 MHz	75 MHz	500 MHz	1 GHz	1 MHz ±10%	350 MHz	200 MHz
		Tr	1.4 ns	3.4 ns P6053B 5.4 ns P6055	4.4 ns	1.6 ns	2.4 ns	4.7 ns	0.8 ns	350 ps	350 ns ±9%	1.0 ns	1.8 ns
		SIG OUT BW	140 MHz	100 MHz P6053B 65 MHz P6055	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	——	1 MHz ±10%	140 MHz	140 MHz
7800 FAMILY (0°C to 35°C)	7844/R	BW	200 MHz	95 MHz P6053B 65 MHz P6055	80 MHz	175 MHz	150 MHz	75 MHz	400 MHz[3]	1 GHz	1 MHz ±10%	300 MHz	160 MHz
		Tr	1.8 ns	3.7 ns P6053B 5.4 ns P6055	4.4 ns	2.0 ns	2.4 ns	4.7 ns	0.9 ns	350 ps	350 ns ±9%	1.2 ns	2.2 ns
7700 FAMILY	7704A Opt 9 (0°C to 30°C)	BW	170 MHz	100 MHz P6053B 65 MHz P6055	75 MHz	170 MHz	150 MHz	75 MHz	250 MHz[4]	——	1 MHz ±10%	200 MHz	170 MHz
		Tr	2.1 ns	3.5 ns P6053B 5.4 ns P6055	4.7 ns	2.1 ns	2.4 ns	4.7 ns	1.5 ns	——	350 ns ±9%	1.8 ns	2.1 ns
		SIG OUT BW	70 MHz	60 MHz P6053B 50 MHz P6055	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	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	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	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	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	——	1 MHz ±10%	160 MHz	140 MHz
		Tr	2.4 ns	3.5 ns P6053B 5.4 ns P6055	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	——	350 ns ±9%	2.2 ns	2.5 ns
		SIG OUT BW	60 MHz	55 MHz P6053B 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	——	1 MHz ±10%	60 MHz	60 MHz
7600 FAMILY and STORAGE FAMILY	7603/R 7633/R 7623A/R 7613/R 7603N Opt 11[5]	BW	100 MHz	75 MHz P6065A 55 MHz P6055	65 MHz	100 MHz	100 MHz	75 MHz	100 MHz	——	1 MHz ±10%	100 MHz	100 MHz
		Tr	3.5 ns	5.0 ns P6065A 6.4 ns P6055	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.5 ns	——	350 ns ±9%	3.5 ns	3.5 ns
		SIG OUT BW	60 MHz	55 MHz P6065A 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	——	1 MHz ±10%	60 MHz	60 MHz
	7313 R7313	BW	25 MHz	25 MHz P6062A 24 MHz P6055	25 MHz	25 MHz	25 MHz	25 MHz	25 MHz	——	1 MHz ±10%	25 MHz	25 MHz
		Tr	14 ns	14 ns P6062A 15 ns P6055	14 ns	14 ns	14 ns	14 ns	14 ns	——	350 ns ±9%	14 ns	14 ns
		SIG OUT BW	60 MHz	55 MHz P6062A 45 MHz P6055	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	——	1 MHz ±10%	60 MHz	60 MHz

System Environmental Specifications—(apply to all instruments except where noted). Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. 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]Bandwidth is 325 MHz to 10 mV/div.

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

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

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

RECOMMENDED COMBINATIONS 7000-SERIES MAINFRAMES AND TIME BASES

MAINFRAME		7904 R7903	7844/R	7704A R7704	7603/R	7603N Opt. 11	7633/R 7623A/R	7613/R	7313/R
Time Base	PERFORMANCE FEATURE	● INDICATES RECOMMENDED COMBINATION							
7B50A	Single time base				●		●	●	●
7B53A	Dual time base with mixed sweep			●	●	●*	●	●	●
7B53A Opt 5	7B53A with TV sync triggering			●	●		●	●	●
7B80	Single time base (used also as delayed time base)	●	●	●					
7B85	Single time base with delaying and Δ delay sweep function	●	●	●					
7B92A	Dual time base with display switching	●	●	●					

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

7000-SERIES
OSCILLOSCOPE SYSTEMS/PROBE SELECTION CART*

		PASSIVE VOLTAGE 1-MΩ INPUT COMPATIBLE							PASS VOLTAGE 50-Ω INPUT COMP		FET PROBES 50 Ω/1 MΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE		**P6101 1 Meter**	**P6063A P6053B 3.5'**	**P6055 3.5'**	**P6009 9'**	**P6015 10'**	**P6062A 6'**	**P6105 P6108 2 Meter**	**P6056 6'**	**P6057 6'**	**P6202 2 Meter**	**P6046 6'**	**P6201 6'**	**w/passive term P6021 5' 10 mV/mA**	**w/passive term P6022 5' 10 mV/mA**	**P6042 6'**
FEATURES		**Minature Probe**	**Fastest Probes Compatible with 1-MΩ Input**	**Adj Attenuation for Differential Use**	**1.5 kV Compatibility**	**40 kV Pk Pulse Compatibility**	**Selectable Attenuation**	**Miniature Probe**	**Fastest 10X Passive Probe Low C**	**Fastest 100X Passive Probe Low C**	**10-MΩ Input Impedance Dc, Offset**	**Differential Probe High cmrr**	**Low Capacitive Loading Ac Coupling Dc Offset**	**Ac High Current**	**Ac High Frequency**	**Dc High Current**
ATTENUATION		**1X**	**10X**	**10X**	**100X**	**1000X**	**Selectable**	**10X**	**10X**	**100X**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**	**Selectable**
7900 FAMILY	**7A11***	NC	NC	NC	NC	NC		NC						55 MHz	150 MHz	45 MHz
	7A13	34 MHz	105 MHz	65 MHz	85 MHz	65 MHz		75 MHz		105 MHz	105 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		80 MHz	80 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	200 MHz		130 MHz	80 MHz				205 MHz	205 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz		75 MHz	75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	500 MHz	480 MHz	300 MHz	95 MHz	430 MHz	NC	NC	50 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	NC	NC		NC	NC	NC	NC	350 MHz	350 MHz	290 MHz	90 MHz	310 MHz	NC	NC	45 MHz
	7A26	34 MHz	175 MHz		125 MHz	75 MHz					185 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
7800 FAMILY	**7A11**	NC	NC	NC	NC	NC	NC	NC						55 MHz	130 MHz	45 MHz
	7A13	34 MHz	95 MHz	65 MHz	85 MHz	60 MHz		100 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	45 MHz
	7A15A	34 MHz	75 MHz		70 MHz	55 MHz	75 MHz	75 MHz			80 MHz	60 MHz	80 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	160 MHz		110 MHz	75 MHz		100 MHz			170 MHz	85 MHz	165 MHz	55 MHz	130 MHz	45 MHz
	7A18	34 MHz	85 MHz		80 MHz	60 MHz	85 MHz	85 MHz			75 MHz	65 MHz	90 MHz	45 MHz	70 MHz	40 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	400 MHz	400 MHz	320 MHz	95 MHz	360 MHz	NC	NC	50 MHz
	7A22	1 MHz	NC	1 MHz	1 MHz	1 MHz	1 MHz	NC						1 MHz	1 MHz	1 MHz
	7A24	NC	NC	NC	NC	NC	NC	NC	300 MHz	300 MHz	270 MHz	90 MHz	280 MHz	NC	NC	45 MHz
	7A26	34 MHz	145 MHz		105 MHz	75 MHz		100 MHz			150 MHz	85 MHz	155 MHz	55 MHz	125 MHz	45 MHz
7704A	**7A11**	NC	NC	NC	NC	NC	NC	NC						55 MHz	125 MHz	45 MHz
	7A13	34 MHz	100 MHz	65 MHz	85 MHz	65 MHz		70 MHz			100 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A15A	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
	7A16A	34 MHz	145 MHz		115 MHz	75 MHz		100 MHz			160 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A18	34 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			75 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19**	NC	NC	NC	NC	NC	NC	NC	250 MHz	250 MHz	220 MHz	85 MHz	215 MHz	NC	NC	45 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A24	NC	NC		NC	NC	NC	NC	200 MHz	200 MHz	185 MHz	80 MHz	180 MHz	NC	NC	45 MHz
	7A26	34 MHz	140 MHz		105 MHz	75 MHz		100 MHz			160 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
7600 FAMILY	**7A11**	NC	NC	NC	NC	NC	NC	NC						50 MHz	85 MHz	40 MHz
	7A13	34 MHz	75 MHz	55 MHz	60 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A15A	34 MHz	60 MHz		55 MHz	50 MHz	60 MHz	60 MHz			65 MHz	50 MHz		40 MHz	60 MHz	35 MHz
	7A16A	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18	34 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			75 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz							1 MHz	1 MHz	1 MHz
	7A26	34 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			100 MHz	70 MHz		50 MHz	85 MHz	40 MHz
7313	**7A11**	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	NC	NC	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A13A	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	NC	NC	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A15A	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	NC	NC	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A18	20 MHz	25 MHz	23 MHz	25 MHz	24 MHz	25 MHz	25 MHz	NC	NC	25 MHz	25 MHz	25 MHz	24 MHz	22 MHz	22 MHz
	7A22	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	NC	NC	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz	1 MHz

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

**** = Option 9 Mainframe**

NC = Not Compatible

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

DIMENSIONS AND WEIGHTS 7000-SERIES MAINFRAMES AND PLUG-INS

Dimensions		**7904**	**R7903**	**7844**	**R7844**	**7704A**	**R7704**	**7603**	**R7603**	**7603N OPT. 11S**	**7603N OPT. 11**	**7633, 7623A, 7613, 7313**	**R7633, R7623A, R7613, R7313**	**PLUG-INS SINGLE**	**PLUG-INS DOUBLE**
Height	in	13.5	5.3	12.9	7.0	13.6	7.0	11.4	5.25	11.5	11.5	12.0	5.25	5.0	5.0
	cm	34.2	13.5	32.8	17.8	34.5	17.8	28.9	13.3	29.2	29.2	30.5	13.3	12.7	12.7
Width	in	12.0	19.0	12.0	19.0	12.0	19.0	8.7	19.0	9.7	9.7	8.7	19.0	2.8	5.5
	cm	30.5	48.3	30.5	48.3	30.6	48.2	22.1	48.2	24.6	24.6	21.1	48.2	7.1	14.0
Length	in	23.3	22.8	23.8	24.8	22.7	22.4	24.0	24.7	25.2	23.5	23.5	22.3	14.5	14.5
	cm	59.0	57.9	60.5	62.9	57.7	56.9	60.9	62.9	64.0	59.7	60.0	56.5	36.9	36.9
Weights (approx)															
Net	lb	32	27	36	33	30	44	30	30	45	36	30	32	2	9
	kg	14.5	12.3	16.3	15.0	13.6	20.0	13.6	13.6	21.0	16.3	13.6	14.5	0.9	4.1
Shipping	lb	44	52	47	63	43	77	46	62	72	42	42	62	5	12
	kg	20	23.5	21.2	28.6	19.5	34.9	20.9	28.1	32.6	19.1	19.1	28.1	2.3	5.4

SUMMARIZED CAMERA CHARACTERISTICS

CAMERA	RECOMMENDED FOR	PERFORMANCE FEATURES AND BENEFITS	LENS				SHUTTER	FILM BACKS		PRICE with back ordinarily used
			MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3½ x 4½-in Polaroid Film except where noted		ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	
C-27	All except 7603	Selectable orientation of off-axis binocular viewing. Movable film backs. Four changeable lenses.	f/1.9 (standard lens)	0.85	1.0	10 x 10 cm/ 3.93 x 3.93 in (with Polaroid 4 x 5-in film)	MECHANICAL (Standard)	Polaroid Pack	Polaroid Roll Film and 4 x 5-in Graflok	$ 690
C-51	All except 7603, 7603N Opt 11S	Fastest writing speed with 0.5 mag lens.	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 in	ELECTRIC	Polaroid Roll	Polaroid Pack and 4 x 5-in Graflok	1300
C-52	7633, 7623A, 7613	Full-size image with medium writing speed.	f/1.4	1.0	1.4	8 x 10 cm/ 3.15 x 3.93 in (with Polaroid 4 x 5-in film)		4 x 5-in Graflok	Polaroid Pack and Roll Film	1265
C-53	7904, R7903, 7844, 7704A 7603N Opt 11S	General-purpose with 0.85 mag lens.	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 in		Polaroid Pack	Polaroid Roll and 4 x 5-in Graflok	1000
C-58	7633, 7623A, 7613	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 in (with Polaroid 4 x 5-in film)	MECHANICAL	4 x 5-in Graflok	Polaroid Pack and Roll Film	730
C-59	7603	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 in		Polaroid Pack	Polaroid Roll and 4 x 5-in Graflok	615
C-5A	All	Low cost	f/16	0.67 or 0.85 selectable	0.02	9.76 x 12.2 cm		Polaroid Pack	None	235

*Relative light gathering power.

Recommended Cameras and Adapter

OSCILLOSCOPE	RECOMMENDED CAMERA
7904, R7903, 7844, 7704A	C-53, C-51, or C-27
7633, 7623A, 7613	C-52, C-58, C-51, or C-27
7603	C-59
7603N Opt 11S	C-53 or C-27

C-50 Series Camera Adapter, Part Number 016-0249-03, included with camera

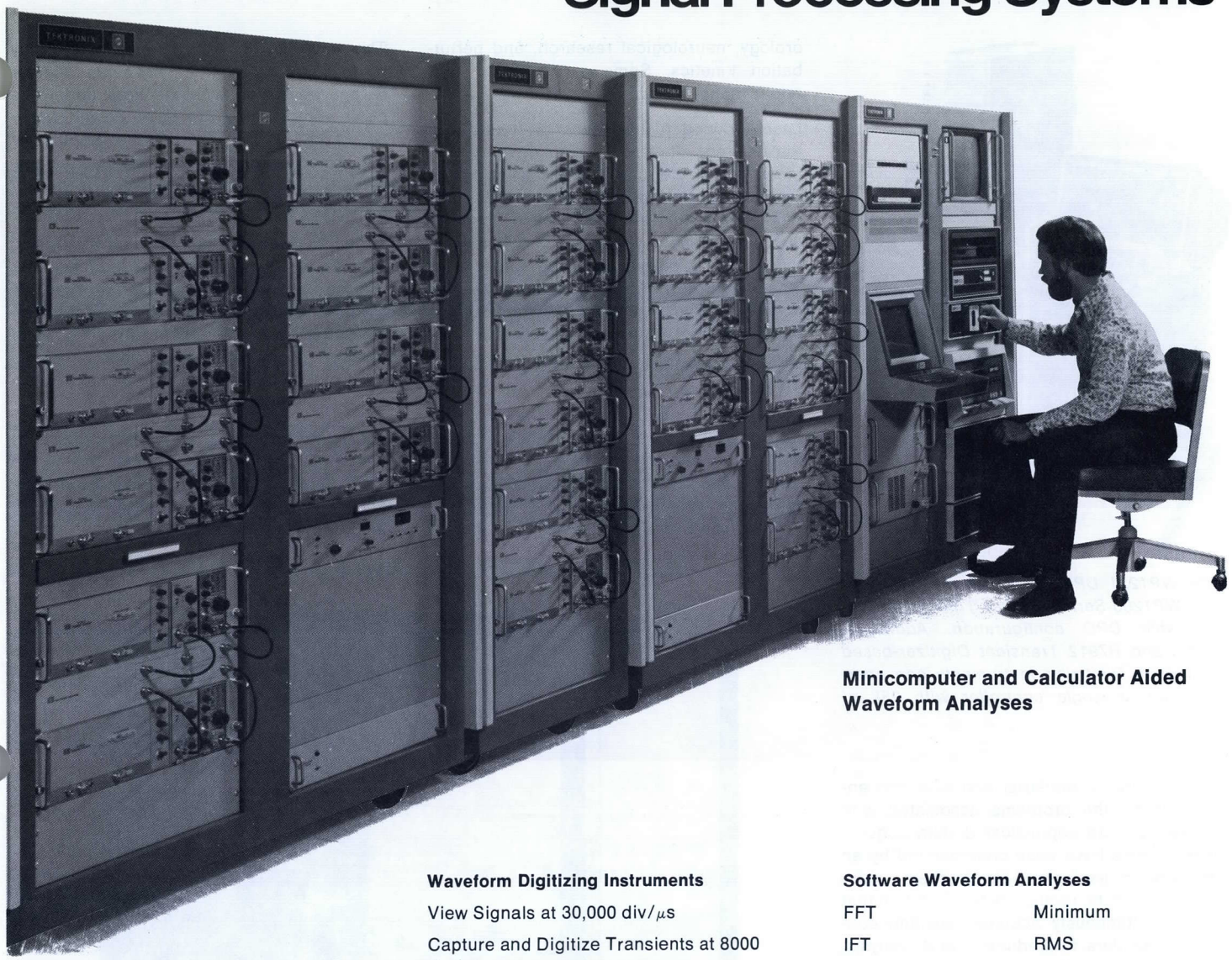
C-27 Camera Adapter, Part Number 016-0249-03

TEK Lab Cart Model 3

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

See Scope-Mobile section for complete information.

Signal Processing Systems



Minicomputer and Calculator Aided Waveform Analyses

Waveform Digitizing Instruments

View Signals at 30,000 div/μs

Capture and Digitize Transients at 8000 div/μs

As many as 32 Acquisition Channels in One Configuration

Single-Shot Sampling Rates to 100 GHz

Digital Processing Oscilloscopes

Digitize, Store, and Process any Displayed Repetitive Waveform

Compare Stored Waveforms with Real-Time Waveforms

Acquisition Plug-ins with Diverse Capabilities

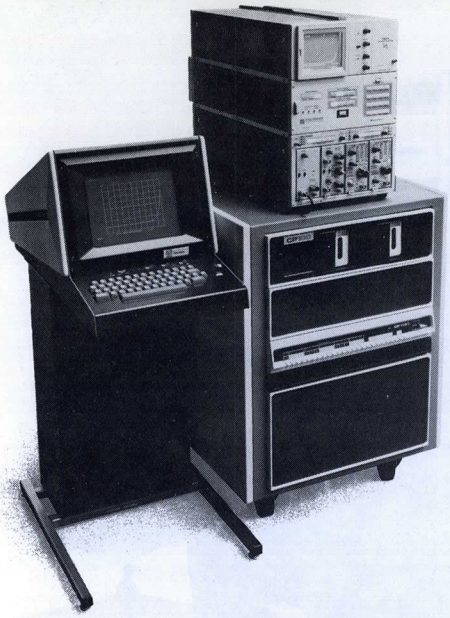
Signal Averaging from dc-14GHz

Software Waveform Analyses

FFT	Minimum
IFT	RMS
Convolution	Cross
Correlation	Addition
Differentiation	Subtraction
Integration	Multiplication
Maximum	Division

Plug-Ins Available

Amplifiers	Counters
Time Bases	Multimeters
Spectrum Analyzers	Samplers



The WP1221 DPO shown above is one of the WP1200-Series DPOs. This is an expandable DPO configuration. Additional DPOs and R7912 Transient Digitizer-based Waveform Digitizing Instruments can operate from a single controller with 28k of memory.

In a variety of industrial and research environments, the problems associated with providing more sophisticated data acquisition systems have been compounded by an information explosion. Researchers, inundated with data, require instrumentation that can simultaneously acquire data and convert these data for reduction and analysis.

The Tektronix Signal Processing Systems (SPS) group provides complete solutions to many of these measurement and analysis problems. Integrated SPS systems offer performance unattainable by individual products. A review of SPS product nomenclature reflects the growth in experience and market leadership that has resulted from years of experience. Today, SPS is used to describe Digital Processing Oscilloscope (DPO) systems, Waveform Digitizing Instrument (WDI) systems, and combined DPO/WDI systems.

SPS hardware is designed to the limits of technology. The software, TEK BASIC, leads the industry in waveform processing capability. The commitment to technological progress in automated measurements represented by this hardware and software has resulted in systems that provide the maximum possible long term value to systems users.

These systems are installed in applications as diverse as aerospace, component testing, computers, foundries, laser research, meterology, neurological research, and perturbation kinetics. Some examples of SPS applications include:

Laser-induced fusion research, to achieve the desired, efficient burning of thermonuclear fuel. To do this, it is necessary to develop lasers that generate extreme amounts of energy in pulses lasting a nanosecond or less. In addition, researchers believe that these lasers pulses must be shaped, or "manufactured," to deliver the maximum power (at exactly the right instant) to the deuterium and tritium fuel pellets.

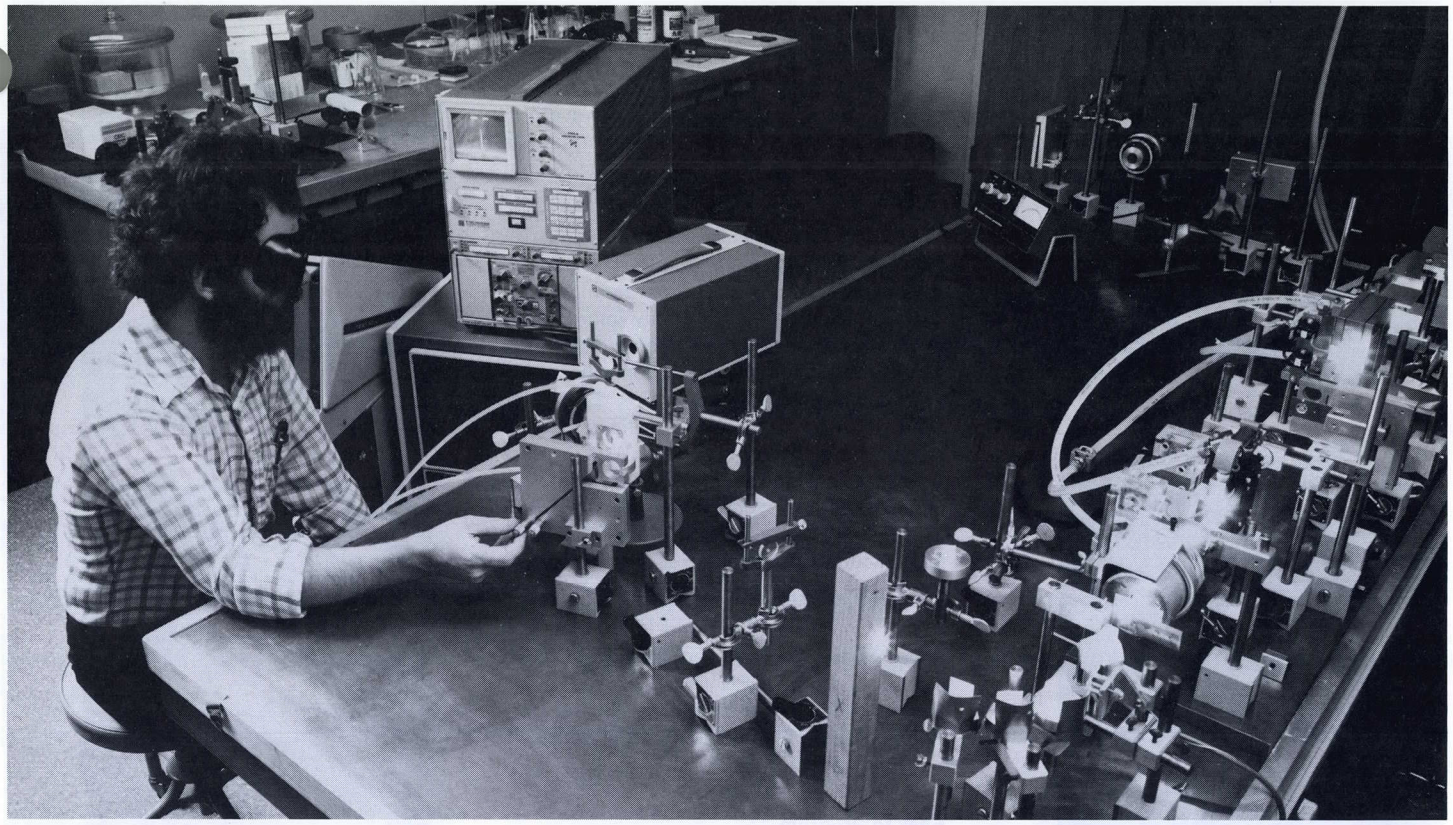
Several parameters in a typical laser fusion experiment may be monitored with SPS instrumentation. For example, the oscillator pulse purity may be checked by using either fiber optics and a photo diode, or a pellicle at the output of the laser to obtain pulse information for analysis. Similar techniques may be used to check the purity of pulses at several stages.

The power levels of these laser pulses may be measured by integrating each detector output waveform, with the area under the curve representing the pulse power. Other detectors that provide suitable outputs for the SPS configurations include Faraday cups, cylindrical analyzers, and secondary electron multipliers.

Dynamic laser trimming of active circuits, or devices, by applying power from the laser to do a cutting sequence that will bring the circuit closer to a specified performance level. SPS instrumentation may be used to monitor the circuit single-shot response characteristics and thus avoid circuit thermal effects.

Laser Interferometry, a technique that uses the Doppler shift effect of laser beams (an example is to examine an explosion front and detect its motion as well as the size of material within the shock front).

The WP2000-Series WDI analysis configurations are designed to acquire waveforms of transient phenomena and immediately perform full analyses. Other WDI analysis configurations include from 1 to 32 R7912 acquisition units, a controller (for waveform processing), a graphics terminal, a TV video or other monitor, a magnetic tape cassette, a disk or paper tape, and WDI TEK BASIC software.



Raman Scattering, a technique that looks at shifts in frequencies scattered or returned from a laser pulse hitting a gas cloud or target, and re-radiating at a frequency other than the frequency going into the sample.

Materials testing in industry, where lasers are used as a means for strengthening materials (shock hardening steel, aluminum, and titanium alloys by focusing a high-energy laser beam onto the surface of the metal) and for welding by using a high-energy laser beam instead of a flame. Here, SPS instrumentation may be used to monitor the lasers (the amount of energy used) and the materials (the effect of that energy on the material).

Time of flight (TOF) mass spectrometry, a method of materials analysis whereby atoms may be separated and identified, the SPS WDI configurations fit an instrumentation gap. In TOF mass spectrometry, materials are heated to cause emission of ions. These ions are accelerated, focused into an ion beam, and detected in a TOF tube. The mass-to-charge ratio (m/e) of each ion type determines its velocity in the TOF tube. Ion species identification is accomplished as a function of time, since each species in the sample travels at a different velocity and arrives at the detector at a different time. With the time data, the m/e may be calculated and each species identified.

Electro magnetic pulses, EMP and the associated rapidly changing electromagnetic fields can interfere with or damage a variety of electronic circuits. These EMP signals can be large amplitude pulses, with high frequency oscillations.

Sources of EMP can include lightning arc discharges. Because EMP can damage circuits, vulnerability studies, often requiring a transfer function analysis, must be made, and protection techniques must be developed. The SPS capabilities offer some solutions to the problems encountered in studying the transient nature and high-frequency components of EMP.

The list of SPS applications is growing, and includes:

Perturbation Kinetics — Stopped flow, T-jump, fluorescence decay.

Computers — Power supply design, bus transient analysis, propagation delay studies.

Communications — Transfer function analysis.

Electronic Warfare — ECM, radar signature analysis.

Component Testing — IC parameters, pc boards, filters.

Ordnance — Shock and acoustic testing.

Power Supply Design — Switching transient analysis.

Power Lines — Transient monitoring and analysis.

Security Systems — Transfer function analyses, ciphonics.

Navigational Systems—Pulse code modulation (pcm), timing information.

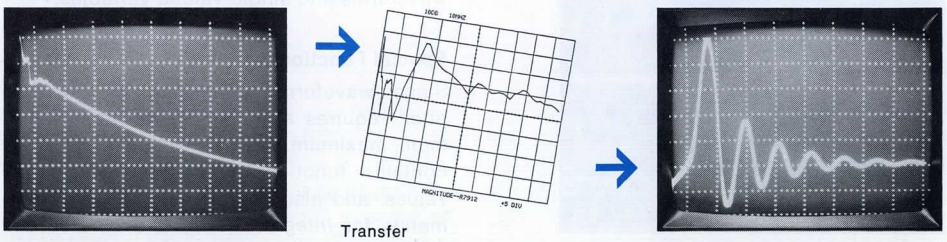
Nuclear Magnetic Resonance — Observing flip resonance.

Meteorology — Cloud pollution content studies using radar and pulsed lasers.

Optics — Determining laser-related optical characteristics.

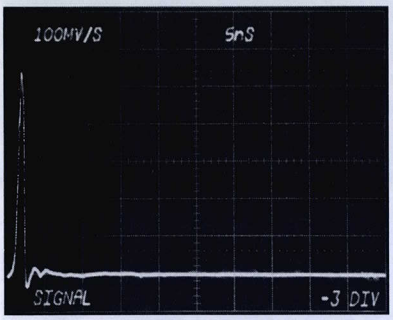
For complete SPS product and application information, use the catalog reply card to send for the DPO and WDI brochures, or contact the nearest Tektronix Field Office.

Transfer Function Analyses

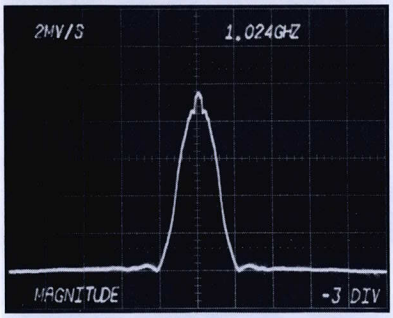


Input — Transfer Function Magnitude — Output

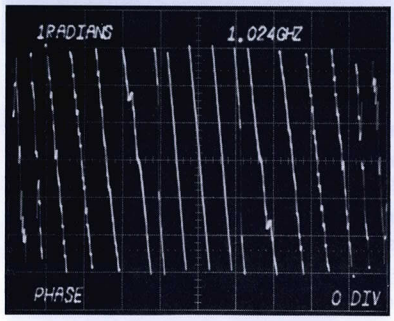
FAST FOURIER TRANSFORMS



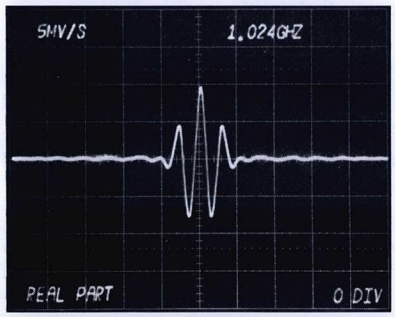
From time-domain data,



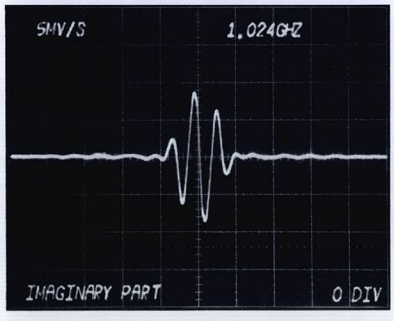
the DPO gives you magnitude vs frequency,



phase vs frequency,



real, and



imaginary vectorial values.

Programming, The TEK BASIC Approach

Because detailed signal analyses involve more than simply estimating a few waveform parameters, software is as important as hardware when considering a measurement system.

SPS waveform analysis configurations use TEK BASIC software, which is an extended version of the BASIC programming language. It is written in assembly (marco) language for maximum speed of program execution and minimum use of controller memory. Tektronix developed TEK BASIC *to facilitate array data manipulations associated with waveform processing.* With it, users can perform analyses of acquired waveforms that are either beyond the scope of BASIC, or are not attainable with standard BASIC programming statements.

Versions of TEK BASIC have been optimized for various DPO and WDI configurations. These are referred to as DPO TEK BASIC and WDI TEK BASIC, respectively. However, the comments here will be generalized to encompass features of both software packages.

Easy to Program

TEK BASIC is *interactive.* Programming via the graphics terminal enables users, even those without formal computer programming experience, to quickly develop measurement and analysis routines. To assist operators, system commands are provided to edit, store, and retrieve programs easily. In addition, *TEK BASIC responds with an error message on the terminal when statements are entered incorrectly.*

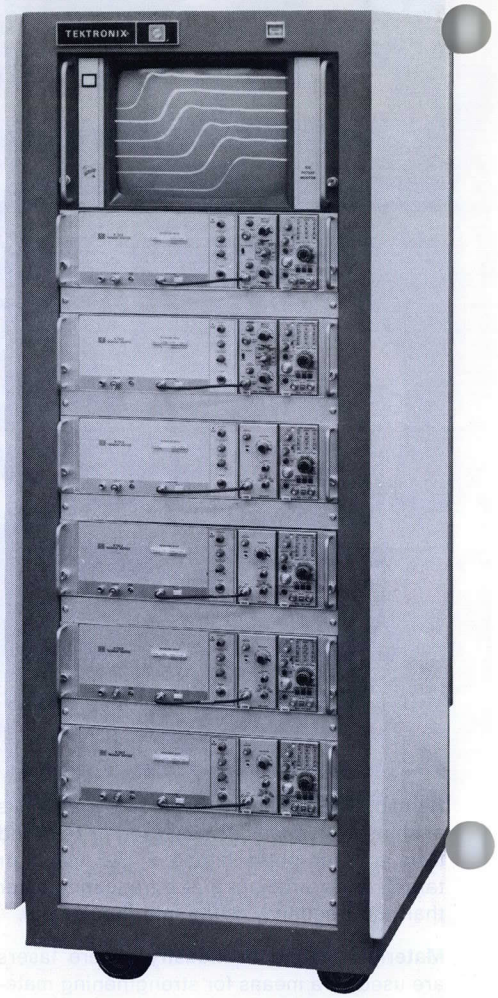
Powerful Through Expanded Capability

Many of the standard BASIC operators, functions, and commands have been retained. With the operators, you can add, subtract, multiply, divide, and exponentiate. Mathematical functions include: square root, power of e, natural log, absolute value, truncate, random number, sign (+ or —), sine, cosine, and arctangent.

These operators and functions have been extended to *process entire waveforms (512-point arrays) as though they were single-valued variables.* This means that you can write algebraic expressions involving both waveforms and single-valued variables.

Special Functions

Since waveform processing for analysis often requires a knowledge of mean, minimum, maximum, and rms values, TEK BASIC contains functions for determining those values, and also contains single-word commands for *integrate (INT)* and *differentiate (DIF).* These functions save a great deal of programming time. There is also a special function, *cross (CRS),* that can be used for determining the point at which array values cross a specified level.



The WP2052 CAMAC Compatible WDI configuration is one of a series of SPS products designed for labs that use the CAMAC interface standard.

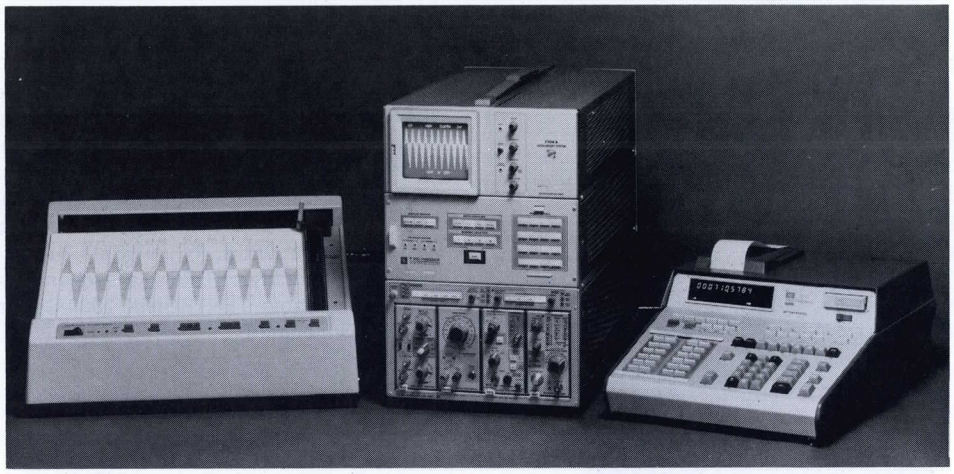
Fast Fourier Transform

Analysis of waveforms and transients often includes determining the frequency components of acquired time domain data. This can be accomplished with the fast Fourier transform. The inverse Fourier transform is also provided to reconstruct time domain information from frequency domain data. In TEK BASIC, these are simple commands, *FFT* and *IFT,* that do not require tedious programming. Both can be executed by single-word commands, or incorporated easily into longer user programs.

Transfer Function Analysis

A transfer function mathematically describes the response characteristics of a circuit or a system. By measuring and analyzing both the input and output signals, one can develop the signal transfer characteristics of a circuit or system under test. When cw techniques are inappropriate, the transient analysis capabilities of our WDI configurations are required. This is often the case in "real life" environments, and it is in these cases that the SPS WDI waveform analyzers are most useful.

TEK BASIC allows the user to write his own transfer function algorithms. While the transfer function analysis is a complex measurement to perform, it is probably one of the most useful measurement tools available to the experimenter today.



Calculator aided SPS instrumentation such as the WP1101 DPO above deliver versatile, low-cost signal acquisition and processing capabilities.

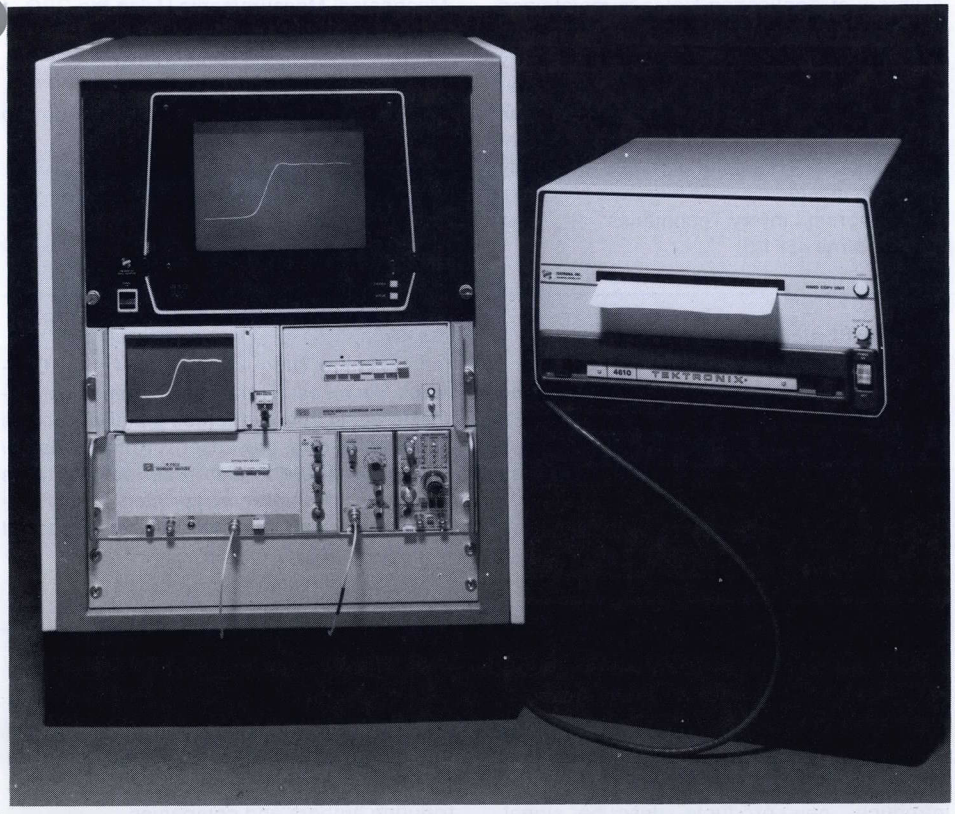
Signals and Noise

Software techniques useful for viewing signals in the presence of noise include signal averaging and correlation. For repetitive signals, averaging can be used to remove uncorrelated noise. In other applications, such as locating an echo following a stimulus pulse (echo ranging with lidar, radar, and sonar), cross correlation can be used. Auto correlation is also provided, and can be used to detect extremely weak signals accompanied by noise, or to detect the presence of unknown periodic signals interspersed among seemingly nonperiodic signals.

Software Digital Filtering

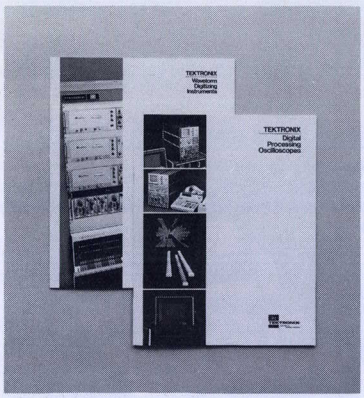
When it is required that a signal be filtered, and it is prohibitively expensive, or not practical to build the desired filters from electronic components, digital filtering often provides a solution. The ability of TEK BASIC to simulate desired circuit effects, through operations such as integration, Fourier transform, etc., enables users to synthesize the required filter.

For more on TEK BASIC software and SPS products, use the catalog reply card to send for the latest DPO and WDI brochures, application notes, and technical article reprints. If your needs are immediate, phone the nearest Tektronix Field Office.



The WP2004 Waveform Digitizing Instrument shown above is one of the WP2000-Series WDI viewing configurations — effectively the world's fastest oscilloscopes. For convenience, a variety of displays is available. Television video monitors can be used for viewing from a distance. Storage monitors and hard copy units can be used to generate permanent copies.

Literature Available

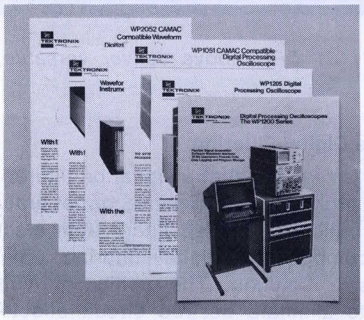


Digital Processing Oscilloscope (DPO) Brochure

This 24-page, color brochure discusses the concept of Digital Processing Oscilloscopes. Specifications and characteristics are included with a description of the relevant features of the calculator-aided WP1100-Series DPOs and the minicomputer-aided WP1200-Series DPOs. To illustrate the acquisition versatility of DPOs, a section outlining compatible TEKTRONIX 7000-Series Plug-ins is included.

Waveform Digitizing Instruments (WDI) Brochure

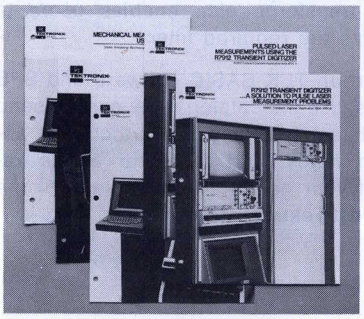
A discussion of some waveforms analysis problems together with the solutions provided by WDI configurations is presented in this 16-page, color brochure. Both the WDI viewing and software assisted configurations are presented together with discussions of waveform processing and WDI TEK BASIC software. Because the WDI configurations feature TEKTRONIX R7912 Transient Digitizers as signal acquisition units, the performance characteristics of the double-ended scan converter tube used in R7912s are included.



Data Sheets

With versatility as an underlying approach to solving measurement problems, the number and variety of Signal Processing Systems is increasing. As new SPS instrumentation applications emerge, data sheets to accompany the product line brochures are generated.

Presently there are DPO and WDI data sheets documenting individual configurations as well as configuration families such as the WP1200-Series DPOs. Also, there are special capabilities data sheets including the series on CAMAC compatible SPS products.



Application Notes

A library of Application Notes is maintained to disseminate technical information about the uses of SPS instrumentation. This library contains notes on specific techniques used in operating SPS instrumentation as well as descriptions of market oriented instrument applications. A sample of notes presently available includes:

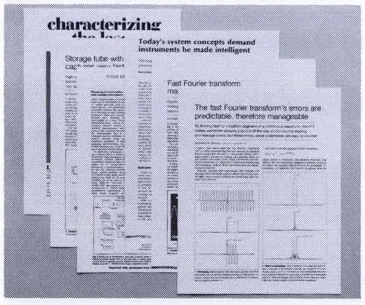
DPO Program Library Techniques
(DPO Note 45F1.0)

Mechanical Measurements Using the DPO
(DPO Note 45A1.0)

Engine Performance Measurements
(DPO Note 45A1.1)

R7912 Transient Digitizer . . . A Solution to Pulse Laser Measurement Problems
(WDI Note 47N1.0)

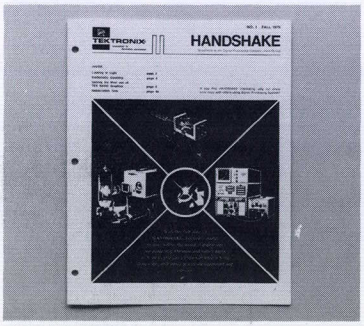
Pulsed Laser Measurements Using the R7912 Transient Digitizer.
(WDI Note 47N1.1)



Technical Article Reprints

Because of the newsworthy nature of many SPS applications, as well as the advanced instrumentation techniques used in SPS products, several technical articles have appeared in the media. Reprints are available.

Topics of these technical articles range from the high technology, instrument-oriented "Storage Tube with Silicon Target Captures Very Fast Transients," from *Electronics,* to applications-oriented material such as "Characterizing the Laser," from *Industrial Research.* There is also a series of articles on Fourier transforms reprinted from *Electronics,* as well as material that appeared in *EDN* and *Laser Focus.*

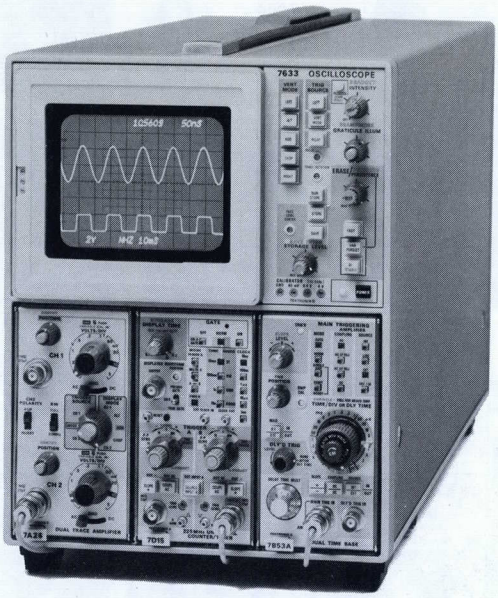


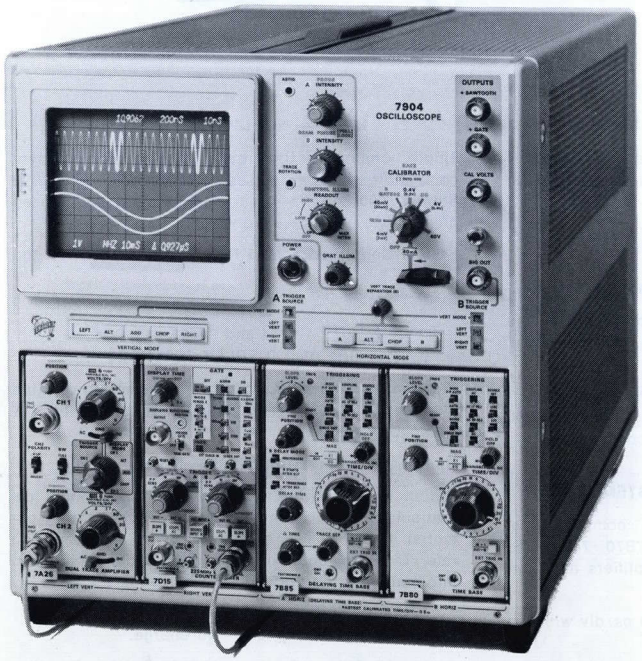
Handshake, a User's Newsletter

In 1975, Tektronix began publishing "Handshake", a quarterly newsletter addressed to users of digital signal processing techniques. Articles contained in "Handshake" introduce new products, describe signal processing applications, and provide operating and programming hints to SPS product users.

Since "Handshake" is a user's newsletter readers are invited to contribute articles. Submitted articles that have been selected for publication carry full credit to the contributing authors and companies.

7000-Series Mainframes



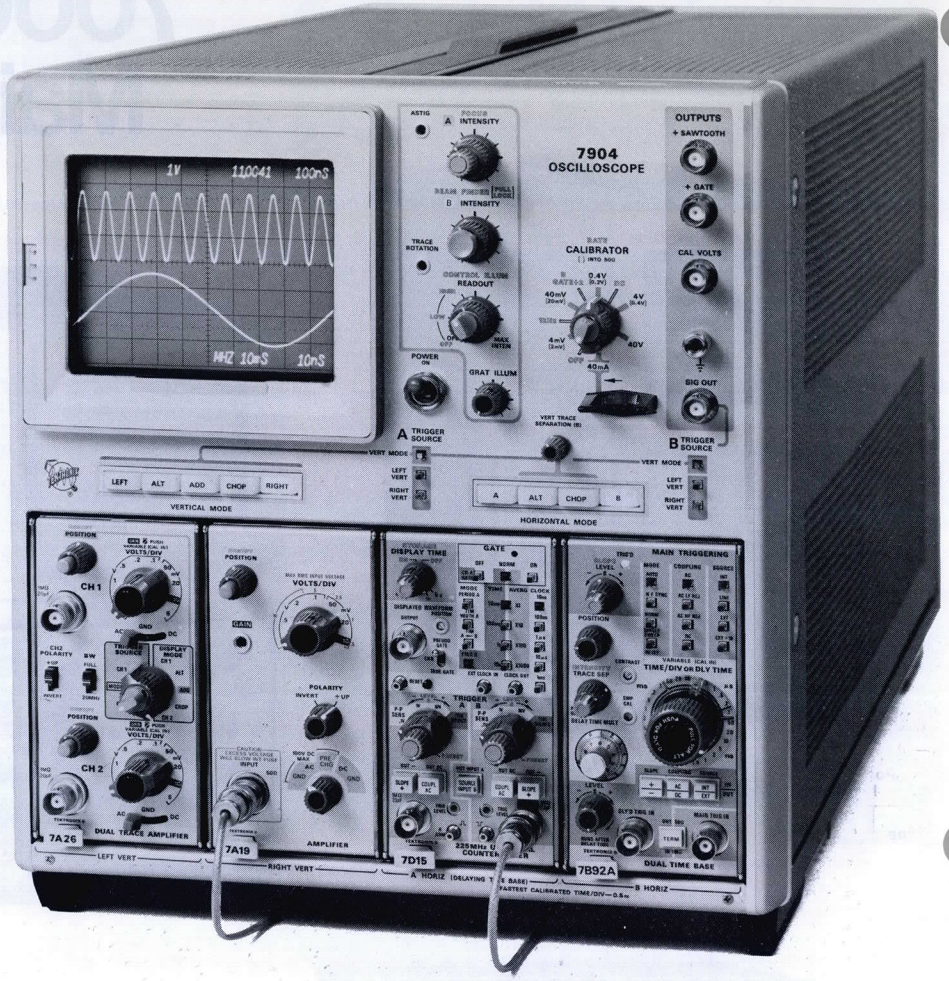


A high performance laboratory instrument system begins with the basic oscilloscope building block—the 7000-Series mainframe. Each mainframe consists of a bright cathode-ray tube, a power supply, electron beam deflection systems, and the switching circuitry necessary to integrate a versatile and complete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

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

7900 Series	**500 MHz**	**page 34**
7800 Series	**400 MHz**	**page 36**
7700 Series	**200 MHz**	**page 38**
7600 Series	**100 MHz**	**page 40**
7600-Series Storage	**100 MHz**	**page 44**
7300-Series Storage	**25 MHz**	**page 48**

the 7000 Series . . . more than an oscilloscope



500 MHz at 10 mV/div

1-GHz Direct-access Plug-in (Less than 4 V/div)

500 ps/div Fastest Calibrated Sweep Rate

Greater than 15 cm/ns Enhanced Writing Speed

Crt Readout

Over 30 Compatible Plug-ins

900-MHz FET Probe Available

The 7904 and 5¼ in rackmount R7903 are the widest real-time-bandwidth, general-purpose oscilloscopes available today. The 7A19 Amplifier/7904 Mainframe attains 500 MHz at 10 mV. A 7A19 variable delay option allows for the matching of signal transit times of two plug-ins and their probes to better than 50 ps.

The P6201 1X FET probe gives you high impedance and wide bandwidth. It has a 900-MHz bandwidth by itself, and in combination with the 7A19/7904, it provides a system bandwidth of 450 MHz at 10 mV.

The crt, the major contributor to the performance of the 7904 and R7903, has excellent visual brightness and an 8 x 10 cm display area. The C-51-R Camera, Writing Speed Enhancer, 10,000 ASA film and P11 phosphor can produce writing speeds of at least 9 cm/ns. Speeds up to 15 cm/ns are possible when an optional max-brightness crt with a 4 x 5 cm display area is used.

7904 and R7903 — VERTICAL SYSTEM

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

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

Chopped Mode — Repetition rate is approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned 4 divisions above or below the A trace (7904 only).

Delay Line — Permits viewing leading edge of displayed waveform when using 7B70, 7B80, and 7B90 Series time bases. 7B50 Series not recommended.

7904 — HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B70, 7B80, and 7B90 Series. 7000-Series vertical amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

Chopped Mode — 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, Option 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, 7B80, and 7B90 Series. 7000-Series vertical amplifiers and specialized plug-ins may also be used.

Fastest Calibrated Sweep Rate — 500 ps/div with the 7B92A.

7904 and R7903 CRT AND DISPLAY FEATURES

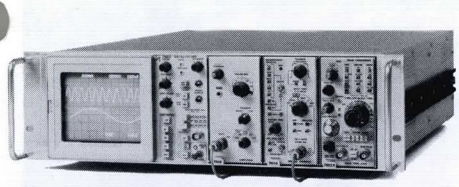
Standard — Internal 8 x 10 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard.

Option 1, without Crt Readout — No crt readout.

Option 4, Max Brightness Crt — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV. P11 phosphor provides max writing rate. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor — No charge.

Option 10, Pulsed Graticule (R7903 Only) — Provides a means of pulsing the graticule lights at a preset level coincident with a single-shot event in one exposure. The graticule lights may be pulsed by the event, an external ground closure, or a front panel pushbutton. If the mainframe is equipped with crt readout, Option 10 provides additional controls and inputs or crt readout pulsed operation.



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

Min Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical applications P31 phosphor has approx one-half the writing speed of P11 phosphor.

Crt	Writing Speed cm/ns P11		Camera	Lens
	Type 410	Type 47		
Standard 8 x 10 cm	6.1	3.1	C-51-R	f/1.2 1:0.5
Option 4 4 x 5 cm	10.0	50	C-51-R	f/1.2 1:0.5

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer. See chart on page 37 for further information.

Polaroid Film		Approx Relative Writing Speed		
Type	ASA Speed	Unfogged		Fogged
		Print Viewed with Front Illumination	Print Viewed with Back Illumination	Print Viewed with Front Illumination*
107	3000	0.8	N/A	3
47	3000	0.8	1.0 (Reference)	3
410	10,000	1.6	2	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

Auto-focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

7904 — CALIBRATOR

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%), dc or B Gate ÷ 2.

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V, 40 V into an open circuit; 2 mV, 20 mV, 0.2 V into 50 Ω (±1%).

Current Output — 40 mA dc or 1 kHz.

R7903 — CALIBRATOR

(Not Available with Option 10)

Output Waveshape — Rectangular positive-going from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V into an open circuit; 4 mV, 40 mV, 0.4 V into 50 Ω (±1%).

Current Output — 40 mA rectangular waveshape with optional current-loop accessory (012-0341-00) connected to calibrator output. Output R is 450 Ω.

7904 — OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±5%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is approx 950 Ω.

+GATE — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω; output R is approx 950 Ω.

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

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

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes.

R7903 — OUTPUTS/INPUTS

(Standard)

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

+Gate — Positive-going rectangular waveform derived from Main or Auxiliary Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 7 ns or less into 50 Ω. Output R is approx 950 Ω.

Sig Out — Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends on the vertical plug-in. See the Vertical Systems Specifications Chart. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5V, rear panel BNC output, for single-sweep ready indication.

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

Crt Readout, Inhibit — Ground closure, rear panel BNC input locks out crt readout. Not available with Option 10.

Crt Readout, Single-shot — Ground closure, rear panel BNC input initiates one frame of crt readout. Not available with Option 10 separately, but in combination with the pulsed graticule input.

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

Probe Power — Two front-panel connectors provide correct operating voltages for two active probes. Not available for R7903 Option 10.

R7903 — OUTPUTS/INPUTS OPTIONS

Option 10, Pulsed Graticule — No crt readout single-shot input, crt readout inhibit input, calibrator, and probe power. Single-shot graticule and crt readout (ground closure) rear-panel BNC input is added. Initiates one frame of crt readout and pulses graticule. Crt readout inputs are not functional with Option 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.

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

R7903 Included Accessories — Test adapter (012-0092-00); two 18 in test leads (012-0087-00); rack-mounting hardware.

7904 ORDERING INFORMATION

(Plug-ins not Included)

7904 Oscilloscope $4100

7904 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 2	X-Y Horiz Comp	Add $100
Option 3	Emi Modification	Add $100
Option 4	Max Brightness Crt (Specify Phosphor)	Add $350
Option 78	P11 Phosphor	No Charge

7904 CONVERSION KITS

040-0605-03	Crt Readout	$530
040-0606-00	X-Y Horiz Comp	$125
040-0570-00	Emi Modification	$165

R7903 ORDERING INFORMATION

(Plug-ins not Included)

R7903 Oscilloscope $3650

R7903 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 4	Max Brightness Crt (Specify Phosphor)	Add $350
Option 10	Pulsed Graticule	Add $100
Option 78	P11 Phosphor	No Charge

R7903 CONVERSION KITS

040-0605-03	Crt Readout	$530
040-0647-00	Emi Modification	$130

400-MHz Bandwidth

Dual Beam

Full Vertical Crossover Switching

8 x 10 cm Full Scan Overlap Crt

Crt Readout

1 ns/div Max Calibrated Sweep

1-GHz Direct-access Plug-ins (Less than 4 V/div)

The 7844 and 7 inch rackmount R7844 are wide bandwidth, dual-beam oscilloscopes designed primarily for fast, single-shot events. Unique features such as pulsed graticule and pulsed crt readout allow you to photograph vertical and horizontal scale factors, test date, test number, and other pertinent data before or after an event. Vertical signal crossover switching permits you to view a single event from a single probe at two sweep speeds.

VERTICAL SYSTEM

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

Display Logic —

Standard Instrument (with Vertical Crossover)	Beam 1	Beam 2
Vertical Compartment Controlling Beam	Left Left Right Right	Left Right Left Right
Opt 21 (without Vertical Crossover)	**Beam 1**	**Beam 2**
Vertical Compartment Controlling Beam	Left	Right

Vertical Crossover — Permits viewing the same signal on two time bases.

Option 21, without Vertical Crossover — No vertical crossover.

Vertical Trace Separation — Beam 1 can be positioned ±4 cm with respect to Beam 2, NA Option 21.

Delay Line — Permits viewing leading edge of displayed waveform when using 7B70, 7B80, and 7B90 Series time bases; not compatible with 7B50 Series.

HORIZONTAL SYSTEM

Channels — Two right-hand plug-in compartments; compatible with time bases of the 7B70, 7B80, and 7B90 Series. 7000-Series vertical amplifiers and specialized plug-ins may also be used. The 7L12 and 7B53AN Opt 11 require modification for use in the 7844.

Fastest Calibrated Sweep Rate — 1 ns/div.

X-Y Mode — Phase shift is within 2° from dc-to-50 kHz.

Bandwidth — Dc to at least 1 MHz.

Horizontal Separation — Beam 1 can be positioned at least 0.25 cm to the right and at least 0.25 cm to the left of Beam 2 with a total 2 cm range.

Display Logic —

Beam 1	Beam 2
A Horizontal	A Horizontal
A Horizontal	B Horizontal
B Horizontal	A Horizontal
B Horizontal	B Horizontal

CRT AND DISPLAY FEATURES

Crt — Dual beam, full overlap. 8 x 10 cm graticule with variable illumination. Crt readout intensity is adjustable with front-panel control. Accelerating potential is 24 kV with P31 phosphor standard.

Option 78, P11 Phosphor — No charge.

Auto-focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder (Beam 1 and Beam 2, Independent Controls) — Limits display within graticule area and intensifies beam.

External Z-Axis Input (Beam 1 and Beam 2) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

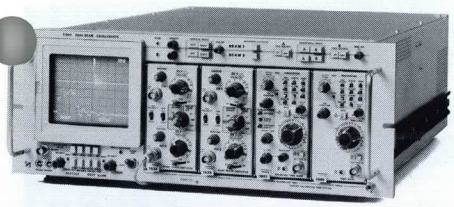
Minimum Photographic Writing Speed — 1.7 cm/ns using Polaroid type 47 film, C-51-R and optional P11 phosphor. In typical camera applications, P31 phosphor has about one-half the writing speed as P11 phosphor. Writing speed can be increased by using the TEKTRONIX Writing Speed Enhancer or Polaroid type 410 film or both.

The following table lists the approx relative writing speed of three types of Polaroid film and the gains that can be achieved by controlled fogging with the Writing Speed Enhancer.

Polaroid Film		Actual Relative Film Writing Speed		
Type	ASA Equivalent Speed	Unfogged		Fogged
		Print Viewed with Front Illumination	Print Viewed with Back Illumination	Print Viewed with Front Illumination
107	3,000	1 (Reference)	Print Base is Opaque	3
47	3,000	1	1.2	3
410	10,000	2	2.2—2.4	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

The Photographic Writing Speed Enhancer (Opt 22) provides a preset automatic method of photographic writing speed enhancement. Opt 22 is recommended for writing speed enhancement when a camera with a writing speed enhancer is not available. With Opt 22, photographic writing speed can be increased approx 2 times.



PULSED READOUT AND GRATICULE ILLUMINATION

Provides a means of pulsing the graticule lights or crt readout at a preset level, coincident with a single-shot event in one exposure. The graticule lights or crt readout can be pulsed by the event, an external ground closure, or front-panel pushbutton.

CALIBRATOR

Calibrator — Rectangular positive-going waveform from ground, 1 kHz (±0.25%).

Voltage Ranges — 4 mV, 40 mV, 0.4 V, 4 V (±1%) into an open circuit; 0.4 mV, 4 mV, 40 mV, 0.4 V (±1%) into 50 Ω.

Current Output — 40-mA (±1%) rectangular waveshape, front panel current loop 7844, optional current loop adapter (012-0341-00) required for R7844.

OUTPUTS/INPUTS

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

A and B +Gate — Positive-going rectangular waveform derived from Main or Delayed Gate. Output voltage 0.5 V (±10%) into 50 Ω. 10 V (±10%) into 1 MΩ. Rise time is 5 ns or less into 50 Ω. Output R is approx 950 Ω.

Single-sweep Ready Indicator — +5 V, rear panel BNC output, for single-sweep ready indication.

External Single-sweep Reset — Ground closure, rear panel BNC, provides input to reset sweeps.

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

Probe Power — Two connectors provide correct operating voltages for two active probes.

POWER REQUIREMENTS

Line Voltage Ranges — Selectable 115 V nominal (90-132 V), 230 V nominal (180-264 V).

Line Frequency — 48 to 440 Hz.

Max Power Consumption — 235 W, 2.9 A at 60 Hz 115 V line.

INCLUDED ACCESSORIES

R7844 — 1 rackmount hardware kit, 1 rackmount slide guide (351-0314-00).

ORDERING INFORMATION

(Plug-ins not Included)

7844 Oscilloscope **$6100**

R7844 Oscilloscope **$6200**

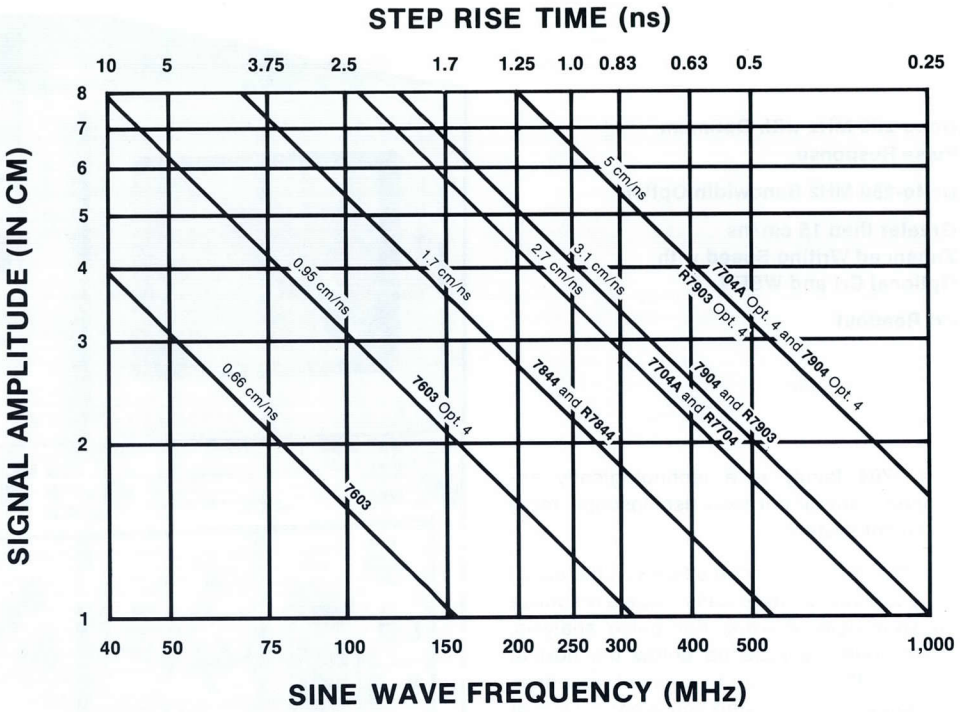
OPTIONS

Option 3 Emi Modification ..... **Add $100**

Option 21 without Vertical Crossover..... **Sub $400**

Option 22 Writing Speed Enhancer Modification ..... **Add $275**

Option 78 P11 Phosphor ..... **No Charge**



The above graph shows the relationship of writing speed to practical measurement parameters of signal amplitude and frequency or rise time.

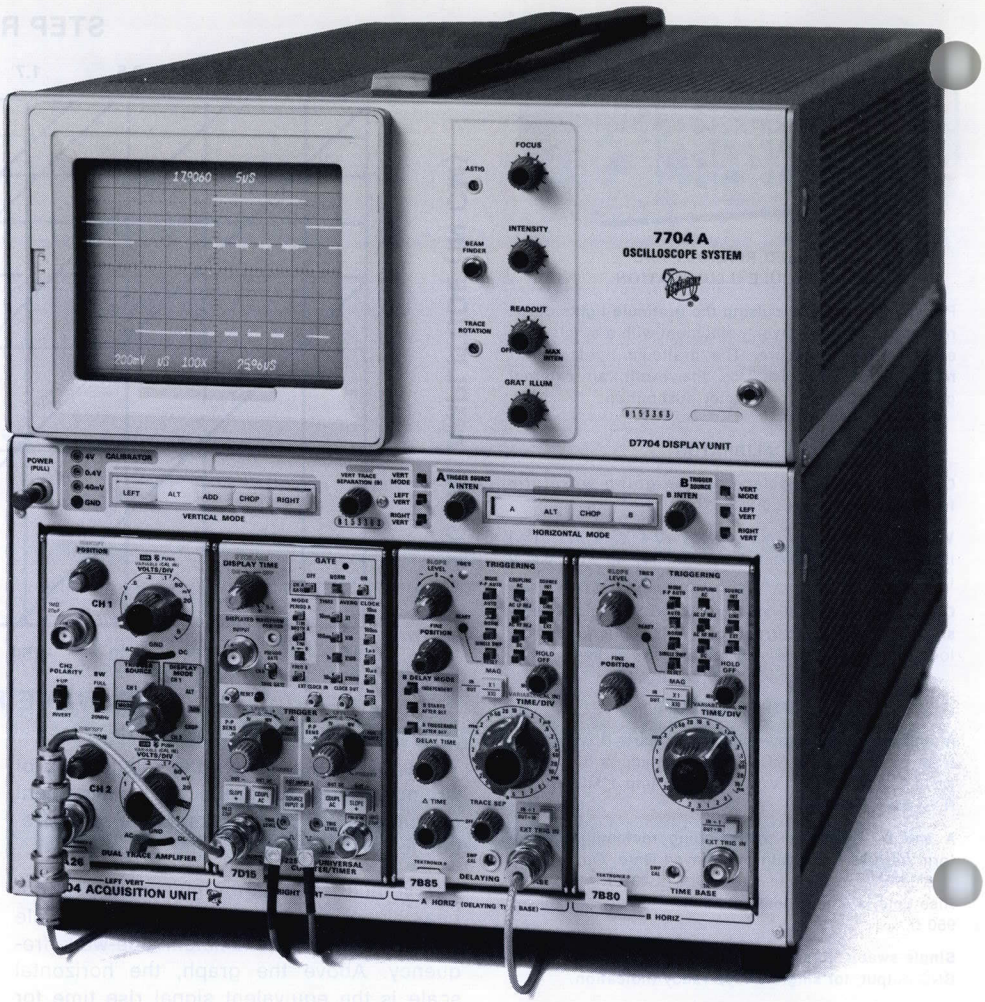
The vertical scale is the maximum peak-to-peak signal amplitude. The horizontal scale below the graph is maximum sine-wave frequency. Above the graph, the horizontal scale is the equivalent signal rise time for nonsinusoidal signals. These speeds assume a horizontal spot velocity that is small compared to the maximum vertical velocity. The step rise time is assumed to be a linear ramp measured between 10% and 90% points. The diagonal lines represent the minimum photographic writing speeds for 7000-Series mainframes and are all measured under the following conditions: Camera, Tektronix type C-51-R, f 1.2, with the shutter opened before the sweep and closed 5 seconds after the sweep. Phosphor, P11 (optional). Film, Polaroid type 47 (ASA 3,000), no fogging for film speed enhancement, developed for 20 seconds at 25°C and viewed with back illumination.

Dc-to-200 MHz with Optimum Pulse Response

Dc-to-250 MHz Bandwidth Option

Greater than 15 cm/ns Enhanced Writing Speed with Optional Crt and WSEN

Crt Readout



The 7704 family is a technologically advanced general-purpose oscilloscope measurement system.

The 7704A Oscilloscope offers you the capability to optimize the oscilloscope's response for your type of work. For pulse analysis, aberrations are reduced below the normal level in the optimized transient response version while still giving you a bandwidth of 200 MHz. The 250 MHz option is optimized for bandwidth performance for high-frequency applications. The R7704 offers a 175 MHz bandwidth.

Simplified circuitry makes this instrument exceptionally reliable and its modular design provides easy maintenance and service. This modularity permits the addition of a processing module. With this addition and a Controller, the 7704A is converted into a Digital Processing Oscilloscope.

Quite often the need arises to photograph the waveforms that are produced. The 7704A gives you a choice of two designs available for this purpose: the standard 8 x 10 cm crt and an optional 4 x 5 cm reduced-scan crt for high writing-speed applications. The standard crt affords 5.3 cm/ns writing speed (C-51-R Camera, P11 phosphor, and 10,000 ASA film), without enhancement, and 8 cm/ns with the TEKTRONIX Writing Speed Enhancer. With the optional crt and film fogging technique, writing speed can be increased to at least 15 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition. See chart on page 37 for additional information.

Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical Systems Specifications 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 this frequency domain.

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

Chopped Mode — 7704A, repetition rate is internally selectable, approx 100 kHz or 1 MHz; R7704, fixed at approx 1 MHz.

Trace Separation Range (Dual-sweep Modes) — The B trace can be positioned above or below the A trace.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 2 ns/div with 7B70, 7B80, or 7B90 Series.

Chopped Mode (between Horizontal Plug-ins) — 7704A, repetition rate is internally selectable, approx 20 kHz or 200 kHz; R7704, fixed at approx 200 kHz.

X-Y Mode — Phase shift is within 2° from dc-to-50 kHz (7704A), from dc-to-35 kHz (R7704) between vertical and horizontal channels. Frequency response at 10% down is dc to at least 3 MHz.

Option 2, X-Y Horizontal Compensation (R7704 only) — Provides phase shift compensation of 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 — No crt readout.

Option 4, Max Brightness Crt (7704A Only) — Internal 4 x 5 cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard, P11 optional. This provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate, high-speed signals.

Option 78, P11 Phosphor — No charge.

Minimum Photographic Writing Speed (Using Polaroid Film without Film Fogging) — Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical application, P31 phosphor has approx one-half the writing speed of P11 phosphor. See chart on page 37 for further information.

Mainframe	P11 Writing Speed cm/ns		Camera	Lens
	Type 410	Type 47		
7704A R7704 8 x 10 cm	5.3	2.7	C-51-R	f/1.2 1:0.5
7704A Option 4 4 x 5 cm	10.0	5.0	C-51-R	f/1.2 1:0.5

Auto-focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

External Z-Axis Input (7704A only) — 2 V p-p for full intensity range. A positive signal blanks the trace. Max input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc-coupled.

External Z-Axis Inputs (R7704 only) — High sensitivity input: minimum pulse width to blank trace is 30 ns at 2 V; 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace; input R is 500 Ω within 10%. Max input voltage is 15 V (dc + peak ac) and p-p ac.

High Speed Input — Minimum pulse width to blank trace is 3.5 ns at 60 V; 60 V p-p for fully intensity range from dc-to-100 MHz. A positive signal blanks the trace; input R is 18 kΩ within 20%. Max input voltage is 60 V (dc + peak ac) and p-p ac.

OUTPUTS/INPUTS

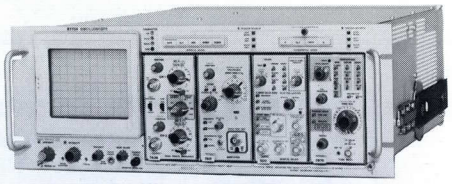
+ Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (±15%) into 50 Ω, 1 V/div (±10%) into 1 MΩ. Output R is 950 Ω nominal.

+ Gate — Positive-going rectangular waveform derived from A, B, or Delayed Gate, internally selectable. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω nominal.

Sig Out — Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in; see Vertical Systems 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) — Without previously described outputs/inputs and External Z-Axis input.



The R7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

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

Probe Power — Two rear-panel connectors provide correct operating voltages for two active probes. R7704 connectors are located on both the front and rear panels. Probe power is deleted on Option 1 of 7704A.

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (40 V and 4 mV available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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

POWER REQUIREMENTS

Line Voltage Ranges — 90 to 132 V ac and 180 to 264 V ac.

Line Frequency — 48 to 440 Hz (7704A), 48 to 66 Hz (R7704).

Option 5, Line Frequency Change (50—400 Hz) — Converts the R7704 to 50—400 Hz operation (not required for 7704A).

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

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

ORDERING INFORMATION
(Plug-ins not Included)

7704A Oscilloscope **$2900**
R7704 Oscilloscope **$3450**

7704A OPTIONS

Option 1	without Crt Readout and Probe Power	Sub $400
Option 3	Emi Modification	Add $100
Option 4	Max Brightness Crt (Specify Phosphor)	Add $350
Option 9	Bandwidth Change (250 MHz)	No Charge
Option 78	P11 Phosphor	No Charge

R7704 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 2	X-Y Horiz Comp	Add $100
Option 3	Emi Modification	Add $100
Option 5	Line Freq Change (50—400 Hz) (Not Required for 7704A)	Add $125
Option 78	P11 Phosphor	No Charge

7704A CONVERSION KITS

040-0613-00	Crt Readout and Probe Power	$480
040-0612-00	Emi Modification	$165
040-0619-00	Sig Out/In	$125

R7704 CONVERSION KITS

040-0533-01	Crt Readout	$480
040-0529-00	X-Y Horiz Comp	$110
040-0562-00	Emi Modification	$130

Dc-to-100 MHz Bandwidth

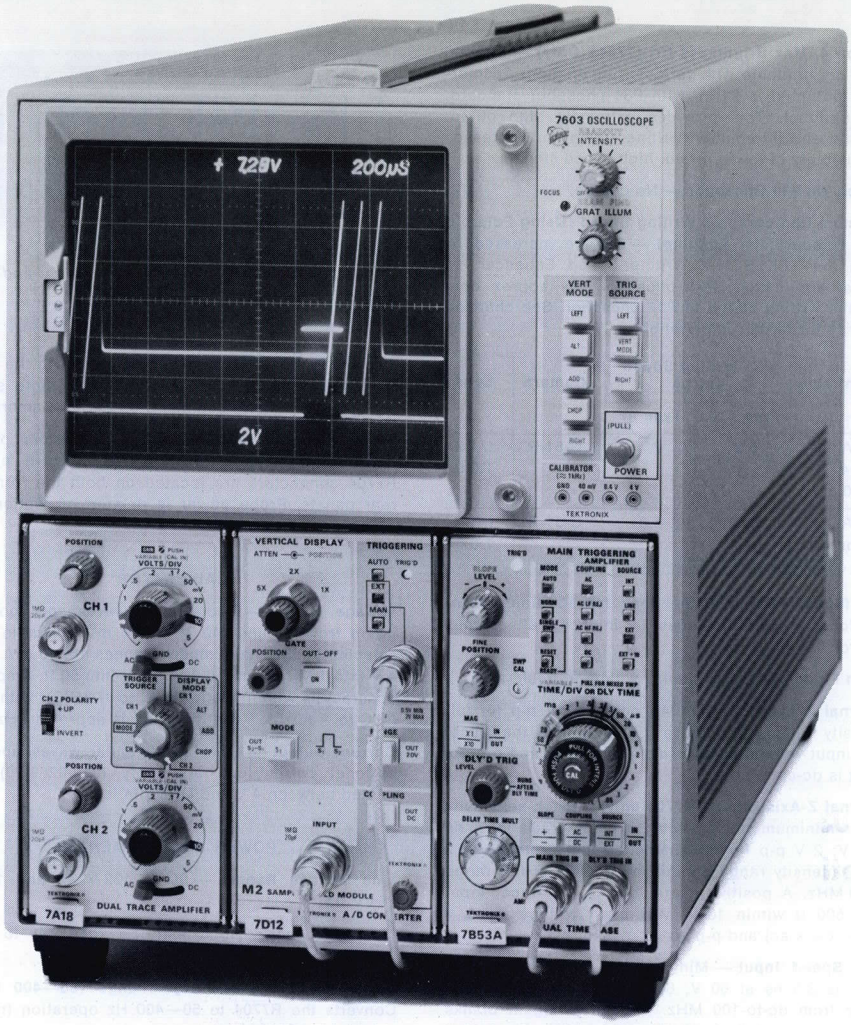
6½ in Crt

Crt Readout

5¼ in Rackmount

The TEKTRONIX 7603 and R7603 Rackmount Oscilloscopes represent the best price/performance ratio available in the 100-MHz plug-in oscilloscope market today.

The crt is large, 8 x 10 div (1.22 cm/div), and features an internal graticule with variable illumination and 15-kV accelerating potential. An optional maximum brightness crt with a smaller 8 x 10 cm display and 18-kV potential gives you greater visual brightness and higher photographic writing speed.



VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical Systems Specifications Chart.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 5 ns/div.

X-Y Mode — The phase shift between vertical and horizontal channels is 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 — No crt readout.

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

Option 6, Spectrum Analyzer Graticule.

Optional Phosphors (Specify) — P7, P11, or P7/SA. (Phosphor/Spectrum Analyzer graticule combination.)

Minimum Photographic Writing Speed — Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical application P31 phosphor has approx one-half the writing rate of P11.

Crt	Writing Speed div/μs				Camera	Lens
	Type 107/47		Type 410			
	P31	P11	P31	P11		
Standard 8 x 10 div (1.22 cm/div)	100	150	200	300	C-50	f/1.9 1:0.7
Option 4 8 x 10 div (1 cm/div)	200	300	400	600		

External Z-Axis Input — 2 V p-p for full intensity range from dc-to-2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Auto-focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

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

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from Main, Delay, or Auxiliary Gate.

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

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 — No 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 to 40-mA rectangular waveshape with optional current-loop accessory (012-0259-00) connected between 4 V and GND pin jacks.

POWER REQUIREMENTS

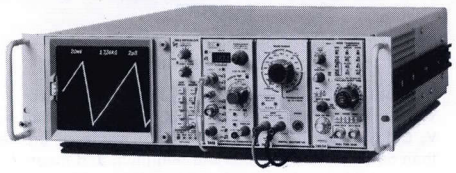
Line Voltage Ranges — 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selectable with quick-change jumpers.

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 W, 2.0 A at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

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



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

ORDERING INFORMATION
(Plug-ins not Included)

7603 Oscilloscope $1800

R7603 Oscilloscope $1900

7603 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 4	Max Brightness Crt (Specify Phosphor)	Add $100
Option 6	with Internal Spectrum Analyzer Graticule	No Charge
Option 7	without Sig Out/In	Sub $50

R7603 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 4	Max Brightness Crt (Specify Phosphor)	Add $100
Option 5	Line Freq Change (50—400 Hz) (not Required for 7603)	Add $125
Option 6	with Internal Spectrum Analyzer Graticule	No Charge
Option 7	without Sig Out/In	Sub $50

7603 CONVERSION KITS

040-0654-02	Crt Readout	$480
040-0662-00	Emi Modification	$165
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28
040-0718-00	X-Y Horiz Comp	$150

R7603 CONVERSION KITS

040-0674-02	Crt Readout	$480
040-0679-00	Emi Modification	$165
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28
040-0718-00	X-Y Horiz Comp	$150

PHOSPHOR OPTIONS (7603/R7603)

Option 76	P7 Phosphor	No Charge
Option 77	P7 Phosphor with Internal Spectrum Analyzer Graticule	No Charge
Option 78	P11 Phosphor	No Charge

7603N Option 11S

7000-Series Oscilloscopes

Ruggedized Oscilloscope System

Ruggedized for Extreme Environments

Meets or Exceeds MIL-O-24311 (EC) (AN/USM-281 Specifications)

Large Bright Display—6½ in Crt (15 kV)

5 ns/div Delaying Sweep

0.5 mV Vertical Sensitivity

Three-plug-in Flexibility

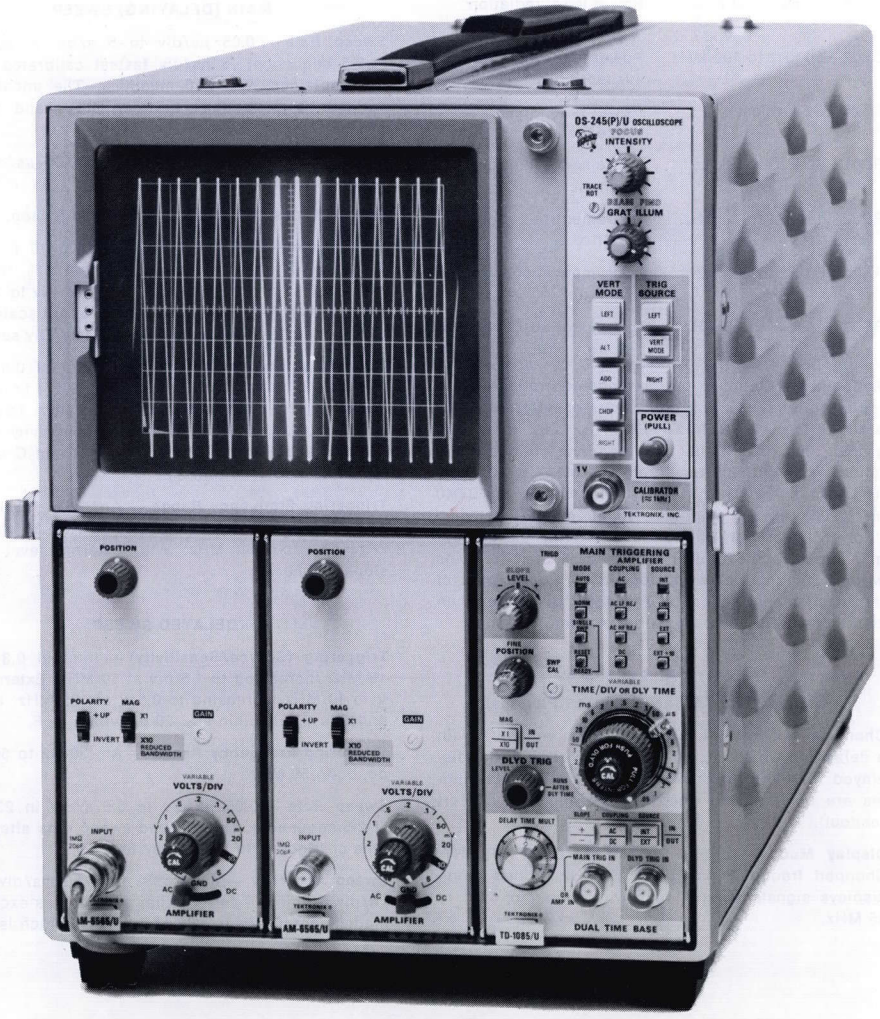
Versatile Trigger-source Selection

Pushbutton Switching

Illuminated No-Parallax Graticule

Color-keyed Panels

Protective Cover with Accessories



The 7603N Option 11S Ruggedized Oscilloscope System meets the rigid environmental and electrical specifications required by MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311. The system consists of a three-plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

Although the military spec requires only 50-MHz performance, this system actually performs to 65 MHz. Other better-than-required specs include operating altitude, sensitivity at reduced bandwidth with X10 gain, "X" sensitivity in X-Y mode, triggering frequency range, delaying and delayed sweep speeds, and crt size.

7603N Option 11S Ruggedized Oscilloscope System

The mainframe and plug-ins are compatible with the TEKTRONIX 7000-Series product line. The system does not have crt readout, and it can't be used with the digital plug-ins.

ENVIRONMENTAL

Temperature — Nonoperating −62°C to +75°C, operating −28°C to +65°C.

Humidity — 0 to 95% RH over entire temperature range, operating or nonoperating.

Altitude — Nonoperating sea level to 50,000 ft, operating sea level to 15,000 ft.

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

Shock (Operating) — 9 consecutive 400-pound hammer blows without failure from 1, 3, and 5 ft in vertical, horizontal, and longitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

Inclination (Operating) — As per MIL-E-16400.

Drip Proof (Nonoperating) — As per MIL-STD-198.

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

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

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 are provided during continuous or interrupted operation. The MIL-O-24311(EC) MTBF requirement of greater than 600 hours is met as tested under the following conditions: temperature +40°C ±2°C; relative humidity 70% ±5%; vibration 25 Hz at 0.040 in ±0.008 in p-p amplitude to 10 minutes of each "Power On" hour during each day of the 8 hour manned schedule; power cycled at 4 hour intervals with 10 minutes power off for each 4 hour period of the manned test schedule. An MTBF of greater than 2000 hours was achieved during testing.

VERTICAL SYSTEM
(Includes Two 7A15AN Option 11 Plug-ins)

Channels — Two left-hand plug-in compartments, with a delay line which allows the leading edge of the displayed waveform to be viewed. All 7000-Series plug-ins are compatible (except those which require crt readout).

Display Modes — LEFT, ALT, ADD, CHOP, RIGHT. Chopped frequency is approx 1 MHz. Added mode displays signals algebraically with a cmrr of 20:1 to 25 MHz.

Bandwidth/Sensitivity — Dc to 65 MHz from 5 mV/div to 10 V/div, accuracy within 2%, variable extends to 25 V/div. Max sensitivity is 0.5 mV at 10 MHz with X10 gain. Ac-coupling lower −3 dB point is less than 2 Hz. Rise time is 5.4 ns with less than 2% aberrations.

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

Max Input Voltage — 400 V (dc + peak ac).

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

HORIZONTAL SYSTEM
(Includes One 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. Rise time 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. With external level range, slope is ±30 V.

DELAYED SWEEP

Triggering (Source/Sensitivity) — Internal 0.3 div to 10 MHz increasing to 1.5 div at 50 MHz. External, 0.1 V to 10 MHz increasing to 0.5 V at 100 MHz. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range — Ac, 30 Hz to 50 MHz; dc, dc-to-50 MHz.

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). The delayed sweep runs after delay time or triggerable after delay time.

Sweep Accuracy — Within 3% from 50 ms/div to 0.5 μs/div, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div, which is within 6%.

CRT

Accelerating Potential — 15 kV.

Phosphor — P31.

Graticule — Internal 8 x 10 cm with variable illumination. The 6½ in crt permits 2 cm of linear overscan in both axes, making a total viewing area of approx 10 x 12 cm.

Crt Controls — Located on front panel are Focus, Intensity, Graticule Illumination, Beam Finder, and Trace Rotation. Astigmatism is an internal control.

External Z-Axis Input (BNC Connector on Rear Panel) — 2 V p-p for full intensity range from dc to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. Max input voltage is 10 V (dc + peak ac).

OUTPUTS

Calibrator (BNC Connector on Front Panel) — 1 V within 1%, 1-kHz square wave within 20%.

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

POWER REQUIREMENTS

Input Voltages — 100, 110, 120, 220, and 240 V ac ± 10% internally selectable with quick-change jumpers with 47.5—440 Hz single phase line frequency. Max power consumption is 125 W.

C281 COVER WITH ACCESSORIES

The cover provides protection during transport and packages the included accessories.

INCLUDED ACCESSORIES
(All Packaged in Cover)

Two P6006 probe packages (010-0127-00); two 8 ft long 50-Ω BNC cables (012-0366-00); two BNC female to UHF male adapters (103-0015-00); two BNC male to UHF female adapters (103-0032-00); two BNC male to binding post adapters (103-0033-00); two BNC T connectors (103-0030-00). One set of technical manuals (not packaged in cover).

ORDERING INFORMATION

7603N Option 11S Oscilloscope System (AN/USM-281C)
Order 7603NMS $3450

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) $1775

7A15AN Option 11 Amplifier Plug-in (AM-6565/U) $350

7B53AN Option 11 Time Base* Plug-in (TD-1085/U) $975

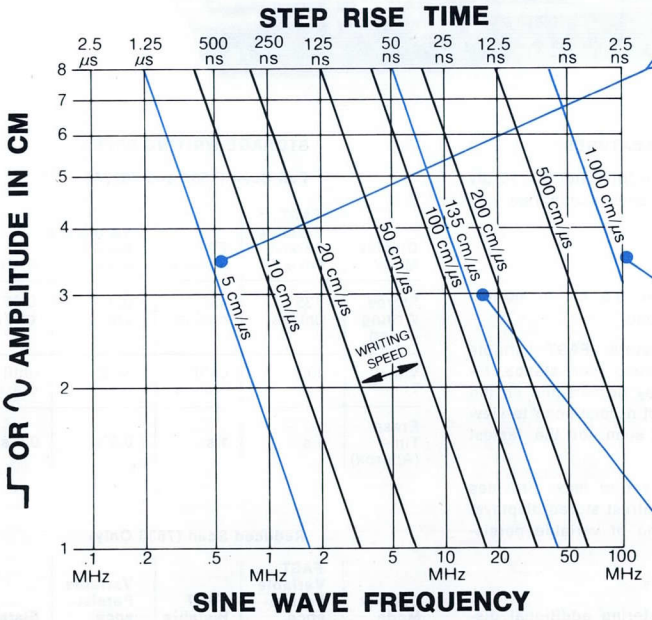
016-0553-00, C281 Cover W/Accessories $120

*Not compatible with 7844.

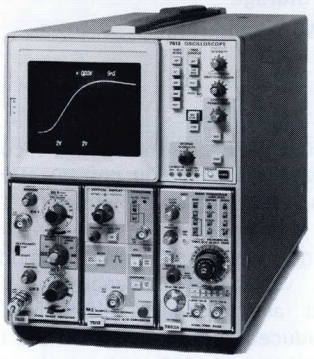
7000-Series Storage Mainframes

Storage mainframes in the 7000 Series offer a full selection of stored writing speeds: from ≃5 cm/μs for mechanical, spectrum analysis, or TDR applications, to 1000 cm/μs for capturing fast single events such as high speed digital logic. A selection of storage modes offer the following features:

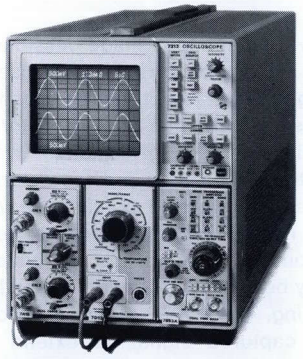
Bistable	**Long View Time**
Variable Persistence	**High Contrast Displays**
FAST	**Capture Fast Single or Multiple Events**
Multimode	**Combines All of the Above Modes and Features**



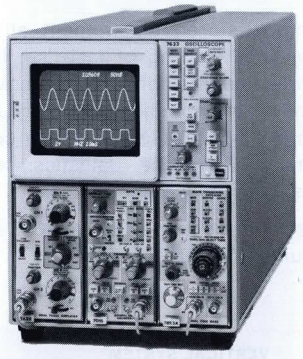
Graph shows the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.



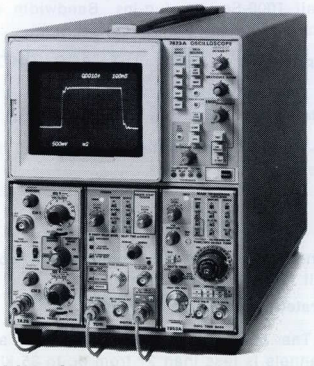
7613
Variable Persistence



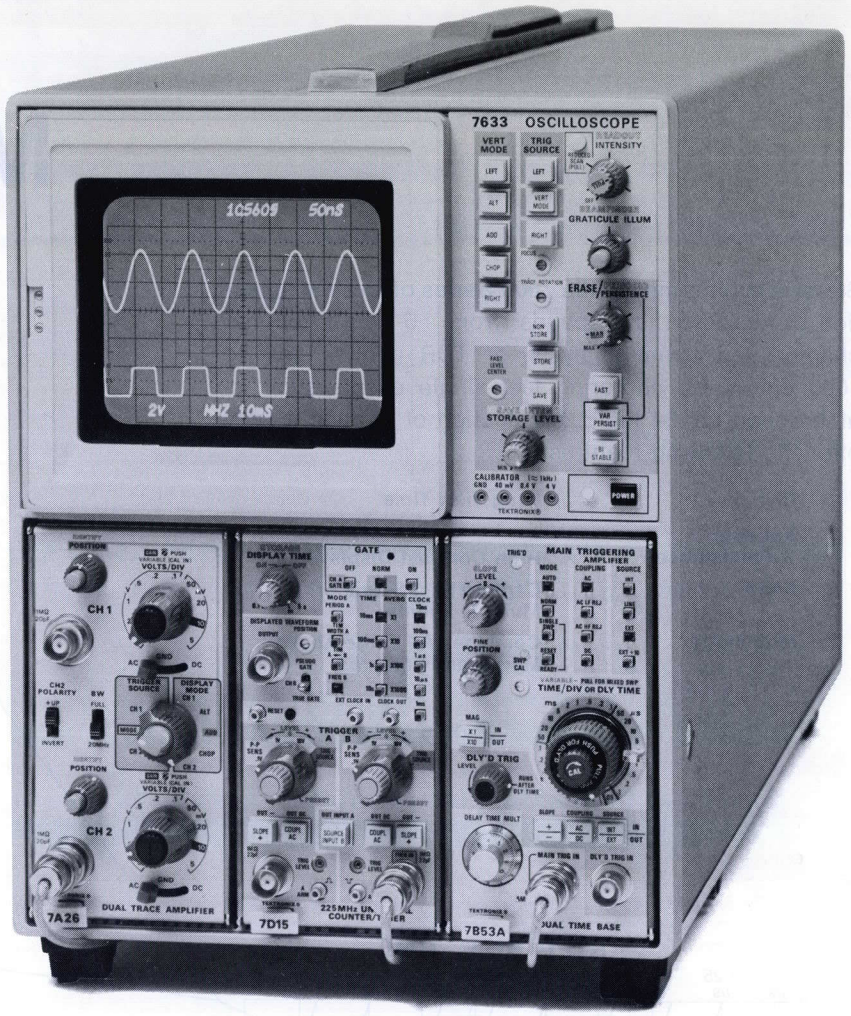
7313
Split Screen Bistable



7633
FAST Multimode



7623A
FAST Multimode



7633

1000 cm/μs Stored Writing Speed
Long View Time
Multimode Storage
Dc-to-100 MHz Bandwidth

The TEKTRONIX 7633 Storage Oscilloscope provides 2200 div/μs (1000 cm/μs) stored writing speed and 100-MHz bandwidth. The instrument has three display modes—store, nonstore, and save—and four storage modes—bistable, variable persistence, fast bistable, and fast variable persistence. The separate reduced scan selector obtains the top writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, 0.45 cm/div).

The high writing speed is made possible by the unique Tektronix storage crt. It uses a special high-speed target and a mesh-to-mesh transfer technique for fast storage modes. This technique gives longer waveform retention times than previous storage instruments. The variable persistence view time with maximum persistence is never less than one-half minute and the bistable display may be viewed for hours without loss due to fading. The SAVE mode is used to retain the captured signal, to extend the variable persistence view time, and to enable the auto-save feature.

This multimode storage instrument allows for retention and viewing of fast-rise, low-repetition-rate, single-shot, or slow-moving waveforms. The instrument's capability and versatility make it a problem solver in computer sciences, aerospace, ballistics, communications, and many other fields.

Characteristics are common to the 7633 and the 7623A unless noted.

VERTICAL SYSTEM

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

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 5 ns/div.

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

CRT AND DISPLAY FEATURES

Crt — Internal 8 x 10 div (0.9 cm/div) and 8 x 10 div (0.45 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 1 — No crt readout.

Accelerating Potential — Approx 8.5 kV in normal mode, 10 kV in reduced scan mode.

Storage Display Modes — Nonstore, FAST variable persistence, FAST bistable, variable persistence, bistable. Full or reduced scan may be selected on the 7633 in all display modes. Select normal scan to view the entire crt; select reduced scan for the fastest writing rate.

Persistence — Variable. When set to max, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

Auto Erase — Variable up to 10 s.

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

External Z-Axis Input — 2 V p-p for useful intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Auto-Focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

STORAGE WRITING SPEED

Full Scan (7633 and 7623A)

Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	135 cm/μs	45 cm/μs	0.45 cm/μs	0.027 cm/μs
View Time*	30 s	until erased	30 s	until erased
Erase Time (Approx)	1 s	1 s	0.5 s	0.5 s

Reduced Scan (7633 Only)

Display Mode	FAST Variable Persistence	FAST Bistable	Variable Persistence	Bistable
Stored Writing Speed	1,000 cm/μs	180 cm/μs	1.35 cm/μs	0.9 cm/μs
View Time*	30 s	until erased	30 s	until erased
Erase Time (Approx)	1 s	1 s	0.5 s	0.5 s

*View times are at full stored display intensity; they may be increased more than 30 times by using reduced intensity in the save display mode.

7623A

135 cm/μs Stored Writing Speed
Long View Time
Multimode Storage
Dc-to-100 MHz Bandwidth

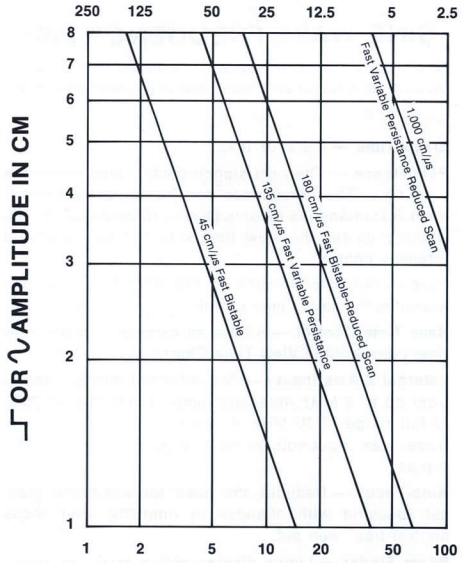
The TEKTRONIX 7623A Storage Oscilloscope has all the features and performance of the 7633 except the reduced scan mode.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-peak Sine wave	Step Response
Reduced Scan** 2200 div/μs (0.45 cm/div)	≥5 ns/div	7.1 div 100 MHz 8 div 89 MHz	7.7 div 3.5 ns 8 div 3.7 ns
Full Scan 150 div/μs (0.9 cm/div)	≥50 ns/div	3.2 div 15 MHz 6.4 div 7.5 MHz	3 div 20 ns 5 div 33 ns

**Applies to 7633 only.

STEP RISE TIME (ns)



SINE WAVE FREQUENCY (MHz)

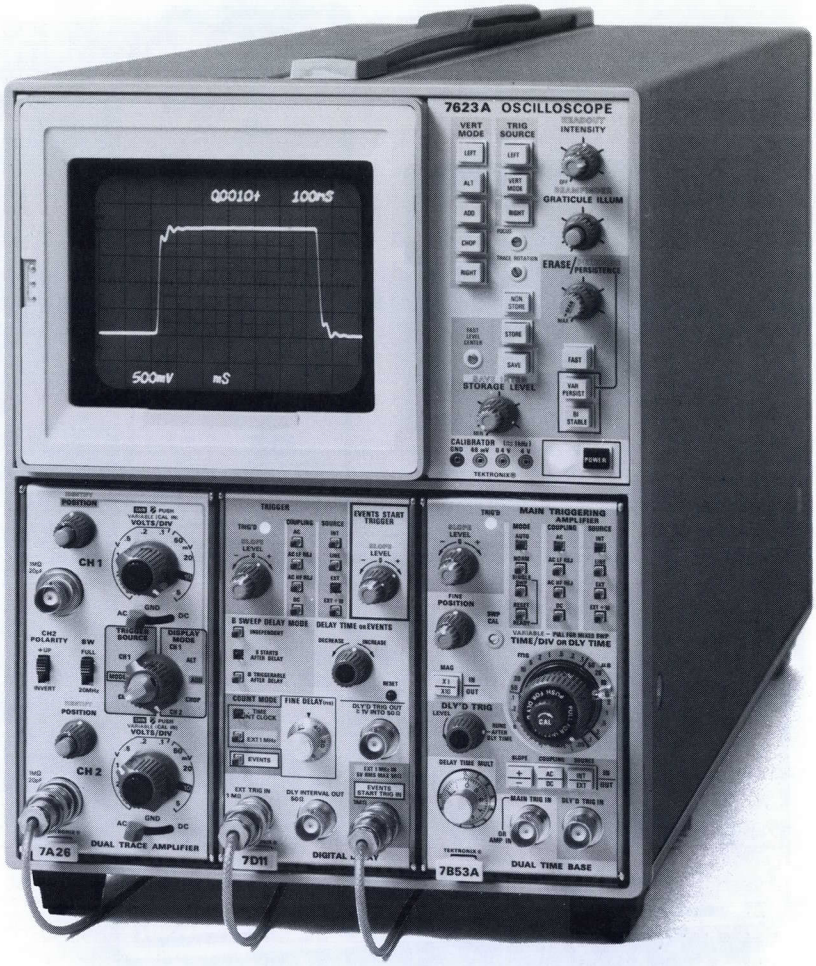
Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

OUTPUTS/INPUTS

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

+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω, output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Vertical Signal Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.



External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace.

Option 7 — No 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 — 50-60 Hz.

Option 5, Line Frequency Change (50-400 Hz) — Converts the 7633 and R7633 to 50-400 Hz operation.

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

Included Accessories — 20 in cable (two-pin-to-BNC) (175-1178-00) crt filter Green (378-0625-08). The R7633 and R7623A include Rackmounting hardware.

ORDERING INFORMATION
(Plug-ins not Included)

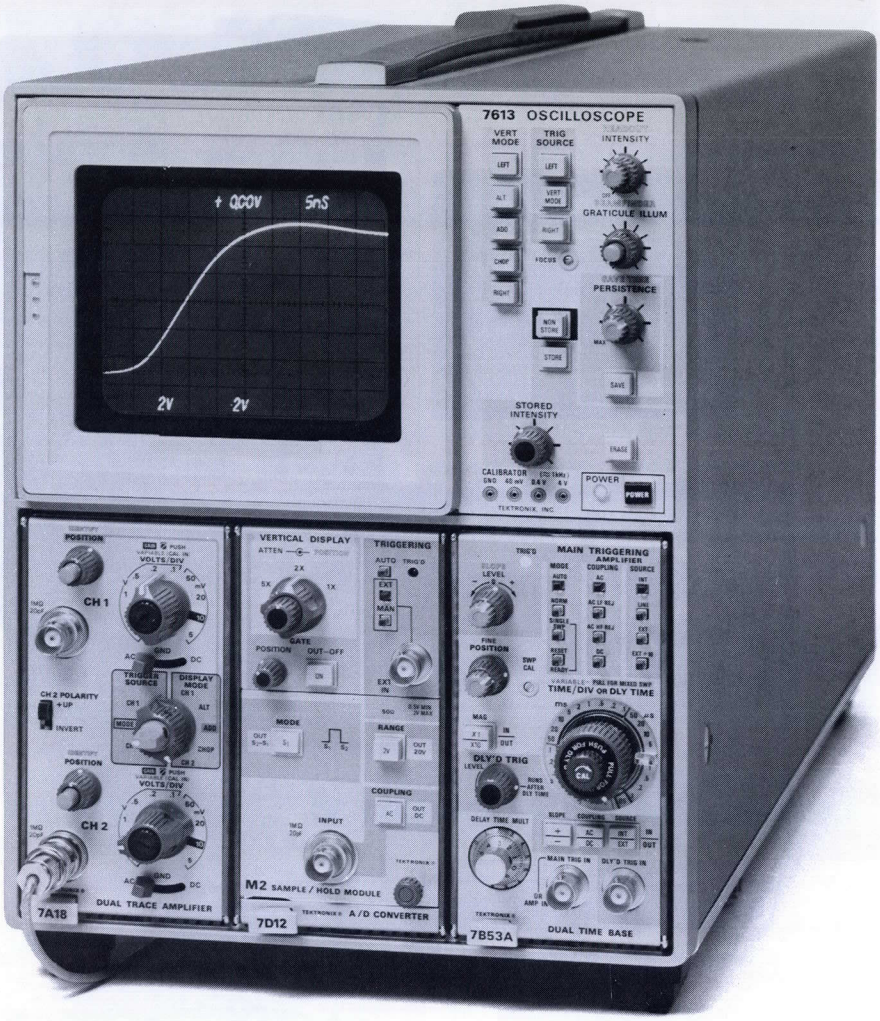
7633 Storage Oscilloscope $4200
R7633 Storage Oscilloscope $4300
7623A Storage Oscilloscope $3500
R7623A Storage Oscilloscope $3600

OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 5	Line Freq Change (50—400 Hz)	Add $125
Option 7	without Sig Out/In	Sub $50

CONVERSION KITS

Crt Readout (040-0748-01 Cabinet)	$480
(040-0759-01 Rackmount)	$530
Emi Modification	
(040-0663-00 Cabinet)	$165
(040-0678-00 Rackmount)	$165
Sig Out/In (040-0629-01 Cabinet)	$120
(040-0633-00 Rackmount)	$85
Power Supply to Light Plug-in Pushbuttons (040-0686-00)	$28



Variable Persistence Storage
4.5 cm/μs Stored Writing Speed
Dc-to-100 MHz Bandwidth
Burn Resistant Crt
5¼ in Rackmount

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

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit; see Vertical Systems Specifications Chart.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 5 ns/div.

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

CRT AND DISPLAY FEATURES

Variable Persistence Storage Crt — Internal 8 x 10 div (0.9 cm/div) graticule with variable illumination.

Phosphor — P31.

Option 1 — No crt readout.

Accelerating Potential — 8.5 kV.

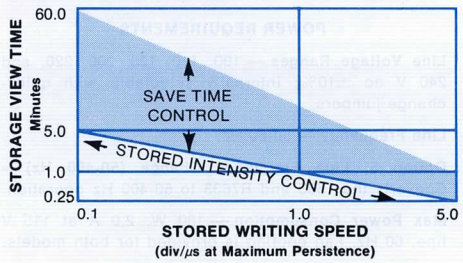
Nonstore Mode — For displaying waveforms in the conventional (nonstorage) mode.

Store Mode — For displaying waveform using the variable persistence storage feature.

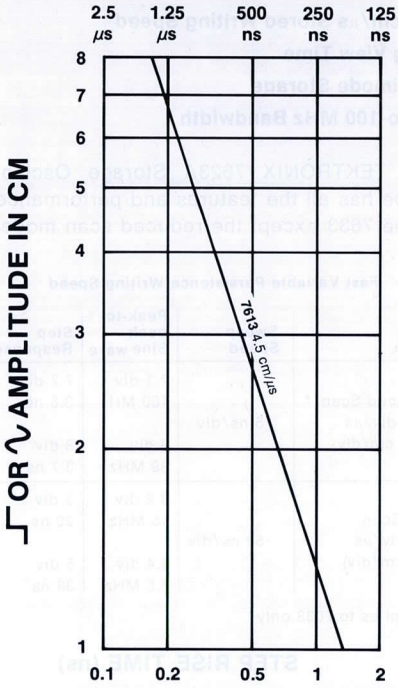
Max Stored Writing Speed — Greater than 4.5 cm/μs.

View Time — The view time is the amount of time the stored signal can be viewed before it fades away.

At the max writing speed the view time is 15 seconds or 0.25 minutes with the stored intensity control fully CW. Adjusting the stored intensity CCW will reduce the stored writing speed, but view time can be increased up to 5 minutes (see the chart below).



STEP RISE TIME



SINE WAVE FREQUENCY (MHz)

Graph showing the stored writing speed needed for a given sine wave or step rise time at a given amplitude.

Erase Time — 0.5 s or less.

Persistence — The persistence control also varies the view time. The persistence can be adjusted from almost instantaneous disappearance (fade away), to off, which provides the view time selected by the stored intensity control.

Save — Prevents erasure of the stored display and activates the save time control.

Save Time Control — Allows an extension of the view time (see Storage View Time Chart).

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Auto-Focus — Reduces the need for additional manual focusing with changes in intensity after focus control has been set.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth — Sawtooth starts 1 V or less from ground (into 1 MΩ). Output voltage is 50 mV/div (±15%) into 50 Ω, 1V/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. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends upon vertical plug-in; see Vertical Systems 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 — No 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 — 50-60 Hz.

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

Max Power Consumption — 180 W, 2.0 A at 115 V line, 60 Hz. Fan cooling is provided for both models.

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

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

DIMENSIONS AND WEIGHTS

Refer to the 7633 dimensions and weights chart.

ORDERING INFORMATION
(Plug-ins not Included)

7613 Storage Oscilloscope $2850
R7613 Storage Oscilloscope $2950

7613 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 5	Line Freq Change (50—400 Hz)	Add $125
Option 6	Special Int Graticule (Spectrum Analyzer)	Add $50
Option 7	without Sig Out/In	Sub $50

R7613 OPTIONS

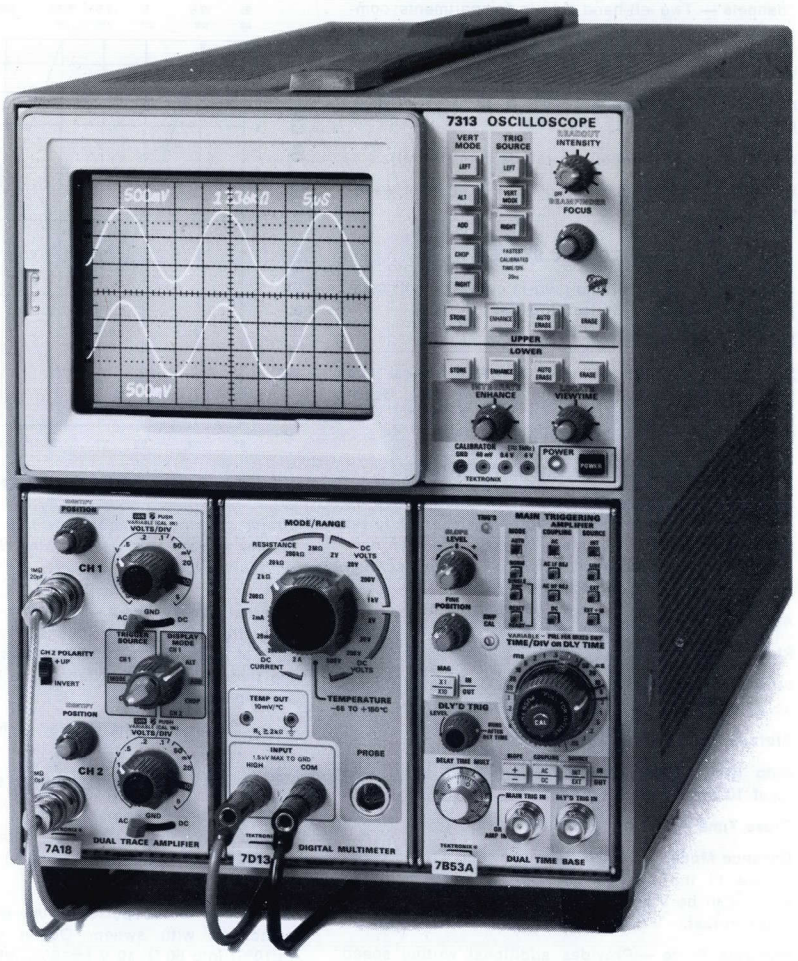
Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 5	Line Freq Change (50—400 Hz)	Add $125
Option 6	Special Int Graticule (Spectrum Analyzer)	Add $50
Option 7	without Sig Out/In	Sub $50

7613 CONVERSION KITS

040-0656-02	Crt Readout	$480
040-0663-00	Emi Modification	$165
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28

R7613 CONVERSION KITS

040-0676-02	Crt Readout	$530
040-0678-00	Emi Modification	$165
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28



Split-screen Bistable Storage
4.9 cm/μs Stored Writing Speed
Dc-to-25 MHz Bandwidth
Burn Resistant Crt
5¼ in Rackmount

The TEKTRONIX 7313 Storage Oscilloscope offers split-screen bistable operation or non-storage operation. It has a stored writing speed of 5 div/μs. Stored traces may be viewed up to 4 hours on a display area of 8 x 10 div (0.98 cm/div). The 7313 crt is burn resistant and doesn't require any special operating precautions.

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

VERTICAL SYSTEM

Channels — Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit, limited to 25 MHz.

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

Chopped Mode — Repetition rate is approx 1 MHz.

Delay Line — Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate — 20 ns/div.

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

STORAGE CRT AND DISPLAY FEATURES

Split-Screen Bistable Storage Crt — Internal 8 x 10 div (0.98 cm/div) graticule. Store on upper or lower half of screen with nonstore display on other half. Store on entire screen or nonstore on entire screen. Independent operation on both halves.

Accelerating Potential — 4 kV.

Phosphor — P1.

Stored Writing Speed — Normal, 500 div/ms; adjustable to at least 5000 div/ms in Enhance Mode.

Storage View Time — Up to 4 hours.

Auto Erase View Time Range — 0.5 or less to at least 10 s after end of sweep.

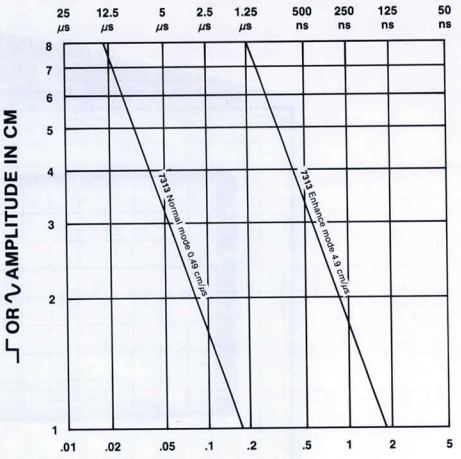
Erase Time — 400 ms or less.

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 enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MANUAL control.

STEP RISE TIME



Graph showing the stored writing speed needed to display a given sine wave or step rise time at a given amplitude.

External Z-Axis Input — 2 V p-p for full intensity range from dc to 2 MHz; intensity range diminishes to 20% of full range to 10 MHz. A positive signal blanks the trace. Max input voltage is 10 V (dc + peak ac) and p-p ac.

Beam Finder — Limits display within graticule area.

OUTPUTS/INPUTS

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

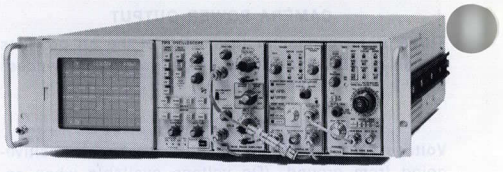
+Gate — Positive pulse of the same duration and coincident with sweep. Output voltage is 0.5 V (±10%) into 50 Ω, 10 V (±10%) into 1 MΩ. Rise time is 20 ns or less into 50 Ω; output R is 950 Ω within 2%. Source is selectable from main, delay, or auxiliary gate.

Sig Out — Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. Bandwidth depends on vertical plug-in. Output R is 950 Ω within 2%.

External Single-Sweep Reset — Ground closure; rear panel BNC provides input to reset sweep.

Remote Erase — Ground closure; rear panel BNC provides input to erase stored trace. Internally selectable for either or both halves of crt.

Option 7 — No outputs/inputs.



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

CAMERA POWER OUTPUT

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

CALIBRATOR

Voltage Output — Rectangular waveshape, positive-going from ground (dc voltage available when selected by internal jumper). Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

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

POWER REQUIREMENTS

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

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

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

Max Power Consumption — 180 W, 2 A at 115 V line, 60 Hz. Fan cooling is provided for the R7313.

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

ORDERING INFORMATION

(Plug-ins not Included)

7313 Storage Oscilloscope $2400

R7313 Storage Oscilloscope $2500

7313 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 7	without Sig Out/In	Sub $50

R7313 OPTIONS

Option 1	without Crt Readout	Sub $400
Option 3	Emi Modification	Add $100
Option 5	Line Freq Change (50—400 Hz) Not Required for 7313	Add $125
Option 7	without Sig Out/In	Sub $50

7313 CONVERSION KITS

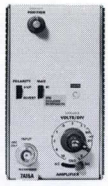
040-0655-02	Crt Readout	$480
040-0664-00	Emi Modification	$150
040-0629-01	Sig Out/In	$120
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28

R7313 CONVERSION KITS

040-0675-02	Crt Readout	$480
040-0678-00	Emi Modification	$165
040-0633-00	Sig Out/In	$85
040-0686-00	Power Supply to Light Plug-in Pushbuttons	$28

7000-Series Plug-ins

7A11


7A15A

7A16A

7A17

7A19

7A21N

NEW 7A13

7A22

7A18

7A24

7A26

Amplifiers Pages 50-53

Eleven vertical amplifiers offer choices in system bandwidth, number of input channels, vertical sensitivity, input impedance, and differential inputs.

7B50A

7B53A

NEW 7B80

NEW 7B85

7B92A

Time Bases Pages 54-57

Five horizontal time bases offer choices in sweep speeds, single or dual sweeps, and now, digital delta delay measurements.

7D11

7D12/M1

7D12/M2

7D12/M3

7D13

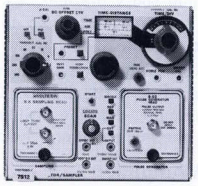
7D14

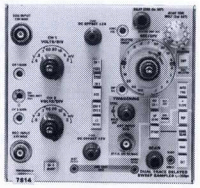
7D15

Digital Measurements Pages 58-63

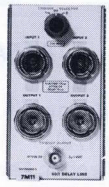
Five digital instruments, one with three interchangeable modules, offer unique solutions to complex measurement problems. Timing and amplitude measurement instruments interact with the oscilloscope to easily obtain accurate measurements of complex signals.

7S11


7S12


7S14

7T11


7M11

Sampling and TDR Pages 64-69

Five plug-in units offer a choice of single- and dual-channel sampling, general-purpose sampling combined with time domain reflectometry, sampling sweep, and dual delay line.

S-1

S-2

S-3A

S-4

S-5

S-6

S-51

S-52

S-53

S-54

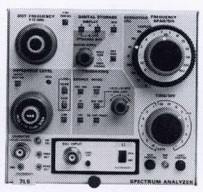
Sampling Heads Pages 66-68

Ten sampling heads offer choices in input impedance, equivalent bandwidth, and triggering for a matched sampling system.

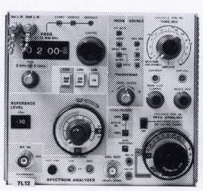
7CT1N

Curve Tracer

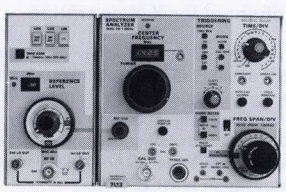
See p. 182


NEW 7L5/L1/L2

See p. 190


7L12

See p. 186


7L13

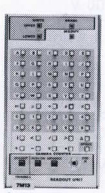
See p. 187

Spectrum Analyzers

7K11

CATV Preamplifier

See p. 195

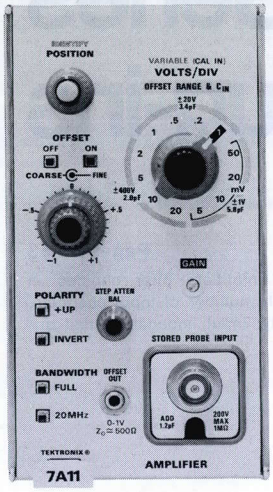

7M13

Readout Unit

See p. 57

Special Purpose Plug-ins

Full details on these special purpose instruments are given on the pages indicated at left.



7A11

Built-in FET Probe

DC-to-250 MHz Bandwidth (7900 Family)

5 mV/div to 20 V/div
Calibrated Deflection Factors

Dc Offset

Lit Pushbuttons

The 7A11 is a wideband plug-in amplifier. The captive FET probe input configuration optimizes signal acquisition with high resistance (1 MΩ) and low capacitance (5.8 pF at 5 mV/div), without loss of signal amplitude by probe attenuation. The 7A11 probe's two 20X attenuators, physically mounted in the probe tip, are relay-switched into the input signal path at the appropriate deflection factor. This frees the operator: he need not concern himself with manual plug-in attenuators and dynamic signal range.

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

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

Signal and Offset Range

Deflection Factor Settings	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
Offset Range	+1 V to −1 V	+20 V to −20 V	+400 V to −400 V
Offset Range to Offset Out	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
Max Dc-coupled Input	200 V (Dc + Peak Ac, Ac Component to 50 kHz)	200 V (Dc + Peak Ac, Ac Component to 40 MHz)	200 V (Dc + Peak Ac, Ac Component to 70 MHz)
Max Ac-coupled Input (Dc Component)	±200 V		

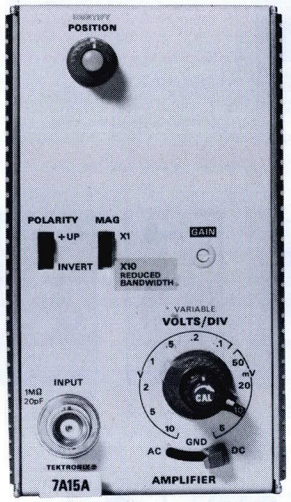
Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 0.1 div or less per minute after 20 minute warm-up. Long term, 0.3 div or less per hour after 20 minute warm-up. Drift with ambient temperature (constant line voltage), 200 μV/°C or less.

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

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

Included Accessories — Capacitor-coupler head (011-0110-00); retractable hook tip (013-0106-00); probe tip ground adapter (013-0085-00); 3 in ground lead (nose) (175-0849-00); 3 in ground lead (screw-in) (175-0848-00); 12 in ground lead (screw-in) (175-0848 02); three miniature alligator clips (344-0046-00); two insulated sleeves (166-0404-01); probe hook tip (206-0114-00); probe tip to GR 50 Ω termination (017-0088-00); 18 in cable (offset out) (175-1092-00).

Order 7A11 Amplifier **$1225**



7A15A

Dc-to-80 MHz Bandwidth (7900 Family)

5 mV/div to 10 V/div
Calibrated Deflection Factors

500 μV/div at 10 MHz (X10 Gain)

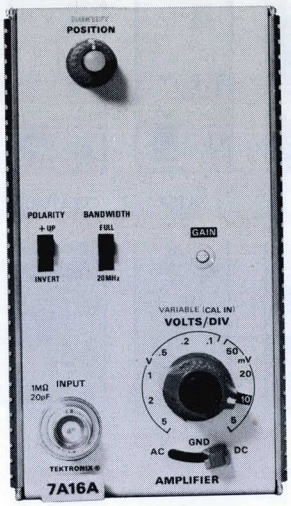
The 7A15A is a wideband amplifier that features a X10 magnifier to increase the sensitivity to 500 μV/div at 10 MHz. It has a constant bandwidth at all deflection factors in the X1 setting. Polarity of the display is selectable. The 7A15A may also be used in the horizontal channel for X-Y operation.

Deflection Factor — 5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 gain accuracy is within 2% with X1 gain adjusted at 10 mV/div. X10 gain (increases sensitivity to 500 μV) accuracy is within 10% at 10-MHz bandwidth throughout deflection factor settings. Uncalibrated VARIABLE is continuous between steps to at least 25 V/div.

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

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac), ac component 500 V p-p max, 1 kHz or less.

Order 7A15A Amplifier **$310**



7A16A

Dc-to-225 MHz Bandwidth (7900 Family)

5 mV/div to 5 V/div
Calibrated Deflection Factors

The 7A16A is a wideband amplifier. It features constant bandwidth over the deflection factor range of 5 mV/div to 5 V/div. Polarity of the display is selectable; bandwidth is selectable to FULL or limited to 20 MHz for low-frequency applications.

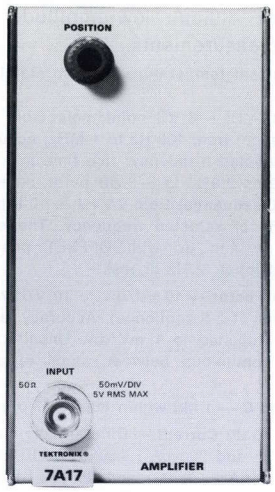
Deflection Factor — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted at 10 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 12.5 V/div.

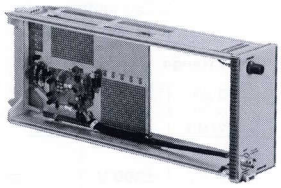
Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

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

Order 7A16A Amplifier **$525**





7A17

Low Cost

Dc-to-150 MHz Bandwidth (7900 Family)

50 mV/div Calibrated Deflection Factor

Easy to Customize

The 7A17 is a unique wideband, plug-in amplifier electrically and mechanically suitable for do-it-yourself design and modification.

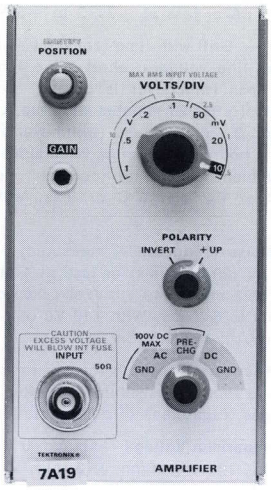
The layout of the circuit board assembly provides a blank soldering pad matrix and ground plane surface totaling approximately 40 square inches. Circuits may be installed here. Mainframe power is identified and available on the circuit board. The front subpanel is prepunched with holes of various sizes and shapes which allow for the mounting of connectors, switches, indicators, etc.

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

Input Z — 50 Ω.

Max Input Voltage — 5 V rms.

Order 7A17 Amplifier **$150**



7A19

Dc-to-500 MHz Bandwidth (7900 Family)

10 mV/Div to 1 V/Div
Calibrated Deflection Factors

Optional ±500 ps Variable Delay Line

The 7A19 is a high-performance, wide-bandwidth, single-trace plug-in amplifier designed primarily for use with the 7900-, 7800-, and 7700-Family mainframes. The polarity of the display is selectable, either normal or inverted.

Deflection Factor — 10 mV/div to 1 V/div in 7 calibrated steps (1-2-5 sequence). Accuracy is within 3%.

Input R — 50 Ω.

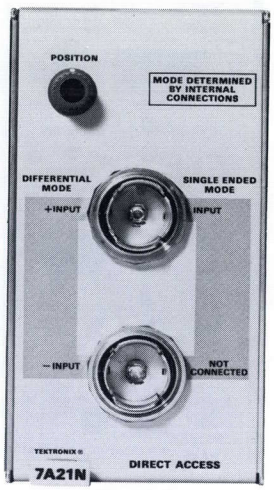
Option 4, Variable Signal Delay — Permits matching the transit time of two preamps and probes to better than 50 ps. Range is ±500 ps.

Max Input — 2 W average or 50 div peak; 100 V dc in both dc- and ac-coupled mode.

Order 7A19 Amplifier **$900**

7A19 OPTION

Order Option 4 Variable Sig Delay . . . . . **Add $150**



7A21N

Bandwidth to 1 GHz
(7900 & 7800 Family Only)

Less than 4 V/Div Deflection Factor

Single and Differential Inputs

Positioning Control

The 7A21N unit is designed so that high-frequency or fast-rise time signals may be ac-coupled directly into the wide-bandwidth crt of the 7900- and 7800- Family Oscilloscopes. Two front-panel input connectors allow single-ended or differential operation (internally selected). Vertical-trace positioning is controlled on the front-panel.

Direct access means that the vertical amplifier is bypassed. Interconnection boards and coupling cables are supplied with each 7A21N. The 7A21N does not incorporate crt readout or an internal trigger.

When used in 7900-Family Oscilloscopes, vertical mode switching is inoperative, and plug-ins can't be used in the adjacent vertical channel.

With the 7844 or R7844 Oscilloscopes, the 7A21N may be used in one or both vertical compartments. When one 7A21N is used with Beam 1 left vertical compartment, preamps or specialized plug-ins may be used with Beam 2 right vertical compartment, leaving the crt readout operative for Beam 2 and the horizontal compartments. Vertical mode switching is inoperative when a 7A21N is used in Beam 1. When two 7A21Ns are used, crt readout and vertical mode switching are inoperative. Horizontal mode switching is always operative.

An 80-ns pretrigger should be provided for fast single-shot events. If this is impractical, use a 7M11 Dual Delay Line in the signal path. The 7A21N is compatible only with the 7900- and 7800-Family Oscilloscopes.

Bandwidth — 20 kHz to 1 GHz.

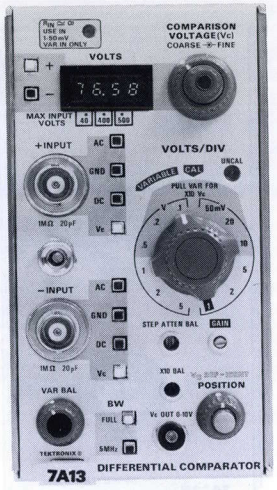
Deflection Factor — Less than 4 V/div.

Input Z — 50 Ω.

Max Input Voltage — 25 V dc, 100 V pulsed ac.

Included Accessories — Interconnecting board assembly.

Order 7A21N Direct Access **$600**



7A13

Dc-to-105 MHz Bandwidth (7900 Family)

1 mV/div to 5 V/div Calibrated Deflection Factors

20,000:1 Cmrr

10,000 Cm Effective Screen Height

Lit Pushbuttons

The 7A13 is a differential comparator amplifier. It incorporates a number of features which make it particularly versatile, especially in multitrace combination with other 7000-Series vertical plug-ins.

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 to FULL or 5 MHz for best displayed noise conditions during low-frequency applications.

As a differential amplifier the 7A13 provides a balanced (+ and –) input for applications requiring rejection of a common-mode signal. The cmrr is 20,000:1 from dc to 100 kHz, derating to 200:1 at 20 MHz. The unit can reject up to 10 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 100-V rejection potential at 10 mV/div (X10 Vc pulled) and 500 V at 0.1 V/div.

As a comparator amplifier the 7A13 uses 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.

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

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

Signal Range

Deflection Factor Settings	1mV to 50mV/div	10 mV to 50 mV/div (X10 Vc out) and 0.1 V to 0.5 V/div	0.1 V to 0.5 V/div (X10 Vc out) and 1 V to 5 V/div
Common-mode Signal Range	±10 V	±100 V	±500 V
Max Dc-coupled Input (Dc + Peak Ac at 1 kHz or Less)	±40 V	±400 V	±500 V
Max Ac-coupled Input (Dc Voltage)	±500 V		

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

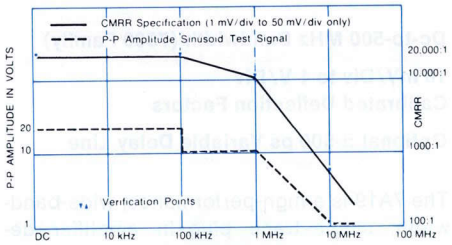
Dc Stability — Drift with time (constant ambient temperature and line voltage): short term, 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minutes warm-up. Long term, 1 mV p-p or 0.1 div or less (whichever is greater) during any 1 hour interval after 20 minutes 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 2 mV and 0.1 ms to recover to within 1 mV after a pulse of ±10 V or less, regardless of pulse duration.

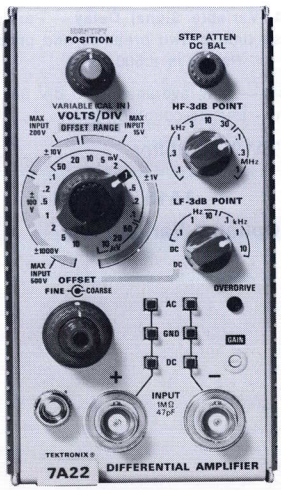
Internal Comparison Voltage — Range, 0 V to ±10 V; accuracy, ±(0.1% of setting + 3 mV); Vc output R, approx 15 kΩ.

Common-Mode Rejection Ratio



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

Order 7A13 Amplifier $1495



7A22

Dc-to-1 MHz Bandwidth

10 μV/div to 10 V/div Calibrated Deflection Factors

100,000:1 Cmrr

Selectable Upper and Lower —3 dB Points

Dc Offset

10 μV/Hour Dc Drift*

The 7A22 is a differential amplifier well-suited for difficult low-amplitude, low-frequency measurements.

*With constant temperature. See dc stability specifications.

Bandwidth — Hf —3 dB point; selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 10% of selected frequency; rise time in 1 MHz position is 350 ns ±9%. Lf —3 dB point; selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 12% of selected frequency. The switch also contains dc and dc with OFFSET positions. Ac-coupled at input, 2 Hz or less.

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

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

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

Signal and Offset Range

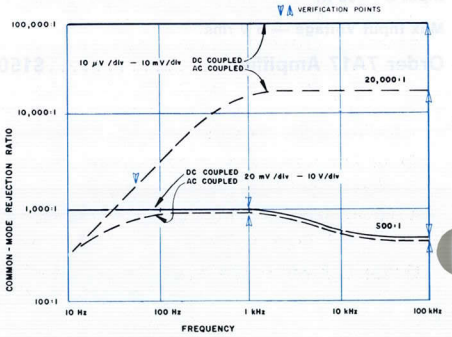
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-mode Signal Range	±10 V	±100 V	±500 V	
Max Dc-coupled Input (dc + Peak ac at 1 kHz or Less)	±15 V	±200 V	±500 V	
Max Ac-coupled Input (dc Voltage)	±500 V dc Rejection, at least 4 x 10^5:1			
Dc Offset 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.

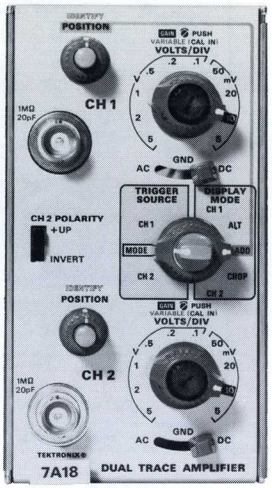
Displayed Noise — 16 μV or 0.1 div (whichever is greater) at max bandwidth; source resistance 25 Ω or less measured tangentially.

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

Common-mode Rejection Ratio (For Signals not Exceeding Common-mode Signal Range)



Order 7A22 Amplifier $715



7A18

Dc-to-75 MHz Bandwidth

5 mV/div to 5 V/div
Calibrated Deflection Factors

The 7A18, the basic building block of 3- and 4-trace operation, is a dual-trace plug-in amplifier. The 7A18 features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The 7A18 has a trace identify function. Polarity of channel 2 is selectable.

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

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

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

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

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

Order 7A18 Amplifier $615

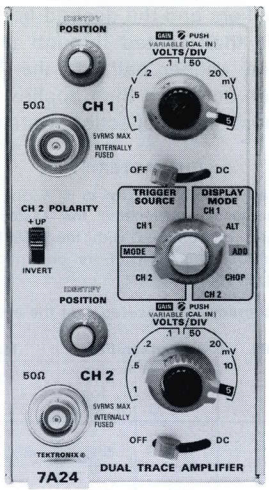
DC OFFSET OPTION

Option 6, Dc Offset — Two separate Channel-1 and Channel-2 variable offset controls are concentric with the position controls replacing the identify push-buttons of the standard 7A18. The ac-dc-ground switch of each channel is expanded to accommodate a fourth position for dc offset.

Offset Range Display — ±200 div max, equivalent to ±1 V at 5 mV/div.

Accuracy — When in DC OFFSET the deflection accuracy is derated by 1%.

Order Option 6 Dc Offset . . . . . Add $115



7A24

Dc-to-350 MHz Bandwidth (7900 Family)

5 mV/Div to 1 V/Div
Calibrated Deflection Factors

50-Ω Input

The 7A24, a dual-trace plug-in amplifier, is a basic building block for 3- or 4-trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable.

Deflection Factor — 5 mV/div to 1 V/div in 8 calibrated steps (1-2-5 sequence). Accuracy is within 2% with gain adjusted to 5 mV/div. Uncalibrated VARIABLE is continuous between steps to at least 2.5 V/div.

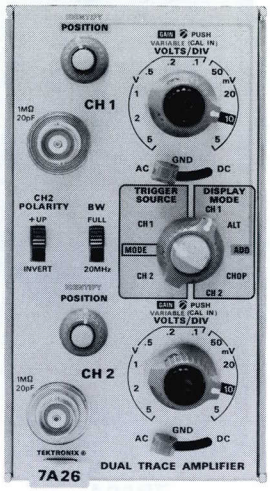
Input R — 50 Ω within 0.5%; VSWR 1.25:1 or less at 5m/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 1 V/div at 250 MHz.

Max Input — 5V rms; 0.5 W max input power, internally protected.

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

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

Order 7A24 Amplifier $1150



7A26

Dc-to-200 MHz Bandwidth (7900 Family)

5 mV/Div to 5 V/Div
Calibrated Deflection Factors

1-MΩ Input

The 7A26, a dual-trace plug-in amplifier, is a basic building block for 3- or 4-trace operation. It features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control groupings. Polarity of channel 2 is selectable. Bandwidth may be set at FULL or limited to 20 MHz for low-frequency applications.

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

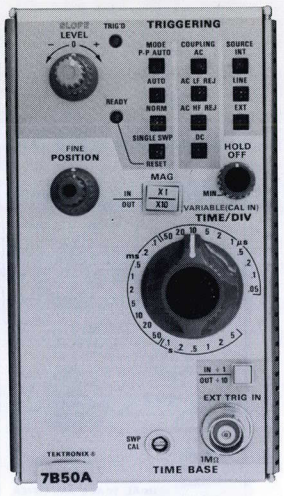
Input R and C — 1 MΩ within 2%; ≈ 20 pF.

Max Input Voltage — Dc-coupled: 250 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less. Ac-coupled: 500 V (dc + peak ac); ac component 500 V p-p max, 1 kHz or less.

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

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

Order 7A26 Amplifier $1150



7B50A

5 ns/div to 5 s/div Calibrated Time Base

Triggering to 150 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering

Single-Sweep Operation

The 7B50A Time Base is recommended for use with 7313 and 7600-Series mainframes to provide optimum bandwidth/sweep-speed compatibility. It may, however, be used in any 7000-Series mainframe. The fastest rate (5 ns/div) is obtained with the X10 MAGNIFIER.

This new time base features expanded capability in maximum triggering frequency — now 150 MHz — and in the addition of variable trigger holdoff—for stability on lengthy asynchronous data trains.

Twelve pushbutton positions program triggering mode, coupling method, and source. For routine applications, hands-off triggering is accomplished by actuating three switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE. The P-P AUTO MODE provides a 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 automatic. The other triggering positions are useful for specific applications.

AC LF REJ attentuates undesirable trigger components below 30 kHz. AC HF REJ attenuates components above 50 kHz, which can cause triggering problems during low-frequency applications. Single-sweep functions with lighted READY indicator and manual reset are associated with the trigger mode controls.

X-Y displays are available with Option 2 installed. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B50A. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Sweep Rates — 0.05 μs/div to 5 s/div in 25 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps 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 1 s/div	4%	5%	5%	6%
0.5 s/div to 0.5 μs/div	2%	3%	3%	4%
0.2 μs/div to 0.05 μs/div	3%	4%	4%	5%

(Fastest calibrated sweep rate is limited by some mainframes.)

Trigger Holdoff Time —

MIN Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
MIN Holdoff Setting	0.5 μs/div to 50 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweeps lengths for sweep rates of 20 ms/div or faster	

Triggering —

Sensitivity (AUTO and NORM modes)

Coupling	Triggering Frequency Range[1]	Min Signal Required Int	Min Signal Required Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
AC LF REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC[3]	DC to 50 MHz	0.3 div	50 mV
	50 MHz to 150 MHz	1.5 div	250 mV

[1] *Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.*

[2] *Will not trigger on sine waves of less than 8 div Int, or 3 V Ext, at or below 60 Hz.*

[3] *Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.*

Sensitivity (P-P AUTO MODE) (Ac or Dc Coupling)

Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 150 MHz	1.5 div	375 mV

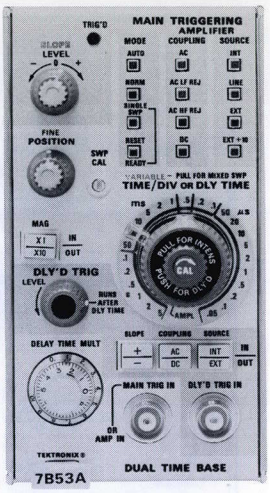
Option 2

X-Y Phase Shift — (Determined by the circuitry in mainframe) For mainframes without X-Y horizontal compensation, the mainframe phase shift specification is retained for frequencies of 50 kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

Order 7B50A Time Base $525

7B50A OPTION

Order Option 2, X-Y . . . . . Add $50



7B53A

5 ns/Div to 5 s/Div Calibrated Time Base

Calibrated Mixed Sweep

Triggering to 100 MHz

Single-Sweep Operation

Optional Tv Sync-Separator Triggering

The 7B53A Dual Time Base is recommended for use with the 7600 and Storage Families to provide bandwidth/sweep-speed compatibility.

The 7B53A time base features four kinds of sweep: normal, intensified delaying, delayed, and mixed. The pushbutton switches cannot be lit.

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 may be displayed with delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system.

DELAYING SWEEP

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

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT, at least +15 V to −15 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate — 0.05 μs/div to 0.5 s/div in 22 steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps to at least 1.25 s/div and is switchable between the main, delayed sweep, and variable main sweep holdoff.

Sweep Accuracy — Measured over the center 8 div.

Time/Div	Unmagnified +15°C to +35°C	Unmagnified 0°C to +50°C	Magnified +15°C to +35°C	Magnified 0°C to +50°C
0.5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	4%	5%	4.5%	6%
50 ms/div to 0.5 μs/div	3%	4%	3.5%	5%

Delayed Sweep Gate — Output voltage is approx +3.5 V into at least 10 kΩ shunted by 100 pF or less, or 0.5 V into 50 Ω. Rise time is 50 ns or less; output R is 350 Ω within 10%. Gate is available at the DLY'D TRIG IN connector when the delayed sweep source switch is set to INT.

Triggering —

Coupling	Triggering Frequency Range	Min Signal Required Int	Ext
Ac	30 Hz—10 MHz 10 MHz—100 MHz	0.3 div 1.5 div	100 mV 500 mV
Dc	Dc—10 MHz 10 MHz—100 MHz	0.3 div 1.5 div	100 mV 500 mV

Internal Trigger Jitter — 1 ns or less at 75 MHz.

External Trigger Input — Max input voltage is 500 V (dc + peak ac), 500 V p-p ac at 1 kHz or less. Input R and C is 1 mΩ within 2%, 20 pF within 2 pF. LEVEL range is at least +1.5 V to −1.5 V in EXT.

MIXED SWEEP

Sweep Accuracy — Within 2% plus measured main sweep error. Exclude the following portions of mixed sweep: first 0.5 div after start of main sweep display and 0.2 div or 0.1 μs (whichever is greater) after transition of main to delayed sweep.

EXT HORIZONTAL INPUT

Deflection Factor — 10 mV/div within 10% when in EXT, MAG X10, 100 mV/div within 10% when in EXT; 1 V/div within 10% when in EXT ÷ 10.

Bandwidth

Coupling	Lower —3 dB	Upper —3 dB
Ac	40 Hz	2 MHz
Ac Lf Rej	16 kHz	2 MHz
Ac Hf Rej	40 Hz	100 kHz
Dc	Dc	2 MHz

Order 7B53A Dual Time Base $925

7B53A OPTION

Order Option 5 TV Triggering . . . . . Add $75

Option 5 — deletes ac line trigger and External ÷ 10 from trigger source.

7B85 Features:

Delay Time with CRT Readout

△ Time with CRT Readout

Vertical Trace Separation Between Two Delayed Sweeps

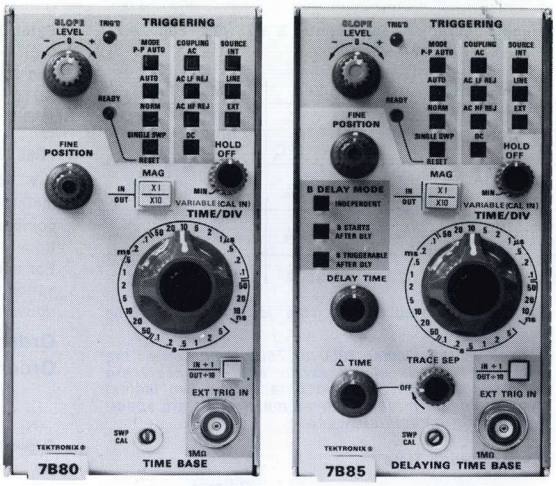
Both Feature:

1 ns/div to 5 s/div Calibrated Time Bases

Triggering to 400 MHz

Variable Trigger Holdoff

Peak-to-Peak Auto Triggering



7B80 **7B85**

The 7B80 and 7B85 are horizontal time bases recommended for use with 7700-, 7800-, and 7900-Series mainframes to provide optimum bandwidth/sweep-speed compatibility. (Each may, however, be used in any slower 7000-Series mainframe with some reduction in sweep accuracy.)

Together they provide delaying sweep and dual delaying sweep with crt digital readout of △ sweep time. The 7B85 provides the delaying and dual delaying sweep, while the 7B80 provides the delayed sweep.

Dual delays provide fast, accurate, and convenient timing measurements with the time difference read directly from the crt △ time display. By overlapping the two expanded waveforms, or by aligning appropriate points on each to the same vertical graticule, the digital display indicates the desired △ time measurement.

In a conventional delaying sweep mode, the time delay to the start of the delayed sweep is shown on the crt digital readout.

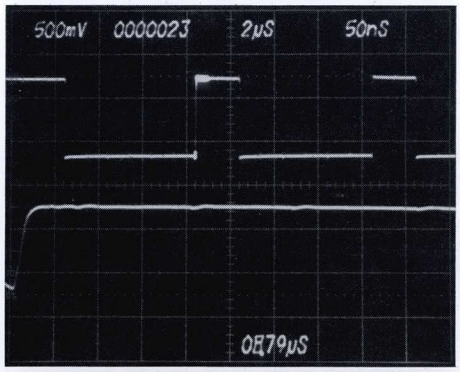


Fig 1. Delaying and delayed sweeps are shown with the mainframe selecting ALT sweep modes. The delay time to the start of the delayed sweep is digitally presented on the lower edge of the crt.

By rotating the TRACE SEPARATION control out of the △ TIME OFF position, the △ delay time mode is activated. Two intensified zones can be independently controlled. As in the conventional delay mode, the DELAY TIME knob adjusts the time to the first delayed sweep; the △ TIME knob adjusts the time between the two delayed sweeps. Now, the crt digital readout shows the △ time between the two delays.

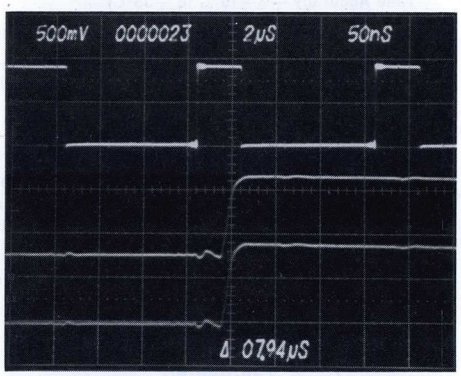


Fig 2. With the mainframe still selecting ALT sweeps, delaying and both delayed sweeps are shown. The digital readout on the lower crt edge shows the time between the two sweep delays. The TRACE SEPARATION knob is used to position the second delayed sweep below the first delayed sweep with up to 3 div of separation.

Either plug-in can be used separately as an independent single time base, or they can be combined in any mainframe with two horizontal compartments for delaying and delayed operation.

X-Y displays are available using a 7B80 with Option 2. A front-panel button (DISPLAY MODE) selects either normal sweep or X-Y display. Both signals are applied to vertical (Y) amplifiers, and the desired horizontal (X) signal is then routed through plug-in and mainframe trigger paths to the 7B80. An X-Y mode selection then applies the signal to the horizontal deflection system.

CHARACTERISTICS

Characteristics are common to both units unless otherwise noted.

Sweep Rates — 5 s/div to 10 ns/div in 27 steps (1-2-5 sequence). X10 MAGNIFIER extends fastest calibrated sweep rate to 1 ns div. The uncalibrated VARIABLE is continuous to at least 2.5 times the calibrated sweep rate.

Sweep Accuracy — Over center 8 div, with 7700, 7800, or 7900 series mainframe.[1]

Time/Div	Unmagnified		Magnified	
Setting	+15°C to +35°C	0°C to +15°C	+15°C to 35°C	0°C to +50°C
5 s/div to 1 s/div	4.0%	5.0%	5.0%	6.0%
0.5 s/div to 0.1 μs/div	1.5%	2.5%	2.5%	3.5%
50 ns/div to 10 ns/div	2.5%	3.5%	4.0%	5.0%

(Fastest calibrated sweep rate is limited by some mainframes.)

[1]*If used in the slower 7300 or 7600 mainframes, the sweep accuracies at 0.2 μs/div and 0.1 μs/div are derated to the 50 ns/div accuracy. The two fastest sweep rates permitted by these mainframes are specified only for magnified sweeps.*

Trigger Holdoff Time —

Minimum Holdoff Setting	5 s/div to 1 μs/div	2 times TIME/DIV setting or less
	0.5 μs/div to 10 ns/div	2.0 μs or less
Variable Holdoff Range	Extends holdoff time through at least 2 sweep lengths for rates of 20 ms/div or faster	

△ **Time Range** — 0 to at least 9 times TIME/DIV setting.

△ **Time Accuracy** — (+15°C to +35°C).

0.5 s/div to 50 ms/div	within (0.5% measurement +0.1% full scale + 1 least significant digit)
20 ms/div to 100 ns/div	within (0.5% measurement +0.03% full scale + 1 least significant digit)

(Full scale equals 10 times the TIME/DIV setting.)

Trace Separation Range — Functional only in △ Delay Time mode when alternating or chopping between time-base units. The second delayed sweep display can be vertically positioned at least 3 div below the first delayed sweep display.

Delay Time Range — 0.2 or less to at least 9.0 times TIME/DIV setting.

Jitter — (0.002% of full scale +0.1 ns) or less.

TRIGGERING

Triggering Sensitivity (Auto and Norm Modes) — (From repetitive signals)

	Triggering	Min Signal Required	
Coupling	Frequency Range[1]	Int	Ext
AC	30 Hz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC LF REJ[2]	30 kHz to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV
AC HF REJ	30 Hz to 50 kHz	0.3 div	50 mV
DC[3]	DC to 50 MHz	0.3 div	50 mV
	50 MHz to 400 MHz	1.5 div	250 mV

1 Triggering frequency ranges are limited to the frequency of the vertical system when operating in the Internal mode.

2 Will not trigger on sine waves of less than 8 div Int, or 3 V Ext, at or below 60 Hz.

3 Triggering Frequency Range for dc coupling applies to frequencies above 30 Hz when operating in the AUTO TRIGGERING MODE.

Single Sweep — Requirements are same as for repetitive inputs.

Internal Trigger Jitter — 0.1 ns or less at 400 MHz.

Sensitivity (P-P AUTO Mode) — (Ac or Dc Coupling)

Triggering	Min Signal Required	
Frequency Range	Int	Ext
200 Hz to 50 MHz	0.5 div	125 mV
50 MHz to 400 MHz	1.5 div	375 mV
Low Frequency Response: At least 50 Hz	2.0 div	500 mV

External Trigger Input — Max input voltage is 250 V (dc + peak ac). Input R and C are 1 MΩ within 5% and 20 pF within 10%. The level range (excluding P-P AUTO) is at least ±1.5 V in EXT ÷ 1, and at least ±15 V in EXT ÷ 10.

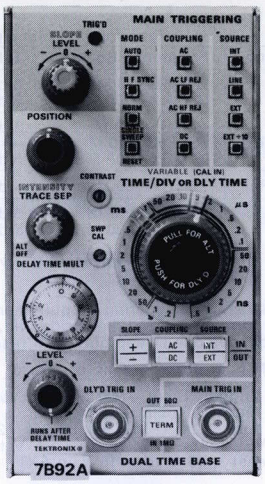
7B80 Option 2

X-Y Phase Shift — (Determined by the circuitry in mainframe). For mainframe without X-Y horizontal compensation, the mainframe phase shift specifications are retained for frequencies of 50kHz and below. For mainframes with optional X-Y horizontal compensation, the extra delay adds to the phase shift error above 50 kHz.

Order 7B80 Time Base $725
Order 7B85 Delaying Time Base $875

7B80 OPTION

Order Option 2, X-Y . . . . . Add $50



7B92A

0.5 ns/div to 0.2 s/div Calibrated Time Base

Triggering to 500 MHz

Alternate Display of Intensified Delaying and Delayed Sweeps

Contrast Regulation Between Delaying and Delayed Sweeps

Lit Pushbuttons

The 7B92A Dual Time Base is recommended for use in the 7700-, 7800-, and 7900-Families of high-frequency oscilloscope mainframes. It is compatible with any other 7000-Series Oscilloscope up to the limits of the mainframe.

There are four display modes: normal sweep, intensified delaying sweep, delayed sweep, and alternate sweep (excepting alternate in R7704).

The 7B92A features calibrated sweeps from 0.2 s/div to 0.5 ns/div. Other features include alphanumeric readout for those oscilloscopes having crt readout systems, contrast control to regulate intensity differences between main and delayed sweeps, and continuous sweep delay from 0 to 9.8 times the delay time selector setting. When operating in the AUTO mode of main triggering, a bright baseline is displayed in the absence of a trigger signal.

DELAYING SWEEP (MAIN SWEEP)

Sweep Rate — 0.2 s/div to 10 ns/div in 23 calibrated steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900-Family Oscilloscope:

Time/div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div	Within 3%	Within 4%

Delay Time Multiplier Range — 0 to 9.8 times the DLY TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.96 seconds).

Differential Delay Time Measurement Accuracy — (+15°C to +35°C).

Sweep Speed

0.2 s/div to 0.1 μs/div	Both delay time mult dial settings at 0.5 or greater	±(0.75% of measurement + 0.25% of full scale)
	One or both delay time mult dial settings at less than 0.5	±(0.75% of measurement + 0.5% of full scale + 5 ns)
50 ns/div to 10 ns/div	Both delay times equal to or greater than 25 ns	±(1% of measurement + 0.5% of full scale)
	One or both delay times less than 25 ns	±(1% of measurement + 1% of full scale + 5 ns)

Full scale is 10 times the TIME/DIV or DLY TIME setting. Accuracy applies over the center 8 Delay Time Multiplier div from +15°C to +35°C.

Delay Time Jitter — Not applicable for the first 2% of max available delay time (DELAY TIME MULT dial setting greater than 0.2).

0.2 s/div to 50 μs/div	1 part in 50,000 of the max available delay time
20 μs/div to 10 ns/div	1 part in 50,000 of the max available delay time + 0.5 ns

Max available delay time is 10 times the TIME/DIV or DLY TIME switch setting.

MAIN TRIGGERING

Auto, Norm

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz—20 MHz	0.5 div	100 mV
	20 MHz—500 MHz	1.0 div	500 mV
Ac Lf Rej	30 kHz—20 MHz	0.5 div	100 mV
	20 MHz—500 MHz	1.0 div	500 mV
Ac Hf Rej	30 Hz—50 kHz	0.5 div	100 mV
Dc	Dc—20 MHz	0.5 div	100 mV
	20 MHz—500 MHz	1.0 div	500 mV

EXT ÷ 10 switch attenuates external signal 10 times.

HF SYNC — Triggering sensitivity is 0.5 div INT or 100 mV EXT, from 100 MHz to 500 MHz for any coupling except Ac Hf Rej.

Single Sweep — Triggering requirements are the same as normal sweep. When triggered, time base produces one sweep only until reset.

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Input — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1 MΩ input, and 1 W average for 50 Ω input. Range of trigger level is at least ±3.5 V in EXT, and at least ±35 V in EXT ÷ 10.

DELAYED SWEEP

Sweep Rate — 0.2 s/div to 0.5 ns/div in 27 steps (1-2-5 sequence). An uncalibrated variable rate is continuous between steps, and extends sweep rate to at least 0.5 s/div. The VARIABLE control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy — Measured over the center 8 div in a 7900-Family Oscilloscope:

Time/div	+15°C to +35°C	0°C to +50°C
0.2 s/div to 20 ns/div	Within 2%	Within 3%
10 ns/div to 5 ns/div	Within 3%	Within 4%
2 ns/div to 1 ns/div	Within 4%	Within 5%
0.5 ns/div	Within 5%	Within 6%

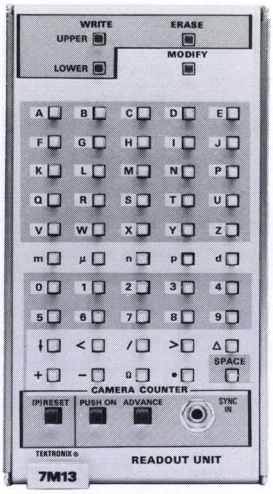
Delayed Triggering

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV
Dc	Dc to 20 MHz	0.5 div	100 mV
	20 MHz to 500 MHz	1.0 div	500 mV

Internal Trigger Jitter — 50 ps or less at 500 MHz.

External Trigger Jitter — Selectable 50 Ω or 1 MΩ inputs (1 MΩ is paralleled by approx 20 pF). Max safe input is 250 V (dc + peak ac) for 1-MΩ input, and 1 W average for 50-Ω input. Range of trigger level is at least ± 3.5 V in EXT.

Order 7B92A Dual Time Base $1625



7M13

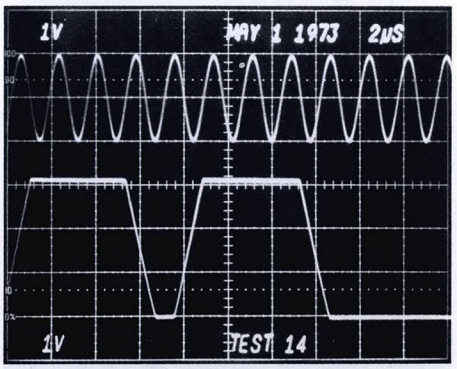
Easy and Convenient Identification of Photographed Displays

Automatic Sequence Advance with Each Camera Exposure

The 7M13 Readout Unit provides front-panel keyboard operation for convenient access to the crt readout characters. The 7M13 is designed for use in all 7000-Series mainframes with crt readout. A remote-advance cable is supplied with the 7M13 to connect it to the shutter x-sync connector of the C-50-Series Cameras. An optional cable is available for cameras using an ASA connector for x-sync.

Included Accessories — Remote-advance cable (012-0339-01).

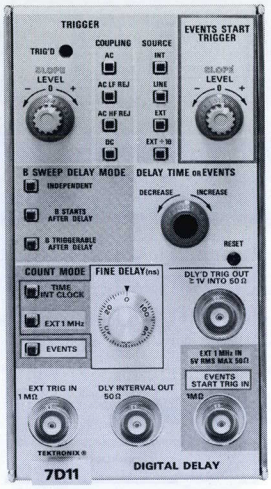
Order 7M13 Readout Unit $425



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 . . . . . $15.00



Delay by Time or Events
Digital Delay Readout to 7½ Digits
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 gives accurate and stable delayed triggers for measurements requiring low jitter and precision time delays. The 7D11 may be used in any compartment of a 7000-Series mainframe equipped with crt readout. It provides a variety of outputs.

The delay-by-events mode is used to eliminate jitter in mechanically based systems such as disc file memories. It is also useful for selecting a certain time frame in data for analysis and for making other measurements under complex timing conditions.

In the delay-by-events, the 7D11 counts arbitrary trigger events, periodic or aperiodic, and delivers an output after the preselected count has been reached (see fig 2).

An accurate delay-by-time is very useful when working with digital logic, PCM telemetry, sonar, radar, shock tube testing, and delay line measurements, to name a few. On receipt of a trigger, the 7D11 in the delay-by-time mode counts a highly accurate clock; at the selected delay time, it delivers a delayed trigger to its front-panel connector and mainframe. In both modes, delay time or number of events to be counted is selected by a single front-panel control.

The 7D11 generates signals which, when applied to the vertical channel and Z-axis, aid in obtaining the proper delay. When the 7D11 is installed in a vertical compartment, the crt will display a waveform that lasts for the duration of the delay interval. This waveform may be displayed together with the signal waveform the 7D11 triggers on. From a vertical compartment, the 7D11 can trigger a time base such as 7B80, 7B53A, or another 7D11 through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 generates 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 (see fig 2). When used in the A horizontal compartment, the 7D11 B sweep delay mode controls will permit the B sweep to 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 delay-by-events, an external pulse (events start trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the events start trigger. Then the 7D11 counts "n" number of horizontal sync pulses (events) into the field or frame. In a similar manner, the origin pulse of a disc memory can be used as the events start trigger, and the disc clock pulses become the events that are counted.

For timing measurements that require a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the delay-by-time clock may be referenced to an external 1-MHz timing standard through the EXT 1-MHz input.

Time delay resolution up to 1 ns may be obtained by using the front-panel fine delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc., the crt readout would display the "one-way-trip" time.

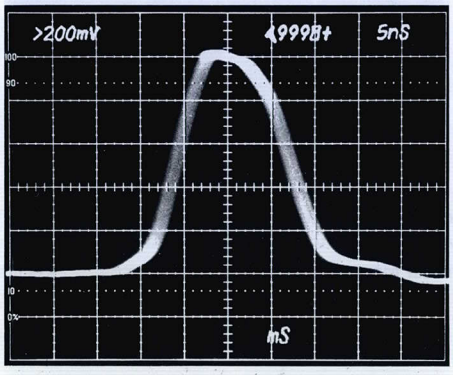


Fig 1: Delay-by-time. A 0.2 µs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

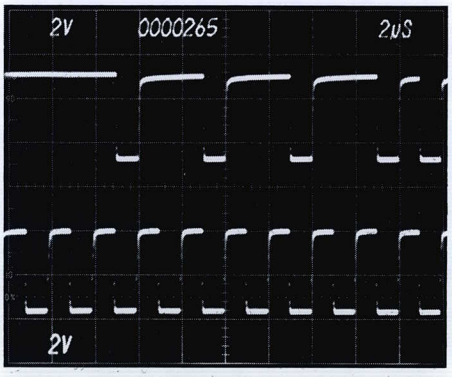


Fig 2: Delay by events. The lower trace is the master clock in our logic circuit. The top trace is our data which is delayed by 265 clock pulses.

EVENTS DELAY

Events Delay Range — One to 10^7 events.
Delay Increment — One event.
Insertion Delay — 35 ns ±5 ns.
Recycle Time — Less than 500 ns.
Max Event Frequency — At least 50 MHz.

TRIGGERING

	External Trigger			
Source	Int, Line, Ext, Ext ÷ 10			
Coupling	Dc, Ac, Ac Lf Rej, Ac Hf Rej			
Max Input Voltage	150 V dc + peak ac			
Level Range	±1.75 V in Ext ±17.5 V in Ext ÷ 10			
Input R and C	1 MΩ ±5%, 20 pF ±2 pF			
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 sine waves of 3 div or less INT or 1.5 V EXT below 120 Hz.

	Events Start Trigger
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc + peak ac
Level Range	±3 V
Input R and C	1 MΩ within 5%, 20 pF ± 2 pF
Sensitivity	100 mV minimum, 30 Hz to 2 MHz; increasing to 250 mV, 2 MHz to 20 MHz; increasing to 500 mV, 20 MHz to 50 MHz.

TIME DELAY

Digital Delay Range — Normal mode: 100 ns to 1 s in 100 ns increments. Echo mode: 200 ns to 2 s in 200 ns increments.
Analog Delay — Continuously variable from 0 to at least 100 ns, accuracy within 2 ns of indicated delay.
Jitter with Internal Clock — 2.2 ns or delay time $X10^{-7}$ whichever is greater.
Insertion Delay — Zero within 2 ns.
Recycle Time — Less than 575 ns.
Time Base — 500 MHz oscillator phase-locked to internal or external clock.
Internal Clock — 5 MHz crystal oscillator. Accuracy is 0.5 ppm.
External Clock — 1 MHz within 1%, ac coupled, 50 Ω.

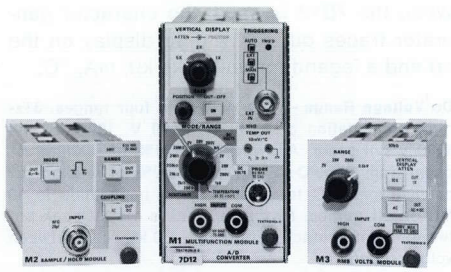
OUTPUTS

Delayed Trigger Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time into 50 Ω Load: 2 ns or less. Fall time into 50 Ω. Load: 5 ns or less. Pulse width: 200 to 250 ns.
Delay Interval Out — Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Rise time and fall time: 5 ns or less. Accuracy: equal to delay interval less 20 to 30 ns.

READOUT

Display — 7½ digit with leading zero suppression, ms legend in time delay mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

Order 7D11 Digital Delay Unit $1525



Versatile 0.01% A/D Converter with Vertical Amplifier

3 Plug-in Modules Available

Automatic, Manual, or External Triggering

Automatic, Polarity, and Overrange Indicators

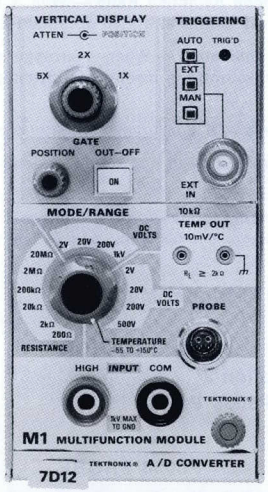
100-MHz Vertical Analog-display Capability

Lit Pushbuttons

The 7D12 A to D Converter, constructed in modules, is a versatile and expandable DVM measurement system. The 7D12 and three interchangeable modules will make most DVM measurements, including dc volts, resistance, temperature, one- or two-point sample and hold, and true rms volts.

The 7D12 is designed for use with all 7000-Series Oscilloscope mainframes with crt readout.

7D12/M1 MULTIFUNCTION MODULE



Temperature Mode

4½ Digit Crt Readout

100-μV Resolution

Probe Measures Temperature or Voltage

The M1 Multifunction Module measures dc volts, resistance, and temperature. The input can be elevated 1 kV above ground, 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 V) is available regardless of mode selected.

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. Max safe input is 1 kV peak between either connector and ground. Polarity is automatic. Cmrr is at least 80 dB at 60 Hz (100 Ω imbalance). Normal-mode rejection ratio is at least 50 dB at 60 Hz.

Resistance Range — 0 to 20 MΩ in six ranges. 4½-digit presentation of 199.99 Ω, 1.9999 kΩ, 19.999 kΩ, 199.99 kΩ, 1.9999 MΩ, 19.999 MΩ full scale. Accuracy is ±0.09% of reading ±0.01% of full scale from +15°C to +40°C. Input is fuse protected.

Temperature Range — −55°C to +150°C in one range. Accuracy (+15°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Temperature out is 10 mV/°C into a load of at least 2 kΩ.

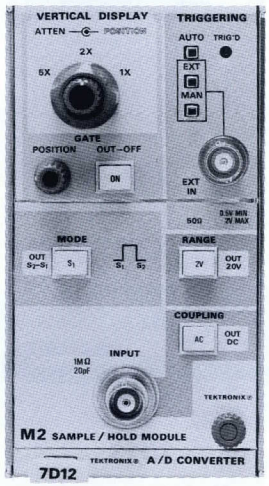
Settling Time — 2 s or less to within 1 count of final reading (voltage and resistance modes).

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Included Accessories — P6058 voltage/temperature probe package (010-0260-00); pair of test leads (012-0427-00).

7D12/M2 SAMPLE/HOLD MODULE



Oscilloscope-controlled Sampling DVM

10-ns Aperture Uncertainty

Input Signal and Sample Points Displayed on Crt

3½ Digit Crt Readout

Approaching 0.25% Accuracy

1-mV Resolution

25-MHz Bandwidth

0-to-2 V and 0-to-20 V Input Range, 200 V with P6055 Probe

The M2 Sample/Hold Module measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) may be triggered automatically, manually, or externally from sources such as the oscilloscope's Delayed B gate, the 7D15's pseudo gate, 7D11's delayed trigger out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and 7D12/M2 gate are displayed together, providing a visual indication of where the sample(s) 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 0 V level, is digitally displayed on the crt readout. In the S2-S1 mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate, and the voltage difference between these two points is digitally displayed on the crt readout.

Sample-gate Display Amplitude — 2 div, rise time and fall time 5 ns or less.

Analog-signal Display — Bandwidth is dc to 25 MHz (dc-coupling), 3.4 Hz to 25 MHz (ac-coupling). Vertical sensitivity is 100 mV/div to 5 V/div in 6 steps (1-2-5 sequence in combination with M2 range and 7D12 vertical display attenuation). Accuracy is within 5%.

Input R and C — 1 MΩ and 20 pF.

Max Input Voltage — 100 V peak.

Measurement Readout — 0 to 20 V in two ranges. 3½-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 probe.

Overrange Indication — When overrange occurs, a > symbol appears to the left of the reading.

Aperture Uncertainty — 10 ns or less.

Pulse-width Sample Time (S2-S1 mode) — 30 ns to 5 ms with repetitive signal. 150 μs to 5 ms with single-shot signal.

Measurement Rate — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

Settling Time — 40 ns.

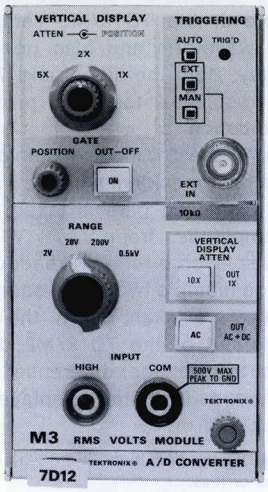
Accuracy without Probe (40 ns after Input Signal Step Function)

Temperature Range	S1 Mode	S2-S1 Mode
+20°C to +30°C	±0.15% of p-p input voltage, ±0.1% of reading, ± 2 counts, ± % of ac decay*	±0.25% of p-p input voltage, ±0.15% of reading, ± 2 counts, ± % of ac decay*
+15°C to +40°C	±0.25% of p-p input voltage, ±0.2% of reading, ± 3 counts, ± % of ac decay*	±0.35% of p-p input voltage, ±0.25% of reading, ± 3 counts, ± % of ac decay*

*Applicable when M2 is ac-coupled.

Included Accessories — 3.5 ft P6055 probe package (010-6055-01).

more on next page



7D12/M3

True Rms Measurements with Isolated-analog Display (Floating Common-mode Capability)
Measures Ac + Dc or Ac Only
40 Hz-to-100 kHz Ac Voltage Range
0.25% Accuracy from 40 Hz to 40 kHz
3½ Digit Crt Readout
1 mV Resolution
500 V Max Peak Common-mode Voltage

The M3 RMS Volts Module measures the true rms voltage of signals from 40 Hz to 100 kHz. Voltages up to 1 kV peak may be measured while floating the input connectors.

Input R and C — 1 MΩ; ≃ 50 pF.
Max Crest Factor — 5 (crest factor = $\frac{E_{pk}}{E_{RMS}}$).
Max Input Voltage

Range		2 V, 20 V, 200 V	0.5 kV
Ac- or Dc-coupled†	Max Input between Connectors	2.5 X Range Peak	500 RMS, 1 kV Peak
	Max Input between either Connector and Chassis Ground	500 V Peak	500 V Peak

†Ac-coupling adds an additional 220 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 — External Trigger: 1 to 12 measurements per second, depending on external trigger frequency and internal adjustment. Auto Trigger: 1 to 4 measurements per second, internally adjustable.

Accuracy — Stated with form factor of 1.2 or less (form factor = $\frac{E_{RMS}}{E_{average}}$); +15°C to +40°C*.

Range	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz	40 kHz to 100 kHz
2 V, 20 V	±0.5%	±0.25%	±0.25%	±0.5%
200 V	±0.5%	±0.25%	±0.5% plus 1% of reading	±0.5% plus 1% of reading
500 V	±1%	±1%	±2% plus 1% of reading	±2% plus 1% of reading

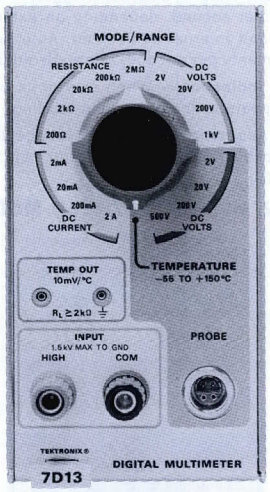
*Accuracies represent a percentage of full scale. For signals with form factors greater than 1.2, add ± [0.1% x (form factor −1)] to the above percent of full scale accuracy specifications.

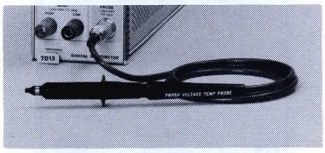
Analog-Signal Display — Bandwidth is dc-to-700 kHz, max slew rate limited to full scale voltage ÷ 1 μs (100 V/μs max). Vertical sensitivity is 100 mV/div to 500 V/div in 12 steps (1-2-5 sequence, combining M3 and 7D12 vertical display attenuation). Accuracy is within 5%, and aberrations are 5% or less.

Included Accessories — Pair of test leads (012-0427-00).

7D12/M1/M2/M3 ORDERING INFORMATION

7D12 A/D Converter (Modules not Included) $775
M1 Multifunction Module $375
Option 2 without P6058 ..... **Sub $100**
M2 Sample/Hold Module $725
Option 2 without P6055 ..... **Sub $120**
M3 RMS Volts Module $575





7D13

Temperature Mode
1.5 kV Max Common-mode Voltage
Probe Measures Temperature or Voltage
3½ Digit Crt Readout

The 7D13 is a digital multimeter designed for use in all 7000-Series Oscilloscope mainframes with crt readout. The 7D13 functions in any compartment.

The 7D13 measures dc volts, dc current, and resistance. It also measures temperature from a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 V). Temperature may be measured simultaneously along with any other function. Almost any NPN transistor may be used as a separate sensor to make small-space "free air" measurements.

When the 7D13 is used, the character generator traces out a 3½ digit display on the crt and a legend for units like kΩ, mA, °C.

Dc Voltage Range — 0 to 1000 V in four ranges. 3½-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is ±0.1% of reading ±1 count from +15°C to +40°C, ±0.2% of reading ±2 counts from 0°C to +50°C. Input impedance is 10 MΩ on all ranges. Max safe input is 1.5 kV peak between either contact and ground, 1.0 kV peak between voltage contacts.

Dc Current Range — 0 to 2A in four ranges. 3½ digit presentation of 1.999 mA, 19.99 mA, 199.9 mA, and 1999 mA full scale. Accuracy is ±0.5% of reading ±2 counts from +15°C to +40°C, ±0.7% of reading ±4 counts from 0°C to +50°C. Max input is 3A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range — 0 to 2 MΩ in five ranges. 3½-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +40°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range — −55°C to +150°C in one range. 3½ digit presentation to +150°C. Accuracy (+5°C to +40°C ambient) is ±1°C from −55°C to +125C, ±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.

Max Common-mode Voltage — 1.5 kV peak between two terminals and ground.

Normal-mode Rejection Ratio — At least 30 dB at 60 Hz increasing at 20 dB/decade.

Common-mode Rejection Ratio — With a 1 kΩ imbalance, at least 100 dB at dc; 80 dB at 60 Hz.

Overrange Indication — When overrange occurs, the readout blinks and the most significant digit displays a 2.

Recycle Time — 5 measurements per second.

Temperature Out — 10 mV/°C into a load of at least 2 kΩ.

Included Accessories — P6058 Voltage/Temperature Probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 Digital Multimeter $650

7D13 OPTION

Order Option 2 without P6058 Probe ..... Sub $90

P6058 PROBE

The P6058 Probe is a combination 1X dc voltage and temperature measuring device. The temperature-sensing element consists of a transistor installed in the tip that plugs into the end of the probe body. For voltage measurements, a twelve-inch and five-inch "common" (low) strap is provided. There is no external ground on the P6058 body; ground or the low-potential point of the circuit under test is referenced to the common strap, a floating common that has no tie to chassis ground. This lead may be floated at up to 40 V dc above chassis ground. The probe tip may be 500 V above ground.

The retractable hook-tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

Dc Voltage Range — 0 to 1000 V. Accuracy is ±0.1% of reading ±1 count.

Max Safe Input — 500 V peak between high and common; 40 V peak between common and chassis ground.

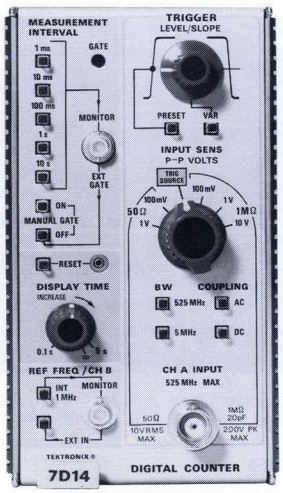
Temperature Range — See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable — 46 in including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight — Approx 5 oz.

P6058 Voltage/Temperature Probe. Order 010-0260-00 . . . . . $100

Includes P6058 Probe (010-0259-00): probe retractable hook tip (013-0121-00); 12 in ground lead screw-in (175-0991-00); two miniature alligator clips (344-0046-00).



7D14

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

Lit Pushbuttons

The 7D14 is a directly gated digital counter plug-in unit designed for use in all 7000-Series Oscilloscope mainframes with crt readout. It will function in any plug-in compartment. The 7D14 has three modes of operation: frequency—0 to 525 MHz, frequency ratio (A/B)—0 to 10^5:1 and totalize— 0 to 10^8.

The 7D14 counts directly to 525 MHz. The gated approach makes possible "single event" counting which is frequently very desirable in rapid burst measurements. The resolution and accuracy can be improved by increasing the measurement interval.

Measurements which were previously impossible can now be made with an oscilloscope having a digital counter plug-in. By locating the counter in one of the vertical compartments of the oscilloscope and operating the scope in the delaying time-base mode, the B sweep (delayed sweep) can drive the counter gate. By doing this, signals may be displayed on the screen. Those being counted will be intensified.

With the 7D14 in a vertical compartment, the output of its trigger circuit can be displayed directly on the crt. This provides an indication of the actual triggering point, thus many signals that were difficult to trigger on in the past can now be measured with much greater reliability. Selective triggering is now possible too.

When the 7D14 is used in a horizontal plug-in compartment, a signal connected to a vertical plug-in may be internally routed to it by the trigger source switches. All the 7000-Series vertical plug-ins are available as signal conditioners for the counter. Another advantage is the reduction of circuit loading. One connection to the oscilloscope deflects the vertical and provides the input for the counter.

FREQUENCY MEASUREMENTS

Input — Channel A, 0 to 525 MHz. Upper bandwidth may be restricted to 5 MHz to filter incoming high frequency noise.

Measurement Interval (Time Base) — 1 ms to 10 s in five decade steps. Up to 0.1 Hz resolution can be obtained.

Accuracy — Within $\pm \frac{1}{\text{total count}} \pm$ time base.

Time-base Stability — Within ±0.00005%, 0°C to +50°C ambient temperature.

Long-term Drift — 1 part or less in 10^7/month.

Input Characteristics

	Channel A		Channel B	Internal Trigger Source
	50 Ω	1 MΩ		
Dc-coupled	Dc to 525 MHz	Dc to 525 MHz	Ac-coupling Only	Ac-coupling Only
Ac-coupled	200 kHz to 525 MHz	5 Hz to 525 MHz	10 Hz to 2 MHz	5 Hz to 525 MHz*
Sensitivity	100 mV p-p (35 mV rms)	100 mV p-p (35 mV rms)	800 mV p-p	1.5 Graticule Div*
Input R & C	50 Ω	1 MΩ ≈20 pF	10 kΩ ≈30 pF	Depends on Amplifier Plug-in Used
Max Voltage	10 V rms	200 V (Dc + Peak Ac) to 5 MHz 50 V (Dc + Peak Ac) 5 MHz to 525 MHz	15 V (Dc + Peak Ac) to 2 MHz	Depends on Amplifier Plug-in Used

*Bandwidth and sensitivity limited by mainframe, sensitivity derated above 150 MHz.

FREQUENCY RATIO

Range — Channel A: 0 to 525 MHz.
Channel B: 10 Hz to 2 MHz.

TOTALIZE

Range — 0 to 10^8.

Gating — Operated manually or with an electrical gate. The external gate input is compatible with the sweep gate from the oscilloscope mainframe. Reset and external gate signals compatible with TTL logic.

MONITORS

Monitor/Ext Gate — Provides crystal-based time markers of +5 V; width determined by the measurement interval.

REF FREQ/CH B Monitor — Provides a crystal-based, 1-MHz, +5-V output pulse. This connector functions as CH B input in the EXT IN mode.

READOUT

Display — Eight digits with leading zero suppression, positioned decimal, MHz or kHz legend.

Display Time — 0.1 to 5 s; also a present position for infinite display time.

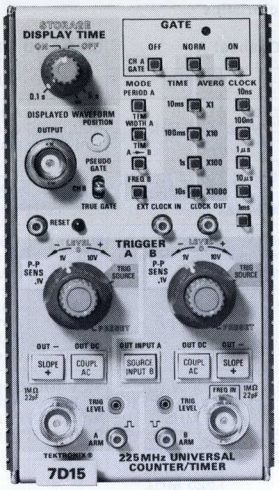
TRIGGERING

Level/Slope Range — + and −0.5 V with INPUT at 100 mV.

Displayed Trigger Indicator — Displayed amplitude of Schmitt trigger output is approx 0.2 div.

Included Accessories — BSM male to BNC female adapter (103-0036-00).

Order 7D14 Digital Counter $1550



Oscilloscope-controlled Time and Frequency Measurements

10 ns "Singleshot" Time Interval Measurement Resolution

Time Interval Averaging

Crt Display of Counting Interval and Schmitt Trigger Signal

10 ps Period Averaging Resolution

Signal Conditioning via Mainframe Trigger Source

Frequency Measurements Directly to 225 MHz

Accurate "Time Mark" Outputs

Lit Pushbuttons

The 7D15 is a universal counter/timer designed for use in all 7000-Series Oscilloscope mainframes with crt readout.

The 7D15 offers all the measurement capabilities of the counter/timer, such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

Three displays, the pseudo gate, Ch B Schmitt trigger output, and true gate, are obtainable from a 7D15 front-panel switch and are also available at a front-panel connector.

The 7D15 can also be completely controlled by the oscilloscope's delayed 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 point on the crt display.

Two identical high-speed trigger circuits provide complete signal processing. Identical trigger circuits also allow single-shot time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

The 7D15 has high resolution because of a 10 ns clock, one of five clock positions obtainable from the front panel. A front-panel Clock Out connector makes the selected clock signal available at a front-panel connector. This provides a time mark function that is TTL compatible and will drive a 50 Ω load.

The Ext Clock In connector allows an external 1 MHz timing standard to be used for measurements requiring a higher degree of accuracy than that provided by the internal time base.

The 7D15 may be used in vertical or horizontal compartments of 7000-Series mainframes. It provides a full 8 digit crt display with leading zero suppression and positioned decimal. Legend and averaging information appear at the bottom of the crt display.

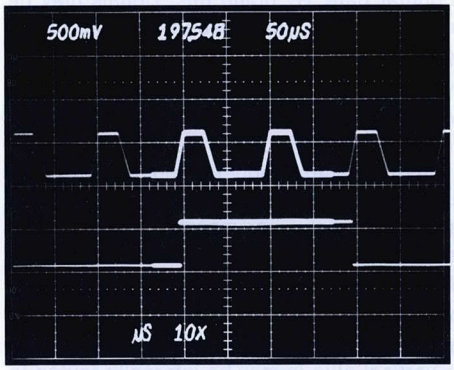


Fig 1: Oscilloscope-controlled digital measurements using the delayed B gate as the arming input logic allow user to make precise time measurement from third to fifth pulse on crt display. Counter Ch A is "armed" with leading edge of B gate while Ch B Counter is "armed" with falling edge of B gate. Lower trace is pseudo gate of 7D15. Crt readout displays the result of 197.548 μs.

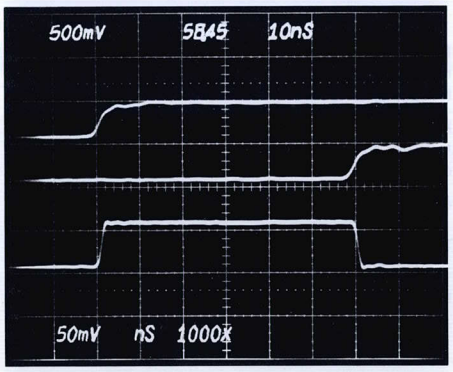


Fig 2: The delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 pseudo gate display. Crt readout displays the result of 58.45 ns.

Modes of Operation		
Frequency Mode	Range	Dc to 225 MHz Resolution 0.1 Hz maximum
	Accuracy	$\epsilon_{freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T}$
Period and Multi-Period Mode	Range	10 ns to 10^5 seconds with averaging times of X1 to X1000 in decade steps. Resolution: 10 picoseconds maximum
	Accuracy	$\epsilon_{period(s)} = \pm TB \cdot P_{in} \pm \frac{10^{-9}}{M} \pm \frac{2E_{npk}}{\frac{dv}{dt} \cdot M} \pm \frac{P_{ck}}{M}$
Time Interval TI and (TI Average) Mode	Range	6 ns to 10^5 seconds with averaging times of X1 to X1000. 0.1 ns resolution (usable)
	Accuracy Worst Case (Nominal)	$\epsilon_{TI(s)} = \pm TB \cdot P_{in} \pm \frac{P_{ck}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{npk}}{\frac{dv}{dt}}$
Frequency Ratio, CH B/ Ext Clock	Range	10^{-7} to 10^4
Manual Stop Watch	Range	0 to 10^5 seconds
Totalize, Ch B	Range	0 to 10^8 counts

NOTE: Formulas given where ϵ is the error; TB (expressed as a decimal) is the time base accuracy; P_{in} is the period or time interval of unknown signal; M is the number of averages given; P_{ck} is the measurement clock period; T is the gate time; f_{in} is the frequency of the unknown signal; E_{npk} equals peak noise pulse amplitude as presented to Schmitt trigger circuit; dv/dt equals signal slope at input to Schmitt trigger (volts per second).

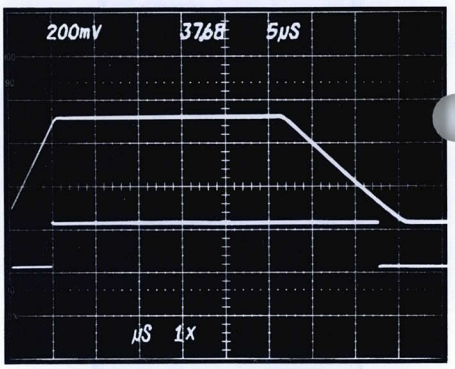


Fig 3: Independent slope and level control allows the user to select precise points on the waveform where the counter starts and stops. Crt readout displays the result of 37.68 μs.

INTERNAL TIME BASE

Crystal Oscillator — Accuracy: within 0.5 ppm (0°C to +50°C ambient). Long-term drift: 1 part or less in 10^7 per month. Oscillator is temperature compensated; no warm up is required.

OUTPUT SIGNALS

Clock Out — Logical 1 ≥ +0.5 V into 50 Ω. Logical 0 ≤ 0 V into 50 Ω. TTL compatible without 50 Ω load (1.6 mA current capacity).

A and B Trigger Level — $Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (Internally Connected) — Front-panel switch selects true gate, pseudo gate, or channel B signal out. Position controlled by front-panel screwdriver control.

External Display — Same as internal except position control has no effect.

Display Mode Switch — Allows selection of readout "follow or store."

Display Time — 0.1 to 5 s; also a preset position for infinite display time.

Readout — Eight-digit display; the four most significant have zero suppression. Overflow indicated by a > symbol.

INPUT 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-p. Trigger source: 0.5 div of vertical deflection.

Input R and C — 1 MΩ and 22 pF.

Triggering (Preset Position) — Automatically triggers at 0 V.

Level Control Range (CH A and B Inputs) — 100-mV range: ±500 mV; 1-V range: ±5 V; 10-V range: ±50 V.

Arming Inputs — Input R and C: 10 kΩ and 20 pF. Sensitivity arm A: logical 1 ≥ +0.5 V, logical 0 ≤ +0.2 V. Sensitivity arm B: logical 1 ≤ +0.2 V, logical 0 ≥ +0.5 V.

External Clock-In — 20 Hz to 5 MHz.

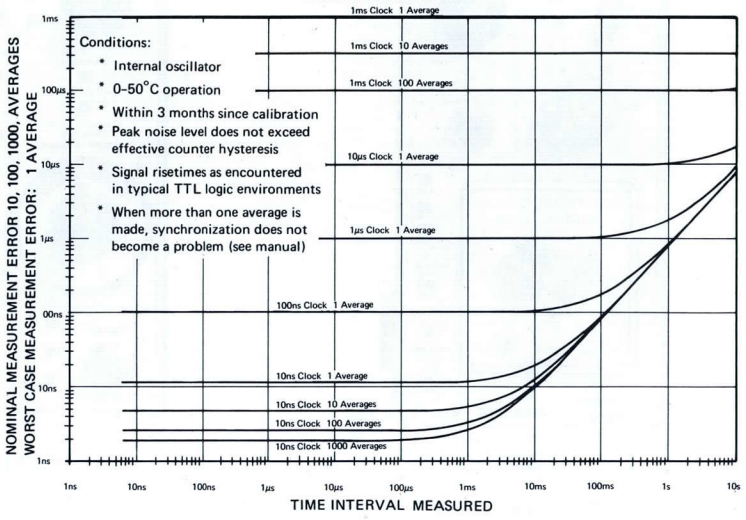
Reset Front Panel — Reset readies the instrument. All counters are affected, including averaging circuits.

Included Accessories — Two cables RF 44 in (012-0403-00, Sealectro to BNC connector).

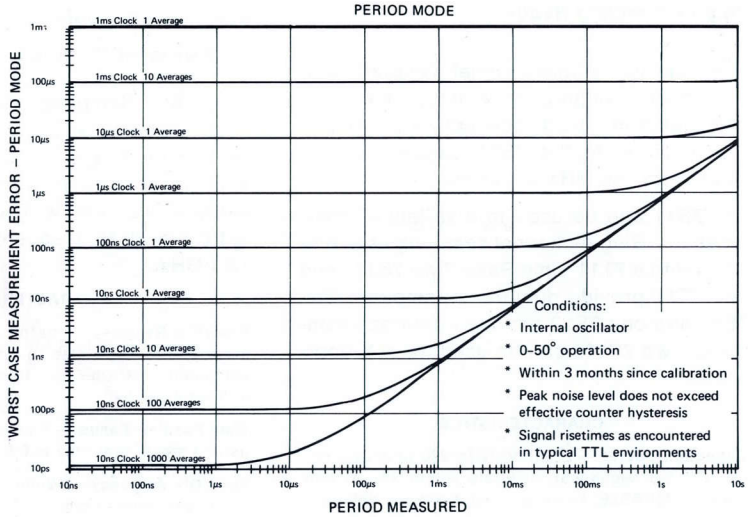
Order 7D15 Universal Counter/Timer $1600

ACCURACY

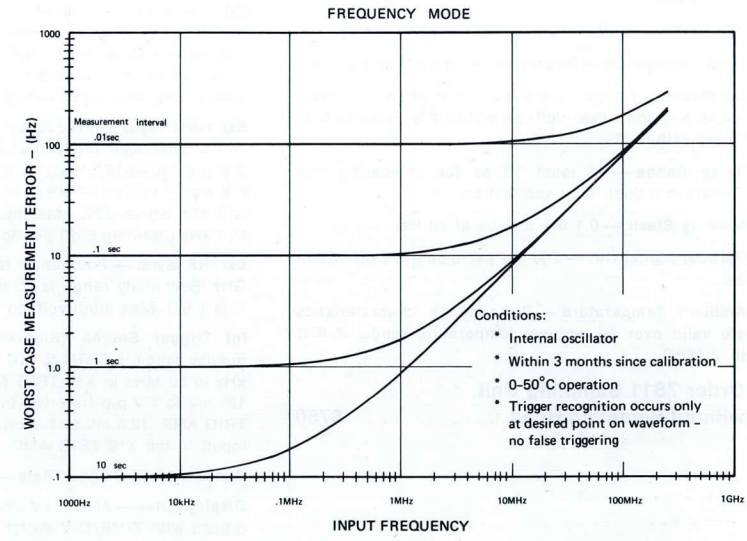
TIME INTERVAL MODES



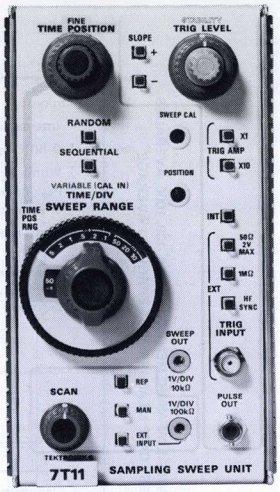
PERIOD MODE



FREQUENCY MODE



7S11



7T11

2 mV/div to 200 mV/div Calibrated Deflection Factors

Plug-in Sampling Heads

The 7S11 is a single-channel sampling unit. The input configuration employs the sampling plug-in head concept. The heads, which mount in the 7S11, range in bandwidth from 350 MHz to 14 GHz.

The 7S11 can be used in a variety of combinations. Single-channel sampling uses one 7S11 with a 7T11 Time Base. Two 7S11s and one 7T11 provide dual-trace sampling. One 7S11 and one 7S12 provide dual-trace sampling. Two 7S11s can be used for X-Y operations.

CHARACTERISTICS

Deflection Factor — 2 units/div to 200 units/div in 7 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/div or less to at least 400 units/div). Deflection factor is determined by the plug-in sampling head.

Bandwidth — Determined by the sampling head.

Input Impedance — Determined by the sampling head.

Dc Offset — Range, +1 V to −1 V or more. Offset out is X10 the offset voltage within 2%. Source R is 10 kΩ within 1%.

Delay Range — At least 10 ns for comparing two signals in a dual-trace application.

Memory Slash — 0.1 div or less at 20 Hz.

Vertical Signal Out — 200 mV per displayed div within 3%.

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

Order 7S11 Sampling Unit without Sampling Head $750

10 ps/div to 5 ms/div Calibrated Time Base

Random or Sequential Sampling

Equivalent or Real-time Sampling

No Pretrigger Required

The 7T11 Sampling Time Base provides equivalent-time and real-time horizontal deflection for single- or dual-trace sampling. Timing accuracy is within 3% and nonlinearity is well below 1%. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz.

CHARACTERISTICS

Time/Div Range — 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to time position ranges. Uncalibrated VARIABLE is continuous between steps to at least 4 ps/div.

Time Position Range — Equivalent time is 50 ns to 50 μs in 4 steps; real time is 0.5 ms to 50 ms in 3 steps.

Time/Div Accuracy — Within 3% for all time/div settings over center 8 cm.

TRIGGERING

Ext 50-Ω Input — Frequency range is dc-to-1 GHz in X1 TRIG AMP mode. Sensitivity range is 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 per octave to a min 5 V p-p).

Ext HF Sync — Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Max input voltage is 2 V p-p.

Int Trigger Source (Sine-wave Triggering)* — Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 125 mV to 1 V p-p (referred to the vertical input) in X1 TRIG AMP; 12.5 mV to 1 V p-p (referred to the vertical input) in the X10 TRIG AMP.

Random Mode Trigger Rate — 100 Hz min.

Display Jitter — Measured under optimum trigger conditions with TIME/DIV switch clockwise.

*Trigger circuits will operate to dc with pulse triggering, except for HF Sync.

Time Pos Range	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div or less	1 div or less
50 ns	10 ps	30 ps

Pulse Out — Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5 ns rise time or less.

Trigger 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.

INCLUDED ACCESSORIES

42-in BNC 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-02); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874 adapter (015-1007-00).

Order 7T11 Sampling Sweep Unit $2200

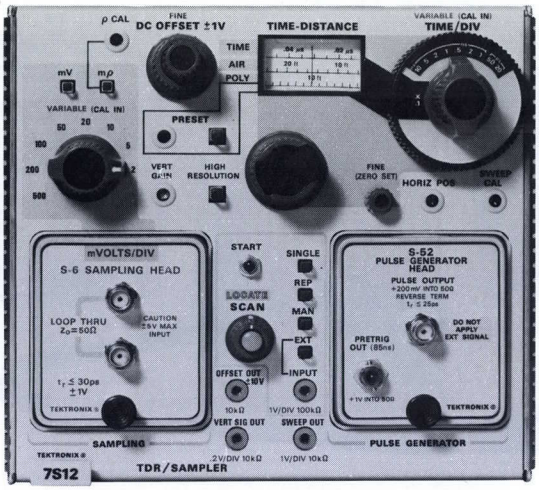
45 ps TDR or 30 ps General-purpose Sampler

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 for high-resolution TDR or general-purpose sampling measurements. As a TDR using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system rise time of 45 ps (return from short-circuit termination) and distance range to 4900 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 as S-54 Pulse Generator Head, distance calibration extends to 4900 ft (air line) and discontinuities to twice this distance may be viewed. System rise time with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5, or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available.

CHARACTERISTICS

System Performance with S-6 and S-52

System Rise Time — 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distance to at least 400 ft (air line). Time range is at least 0.9 μs round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude — At least +200 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω, feed-through signal channel (termination supplied). SMA (3 mm) connectors.

Jitter — Less than 10 ps (without signal averaging).

Aberrations — +7%, −7% total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, −2% total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

TDR System Performance with S-5 and S-54

System Rise Time — 1.5 ns or less for the displayed reflection from a short-circuited test line.

Time and Distance Ranges — Direct-reading tape dial gives calibrated one-way distances to 4900 ft air line, 3240 ft solid polyethylene. Time range is 20 μs round trip.

Pulse Amplitude — At least +400 mV into 50 Ω.

Input Characteristics — Nominal 50 Ω test-line connection (cable and T supplied). BNC connectors.

Jitter — Less than 20 ps (without signal averaging).

Aberrations — +4%, −6%, total of 10% p-p within first 17 ns of step; +1.5%, −1.5%, total of 3% thereafter.

OTHER 7S12 CHARACTERISTICS

Vertical Scale — Calibrated in mρ (reflection coefficient X10^{-3}) and mV from 2 to 500 units/div in 8 steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous between steps.

Resolution — Reflection coefficients as low as 0.001 may be observed. Signal averaging reduces test-line noise in display.

Dc Offset Range — +1 V to −1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 dc offset through 10 kΩ.

Time/Distance — Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectrics having propagation factors from 0.6 to 1.

Time/Div — 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button — Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes — Repetitive or single sweep, manual or external scan.

Signal Outputs — Pin jacks provide both vertical signal and sweep outputs.

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00).

Order 7S12 TDR Sampling Unit (Tape Dial in Feet) without Sampling Heads $1600

Order Option 3 Tape Dial Change (Meters) ..... No Charge

OPTIONAL ACCESSORIES

Patch Cords — available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT, and SWEEP OUT jacks of the 7S12. Pin-jack to pin-jack, 0.08 in dia pin.

Red, 8 in, Order 012-0179-00 ..... $2.85

Red, 18 in, Order 012-0180-00 ..... $2.85

Black, 8 in, Order 012-0181-00 ..... $2.85

Black, 18 in, Order 012-0182-00 ..... $2.85

Tape Dial (Calibrated in Feet)— Order 331-0273-00 ..... $10.50

Tape Dial (Calibrated in Meters)— Order 331-0276-00 ..... $10.50

NOTE: See 1502-1503 Portable TDR Cable Tester on page 164.

Sampling and TDR

Sampling Heads

S-1

Dc-to-1 GHz Bandwidth
Clean Transient Response

The S-1 Sampling Head is a low-noise, 350-ps rise time unit with a 50 Ω input impedance. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Rise Time— 350 ps or less.

Bandwidth—Equivalent to dc to 1 GHz at 3 dB down.

Transient Response—Aberrations as observed with the 284 Pulse Generator are +0.5%, —3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; +0.5%, —0.5% or less, total of 1% or less p-p after 5 ns.

Displayed Noise— 2 mV or less, unsmoothed; 1 mV, smoothed.

Signal Range—Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights (Approx)

	lb	kg
Net Weight	1	0.5
Shipping Weight	3	1.4

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 $550

S-2

Dc-to-4.6 GHz Bandwidth
Displayed Noise Less than 6 mV (Unsmoothed)

The S-2 Sampling Head is a 75 ps rise time unit with a 50 Ω input impedance. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Rise Time— 75 ps or less.

Bandwidth—Equivalent to dc-to-4.6 GHz at 3 dB down.

Transient Response—Aberrations as observed with the 284 Pulse Generator are +5%, —5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, —2% or less, total of 4% or less p-p after 2.5 ns.

Displayed Noise— 6 mV or less, unsmoothed; 3 mV, smoothed.

Signal Range—Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 200 mV p-p.

Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights (Approx)

	lb	kg
Net Weight	1	0.5
Shipping Weight	3	1.4

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 $575

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe
Order (Std) 015-0041-00 ..... $75

P6050 10X Passive Probe,
Order (Std) 010-6056-03 ..... $75

P6057 100X Probe,
Order (Std) 010-6057-03 ..... $75

Coupling Capacitor, GR874-K,
Order 017-0028-00 ..... $33

Power Divider GR874-TPD,
Order 017-0082-00 ..... $145

GR to BNC Adapter,
Order 017-0063-00 ..... $16.5

S-3A

Compact, 4.5 Ft, 100 kΩ, 2.3 pF Probe
Dc-to-1 GHz Bandwidth
Displayed Noise Less than 3 mV (Unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100 kΩ, 2.3 pF input impedance. Up to 2 V of dc offset may be used while maintaining a 2 mV/div deflection factor.

Rise Time— 350 ps or less.

Bandwidth— (Probe Only) Equivalent to dc-to-1 GHz at 3 dB down.

Transient Response (Probe Only)—Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe Only)— 3 mV or less referred to probe tip (includes 90% of dots).

Signal Range—Variable dc offset allows signals between + 1 V and − 1 V, X1 range, or + 2 V and − 2 V, X2 range, to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the probe attenuators.

Weights (Approx)	lb	kg
Net Weight	3	1.4
Shipping Weight	5	2.3

Included Accessories— 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½ in ground lead (175-1017-00); 12½ in ground lead (175-1018-00); 3 in cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50 Ω voltage pickoff (017-0077-01); carrying case (016-0121-01); 3 in elec lead (175-0849-00); 6 in elec lead (175-0849-01).

Order S-3A Sampling Head $800

S-4

25 ps Sampling Head
Dc-to-14 GHz Equivalent Bandwidth
Displayed Noise Less than 5 mV (Unsmoothed)

The S-4 Sampling Head is 25 ps rise time unit with a 50 Ω input impedance. The S-4 can be plugged into the sampling unit or attached by a sampling-head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Rise Time— 25 ps or less.

Bandwidth—Equivalent to dc-to14 GHz at 3 dB down.

Transient Response—Aberrations in the first 400 ps following a step from 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 offet 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 (Approx)	lb	kg
Net Weight	1	0.2
Shipping Weight	2	0.9

Included Accessories— 2 ns cable with SMA connectors (015-1005-00); 10X 50 Ω SMA attenuator (015-1003-00); GR874 to SMA male adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); 5/16 in wrench (003-0247-00).

Order S-4 Sampling Head $1150

S-5

1 MΩ, 15 pF Input Impedance
Passive Probe
Internal Trigger Pickoff

The S-5 Sampling Head is a low-noise, 1 ns rise time sampling unit with a 1 MΩ, 15 pF input impedance. When used with the included P6010 passive probe, the input impedance increases to 10 MΩ, 10 pF while maintaining the 1 ns rise time at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

Rise Time—S-5 only, 1 ns or less; with 3.5 ft, P6010, 1 ns or less.

Bandwidth—Equivalent to dc-to-350 MHz at 3 dB down at input connector or probe tip.

Transient Response—S-5 only (driven with a 50 Ω source terminated in 50 Ω: aberrations + 2.5%, − 5% or less, total of 7.5% or less p-p within 17 ns after step; + 1%, − 1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5 ft probe, properly compensated): aberrations + 5%, − 5% or less, total of 10% or less p-p within 25 ns after step; +1%, −1% or less, total of 2% or less p-p thereafter.

Displayed Noise—S-5 only, 500 μV or less (includes 90% of dots). S-5/P6010, 5 mV or less (includes 90% of dots).

Signal Range—S-5 only: dc coupled, 1 V p-p from + 1 V to − 1 V; ac coupled, 1 V p-p. S-5/P6010: dc coupled (dc + peak ac), 10 V p-p; ac coupling, dc voltage, 100 V.

Input Characteristics—S-5 only, 1 MΩ within 1% paralleled by 15 pF. S-5/P6010, 10 MΩ paralleled by approx 10 pF.

Attenuator Accuracy—Probe attenuation is 10X within 3%.

Weights (Approx)	lb	kg
Net Weight	9 oz	0.2
Shipping Weight	2	0.9

Included Accessories—P6010 probe package (010-0188-00), 50 Ω termination (011-0049-01).

Order S-5 Sampling Head $550

OPTIONAL ACCESSORIEES

Probe Tip-to-BNC Adapter, Order 013-0084-01 ..... $8.00

Probe Tip-to-GR Adapter, Order 017-0076-00 ..... $20.00

Probe Tip-to-GR Terminated Adapter, Order 017-0088-00 ..... $31.00

S-6

30 ps Rise Time
Displayed Noise Less than 5 mV (Unsmoothed)
Loop-Through Input

The S-6 Sampling Head is a 50 Ω feed-through unit for high-speed applications.

Rise Time— 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth—Equivalent to dc-to-11.5 GHz at 3 dB down.

Transient Response—Pulse aberrations following the steps are + 7%, − 7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; + 2%, − 2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Displayed Noise— 5 mV or less, measured tangentially.

Signal Range— +1 V to −1 V (dc + peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics—Nominally 50 Ω, loop-through system, unterminated. SMA (3 mm) connectors. Max safe overload is ± 5 V.

Weights	lb	kg
Net Weight	1	0.5
Shipping Weight	2	0.9

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 $1100

OPTIONAL ACCESSORIES FOR SAMPLING HEADS with SMA (3 mm) Connectors

2X 50 Ω Attenuator, Order 015-1001-00 .... $120.00
5X 50 Ω Attenuator, Order 015-1002-00 .... 120.00
10X 50 Ω Attenuator, Order 015-1003-00 .... 120.00
50 Ω Termination, Order 015-1004-00 ..... 50.00
2-ns 50 Ω Signal Cable, Order 015-1005-00 .. 44.00
5-ns 50 Ω Signal Cable, Order 015-1006-00 .. 60.00
Male-to-GR874 Adapter, Order 015-1007-00 ..... 38.00
Female-to-GR874 Adapter, Order 015-1008-00 ..... 50.00
Male-to-N Female Adapter, Order 015-1009-00 .... 47.00
Male-to-7-mm Adapter, Order 015-1010-00 .. 150.00
Male-to-Male Adapter, Order 015-1011-00 .. 15.00
Female-to-Female Adapter, Order 015-1012-00 ..... 15.00
Coupling Capacitor, Order 015-1013-00 .... 120.00
50 Ω Power Divider T, Order 015-1014-00 .. 200.00
500-ps 50 Ω Semirigid Cable Order 105-1015-00 .... 28.00
SMA T Adapter, Order 015-1016-00 ..... 25.00
SMA Male-to-BNC Female Adapter, Order 015-1018-00 ..... 5.00
1-ns 50 Ω Cable, Order 015-1019-00 ..... 40.00
SMA Male Short-Circuit Termination, Order 015-1020-00 ..... 15.00
SMA Female Short-Circuit Termination, Order 015-1021-00 ..... 15.00
SMA Male 50 Ω Termination, Order 015-1022-00 ..... 32.00

More on next page

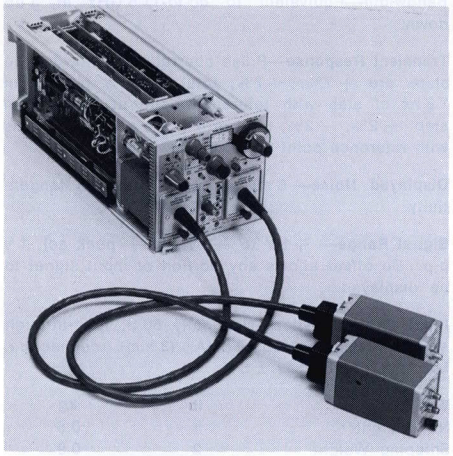
S-51
S-52
S-53
S-54

Sampling and TDR

Pulse Generator Head and Trigger Countdown Head

With BNC Connectors

50 Ω Feed-through Termination,
Order 011-0049-01 ..... $20.00
50 Ω Feed-Through (5 W),
Order 011-0099-00 ..... 30.00
50 Ω 2X Attenuator, Order 011-0069-02 ..... 23.00
50 Ω 2.5X Attenuator, Order 011-0076-02 ..... 23.00
50 Ω 5X Attenuator, Order 011-0060-02 ..... 23.00
50 Ω 10X Attenuator, Order 011-0059-02 ..... 23.00
50 Ω 18 in, Coaxial Cable,
Order 012-0076-00 ..... 9.00
50 Ω 42 in, Coaxial Cable,
Order 012-0057-01 ..... 9.00



3 ft Sampling-Head Extender,
Order 012-0124-00 ..... 135.00
6 ft Sampling-Head Extender,
Order 012-0125-00 ..... 150.00

S-51

18 GHz Countdown

10 ps or Less Trigger Jitter

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

Input Signal—Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω, 5 V, p-p max.

Input Characteristics— 50 Ω SMA (3 mm) connector. Open termination paralleled by 1 pF.

Trigger Output—Front-panel trigger output is at least 200 mV into 50 Ω, type BSM connector. Internal trigger output is at least 100 mV into 500 Ω, internally connected to sampling unit. Jitter is 10 ps or less with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less; kickout occurs between successive samples.

Weights (Approx)

	lb	kg
Net Weight	1	0.45
Shipping Weight	5	2.3

Order S-51
Trigger Countdown Head $675

S-52

25 ps Rise Time

200 mV into 50 Ω

50 Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer.

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50 Ω reverse termination minimizes reflections. The pulse width is sufficient for distances up to 32 ft in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

Pulse Output—Rise time is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 800 ns, pulse period 16 μs within 2 μs. Pulse aberrations following the step are +7%, —7%, total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step +2%, —2%, total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Pretrigger Output—Rise time is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Output Connectors—Pulse output uses an SMA (3 mm) connector. Pretrigger output uses a BSM connector.

Weights (Approx)

	lb	kg
Net Weight	¾	0.3
Shipping Weight	1	.45

Included Accessories— 1 ns, 50 Ω semirigid coax delay line (015-1023-00).

Order S-52 Pulse Generator Head .. $725

S-53

Dc-to-1 GHz Operation

10 mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general purpose sampling system. The S-53 supplies triggering for the 7S12 or for other applications.

Input Characteristics—Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics—Rise time is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Pulse period is 27 μs minimum. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

Connectors—Trigger input connector is BNC type. Front-panel trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Weights (Approx)

	lb	kg
Net Weight	¾	0.3
Shipping Weight	1	.45

Included Accessories— 42 in, 50 Ω cable (012-0057-01); 10X 50 Ω attenuator (011-0059-01).

Order S-53
Trigger Recognizer Head $550

S-54

1 ns Rise Time

Low Aberrations

400 mV into 50 Ω

50 Ω Source

Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long line Time Domain Reflectometer unit.

Intended for TDR applications, the S-54 is 50 Ω reverse terminated to minimize reflections and has a 0 V baseline to eliminate baseline shift with load changes. A continuously variable front-panel control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

Pulse Output—Rise time is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are +1.5%, —1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Baseline level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output—Rise time is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger-to-pulse-output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

Output Connectors—Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Weights (Approx)

	lb	kg
Net Weight	¾	0.3
Shipping Weight	1	0.45

Included Accessories—BNC T connector (103-0030-00); 8 in 50 Ω cable (012-0118-00).

Order S-54 Pulse Generator Head .. $425

Calibrated Delayed Sweep

Two-dot Measurements

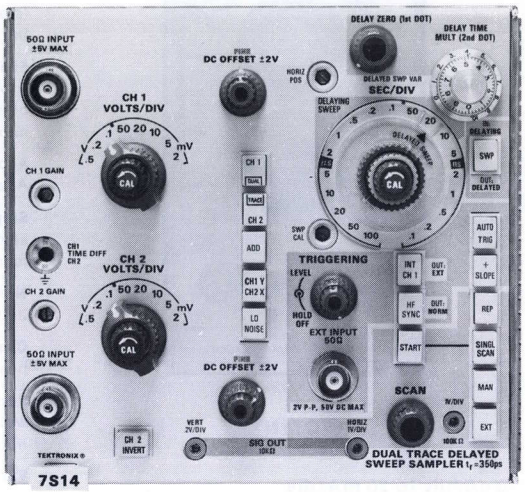
Dc-to-1 GHz Bandwidth

Dual Trace, 2-mV Sensitivity

Crt Readout

Simplified Triggering

Operational Ease of a Conventional Oscilloscope



The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in.

Two identical vertical channels provide dual-trace sampling, a two-ramp time base and calibrated delayed sweep.

Front-panel controls are grouped by color, and the control nomenclature is like conventional oscilloscope nomenclature. Learning to operate the 7S14 requires a minimum of effort for those familiar with conventional oscilloscope operation.

CHARACTERISTICS

VERTICAL CHANNEL

Modes — Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 Vertical (Y), Channel 2 Horizontal (X).

Input Impedance — Nominally 50 Ω.

Bandwidth — Equivalent to dc-to-1 GHz.

Rise Time — 350 ps or less.

Step Aberrations — +2%, −4%, total of 6% p-p within first 5 ns, ±1% thereafter, tested with a 284 Pulse Generator.

Deflection Factor — 2 mV/div to 0.5 V/div in 8 steps (1-2-5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy — Within ±3%.

Max Input Voltage — ±5 V.

Input Signal Range — 2 V p-p max within a +2 V to −2 V window at any sensitivity.

Dc Offset Range — At least +2 V to −2 V.

Displayed Noise — 2 mV or less unsmoothed (measured tangentially). Low noise pushbutton reduces random noise by a factor of 4 to 1 or more.

Vertical Signal Output — 0.2 V/div of vertical deflection; 10 kΩ source resistance.

Channel Delay Difference — Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE

Scan Modes — Repetitive, single, manual, or external.

Delaying Sweep — May be used as the crt time base or as a delay generator for the delayed sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the delaying sweep mode is selected for the time base, two bright dots in the trace, which may be positioned anywhere on the displayed waveform, are generated. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep — This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The delayed sweep may be started with zero delay time with respect to the start of the delaying sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the delaying sweep selected.

Horizontal Signal Output — 1.0 V per div of horizontal deflection; 10 kΩ source resistance.

DELAYING SWEEP

Range — 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy — Within ±3%, excluding first one-half div of displayed sweep.

Delayed Zero (1st Dot) — Adjustable to correspond to any instant within the time interval represented by the first 9 div of the delaying sweep selected.

Delay Time (2nd Dot) — Adjustable to any portion of the time interval represented by 10 div of the delaying sweep selected.

Delay Accuracy — Within ±1% of 10 div when measurement is made within the last 9.5 div.

DELAYED SWEEP

Range — 100 ps/div to 100 μs/div in 19 steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy — Within ±3% excluding first one-half div of displayed sweep.

Start Delay — Depends on the delaying sweep time selected and the setting of the Delay Time Multiplier dial. Adjustable from zero to any time interval up to that represented by 10 div of the delaying sweep selected. The delaying sweep start point corresponds to the position of the second bright dot.

Delay Jitter — Less than 0.05% of the time represented by 1 div of the delaying sweep selected.

TRIGGERING AND SYNC

Signal Sources — Internal from Channel 1 vertical input or external through front-panel connector.

External Triggering — Nominal 50 Ω input, ac coupled, 2 V p-p 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less. 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering — Pulse amplitude 50 mV p-p or more with rise time of 1μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

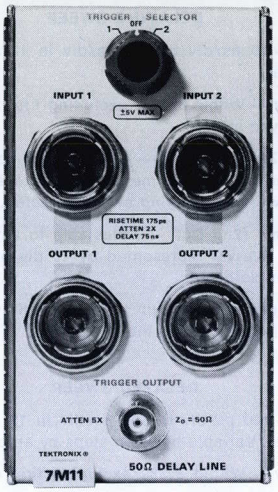
Triggered Mode — Trigger recognition may be made to occur at any selected voltage level between +0.5 V and −0.5 V on either a + slope or a − slope of the triggering signal.

Auto Trigger Mode — For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so that a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff — Varies the length of the interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode — For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

Order 7S14 Dual Trace Delayed Sweep Sampler $2400



7M11

75 ns Time Delay

Selectable Trigger Out

175 ps Rise Time

The 7M11 is a passive dual delay line unit for use with the 7000-Series sampling system. In low-repetition-rate applications requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at fast time-per-div settings.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50 Ω, 75 ns delay lines. The closely matched (30 ps) lines have GR874 input-output connectors, 175 ps rise time, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a rise time of 600 ps or less.

CHARACTERISTICS

DELAY LINE

Time Delay — 75 ns within 1 ns.

Delay Difference — 30 ps or less between channels.

Rise Time — 175 ps or less.

Attenuation — 2X within 2% into 50 Ω.

Input Impedance — 50 Ω within 2%.

Max Input Voltage — ±5 V rms, 50 V peak.

TRIGGER OUTPUT

Rise Time — 600 ps or less.

Attenuation — 5X within 10% into 50 Ω (referred to INPUT).

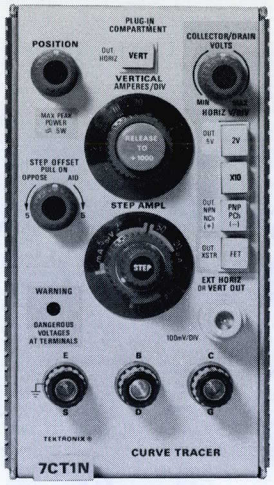
Output Impedance — 50 Ω within 10%.

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

INCLUDED ACCESSORIES

10 in BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00).

Order 7M11 Delay Line Unit **$395**



7CT1N

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

The 7CT1N Curve Tracer plug-in displays characteristic curves of small-signal semiconductor devices to power levels up to 0.5 W. The 7CT1N operates in horizontal or vertical compartments of 7000-Series Oscilloscopes.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Max Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short-circuit current, within 30%.

Series Resistance — Automatically selected with horizontal V/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning — When the horizontal V/div switch is in the X10 position, a flashing warning light, indicating that dangerous voltages may exist at the test terminals, appears on the front panel.

STEP GENERATOR

Transistor Mode — Step amplitude range is 1 μA/st to 1 mA/step, 1-2-5 sequence. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least X5 amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental: within 3% between steps. Absolute: within ± (3% + X0.3 amplitude setting).

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in 1 step increments between 0 and 10.

Offset — Selectable to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

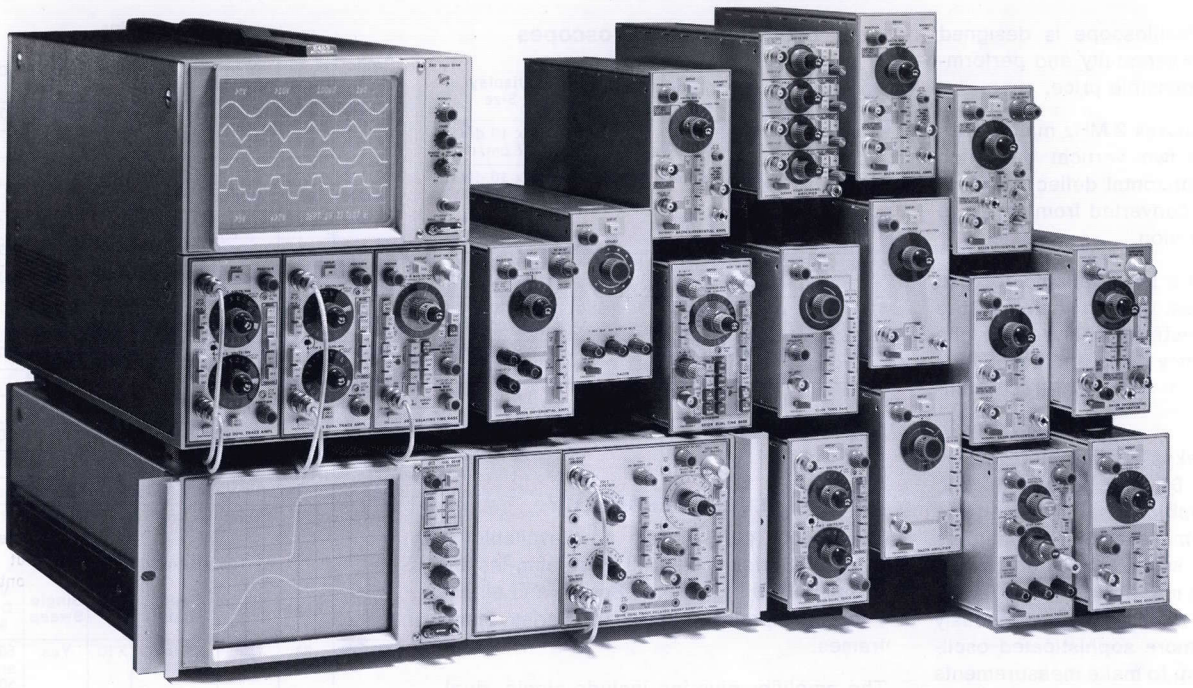
Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal volt in the ÷1000 mode.

Horizontal Deflection Factors — Selectable: 0.5 V, 2 V, 5 V, or 20 V.

Horizontal Display Accuracy — Within 5% plus the deflection factor accuracy on the plug-in being driven. The plug-in is a vertical or horizontal amplifier with a 100 mV/div deflection factor and an input R of at least 50 kΩ when it is used in the horizontal compartment.

Order 7CT1N Curve Tracer **$72**

5000-Series Oscilloscopes



designed to be added to . . .

by you and by us

Low cost; easily understood controls; crt readout of deflection factors; a choice of conventional, bistable storage, or variable persistence storage displays; 24 diverse plug-ins and bench-mount/rackmount convertibility, all make 5000-Series Oscilloscopes an excellent choice for your measurement needs from dc to 60 MHz. Fourteen versatile amplifiers, 7 time bases, a dc to 1 GHz sampler, a dc to 100 kHz spectrum analyzer, and a semiconductor curve tracer provide wide-ranging capability today — and more are on the way.

5400 Series	**Dc to 60 MHz Oscilloscopes**	**74-75-76**
5100 Series	**Dc to 2 MHz Oscilloscopes**	**81-82**
5400 Series	**Amplifier Plug-ins**	**77**
5400 Series	**Time-Base Plug-ins**	**78-79-80**
5100 Series	**Amplifier Plug-ins**	**83-84**
5100 Series	**Differential Amplifier Plug-ins**	**85-86-87**
5100 Series	**Time-Base Plug-ins**	**87-88**
5000 Series	**Curve Tracer Plug-in**	**89**
5000 Series	**Spectrum Analyzer Plug-in**	**89**
5000 Series	**Dual-Trace Delayed Sweep Sampling Plug-in**	**90**

5000-Series Oscilloscopes

60 MHz 5400 Series and 2 MHz 5100 Series

Low Cost

2 MHz or 60 MHz Bandwidth

Sampling to 1 GHz

0 to 100 kHz Spectrum Analysis

8 Oscilloscope Models

Dual-Beam and Storage Displays

Crt Readout (5400 Series Only)

Large 6½ in Crt (8 x 10 div)

10 μV/div High Gain Differential Amplifier

1 to 8 Trace Capability

Delayed-Sweep Time Bases

Y-T or X-Y Operation

Color-Coded Front Panels

Bench-to-Rack Convertibility

The 5000-Series Oscilloscope is designed to provide optimum versatility and performance at the lowest possible price.

The 5100 Series features 2 MHz mainframes that accommodate two vertical deflection plug-ins and one horizontal deflection plug-in. It can be easily converted from bench to rackmount configuration.

To date, 17 plug-ins are available for use with the 5100 Series. Among them are the low-cost 5L4N Spectrum Analyzer for the 0 to 100 kHz frequency range and the 5S14N, a general-purpose, 1 GHz dual-trace sampling plug-in.

The 5400 Series takes a giant step in performance; it offers 60 MHz bandwidth. The 5400 Series is capable of satisfying a wide range of measurement needs. It features readout of plug-in scale factors on the crt (except with plug-ins having a suffix N: 5A22N, 5B10N, etc.). This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements more quickly and conveniently. The crt readout can also be externally accessed.

Like the 5100 Series, the 5400 Series features 3 plug-in compartments and bench-mount-to-rackmount convertibility.

Whether you choose the 2 MHz 5100 Series or the 60 MHz 5400 Series, TEKTRONIX 5000 Series Oscilloscopes always give you the most versatility and performance for your dollar.

5100-Series Oscilloscopes

Five 5100 Series Oscilloscopes are available. They include single beam, dual beam, and storage displays. The storage display units feature bistable, split-screen storage with burn resistant phosphor. The dual beam display units have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drive both beams.

5400-Series Oscilloscopes

Three 5400 Series display units are presently available: a single-beam, non-storage display, a variable persistence storage display, and a true dual-beam display. All feature crt readout of plug-in scale factors.

5000-Series Oscilloscopes

Mainframe/ Display Unit	Page	Beams	Storage	Display Size
5110	81	Single		8 x 10 div (1.27 cm/div)
5111	81	Single	Bistable	8 x 10 div (1.27 cm/div)
5112	82	Dual		8 x 10 div (1.27 cm/div)
5113	82	Dual	Bistable	8 x 10 div (1.27 cm/div)
5115	81	Single	Bistable	8 x 10 div (1.27 cm/div)
5440	75	Single		8 x 10 div (1.22 cm/div)
5441	76	Single	Variable Persistence	8 x 10 div (0.9 cm/div)
5444	74	Dual		8 x 10 div (1.22 cm/div)

PLUG-IN VERSATILITY

Twenty-four plug-ins are now available in the 5000 Series family. All these plug-ins are compatible with the 5400 Series, and all but 7 are compatible with 5100 Series mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time-base plug-ins include single, dual, delayed sweep units, and a digital delay time base.

Three special-purpose plug-ins are also available. The 5L4N is a Spectrum Analyzer for the 0 to 100 kHz frequency range. It has 10 Hz bandwidth resolution. The 5CT1N is a semiconductor curve-tracer plug-in. It allows characteristic curves of transistors, FETs, diodes, and other semiconductor devices to be displayed on the crt. The 5S14N, a general-purpose dual-trace, delayed sweep sampler, extends the bandwidth of either the 5100- or the 5400-Series to 1 GHz at 2 mV sensitivity.

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	Type	Minimum Deflection Factor	Bandwidth —3 dB	Cmrr
5A13N	85	Single	1 mV/div	2 MHz	10,000:1
5A14N	83	Four	1 mV/div	1 MHz	
5A15N	83	Single	1 mV/div	2 MHz	
5A18N	83	Dual	1 mV/div	2 MHz	
5A19N	85	Single	1 mV/div	2 MHz	1000:1
5A20N	85	Single	50 μV/div	1 MHz	100,000:1
5A21N	86	Single (Voltage and Current)	50 μV/div 0.5 mA/div	1 MHz	100,000:1
5A22N	86	Single	10 μV	1 MHz	100,000:1
5A23N	84	Single	10 mV/div	1.5 MHz	
5A24N	84	Single	50 mV/div	2 MHz	
5A26	87	Dual	50 μV/div	1 MHz	100,000:1
5A38	77	Dual	10 mV/div	35 MHz	
5A45	77	Single	1 mV/div	60 MHz	
5A48	77	Dual	1 mV/div	60 MHz	

Time-Base Plug-ins

Product	Page	Type	Sweep Rate	Mag	Single Sweep	Volts/ Div Ext Mode
5B10N	88		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	88	Dual Delaying	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B13N	87		1 μs to 100 ms			50 mV
5B31	79	Digital Delaying	0.2 μs to 5 s	X10	Yes	50 mV
5B40	78		0.1 μs to 5 s	X10	Yes	50 mV
5B42	78	Delaying	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes —	50 mV
5B44	80	Dual Delaying	50 ns to 5 s	X10	Yes	50 mV

Do you need rear-panel signal inputs or outputs, or other special features? If so, contact your Tektronix Field Engineer for details.

Special-Purpose Plug-ins

Product	Page	Description
5CT1N	89	Semiconductor Curve Tracer
5L4N	89	Low-Cost Spectrum Analyzer
5S14N	90	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**		**Shipping**			
	lb	kg	lb	kg		
Single Width	2.8	1.2	10.0	4.5		
Double Width	5.8	2.6	10.8	4.9		

5100-Series Dimensions and Weights

	Cabinet		Rackmount	
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.25	13.3
Width	8.4	21.3	19.0	48.3
Length	20.4	51.8	19.0	48.3
Weights (approx)	lb	kg	lb	kg
Net	23.0	10.5	24.0	10.9
Shipping	32.0	14.5	43.0	19.5

5400-Series Dimensions and Weights

	Cabinet		Rackmount	
Dimensions	in	cm	in	cm
Height	11.9	30.2	5.25	13.5
Width	8.4	21.3	19.0	48.0
Length*	20.4	51.3	20.4	51.9
Weight (approx)	lb	kg	lb	kg
Net	25.0	11.0	26.0	13.3
Shipping	34.0	15.4	45.0	20.4

*5444 Length is 21.4 in.

RECOMMENDED 5000-SERIES PROBES

Amplifiers	Probe	Type	Attenuation/ Sensitivity	Readout	Feature
	P6105	Voltage	10X	Yes	Full bandwidth
	P6108	Voltage	10X	No	Full Bandwidth
	P6101	Voltage	1X	Yes	Full Bandwidth
5A38	P6062A	Voltage	1X/10X	Yes	Full Bandwidth
5A45	P6015	Voltage	1000X	No	40 kV peak; 20 kV, dc, or RMS; full bandwidth
5A48	P6009	Voltage	100X	Yes	1.5 kV, dc, or rms
	P6202	FET	10X/100X	Yes 10X	Full bandwidth, high input Z
	P6021	Current	2 mA or 10 mA	No	Ac, 120 and 450 Hz lower 3 dB point
	134	Current Amp for P6021	1 mA to 1 A	No	Extends lower 3 dB point to 12 Hz
	P6060	Voltage	10X	Yes	Full bandwidth
	P6101	Voltage	1X	Yes	Full bandwidth
5A13N	P6015	Voltage	1000X	No	40 kV peak; 20 kV, dc, or rms; full bandwidth
	P6021	Current	2 mA or 10 mA	No	Ac, 120 and 450 Hz lower 3 dB point
	134	Current Amp for P6021	1 mA to 1 A	No	Extends lower 3 dB point to 12 Hz
5A14N	P6108	Voltage	10X	No	Full bandwidth
5A15N	P6101	Voltage	1X	Yes	Full bandwidth
5A18N	P6062A	Voltage	1X/10X	Yes	Full bandwidth
5A20N	P6055	Voltage	Adjustable to 10X	Yes	Differential, 20,000:1 cmrr
5A21N	P6021	Current	2 mA or 10 mA	No	Ac, 120 and 450 Hz lower 3 dB point
5A22N 5A23N	134	Current Amp for P6021	1 mA to 1 A	No	Extends lower 3 dB point to 12 Hz

See probe section for complete information.

CARTS

SCOPE-MOBILE® CARTS — For cabinet models, order Tek Lab Cart, Model 3; for rackmount models, order 205.

CAMERAS

All 5000 Series — C-5A, suitable for repetitive or stored traces.

5444 — C-27 Option 1, general purpose.

5100 Storage Instruments, 5444, 5440 (with P or R back), 5441 (with G back) — C-59, general purpose.

See camera section for complete information.

ACCESSORIES

Blank Panel — (016-0195-00)

Viewing Hoods — (016-0154-00, or 016-0260-00 folding)

Protective cover — (016-0544-00)

See accessories section for complete information.

True Dual Beam

Full Beam Overlap

60 MHz Bandwidth

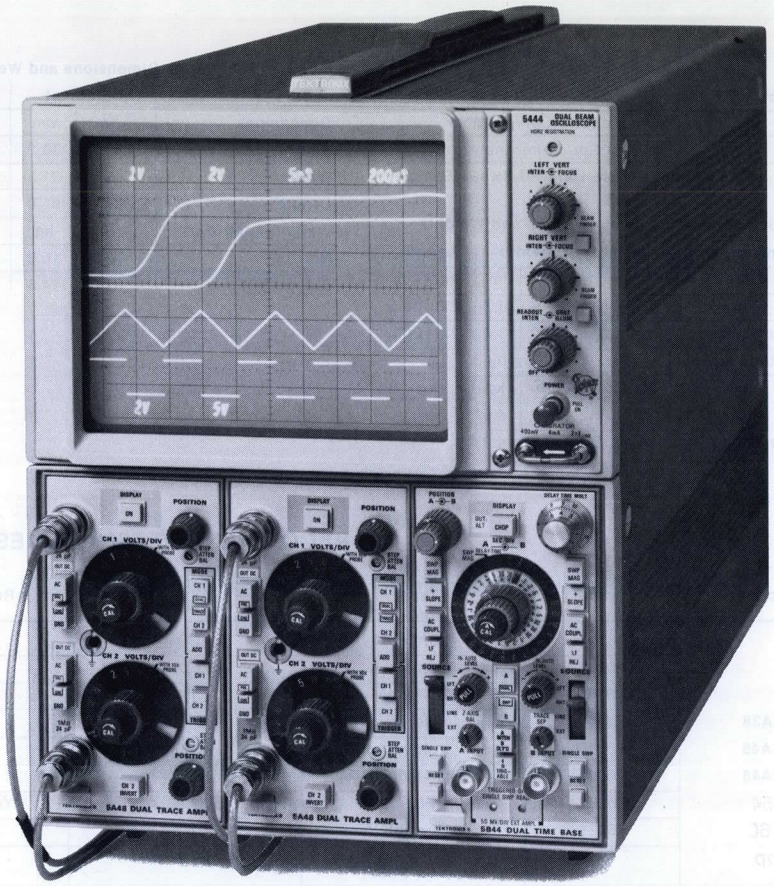
5 ns/div Sweep Rate

Large Screen

Crt Readout

35 lb

5¼ in Rackmount



The 5444 True Dual Beam Oscilloscope is essentially two oscilloscopes in one: each electron beam operates completely independently of the other. The 5444, a three-hole mainframe, is compatible with all 5400-Series plug-ins.

With the recommended 5B44 Dual Time Base (a plug-in with two independent time bases) and two appropriate amplifiers, the 5444 can display one signal at two sweep rates or two signals at the same or different sweep rates. These signals may be positioned anywhere on the large crt screen.

With this capability, any two traces can be compared easily and accurately, even traces from fast single-shot events. The 5444 can also display up to four waveforms at 60 MHz bandwidth in the alternate or chop mode (up to eight at lower bandwidths), and four multiple-trace single-shot events at sweep rates of up to 100 μs/div in the chop mode.

CHARACTERISTICS

VERTICAL SYSTEM

Dedicated Channels—The left and center plug-in compartments are each dedicated to their own completely independent horizontal deflection system. Compatible with all 5400-Series and 5100-Series plug-ins. Crt readout is not available with plug-ins having a suffix N (5A13N, 5B10N, etc).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz max, determined by plug-in.

Note: The time-sharing modes described below apply to multichannel amplifier plug-ins only.

Chopped Mode—Any multichannel amplifier plug-in will chop between channels at about 200 kHz depending on plug-ins and operating modes (3 μs on, 2 μs off). The chopped or alternate mode is selected at the time-base unit.

Alternate Mode—In this mode, each channel of any multichannel amplifier plug-in is swept once before switching to the next.

Full Beam Overlap—Either beam may be positioned to any point within the graticule area.

HORIZONTAL SYSTEM

Channels—Two independent channels are accessible when the 5B44 Dual Beam Time Base is inserted in the right-hand plug-in compartment. They provide two independent sweeps to 5 ns/div and two horizontal inputs at 50 mV/div.

DUAL-BEAM DISPLAY UNIT

The dual-beam display unit provides true dual-beam displays. Two completely separate vertical and horizontal deflection systems provide truly independent operation. The crt has an 8 x 10 div (1.22 cm/div) display area with parallax free, internally edge-lit graticule. A bright display is provided by an 18 kV accelerating potential and P31 phosphor.

Crt readout labels the crt with deflection factors, sweep rates, invert, and uncalibrated symbols. The readout is automatically changed when magnified sweeps and recommended 10X or 100X probes are used.

Beam Finders—Bring traces within viewing area and intensify traces.

External Intensity Inputs For Each Beam— +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. Max input is ±50 V (dc + peak ac).

Photographic Writing Speed — The photographic writing speed is approx 800 cm/us when using the C27R Option 1 Camera, 10,000 ASA film, and the Tektronix Writing Speed Enhancer and P11 phosphor. This combination allows for single-shot recording of waveforms up to the bandwidth and rise time limits of the 5444.

Calibrator—Voltage amplitude is 400 mV within 1%, current is 4 mA within 1%, frequency is twice the line frequency.

POWER REQUIREMENTS

Line Voltage Ranges— 100, 110, 120, 200, 220, 240 V ac ±10%. Internally selected with quick-change jumpers.

Line Frequency— 48-440 Hz.

Power Consumption—With typical plug-ins, 105 W.

ORDERING INFORMATION
(Plug-ins not Included)

5444 Oscilloscope **$3300**

R5444 Oscilloscope **$3300**

Options

Option 1 Without Crt Readout ..... **Sub $325**

Option 3—User Addressable Crt Readout ..... **Add $65**

Option 4—Protective Panel Cover (Cabinet Model Only) ..... **Add $2**

Option 76—P7 Phosphor ..... **No Charg**

Option 78—P11 Phosphor ..... **No Charge**

Input and output signals are accesible from the rear panel on special order. Check with your Field Engineer for price and availability.

Low Cost

Dc to 60 MHz

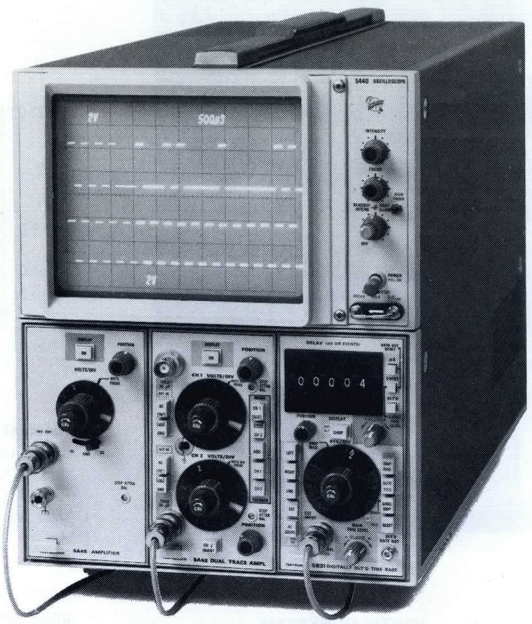
Sampling to 1 GHz

Crt Readout

3-Plug-in Flexibility

Choice of 24 Plug-ins

Bench to Rack Convertibility



The 5440 combines versatility and low cost in a 60 MHz general-purpose plug-in oscilloscope. It features crt readout of plug-in scale factors, a 3-plug-in mainframe, a choice of 24 plug-ins*, and bench to rack convertibility.

Crt readout displays plug-in scale factors on the crt, so measurement time is reduced: the operator can concentrate on the crt display rather than having to look down at the plug-in knobs. Crt readout reduces operator errors by taking into account magnifiers and probe attenuators. It can also be accessed externally. This unique ability can be used to read out dates, picture numbers, digital clock times, etc.

All the plug-ins in the 5000 Series are compatible with the 5440.**

The plug-ins provide multitrace amplifiers (up to four), differential amplifiers, a differential comparator amplifier, a transistor curve tracer, a 1 GHz dual-trace sampler, spectrum analyzer, and delayed sweep time bases.

The 5440/5A48/5B42 provides 5 mV/div sensitivity at 60 MHz and 1 mV/div sensitivity at 25 MHz. This 1 mV/div sensitivity, for example, allows you to analyze the heads of tape drive and disc drive units and determine possible problems in computer systems.

If you're looking for a general-purpose 60 MHz oscilloscope, the 5440 gives you the most versatility and performance at the lowest price.

**Plug-ins with a suffix N (5A13N, 5B12N, etc.) do not provide crt readout.*

***The 5B10N, 5B12N, and 5B13N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.*

VERTICAL SYSTEM

Channels—Left and center plug-in compartments are compatible with all 5000-Series plug-ins. Crt readout is not available with plug-ins having a suffix N (5A13N, 5B10N, etc).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz max, determined by plug-in unit.

Chopped Mode—The 5440 will chop between channels at approx 25 to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5440 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5000-Series plug-ins. Crt readout is not available for plug-ins with a suffix N.

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate— 5 ns/div, determined by plug-in.

X-Y Mode—Phase shift within 1° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal parallax-free 8 x 10 div (1.22 cm/div) graticule with edge-lit illumination.

Phosphor—P31 Standard, P7 or P11 optional.

Accelerating Potential— 15 kV.

External Intensity Input— +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 2 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input is ± 50 V (dc + peak ac).

Other Characteristics

Calibrator—Voltage amplitide is 400 mV within 1%. Current is 4 mA within 1%. Frequency is 2 times the line frequency.

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Writing speed can be increased with the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information).

Writing Speed cm/μs				Camera	Lens
P31 Phosphor		P11 Phosphor			
10,000 ASA	3,000 ASA	10,000 ASA	3,000 ASA		
180	90	245	125	C-59R	f/2.8 0.67 mag
330	160	450	230	* ** C-50R	f/1.9 0.7 mag

**Slight cropping of the graticule corners.*

***Requires optional battery pack (016-0270-00) for operation with the 5440.*

Beam Finder—Intensifies trace and brings it into graticule areas.

Ambient Temperature—Performance characteristics valid from 0°C to + 50°C unless otherwise specified.

Line Voltage Range— 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selected with quick change jumpers. Line frequency range is 48 to 440 Hz.

Max Power Consumption— 100 W at 120 V ac, 60 Hz.

OPTIONS

Option 1 without Crt Readout—The 5440 may be ordered without crt readout. This feature can easily be added later with a conversion kit.

Option 3 User Addressable Crt Readout—An additional crt readout access is available for the operator to program two 10-digit characters such as time, operator name, or test number. The additional display is useful for photographic records and is programmed by external resistors and switches.

Option 4 Protective Panel Cover (Cabinet Model Only)—The 5440 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

ORDERING INFORMATION

The 5440 may be ordered as a cabinet-model oscilloscope equipped with a tilt bail, or as a 5¼ in rackmount oscilloscope with slide-out assembly.

5440 Oscilloscope **$1350**

R5440 Oscilloscope (Rackmount) ... **$1350**

OPTIONS

Option 1 without Crt Readout ..... **Sub $325**

Option 3 User Addressable Crt Readout ..... **Add $65**

Option 4 Protective Panel Cover (Cabinet Model Only) ..... **Add $20**

Option 76 P7 Phosphor ..... **No Charge**

Option 78 P11 Phosphor ..... **No Charge**

Conversion Kits

Cabinet-to-Rackmount, Order 040-0583-01 ..... **$55**

Rackmount-to-Cabinet, Order 040-0584-02 .... **$55**

Crt Readout, Order 040-0691-00 ..... **$436**

5441

5000-Series Oscilloscopes

60 MHz Variable Persistence Storage Oscilloscope

Low Cost

Variable Persistence Storage

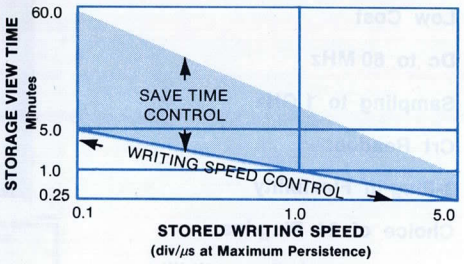
Crt Readout

Dc to 60 MHz

3-Plug-in Flexibility

24 Versatile Plug-ins

Bench to Rack Convertibility



With the 5441 Variable Persistence Storage Oscilloscope, the length of time a waveform persists on the crt is continuously variable simply by turning a dial. View time at normal intensity can be varied from a fraction of a second to more than 5 minutes. In the save mode, signals can be viewed at lower intensity for up to an hour.

High-speed events that occur only once or at very low repetition rates are easily observed. You can make low-frequency measurements more easily and accurately by eliminating flicker or transforming a slowly moving dot into a stable display. Repetitions of the same signal can be compared simultaneously to detect changes in amplitude or phase. The integrating effect of variable persistence can be used to suppress the random noise that obscures low signal-to-noise ratio waveforms.

The 5441 enhances the capabilities of the 5000-Series Sampler and Spectrum Analyzer plug-ins. In sampling applications, discrete dot traces are converted into a continuous waveform by holding repeated sweeps on the crt.

In spectrum analysis, slow scan rates are used to maximize resolution. With the 5441, it is easy to display a full-scan pattern simultaneously even when the scan rate yields full-scale periods of more than a second.

Like other 5400-Series Oscilloscopes, the 5441 offers crt readout of deflection factors for convenient, error-free measurements and optional user programmable crt readout of test information for ready identification and easy photographic recording. With the flexibility of a 3-plug-in mainframe and a choice of 24 plug-ins, you can make virtually any measurement from dc to 60 MHz.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5000-Series plug-ins. Crt readout not available for plug-ins with suffix N.

Deflection Factor—Determined by plug-in.

Bandwidth— 60 MHz max, determined by plug-in.

Chopped Mode—The 5441 will chop between channels at approx 25 kHz to 100 kHz, depending on plug-ins and operating modes.

Alternate Mode—Each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5441 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5000-Series plug-ins. Crt readout not available for plug-ins with suffix N.

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate— 5 ns/div, determined by plug-in.

X-Y Mode—Phase shift within 1° from dc to 20 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal, parallax-free, 8 x 10 div (0.9 cm/div) graticule with edge-lit illumination.

Persistence—Continuously variable. May be turned off when not needed, thus producing high-contrast stored displays without the characteristic fading of variable persistence.

Phosphor—P31.

Accelerating Potential— 8.5 kV.

Max Stored Writing Speed—Writing speed greater than 5 div/μs for a view time of 15 s.

Storage View Time— 5 min with writing speeds greater than 0.1 div/μs. View time can be increased to 1 hr at reduced intensity in the SAVE mode.

Save Mode—Extends view time of stored displays up to 1 hr; prevents erasure of stored display and storage of unwanted displays.

Erase— 0.5 s ±10%.

External Intensity Input— +5 V turns beam on from off condition. −5 V turns beam off from on condition. Dc to 2 MHz usable frequency range. Input R and C approx 10 kΩ paralleled by approx 40 pF. Max input 50 V (dc + peak ac).

OTHER CHARACTERISTICS

Beam Finder—Intensifies trace and brings it into graticule area.

Calibrator—Voltage amplitude 400 mV ±1%. Current amplitude 4 mA ±1%. Frequency is 2 times line frequency.

Ambient Temperature—Performance characteristics valid from 0°C to +50°C unless otherwise specified.

Line Voltage Ranges— 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selected with quick-change jumpers. Line frequency range, 48-440 Hz.

Max Power Consumption—100 W at 120 V ac, 60 Hz.

OPTIONS

Option 1 without Crt Readout—The 5441 may be ordered without crt readout. This feature can easily be added later with a conversion kit.

Option 3 User Addressable Crt Readout—Crt readout access allows the operator to program up to two 10-digit words.

Option 4 Protective Panel Cover (Cabinet Model Only)—The 5441 may be ordered with a protective front-panel cover. The cover protects the front panel and knobs during transportation and storage.

Option 5—A 1 div/μs writing speed can be ordered (at a significantly lower price) when a writing speed of 5 div/μs is not required.

ORDERING INFORMATION

(Plug-ins not Included)

5441 Oscilloscope **$2475**

R5441 Oscilloscope (Rackmount) . **$2475**

OPTIONS

Option 1 without Crt Readout ..... **Sub $325**

Option 3 User Addressable Crt Readout . **Add $ 65**

Option 4 Protective Panel Cover (Cabinet Model Only) ..... **Add $ 20**

Option 5 Reduce Writing Speed to 1 div/μs ..... **Sub $300**

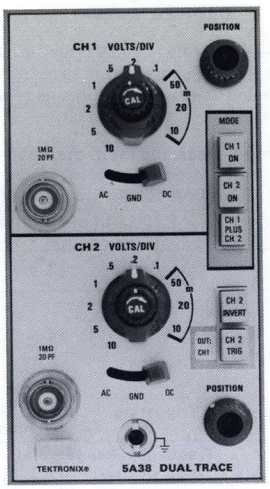
CONVERSION KITS

Cabinet-to-Rackmount, Order 040-0583-01 .... **$ 55**

Rackmount-to-Cabinet, Order 040-0584-02 .... **$ 55**

Crt Readout, Order 040-0691-00 ..... **$436**

5A38



Low Cost

Dc-to-35 MHz Bandwidth

10 mV/div to 10 V/div Calibrated Deflection Factors

The 5A38 is a dual-trace, 35 MHz plug-in Amplifier for use in 5400-Series Mainframes. It features 10 mV/div sensitivity and crt readout of deflection factor.

Bandwidth—Dc coupled, to ≥35 MHz. Lower end response, ac coupled, ≤ 10 Hz.

Rise Time— ≤10 ns.

Deflection Factors—Calibrated deflection factors from 10 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤ 3% from 15°C to 35°C, 4% from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

Common-Mode Rejection Ratio— ≥50:1 up to 1 MHz.

Display Modes—Channel 1 only, channel 2 only (normal or inverted), dual trace, and added. Alternated or chopped operation determined by time base plug-in. Internal trigger selectable from channel 1 or channel 2.

Channel Isolation— ≥50:1 to 35 MHz with both traces displayed.

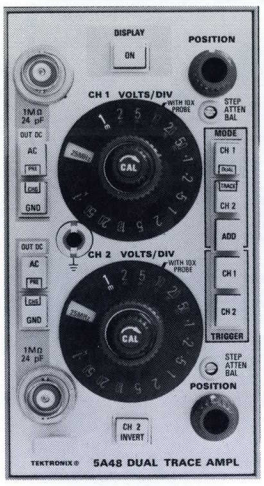
Input R and C— 1 MΩ shunted by approx 20 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max at 1 kHz or less.

Stability— ≥0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A38 Dual-Trace Amplifier **$375**

5A48



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 5400-Series 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).

Rise Time— 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.

Common-Mode Rejection Ratio— ≥ 50:1 from 5 mV/div to 10 V/div, up to 1 MHz. ≥ 20:1 from 1 mV/div to 2 mV/div, up to 1 MHz.

Display Modes— Channel 1 only, Channel 2 only (normal or inverted), dual trace, added, alternated, chopped (determined by time-base plug-in horizontal compartment). Internal trigger source is selectable from channel one or channel two.

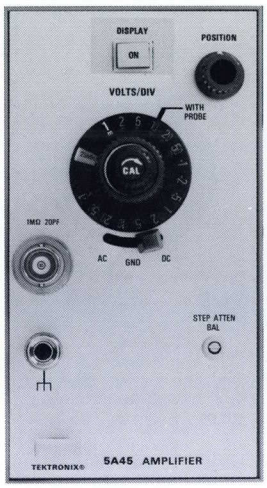
Input R & C— 1 MΩ within 1%, approx 24 pF.

Max Input Voltage—Dc coupled, 250 V (dc + peak ac); ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 1 kHz or less.

Stability— ≥0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A48 Dual-Trace Amplifier **$495**

5A45



Low Cost

DC-to-60 MHz Bandwidth

1 mV/div to 10 V/div Calibrated Deflection Factors

The 5A45 is a single-trace, 60 MHz plug-in Amplifier for use in 5400-Series Mainframes. It features 5 mV/div sensitivity (1 mV/div at 25 MHz) and crt readout of deflection factor.

Bandwidth—Dc coupled, greater than 60 MHz for 5 mV/div through 10 V/div deflection factors greater than 25 MHz for 1 mV/div and 2 mV/div deflection factors. Ac coupled, lower end response ≤10 Hz (≤1.0 Hz with 10X probe) for all deflection factors.

Rise Time— ≤14 ns, 1 mV/div and 2 mV/div. ≤5.8 ns, 5 mV/div through 10 V/div.

Deflection Factors—Calibrated deflection factors from 1 mV/div to 10 V/div in a 1-2-5 sequence. Accuracy ≤5% at 1 mV/div and 2 mV/div, ≤3% from 5 mV/div to 10 V/div from 15°C to 35°C, <4% from 5 mV/div to 10 V/div from 0°C to 50°C. A continuously variable control provides ≥2.5X additional attenuation on each range.

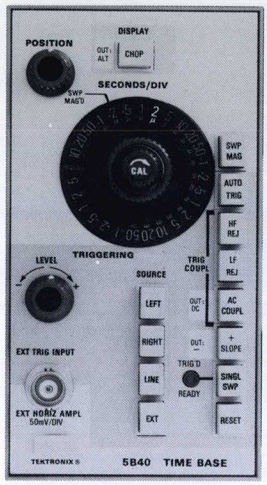
Input R and C— 1 MΩ, shunted by approx 20 pF.

Max Safe Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V p-p max, 1 kHz or less.

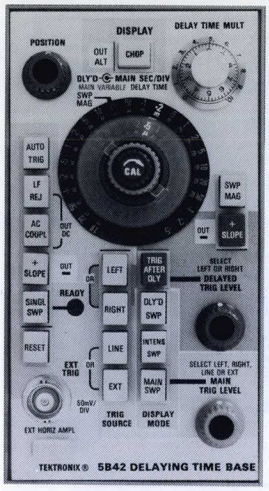
Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A45 Single-Trace Amplifier **$265**

5B40



5B42



Low Cost

10 ns/div to 5 s/div Calibrated Time Base

Triggering to 60 MHz

The 5B40 Time Base is designed for use in 5400-Series Mainframes. It features sweep rates from 10 ns/div to 5 s/div and crt readout of the sweep rate selected.

Sweep Rate— 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is fastest sweep rate obtained with X10 magnifier. Uncalibrated, continuously variable between steps and up to 12.5 s/div.

Sweep Accuracy—Measured in 5400-Series Oscilloscope over center 8 graticule divisions. Valid for 100 div of magnified sweep after the first 30 ns.

Time/Div	+15°C to +35°C		0°C to +50°C	
	Unmag	Mag	Unmag	Mag
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div, 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

Triggering

Coupling	Frequency Range	Minimum Signal Required	
		Internal	External
Dc	Dc to 10 MHz	0.4 div	60 mV
	10 MHz to 60MHz	1.0 div	150 mV
Ac	Trigger requirements increase below 50 Hz.		
Lf Rej	Trigger requirements increase below 7.5 kHz.		
Hf Rej	Trigger requirements increase above 50 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input—Max input voltage is 350 V dc + peak ac, 350 V p-p ac at ≤ 1 kHz. Input R and C is 1 MΩ paralleled by approx 24 pF. Trigger level range is ≥ ± 1.5 V.

External Horizontal Input—Deflection factor is 50 mV/div ±3%. Input R and C is MΩ paralleled by approx 24 pF. Dc coupled bandwidth is dc to ≤ 2 MHz. The ac coupled lower response is ≤ 50 Hz. Max input voltage is 350 V (dc + peak ac) or 350 V p-p ac at ≤ 1 kHz.

5B40 Time Base $325

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 5400-Series Mainframes. The 5B42 is designed so that the user may easily operate the time base in the many applications where delayed sweep and sweep rates up to 10 ns/div are required.

Sweep Rate— 0.1 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div and 2 s/div. 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

Triggering

Coupling	Triggering	Min 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 Rejection	Requirements increase below 7.5 kHz		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 20 pF. Trigger level range is at least ± 2.5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range— 0.2 to 10 times the TIME/DIV setting.

Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μs to 0.5 s delay time. Within 2% plus 0.2% of full scale for 1 s to 5 s delay time.

Jitter—Less than 0.05% of the time represented by one div of delaying sweep selected.

DELAYED SWEEP

Sweep Rate— 0.1 μs/div to 0.5 s/div in 21 calibrated steps (1-2-5 sequence). 10 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier

Sweep Accuracy—Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
0.1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
0.5 s/div to 0.2 s/div, 0.2 μs/div and 0.1 μs/div	4%	5%	5%	6.5%

Triggering

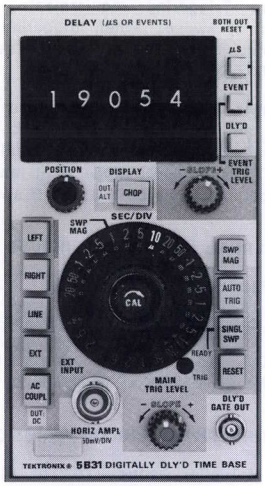
Coupling	Triggering	Min Signal Required
	Frequency Range	Int
Dc 5400 ampl	Dc to 10 MHz	0.4 div
5400 ampl	10 MHz to 60 MHz	1.0 div
5100	Dc to 2 MHz	0.4 div

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 Delaying Time Base $640



Jitter-Free Digital Delay

Delay by Time or Events

20 ns/div Sweep Rate

Crt Readout

The 5B31 Delaying Time Base with digital design features easy and accurate operation. It adds digital delay to the line of low-cost, high-performance 5000-Series Laboratory Oscilloscopes, and may be used in any 5400-Series Mainframe.

The 5B31 can delay by time or by events, and its digital delay system eliminates most inherent delay jitter. The delay mode is selected by pushbutton: the delay time (from 1 μs to 99,999 μs) or number of events (up to 99,999) is clearly displayed on thumbwheel dials.

The 5B31 has many applications, including analyzing high-jitter digital data or rotating machinery and production line testing. Its simple operation is helpful in introducing technical and engineering students to the concepts of delaying and delayed sweep.

CHARACTERTISTICS

Sweep Rate— 0.2 μs/div to 5 s/div in 24 calibrated steps (1-2-5 sequence). 20 ns/div is the fastest calibrated sweep rate obtained with the X10 magnifier. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
5 s/div, 2 s/div, and 0.2 μs/div	4%	5%	5%	6.5%

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

Triggering

Coupling	Amplifier Type	Frequency Range	Minimum Signal Required	
			Int	Ext
Dc	5400 Plug-ins	Dc to 10 MHz	0.4 div	100 mV
		10 MHz to 35 MHz	1.0 div	400 mV
		35 MHz to 60 MHz	2.0 div	600 mV
	5100 Plug-ins	Dc to 2 MHz	0.4 div	
Ac		Requirements increase below 50 Hz.		

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 24 pF. Trigger level range is at least ±2.0 V.

DELAY BY MICROSECOND

Delay Range— 0 to 99,999 μs in 1-μs steps.

Differential Time Measurement Accuracy—Within 2 parts in 10^5 plus 1 part in 10^5 per month.

Jitter—Less than 10 ns + 1 part in 10^7 of selected delay.

DELAY BY EVENTS

Delay Range— 1-event steps from 0 to 99,999.

Triggering—Dc coupled from left vert only. Separate slope and level controls provided.

Amplifier Type	Frequency Range	Minimum Signal Required
5400	Dc to 10 MHz	0.4 div
5400	10 MHz to 20 MHz	1.5 div
5100	Dc to 2 MHz	0.4 div

EXTERNAL HORIZONTAL INPUT

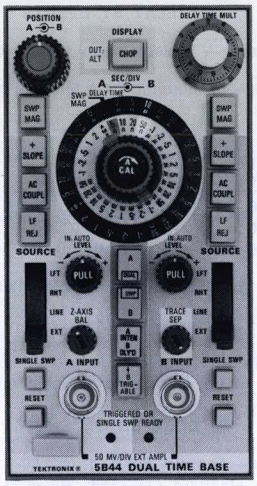
Deflection Factor— 50 mV/div within 3%.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

DELAYED GATE OUT

Amplitude—Approx 2.5 V from 50-Ω source will drive one standard TTL load. Rises at end of delay, falls at end of sweep.

5B31 Digitally Delayed Time Base $600



Two Independent Sweeps
5 ns/div Sweep Rate
True Dual-Sweep Operation (with 5444)
Sweep Switching in Single Beam
Crt Readout

The 5B44 Dual Time Base can be used in all 5400-Series oscilloscopes, but is particularly recommended for use with the 5444 True Dual Beam Oscilloscope. The 5B44 features true simultaneous dual-sweep operation with the 5444 and dual-sweep by sweep-switching with other 5400-Series oscilloscopes. For delayed sweep operation, A sweep delays B sweep.

The 5B44 also features crt readout and an edge-lighted s/div selector switch. For ease of operation, the controls are symmetrically laid out.

CHARACTERISTICS

Sweep Accuracies—Measured over the center 8 div for A and B sweeps.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
1 s/div to 0.5 μs/div	3%	4%	4%	5.5%
2 s/div and 0.2 μs/div to 100 ns/div	4%	5%	5%	6.5%
50 ns/div	4%	5%	6%	7%

Sweep Rate— 50 ns/div to 2 s/div in 25 calibrated steps (1-2-5 sequence). 5 ns/div, the fastest calibrated sweep rate, is obtained with the X10 magnifier. Uncalibrated, continuously variable between steps up to 5 s/div (A sweep only).

TRIGGERING

Coupling	Triggering Frequency Range	Minimum Signal Required	
		Int	Ext
Dc	Dc to 10 MHz 10 MHz to 60 MHz	0.4 div 1.0 div	100 mV 400 mV
Ac	Requirements increase below 50 Hz.		
Ac LF REJ	Requirements increase below 7.5 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggering, sweep generator produces one sweep. Single sweep o... both A and B sweep.

External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, paralleled by approx 26 pF. Trigger level range is at least ±2 V. External trigger inputs on both A and B sweep.

EXTERNAL HORIZONTAL INPUTS

Deflection Factor— 50 mV/div ±3%.

Input R and C— 1MΩ ±2% paralleled by ≃ 26 pF.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

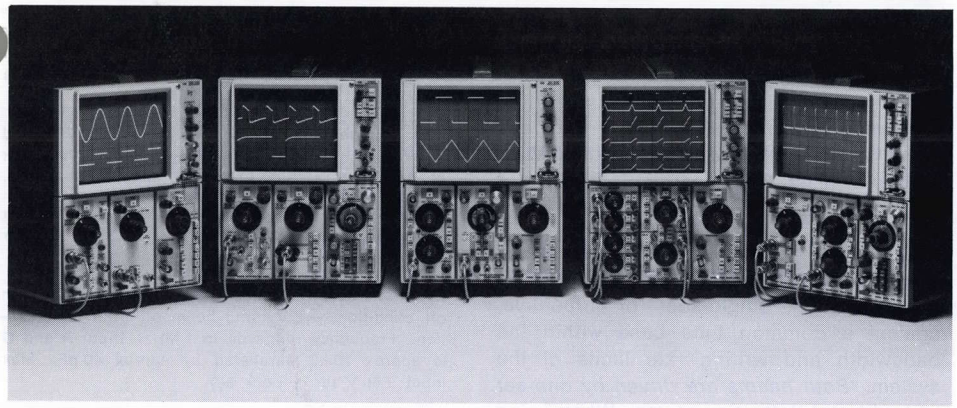
DELAYING SWEEP CHARACTERISTICS

Delay Time Multiplier Range— X0.2 to X10 the A sweep TIME/DIV setting.

Differential Time Measurement Accuracy—Within 1% plus 0.2% of full scale from 1 μs to 1 s of A sweep rate setting. Within 2% plus 0.2% of full scale for 1 s to 2 s delay time.

Jitter—Less than 0.05% of the delaying sweep TIME/DIV.

5B44 Dual Time Base $895



Low Cost
Dc to 2 MHz
Sampling to 1 GHz
Choice of 17 Plug-ins

5110

The 5110 is a single-beam nonstorage oscilloscope featuring large screen (6½ in diagonal, 1.27 cm/div) crt.

Tailor your measurement needs with the appropriate plug-in units to obtain high-gain differential (10 μV/div), four-channel differential at 50 μV/div, eight-channel displays at 1 mV/div. Or choose from our extra low cost basic amplifier and time-base plug-ins to suit the special needs of education and industry.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5100-Series plug-ins.

Deflection Factor—Determined by plug-in.

Bandwidth— 2 MHz max.

Chopped Mode—The 5110 will chop between two amplifiers at approx 25 to 100 kHz, depending on plug-ins and operating modes. Chop or alternate mode is selected at the time base.

Alternate Mode—Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5110 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5100-Series plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—Phase shift within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal 8 x 10 div (1.27 cm/div) parallax-free graticule.

Accelerating Potential— 3.5 kV.

Phosphor—P31 standard, P7 or P11 optional.

5111

The 5111 is a single-beam bistable storage oscilloscope featuring split-screen storage and large-screen displays (6½ in diagonal, 1.27 cm/div).

The 5111 extends measurement capability into areas requiring retention of single and multitrace displays for long-term examination and /or photography.

The 5111 is particularly useful for recording low and medium speed displays like those found in audio spectrum analysis, semiconductor curve tracing, sampling, and the biophysical sciences.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5100-Series plug-ins.

Deflection Factor—Determined by plug-in.

Bandwidth— 2 MHz max.

Chopped Mode—The 5111 will chop between two amplifiers at approx 25 to 100 kHz, depending on plug-ins and operating modes. Chop or alternate mode is selected at the time base.

Alternate Mode—Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5111 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5100-Series plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—Phase shift within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal 8 x 10 div (1.27 cm/div) parallax-free graticule.

Accelerating Potential— 3.5 kV.

Phosphor—Similar to P1.

Max Stored Writing Speed—At least 20 div/ms.

Storage View Time—At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time—Approx 250 ms.

5115

The 5115 is a single-beam bistable storage oscilloscope with a writing speed of at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage view time is at least 1 hr at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hr at reduced intensity, after which time intensity may be increased to original level. Variable brightness also gives optimal photographic results and allows for the integration of multiple traces.

The 5115 is useful in a wide variety of fields, including education, biophysical engineering, component testing, and industrial electronics.

When using two amplifiers and a dual time-base plug-in in the dual-sweep mode, the sweeps are slaved to the amplifiers.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5100-Series plug-ins.

Deflection Factor—Determined by plug-in.

Bandwidth— 2 MHz max.

Chopped Mode—The 5115 will chop between two amplifiers at approx 25 to 100 kHz, depending on plug-ins and operating modes. Chop or alternate mode is selected at the time base.

Alternate Mode—Each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5115 switches to the second amplifier.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5100-Series plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10B or 5B12N.

X-Y Mode—Phase shift within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal 8 x 10 div (1.27 cm/div) parallax-free graticule.

Accelerating Potential— 3.5 kV.

Phosphor—Similar to P1.

Max Stored Writing Speed—At least 200 div/ms in the normal mode and 800 div/ms in the enhanced mode.

Storage View Time—At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time—Approx 250 ms.

More on next page

5000-Series Oscilloscopes

Dual Beam and Dual Beam Storage

5112

The 5112 is a dual beam nonstorage oscilloscope featuring two independent vertical systems referenced against a common horizontal deflection system.

The 5112 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. *Both beams are driven by one set of horizontal deflection plates. When using a dual time-base plug-in in the dual-sweep mode, both beams will be deflected by both sweeps; with two single-trace plug-ins, four traces will be displayed.* When teamed up with the appropriate differential amplifiers, the 5112 can display up to four channels of high-gain (50 μV) differential information for use in the biophysical, electromechanical, and component testing fields.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5100-Series plug-ins.

Deflection Factor—Determined by plug-in.

Bandwidth— 2 MHz max.

Chopped Mode—The 5112 will chop between amplifier channels at approx 25 to 100 kHz, depending on plug-ins and operating modes. Chop or alternate mode is selected at the time-base unit.

Alternate Mode—Single-trace amplifiers are swept full time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5100-Series plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—Phase shift within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

CRT—Internal 8 x 10 div (1.27 cm/div) parallax-free graticule.

Accelerating Potential— 3.5 kV.

Phosphor—P31 standard, P7 or P11 optional.

5113

The 5113 is a dual beam bistable storage oscilloscope featuring easy-to-use split-screen storage. Stored writing speed is at least 20 div/ms (Option 3 provides 200 div/ms for the center 6 x 8 div). View time is at least 1 hr at normal intensity and can be increased to 10 hr at reduced intensity.

The 5113 can display two simultaneous events, either single-shot or repetitive, against a common time base within the bandwidth and writing rate limits of the system. *Both beams are driven by one set of horizontal deflection plates. When using a dual time-base plug-in in the dual-sweep mode, both beams will be deflected by both sweeps; with two single-trace plug-ins, four traces will be displayed.*

The 5113 is particularly useful in biomedical research where low-repetition-rate stimulus/response potentials need to be observed and recorded.

VERTICAL SYSTEM

Channels—Left and center plug-in compartments compatible with all 5100-Series plug-ins.

Deflection Factor—Determined by plug-in.

Bandwidth— 2 MHz max.

Chopped Mode—The 5113 will chop between amplifier channels at approx 25 to 100 kHz, depending on plug-ins and operating modes. Chop or alternate mode is selected at the time-base unit.

Alternate Mode—Single-trace amplifiers are swept full-time. Each channel of a multitrace amplifier is swept once before switching to the next channel. No channel switching is necessary between left and center plug-in compartments.

HORIZONTAL SYSTEM

Channel—Right-hand plug-in compartment compatible with all 5100-Series plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—Phase shift within 1° from dc to 100 kHz.

CRT AND DISPLAY FEATURES

Crt—Internal 8 x 10 div (1.27 cm/div) parallax-free graticule.

Accelerating Potential— 3.5 kV.

Phosphor—Similar to P1.

Max Stored Writing Speed—At least 20 div/ms. At least 200 div/ms at lower stored brightness (over center 6 x 8 div) with Option 3.

Storage View Time—At least 1 hr at normal intensity; up to 10 hr at reduced intensity, after which time it may be increased to original level.

Erase Time—Approx 250 ms.

Option 3 Fast Writing Speed Crt—Increases stored writing speed to 200 div/ms (center 6 x 8 div).

OTHER CHARACTERISTICS
for 5110, 5111, 5112, 5113, 5115

Ambient Temperature—Performance characteristics valid from 0°C to +50°C.

Line Voltage Ranges— 100, 110, 120, 200, 220, and 240 V ac ±10%; internally selected with quick change jumpers. Line frequency range, 48 to 440 Hz.

Typical Power Consumption—For 5110, 53 W. For 5111, 74 W. For 5112, 67 W. For 5113, 88 W. For 5115, 74 W.

External Intensity Input— +5 V turns beam on from off condition. −5 V turns beam off from on condition. Frequency range dc to 1 MHz. Input R and C is approx 10 kΩ paralleled by approx 40 pF. Max input ±50 V (dc + peak ac).

Calibrator—Voltage output 400 mV within 1%. Current output (loop) 4 mA within 1%. Frequency is 2 times line frequency.

Beam Finder—Positions beam on screen regardless of vertical and horizontal position control settings.

ORDERING INFORMATION

(Plug-ins not Included)

Cabinet Model	
5110 Oscilloscope	**$ 625**
5111 Oscilloscope	**$1250**
5112 Oscilloscope	**$1100**
5113 Oscilloscope	**$1650**
5115 Oscilloscope	**$1350**
Rackmount Model	
R5110 Oscilloscope	**$ 625**
R5111 Oscilloscope	**$1250**
R5112 Oscilloscope	**$1100**
R5113 Oscilloscope	**$1650**
R5115 Oscilloscope	**$1350**

OPTIONS

Option 2 Protective Panel Cover (Cabinet Models Only)—The cover protects the front panel and knobs during transportation and storage.

Option 2 Protective Panel Cover (Cabinet Models Only) ..... **Add $20**

Option 3 Fast Writing Speed Crt (5113, R5113 Only) ..... **Add $50**

Option 76 P7 Phosphor (5110, R5110, 5112, R5112 Only) ..... **No Charge**

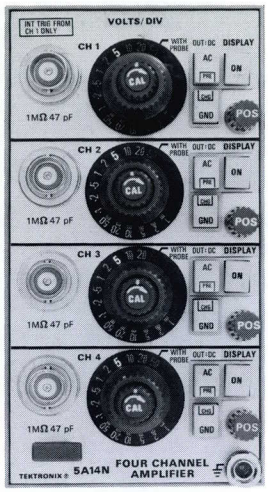
Option 78 P11 Phosphor (5110, R5110, 5112, R5112 Only) ..... **No Charge**

CONVERSION KITS

Cabinet-to-Rackmount Conversion Kit, Order 040-0583-01 ..... **$55**

Rackmount-to-Cabinet Conversion Kit, Order 040-0584-02 ..... **$55**

5A14N



1 mV/Div to 5 V/Div

The 5A14N Four Channel Amplifier features simplified front panel controls and can be used in any 5000-Series Mainframe.

5A14N operating modes are: each channel separately, and alternated or chopped between any combination of channels. Internal trigger is available from channel one only.

CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 1 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1 MHz at all deflection factors.

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

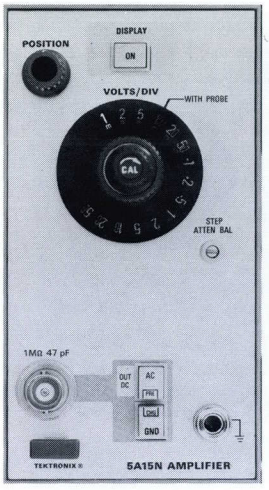
Input R and C— 1 MΩ within 1%, approx 47 pF.

Max Input—Dc coupled, 350 V (dc + peak ac). Accoupled, 350 Vdc.

Chopping Rate— 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A14N Four-Trace Amplifier **$665**

5A15N



1 mV/Div to 5 V/Div

The 5A15N Single Channel Amplifier features simplified front panel controls and can be used in any 5000-Series Mainframe.

CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

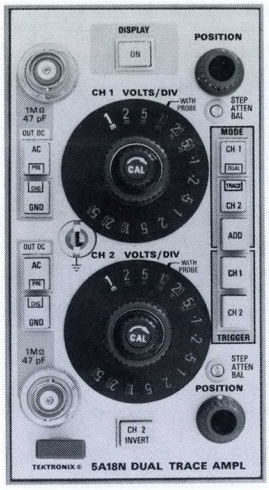
Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C— 1 MΩ within 1%, approx 47 pF.

Max Input—Dc coupled, 350 V (dc + peak ac). Accoupled, 350 Vdc.

5A15N Single-Trace Amplifier **$145**

5A18N



1 mV/Div to 5 V/Div

The 5A18N Dual Trace Amplifier features simplified front panel controls and can be in any 5000-Series Mainframe.

5A18N operating modes include channel one or two only, channels one and two added, and channel one alternated or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

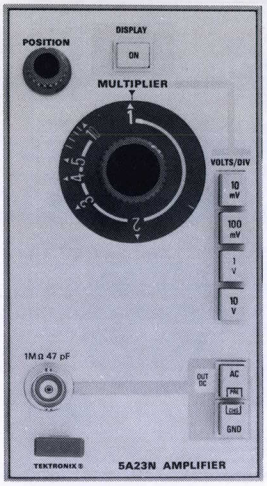
Input R and C— 1 MΩ within 1%, approx 47 pF.

Max Input—Dc coupled, 350 V (dc + peak ac). Accoupled, 350 Vdc.

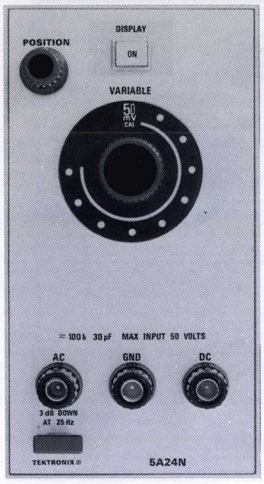
Chopping Rate— 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

5A18N Dual-Trace Amplifier **$320**

5A23N



5A24N



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 Mz within 1%, approx 47 pF.

Max Input— 350 volts (dc + peak ac).

5A23N Single-Trace Amplifier **$120**

50 mV/div to 1 V/div Deflection Factors

Easy to Customize

The 5A24N is a low-cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000-Series mainframes. It contains mode switching, crt beam positioning, trigger pickoff for basic measurements, and a built-in 3⅜ x 2¾ in soldering pad matrix for use by the customer who wishes to build his own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

Bandwidth—Dc coupled, dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenuator range. Ac coupled, 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

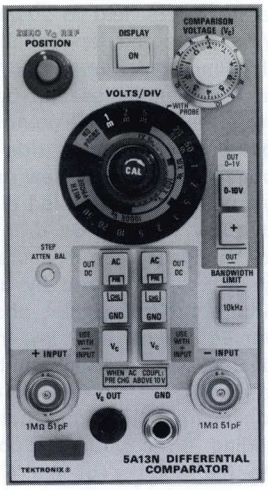
Deflection Factor— 50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/dv to at least 1 V/div.

Input R and C—Approx 100 kΩ, approx 30 pF.

Max Input— 50 volts (dc + peak ac).

5A24N Single-Trace Amplifier **$75**

5A13N



Dc-to-2 MHz Bandwidth
1 mV/div to 5 V/div
10,000:1 Cmrr
10,000 Div Effective Screen Height

The 5A13N is a differential comparator plug-in Amplifier for the 5000 Series. It incorporates a number of performance features that makes it particularly versatile, especially in multitrace combination with other 5000-Series Amplifier plug-ins. The following operational areas describe the functions of the 5A13N.

Conventional Mode—As a conventional amplifier, the 5A13N has constant bandwidth over the 1 mV/div to 5 V/div deflection factor range. The bandwidth is selectable at 2 MHz or 10 kHz for best displayed noise conditions during low-frequency applications. The plus or minus inputs allow normal or inverted displays.

Differential Mode—As a differential amplifier, the 5A13N maintains its conventional features and provides a balanced input for applications requiring rejection of a common-mode signal. The cmrr is 10,000:1 from dc to 20 kHz, decreasing to 100:1 at 2 MHz. The unit rejects up to 15 V of common-mode signal at a deflection factor setting of 1 mV/div, increasing to 350 V rejection capability above 100 mV/div.

Comparator Mode—As a comparator Amplifier, the 5A13N uses its differential capabilities, but provides an accurate positive or negative internal offsetting voltage. A signal of up to ± 10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 div by offsetting the signal with the opposing comparison voltage. A ± 1 V comparison voltage is also available for applications requiring max resolution. The offset voltage may be externally monitored through a front-panel output.

CHARACTERISTICS

Bandwidth—Dc to 2 MHz. Bandwidth limit mode, dc to 10 kHz. Ac coupled, 2 Hz or less at the lower −3 dB point.

Deflection Factor— 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ, approx 51 pF.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±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.

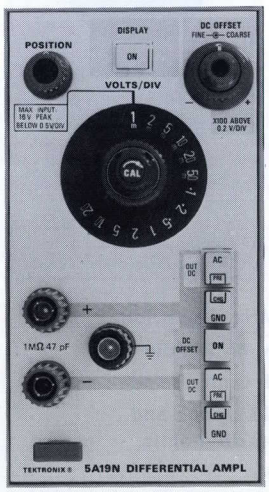
Overdrive Recovery— 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after removal of an overdrive signal between +15 V and −15 V, regardless of overdrive signal duration.

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 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, cmrr is the same as stated for dc coupled. Below 5 kHz ac coupled, cmrr decreases to 400:1 at 10 Hz. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

5A13N Differential Comparator Amplifier $650

5A19N



Dc-to-2 MHz Bandwidth
1 mV/div to 20 V/div
Dc Offset

The 5A19N is a low cost Differential Amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000-Series Mainframe for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth—Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection 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.

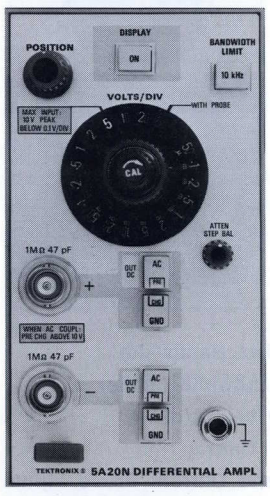
Signal and Offset Range

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.

5A19N Differential Amplifier $190

5A20N



Dc-to-1 MHz Bandwidth
10 kHz Bandwidth Limiter
50 μV/div to 5 V/div
100,000:1 Cmrr

The 5A20N is a 50 μV/div, dc coupled Differential Amplifier for the 5000 Series.

VOLTAGE CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor— 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C—Voltage mode, 1 MΩ within 0.15%, approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap pre-charged), 10 V peak ac
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

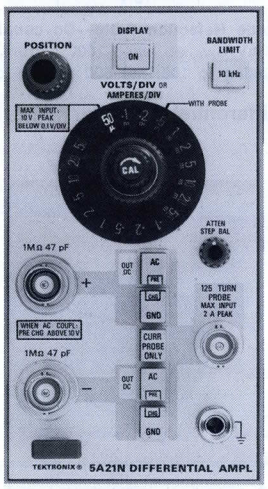
Input Gate Current— 100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Displayed Noise— 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio—Ac coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sine wave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sine wave. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

5A20N Differential Amplifier **$255**

5A21N



Dc-to-1 MHz Bandwidth
10 kHz Bandwidth Limiter
50 μV/div to 5 V/div
100,000:1 Cmrr
Voltage and Current Probe Inputs

The 5A21N is a 50 μV/div, dc coupled Differential Amplifier for the 5000 Series. The 5A21N has a current probe input.

VOLTAGE CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor— 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C—Voltage mode, 1 MΩ within 0.15%, approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap pre-charged), 10 V peak ac
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

Input Gate Current— 100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

Displayed Noise— 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio—Ac coupled, 50 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz at 50 μV/div and 100 μV/div with up to 20 V p-p sine wave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sine wave. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

CURRENT PROBE INPUT CHARACTERISTICS (with P6021 CURRENT PROBE)

Bandwidth— 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor— 0.5 mA/div to 0.5 A/div in 10 calibrated steps (1-2-5 sequence). Accurate within 3%. Uncalibrated, continuously variable between steps and to 1.25 A/div.

Max Input Current— 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

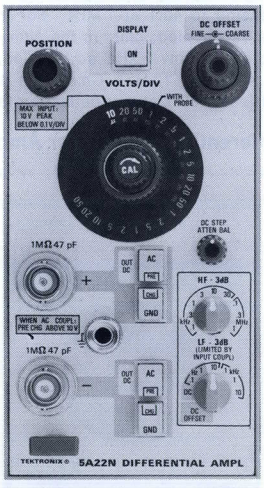
Displayed Noise— 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A21N from 0°C to +50°C.

ORDERING INFORMATION

5A21N Differential Amplifier **$285**

P6021 5-Ft Current Probe, Order 010-0237-02 $115
P6021 9-Ft Current Probe, Order 010-0244-02 $115

5A22N



Dc-to-1 MHz Bandwidth
10 μV/div to 5 V/div
100,000:1 Cmrr
Selectable Upper and Lower —3 dB Points
Dc Offset

Many factors contribute to the usability and performance of this high-gain, wide-band differential amplifier. Displayed noise (grounded inputs) is held to 20 μV or less at 10 μV/div measured tangentially 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 off screen 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 dc-coupled inputs and low-frequency limits selected with 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 to within 20% of selected frequency; at 1 MHz, bandwidth is down 3-dB or less. LF —3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate to within 20% of selected frequency. Ac coupled, 2 Hz or less.

Deflection Factor— 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Common-Mode Rejection Ratio—Ac coupled, 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sine wave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sine wave. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

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

Input R and C—1 MΩ within 0.15%, approx 47 pF.

Overdrive Recovery— 10 μs or less to recover within 99.5% of reference level after removal of a test signal applied for 1 s. Signal amplitude not to exceed common-mode signal range.

Max Input Gate Current— 200 pA or less.

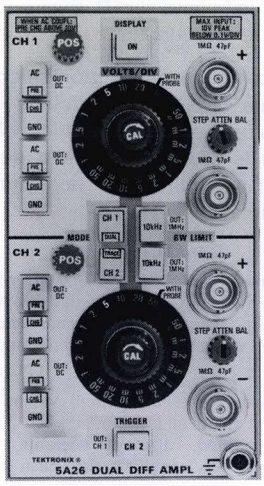
Displayed Noise— 20 μV at max bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift with Temperature— 100 μV/°C or less.

5A22N Differential Amplifier **$480**

Note: Crt readout for the 5A20, 5A21 and 5A22 (5400-Series mainframes only) is available at additional cost. Contact your local Tektronix Field Engineer for information.

5A26



Two Differential Amplifiers in One Plug-In
50 μV/div Sensitivity at 1 MHz
100,000: 1 Cmrr
Crt Readout

The 5A26 Dual Differential Amplifier combines two independent differential amplifiers in one plug-in. Its adds no-compromise differential measurement capability to the line of low-cost, high-performance 5000-Series Laboratory Oscilloscopes. It may be used in any 5000-Series Mainframe.

The 5A26 provides 50 μV/div at 1 MHz, high common-mode rejection ratio, crt readout in any standard 5400-Series Mainframe, trigger-source selection, and bandwidth limit on each channel. With two 5A26s, it is possible to observe up to four differential channels at one time in the chop or alternate mode.

The 5A26 has many applications in areas that require dual differential performance, especially in biomedical and electromechanical fields, education, and component manufacturing.

CHARACTERISTICS

Number of Differential Channels—Two.

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor—50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Crt Readout—Crt readout of deflection factors. Functional in crt readout-equipped 5400-Series Oscilloscopes, nonfunctional in 5100-Series Oscilloscopes.

Input R and C—1 MΩ within 0.15% paralleled by approx 47 pF.

Max Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 V dc (coupling cap precharged), 10 V peak ac
100 mV/div to 5 V/div	350 V (dc + peak ac)	350 V (dc + peak ac)

Input Gate Current—100 pA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

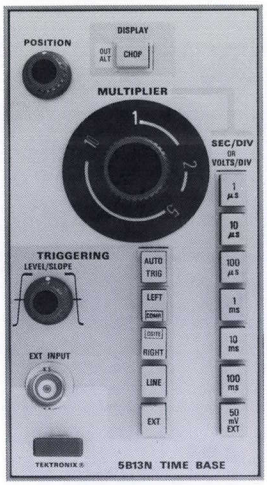
Displayed Noise—30 μV or less, tangentially measured.

Common-Mode Rejection Ratio

Dc Coupled 50 μV/div to 50 mV/div	At least 100,000:1 from dc to 30 kHz with up to 20 V p-p sine wave
100 mV/div to 5 V/div	At least 300:1 from dc to 30 kHz with up to 100 V p-p sine wave
Ac Coupled 50 μV/div to 50 mV/div	At least 20,000:1 at 5 kHz to 30 kHz, decreasing to not less than 2000:1 at 60 Hz
With 2 P6062A Probes	400:1 at 10X probe attenuation

5A26 Dual Differential Amplifier $525

5B13N



1 μs/div to 100 ms/div
Calibrated Time Base
External Horizontal Input

The 5B13N is a low-cost, general-purpose time base for 5000-Series Oscilloscopes. Sweep rates are selected by pushbutton.

The 5B13N suits 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 pushbutton-selected rate to at least 1 s/div.

TRIGGERING

Coupling		Sensitivity and Frequency Range
Ac	Int	0.4 div from 50 Hz to 100 kHz, increasing to 1 div at 1 MHz
	Ext	200 mV from 50 Hz to 1 MHz

External Trigger Input—Max input voltage is 200 V (dc + peak ac). Input R and C is approx 100 kΩ paralleled by approx 1000 pF. Trigger-level voltage range is +1.5 V to −1.5 V.

EXTERNAL HORIZONTAL INPUT

Deflection Factor—50 mV/div, accurate to within 5%. A continuously variable deflection factor multiplier provides variation between 50 mV/div and 0.5 V/div.

Bandwidth—Dc to at least 100 kHz.

Input R and C—Approx 50 kΩ paralleled by 1000 pF.

Max Input Voltage—200 V (dc + peak ac).

5B13N Time Base $110

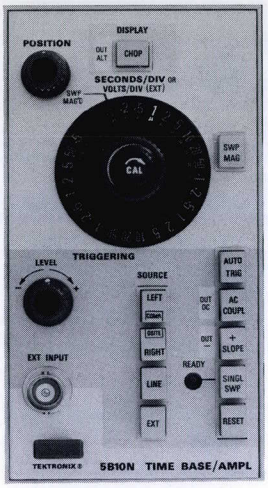
5B10N
5B12N

5000-Series Oscilloscopes

Single-Sweep, Time Base/Amplifier

Dual Time Base

5B10N



100 ns/div to 5 s/div Calibrated Time Base

Single Sweep

Direct Readout X10 Mag

Provides Alternate and Chopped Displays

50 mV/div and 500 mV/div 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 pushbutton selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line, and external.

CHARACTERISTICS

Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div, and within 4% at 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

Auto Trig—Same as above except signal rate requirements are 15 Hz and above.

Single Sweep—Same as for ac and dc coupled.

External Trigger Input—Max input is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div, accurate within 3%. 10X variable extends range to at least 5 V/div.

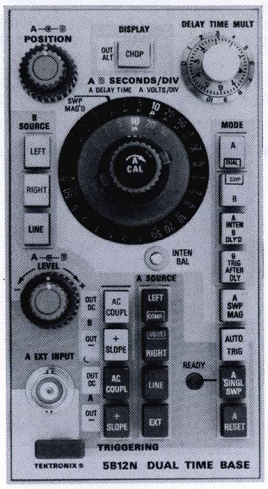
Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

Max Input Voltage— 350 V (dc + peak ac).

5B10N Time Base/Amplifier **$225**

5B12N



100 ns/div to 5 s/div Calibrated Time Base

Dual and Delayed Sweep

Direct Readout X10 Mag

The 5B12N is a time base for generating single, dual, or delayed sweeps in 5000-Series Oscilloscopes. The 5B12N is normally used in the right plug-in compartment but is compatible with the vertical deflection compartments as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by pushbutton switches. Triggering sources for A and B sweep include left and right plug-in, line, and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time.

When operated in the dual-sweep mode in a dual-beam oscilloscope with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers; four traces will be displayed. Both sweeps are displayed simultaneously in chop mode.

When operated in the dual-sweep mode in a single-beam oscilloscope with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode pushbutton selects chop or alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

CHARACTERISTICS

A Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

A Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Magnified, displays accurate to within 1% in addition to specified time-base sweep accuracy.

B Sweep Rates— 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

B Sweep Accuracy—Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div, and 0.5 s/div.

TRIGGERING

The following applies to the A and B trigger except as noted.

	Coupling	To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac	Requirements increase below 50 Hz		

*A trigger only.

B sweep operates in triggered or free-run mode after delay time.

Auto Trig—Same as above on signal rates of 15 Hz and above.

The following characteristics apply to the A trigger only.

Single Sweep—Same as for ac and dc coupled.

External Trigger Input—Max input voltage is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by approx 70 pF. Trigger level voltage range is +5 V to −5 V.

DELAYING SWEEP CHARACTERISTICS

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

Delay Time Multiplier Range— 0.2 to 10.2 times the time/div setting.

Delay Time Multiplier Incremental Linearity—Within 0.2%.

Differential Time Measurement Accuracy—Within 1% plus 2 minor dial div for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial div for 1 s to 5 s delay times.

Jitter—Less than 0.05% of the time represented by one div of the delaying sweep selected.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div accurate to within 3%. 10X variable extends range to at least 5 V/div.

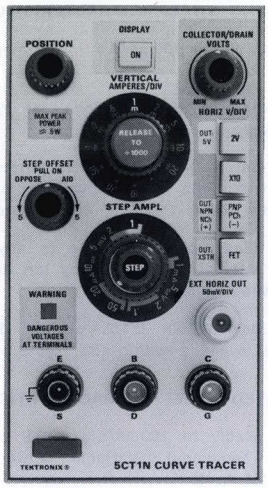
Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

Max Input Voltage— 350 V (dc + peak ac).

5B12N Dual Time Base **$525**

5CT1N



Test Semiconductor Devices to 0.5 W

10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

The 5CT1N Curve Tracer is a plug-in unit for 5000-Series Oscilloscopes. It displays characteristic curves of semiconductor devices to power levels of up to 0.5 W. The plug-in operates in either vertical deflection compartment. Horizontal deflection is achieved through a front-panel source which drives the external input of either an amplifier or a time-base plug-in unit installed in the mainframe's horizontal deflection compartment.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 V; 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. Max power output is 0.5 W. 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.

5CT1N Curve Tracer **$600**

See complete description on page 182.

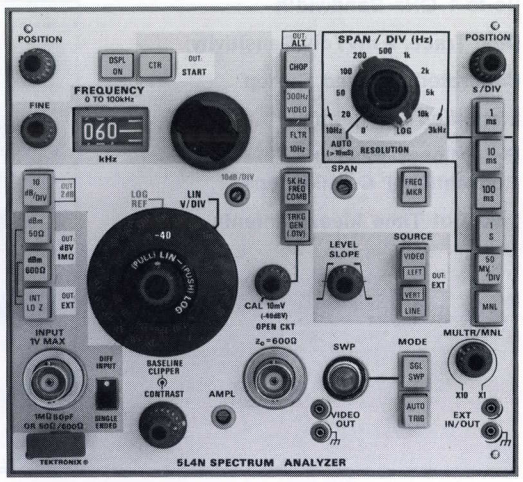
Low Cost

0-100 kHz Frequency Range

Resolution Bandwidth 10 Hz to 3 kHz

Log and Linear-Span Modes

Auto Resolution



5L4N

The 5L4N is a low cost, high performance spectrum analyzer plug-in designed to operate over the frequency range 0 to 100 kHz. Accuracy is ± 3 kHz (fine tune control midrange and span/div calibrated for 10 kHz). Stability is within 30 Hz over a 10 minute period at a fixed ambient temperature.

Resolution bandwidth is continuously variable from 10 Hz to 3 kHz. An auto mode provides the best resolution for the frequency span and sweep rate selected. Linear frequency spans can be chosen from 20 Hz/div to 10 kHz/div in a 2-5-10 sequence. A log frequency span of 100 Hz to 100 kHz or 20 Hz to 20 kHz can also be selected. At zero frequency span setting the 5L4N can be used for time domain displays within the 3 kHz bandwidth.

Unique features of the 5L4N include front panel pushbutton selection of 50 ohm, 600 ohm, or 1 megohm input impedance with calibration appropriate to the selected impedance. Dynamic range is 80 dB with intermodulation products more than 70 dB down from two full screen signals. A built-in tracking generator is standard.

This low-frequency swept-front-end spectrum analyzer operates with any 5000-Series Oscilloscope, using two of the three mainframe compartments. A recommended combination consists of the 5L4N Spectrum Analyzer plug-in with the 5111 Storage Oscilloscope. This high performance, attractively priced analyzer system weighs only 32 pounds for easy carrying, and a rackmount version is available at the same price. The left mainframe compartment holds one of the many optional 5000-Series plug-ins.

A complete detailed description of the 5L4N Spectrum Analyzer plug-in can be found in the spectrum analyzer section.

5L4N Spectrum Analyzer **$2350**

5S14N

5000-Series Oscilloscopes

Dual-trace, Delayed-sweep Sampler

Dc-to-1 GHz Bandwidth

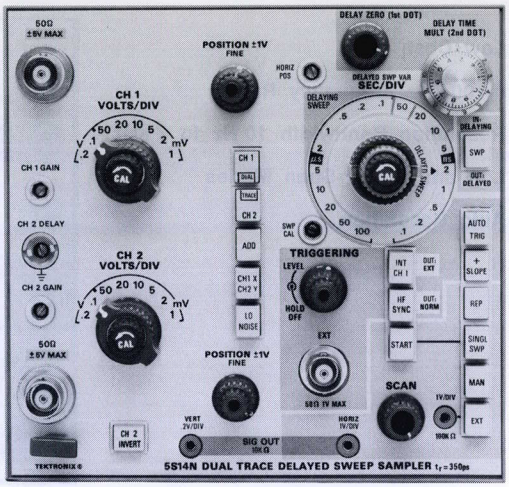
Dual Trace, 2 mV/div Sensitivity

Calibrated Delayed Sweep

Simplified Triggering

Operational Ease of Conventional Oscilloscope

Two Dot Time Measurements



The 5S14N Sampling Unit combines amplifier and time-base functions in one double-width plug-in unit designed to operate in all 5000-Series Mainframes. Combining the Sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical amplifier channels provide dual-trace sampling. A two-ramp base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time 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.

AMPLIFIER CHARACTERISTICS

Modes—Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 vertical (Y), Channel 2 horizontal (X).

Input Impedance—Nominally 50 Ω.

Bandwidth—Equivalent to dc-to-1 GHz.

Rise Time— 350 ps or less.

Step Aberrations— +2%, —3%, total of 5% p-p within first 5 ns, ±1% thereafter, tested with 284 Pulse Generator.

Deflection Factor—2 mV/div to 0.5 V/div in 8 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy—Within ±3%.

Max Input Voltage— ±5 V.

Input Signal Range— 2 V p-p max within a +2 V to —2 V window at any sensitivity.

Dc Offset Range—At least +2 V to —2 V.

Displayed Noise— 2 mV or less unsmoothed (tangentially measured). Low noise pushbutton reduces random noise by factor of 4 to 1 or more.

Vertical Signal Output— 0.2 V/div of vertical deflection; 10-kΩ source resistance.

Channel Delay Difference—Adjustable to zero or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

Scan Modes—Repetitive, Single, Manual, or External.

Delaying Sweep—May be used as crt time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep—This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per div. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by ten div of the Delaying Sweep selected.

Horizontal Signal Output— 1.0 V per div of horizontal deflection; 10-kΩ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range— 10 ns/div to 100 μs/div in 13 steps (1-2-5 sequence).

Accuracy—Within ±3% excluding first ½ div of displayed sweep.

Delay Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first 9 div of the Delaying Sweep selected.

Delay Time (2nd Dot)—Adjustable to any portion of the time interval represented by ten div of the Delaying Sweep selected.

Delay Accuracy—Within ±1% of ten div when measurement is made within the last 9.5 div.

DELAYED SWEEP CHARACTERISTICS

Range— 100 ps/div to 100 μs/div in 19 calibrated steps (1-2-5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy—Within ±3% excluding first ½ div of displayed sweep.

Start Delay—Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by 10 div of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

Delay Jitter—Less than 0.05% of the time represented by 1 div of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Source—Internal from channel 1 vertical input or external through front-panel connector.

External Triggering—Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc max. Trigger pulse amplitude 10 mV p-p or more with rise time of 1 μs or less, 10 Hz to 100 MHz. Sine-wave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering—Pulse amplitude 50 mV p-p or more with rise time of 1 μs or less. Sine-wave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode—Trigger recognition may be made to occur at any selected voltage level between + 0.5 V and — 0.5 V at instants when either a + slope or a — slope of the triggering signal crosses that level.

Auto Triggered Mode—For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approx the p-p voltage of the signal.

Holdoff—Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode—For sine waves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

5S14N Sampler **$2200**

Portable Oscilloscopes

From Tektronix - - - - the first name in Portables

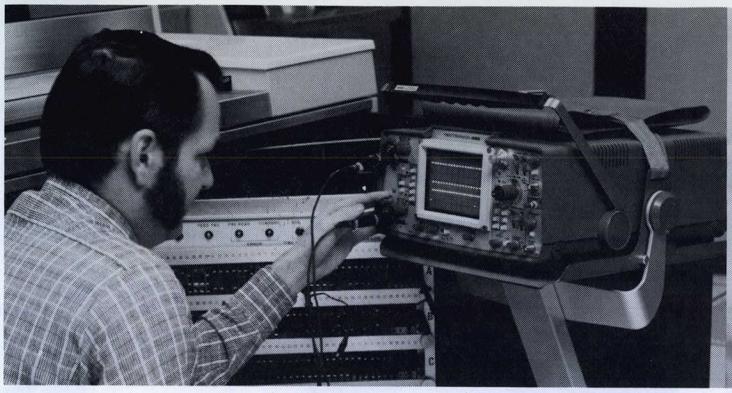
Tektronix offers an unmatched selection of performance-and value-leading portable oscilloscopes. Wherever and whatever your portable oscilloscope application, you can choose the best cost/performance/weight combination for your needs from our comprehensive line of 16 models.

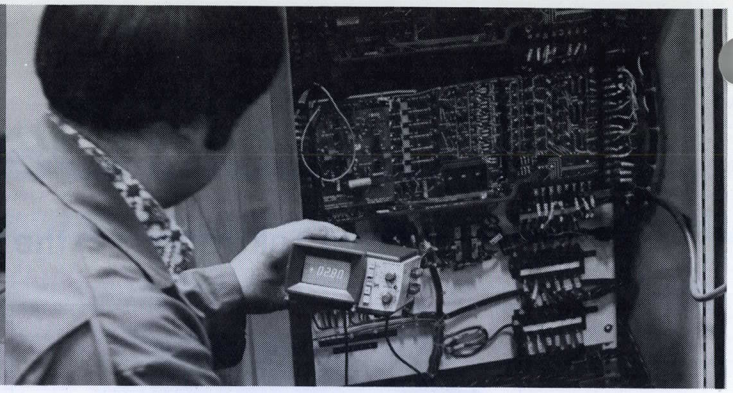
On the following pages three outstanding series are described. The 400 Series brings high performance to the field with such features as wide bandwidth, fast storage, and direct numerical readout of time intervals. Weights of these instruments are in the low to mid 20 pound range.

At 3.5 pounds (including batteries) the 200 Series provides oscilloscopes which make measurements anywhere. One model even combines an oscilloscope and a full function digital multimeter.

The 7 to 10.5 pound 300 Series covers weight and performance requirements midway between the 400 and 200 Series.

Portable Oscilloscope Selection Considerations





Many aspects enter into an instrument's ability to make a measurement. The following are the areas considered most important.

MEASUREMENT CAPABILITY

Bandwidth — This specification reflects the range of frequencies and rise times that the instrument is capable of measuring and displaying. To insure optimum fidelity, the bandwidth/rise time capability of the scope must exceed the frequency/rise time of the signal to be displayed.

Dual Trace — Two or more traces are essential when making time and amplitude comparisons between events.

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 Sweep Rates — This is an indication of the speeds at which the crt beam is deflected. Instruments with higher bandwidths must be capable of moving the beam horizontally with greater velocity to permit detailed viewing of the signal.

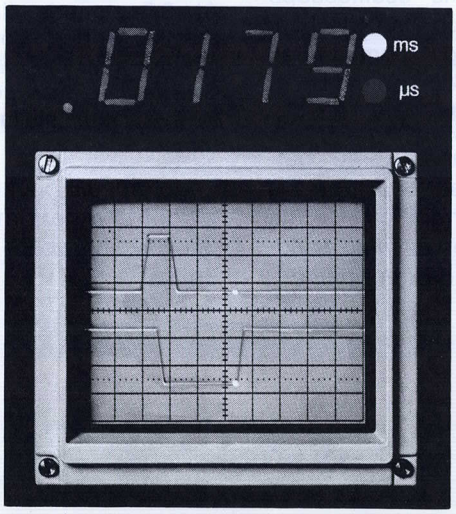
Crt Storage — Storage retains a non-repetitive or slow-moving event on the crt, providing time for inspection. This capability, together with single sweep, allows you to arm the scope, then have it wait for and automatically capture a single event. The display is normally held until removed by the operator. Tektronix has five portables with storage.

DIGITAL MEASUREMENTS

Delayed sweep measurements may impose special requirements upon oscilloscope technique. Confidence in the accuracy of delayed time using analog waveforms and calibrated dials may not be appropriate to the overall measurement needs. Here, an accurate direct numerical readout of sweep delay times is needed to augment the basic oscilloscope.

Measurement problems at times require more accuracy than that which is conventionally available in an oscilloscope. At such times, a digital multimeter is needed to achieve the required accuracy, while at the same time the measurement needs the interpretive capability of an oscilloscope's analog display.

Tektronix offers a numerical time interval readout and digital multimeter installed as an integral part of a 464, 465, 466, or 475 Portable Oscilloscope. The DM40 and DM43 display delay time, voltage, or resistance on a 3½ character LED panel. Additionally, the DM43 provides temperature measurement. The delay time counter, which offers direct numerical readout of any time interval displayed on the oscilloscope, takes its input directly from the sweep delay circuitry.



COST

Careful consideration must be given to the total cost of owning an instrument. While initial price is obviously important, the instrument must be capable of handling your present and anticipated applications. Warranty and service-after-sale policies should insure lasting performance. TEKTRONIX instruments are warranted against defective materials and workmanship for one year. To assist you if service is required, Tektronix has service centers located worldwide. Many years of satisfactory performance can be gained by conducting a thorough value analysis of the product prior to purchase.

PORTABILITY

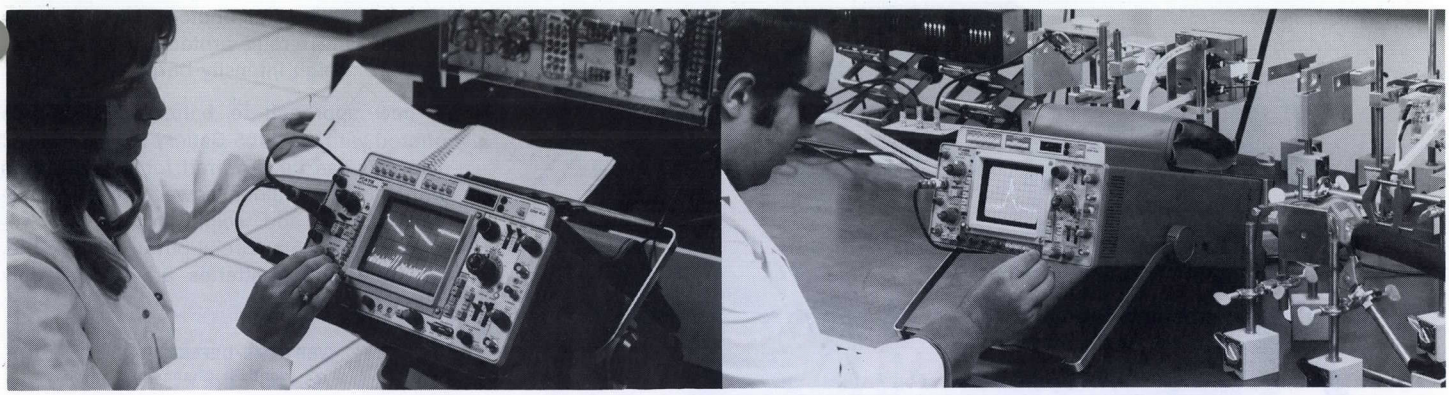
The accessibility of the equipment to be repaired dictates size and weight requirements. Some applications require that the oscilloscope be used in and around heavy equipment; that it be carried on catwalks, cranes, trucks, etc. Other situations required transport over great distances. The TEKTRONIX 200- and 300-Series weigh only 3.5 lb and 10 lb respectively. At about 25 lb, the 400-Series offers unequalled performance in a portable oscilloscope.

Beyond size and weight, a portable oscilloscope should be equipped for convenient carrying and viewing. The small, lightweight, 200-Series miniscopes easily fit into a toolkit, briefcase, or glove compartment. In operation, they can be rested on the equipment under test. The 300- and 400-Series Oscilloscopes can be stood upright on the floor, with the front panel horizontal, and the crt in a position for convenient viewing.

Both the 300- and 400-Series Portables use their handles as tilt stands for bench-top use. The 300-Series friction locks to any desired position, while the 400-Series has thirteen convenient self-locking positions. In all cases, the handles swing out of the way when not in use. The 200-Series has a special flip stand to tilt the instrument 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 (except for those with DM43 and DM40 options) can be battery powered. Some have internal batteries while others are operated from the free-standing 1105 Battery Power Supply. The 1106 is a snap-on power supply for 464, 465, 466, and 475 Option 7 Oscilloscopes. It provides 22 V to 26 V dc. With the detachable 1105 and 1106, the extra weight of batteries need not be carried to sites where ac power is available.

DURABILITY

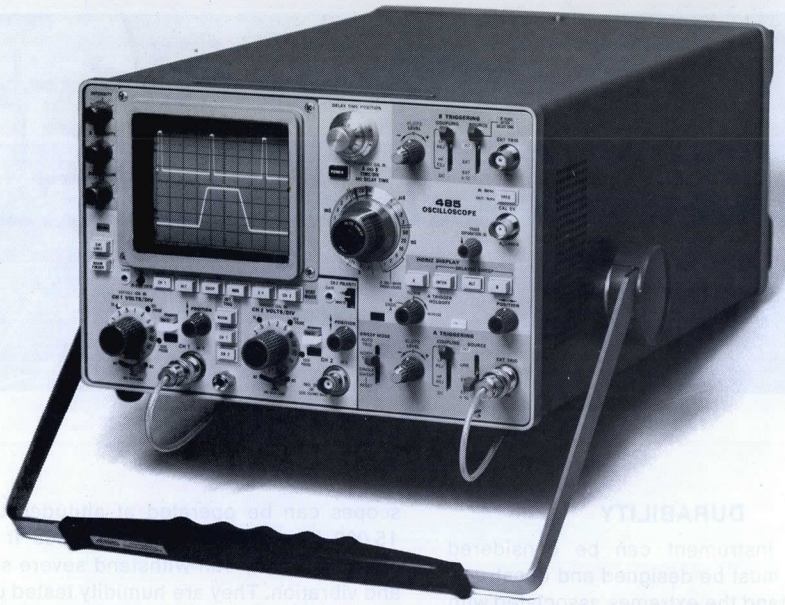
Before an instrument can be considered portable, it must be designed and constructed to withstand the extremes associated with mobility — temperature, altitude, humidity, vibration, and shock. It must be rugged.

TEKTRONIX Portable Oscilloscopes are tested for operation under severe environmental conditions. Operating temperatures may range from −15°C to +55°C. The oscilloscopes can be operated at altitudes up to 15,000 ft and carried up to 50,000 ft nonoperating. They can withstand severe shock and vibration. They are humidity tested using MIL-E-16400F as a guide. TEKTRONIX Portable Oscilloscopes operate reliably in virtually any environment normally encountered.

	Product	Page	BW	Maximum Sensitivity	Dual Trace	Delayed Sweep	Fastest Sweep Rate	Battery Power	Display Size	Other Special Features
Storage Models	**466 & 464**	101	100 MHz	5 mV/div @ BW	YES	YES	5 ns/div	YES W/1106	8 x 10 div (0.9 cm/div)	Writing Speed to 1350 cm/μs
	434	105	25 MHz	1 mV/div (10 mV/div @ BW)	YES		20 ns/div	YES W/1105	8 x 10 div (0.98 cm/div)	Split Screen
	314 (NEW)	111	10 MHz	1 mV/div @ BW	YES		100 ns/div	YES W/1105	8 x 10 div (0.635 cm/div)	Only 10.5 lbs.
	214	113	500 kHz	1 mV/div (10 mV/div @ BW)	YES		1 μs/div	YES INTERNAL	6 x 10 div (0.508 cm/div)	Only 3.5 lbs.
Nonstorage Models	**485**	94	350 MHz	5 mV/div @ BW	YES	YES	1 ns/div	YES W/1105	8 x 10 div (0.8 cm/div)	Alternate switching between intensified/delayed sweep
	475	98	200 MHz	2 mV/div @ BW	YES	YES	1 ns/div	YES W/1106	8 x 10 div (1 cm/div)	Excellent price/ performance at 200 MHz
	465	98	100 MHz	5 mV/div @ BW	YES	YES	5 ns/div	YES W/1106	8 x 10 div (1 cm/div)	Excellent price/ performance at 100 MHz
	455 (NEW)	103	50 MHz	5 mV/div @ BW	YES	YES	5 ns/div	YES W/1106	8 x 10 div (1 cm/div)	Excellent price/ performance at 50 MHz
	335 (NEW)	107	35 MHz	1 mV/div (10 mV/div @ BW)	YES	YES	20 ns/div	YES W/1105	8 x 10 div (0.635 cm/div)	Only 10.5 lbs.
	326	108	10 MHz	1 mV/div (10 mV/div @ BW)	YES		100 ns/div	YES INTERNAL	8 x 10 div (0.635 cm/div)	Only 10 lbs.
	323	109	4 MHz	1 mV/div (10 mV/div @ BW)			500 ns/div	YES INTERNAL	6 x 10 div (0.635 cm/div)	Only 7 lbs.
	221	112	5 MHz	5 mV/div @ BW			100 ns/div	YES INTERNAL	6 x 10 div (0.508 cm/div)	Only 3.5 lbs.
	213 (NEW)	114	1 MHz	5 mV/div (20 mV/div @ BW)			400 ns/div	YES INTERNAL	6 x 10 div (0.508 cm/div)	DMM/Oscilloscope in one 3.7 lb. unit
	212	113	500 kHz	1 mV/div (10 mV/div @ BW)	YES		1 μs/div	YES INTERNAL	6 x 10 div (0.508 cm/div)	Only 3.5 lbs.
Options + Accessories	**1105 & 1106 Battery Packs**	116	The rugged 1105 is suitable for powering any portable oscilloscope. The 1106 is a snap-on power supply for 464, 465, 466 and 475 Option 7 Oscilloscopes.							
	DM43 & DM40	96	Direct numerical readout of time intervals and a built-in DMM and for 464, 465, 466 and 475 Portable Oscilloscopes.							
	DD 501	116	Digital Delay, provides a delay-by-events trigger.							

Portable Oscilloscope

350-MHz Lightweight Dual-Trace



350 MHz at 5 mV/Div

1 ns/Div Sweep Rate

3.0 Div/ns Writing Speed

Alternate Switching between Intensified and Delayed Sweeps

1 MΩ and 50 Ω Input Impedances

Input Protection 50 Ω Internal

Automatic Deflection Factor Readout

Autofocus

Variable Trigger Holdoff

Pushbutton Ext Trigger View

Weighs Only 21 Lb

The 485 is a 350 MHz, 1 ns/div Portable Dual-Trace Oscilloscope weighing 21 lb, 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, autofocus, and B sweep intensity control. Single-function pushbuttons 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 portable oscilloscope. 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 V/div 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 pushbutton automatically routes the external signal used to trigger Time Base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

Full bandwidth triggering and "Variable Trigger Holdoff" provide stable presentation of repetitive complex waveforms.

An autofocus 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 impedances are available at a single BNC connector by pushbutton selection.

50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div to 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 rise time at all deflection factors from 50 Ω terminated source

	−15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

*Measured at −3 dB. 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 V. The "disconnected" condition is indicated, and has manual reset.

Max Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approx: 5 V rms continuous. 0.1 watt-second for instantaneous voltages of 5 V to 50 V.	
	Ac Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
1 MΩ	Dc Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
	Ac Coupled	500 V (dc + peak ac), 500 V p-p to 1 kHz.

Selectable Input Coupling—Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50 Ω load in 50 Ω mode).

Delay Line—Permits viewing leading edge of displayed waveform.

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 View—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 approx 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the postive 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. Max 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

Crt— 4 in rectangular tube; 8 + 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 1.5 div/ns with standard P31 phosphor and at least 3 div/ns with optional P11 phosphor using the TEKTRONIX C-31-R Camera and 3000 speed film.

Auto Focus—Automatically maintains beam focus for all intensity settings.

Graticule—Internal, no parallax; variable edge lighting; markings for measurement of rise time. 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.

External Z-Axis—Rise time ≈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 max intensity trace.

Beam Current Limit—Automatically limits the average beam current to protect the crt phosphor.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Filtered forced air ventilation is provided. Nonoperating: −35°C to +75°C.

Altitude—Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration—Operating: 15 minutes along each of the three axes, 0.025 in p-p displacement (4 gs at 55 Hz) 10-to-55-to-10 Hz in 1-minute cycles.

Shock—Operating and Nonoperating: 30 gs, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator—Output resistance is 450 Ω with a rise time (positive slope) into 50 Ω of 1 ns or less. 1 kHz, duty cycle 49.8% to 50.2%. Amplitude is 5 V 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, approx 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs—Open circuit, approx 4 V positive-going rectangular pulse; into 50 Ω, approx 0.5 V.

Power Requirements—Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 W max power consumption at 115 V. Line frequency 48 to 440 Hz.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**cm**
Height	6.6	16.8	7.0	17.7
Width	12.0	30.5	19.0	48.3
Depth			18.0	45.7
handle extended	20.6	52.3		
handle not extended	18.5	47.0		
Weights (Approx)	**lb**	**kg**	**lb**	**kg**
with accessories	24	10.9		
without accessories	21	9.5	26.2	11.9
Shipping	33	15	54	24.5

Included Accessories— 50 Ω 18 in BNC cable (012-0076-00); two BNC jack posts (012-0092-00); 50 Ω terminator (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 **$4550**
R485 Oscilloscope, 7 in rack model **$4670**
485-1 or R485-1 Oscilloscope, without A Ext Trig Display ..... **Sub $100**
485-2 or R485-2 Oscilloscope, without A Ext Trigger Display and with 50 Ω input only instead of selectable input impedance ..... **Sub $350**

INSTRUMENT OPTIONS

Option 4, EMC Modification ..... **Add $40**
The 485 may be ordered to meet the compatibility specification of MIL-Std-461A.

Emc 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**

More on next page.

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability and provide added convenience.

Probes—Due to the wide range of applications open to the 485, probes are not provided as standard accessories. The probes listed in the table below are recommended for use with the 485. For a complete list of available probes, with full specifications and ordering information, consult the "Probes and Accessories" section of this catalog.

Input Terminal	Probe Type	Attenuation	Input Impedance	Bandwidth* with 485
50 Ω Input	P6056 6 ft	10X	500 Ω-1 pF	350 MHz
	P6057 6 ft	100X	5000 Ω-1 pF	350 MHz
	P6201 FET 2 Meter	1X	100 kΩ-3 pF	330 MHz
		10X Head	1 MΩ-1.5 pF	
		100X Head	1 MΩ-1.5 pF	
1 MΩ Input	P6053B 6 ft	10X	10 MΩ-12 pF	250 MHz
	P6063A 6 ft	1X	1 MΩ-105 pF	6 MHz
		Switch 10X	10 MΩ-14 pF	200 MHz

Current Probe	Probe Type	Calibration	Insertion Impedance	Bandwidth with 485
	P6022	1 mA/mV 10 mA/mV (Selectable)	.03 Ω @ 1 MHz Increasing to .2 Ω @ 120 MHz	130 MHz

*Bandwidths are measured at the upper —3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

Current Loop Adapter—The adapter provides an accurate 50 mA square-wave calibrator when connected to the 485 voltage calibrator. The rise time is approx 25 ns.
Order 012-0341-00 ..... **$26**

50 Ω 5X Pad—Provides reverse termination for the calibrator.
Order 011-0060-02 ..... **$23**

Folding Viewing Hoods—Improves viewing in high ambient light conditions.
Folds to 7/16 x 4½ x 7½ in.
Order 016-0274-00 ..... **$8.75**

Folds to 9/16 x 6¾ x 13¾ in.
Order 016-0082-00 ..... **$12**

C-30A-P Compact Camera—f/1.9 lens magnification variable from 0.7 to 1.5. Polaroid Land Pack-Film back for type 107, 3000-speed film (includes adapter 016-0306-00).
Order C-30A-P **$650**

C-31-R High Speed Camera—f/1.2, 0.5 mag lens with Roll-Film back for type 410 10,000-or type 47 3000 speed film.
Order C-31-R **$800**

C-32-P Medium Speed Camera—f/1.4, 1.0 magnification lens, Polaroid Land Pack Film back for type 47, 3000 speed film.
Order C-32-P **$835**

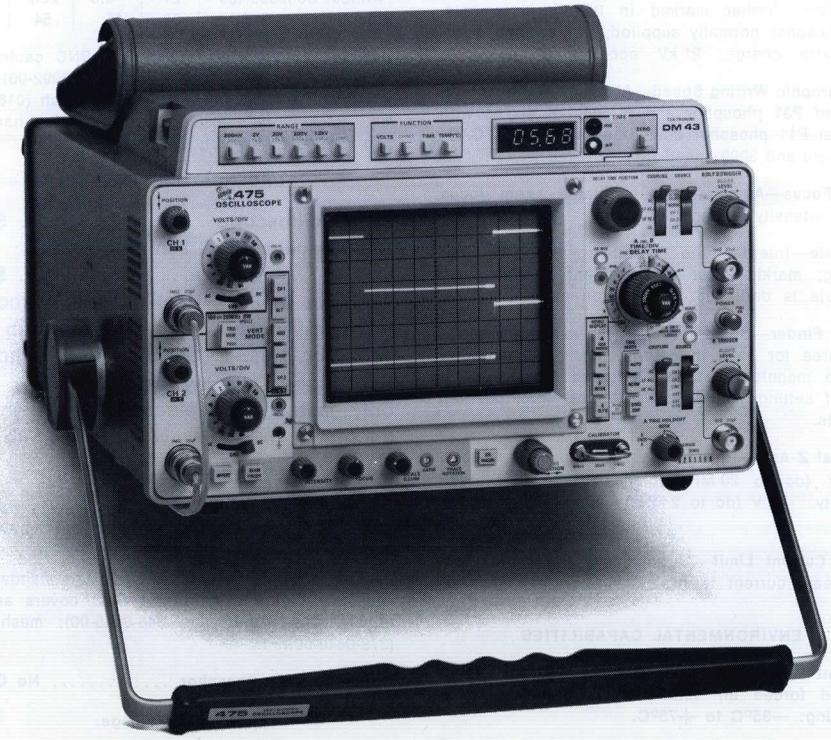
SCOPE-MOBILE® Cart—Occupies less than 18 in aisle space, has storage area in base.
Order 200C **$145**

1105 Battery Power Supply—Provides 2.3 hours of battery operation.
Order 1105 Battery Power Supply **$625**

DM40
DM43

Digital Multimeter/with Temperature

A DMM within a Portable Oscilloscope



Time Interval Measurement

Dc Volts, 0 mV to 1200 V

Ohms, 0 Ω to 20 MΩ

Temperature, —55°C to +150°C (DM43 Only)

3½ Digit LED Display

The DM40 or DM43 Digital Multimeter as part of a TEKTRONIX 464, 465, 466, or 475 provides a truly remarkable measurement package for field service. Both provide accurate differential time measurements between any two points on the display waveform, dc voltage measurements and resistance. Additionally, the DM43, with its included P6430 probe, provides direct-reading probe-tip temperature measurement in °C.

Adding approximately one inch in height to the oscilloscope, the DM40- or DM43-equipped portable retains the mobility and convenience for which TEKTRONIX Portables have become famous.

A bright display consisting of five seven-segment LEDs presents a crisp, clear 3½ digit measurement solution. Four clearly marked pushbuttons select the desired multimeter function (three functions only on DM40), while a second set of buttons selects measurement range. When differential time is selected, indicator lamps adjacent to the LEDs automatically display the proper range (ms or μs).

These versatile multimeters replace the delay time dial with digital readout display. With a simple control, they offer the unique capability of directly displaying the time delay between two points on the crt as a digital number. The ease and freedom from error of the measurement are both enhanced since the operator does not need to make mental calculations to arrive at the delay time.

Delay measurements are made by selecting the first of two points by means of the oscilloscope's Delay Time Position control. The meter is set to zero at this point. Next, the Delay Time Position control is used to select the second point and the delay is read out directly on the digital display. Such delay measurement capability has wide application in checking the critical timing in computer installations and other logic circuitry.

Voltage and resistance functions on the DM43 and DM40 are electrically isolated from the oscilloscope mainframe. Additionally, the DM43 includes a P6430 temperature probe. Temperature probing of semiconductor power components is another wide-spread field servicing application for the DM43.

The DM40 or DM43 can be ordered as a factory-installed, integral part of the portable 465 or 475, or of the storage 464 or 466. Additionally, modification kits are available to retrofit the multimeter into most existing units from any of these four models. (See your Tektronix field engineer for particulars on retrofit packages.)

CHARACTERISTICS

All characteristics apply to both DM40 and DM43 except where indicated.

TIME (DIFFERENTIAL DELAY)

Accuracy— +15°C to +35°C: within 1% of reading, ± 1 count. −15°C to +55°C: within 1.5% of reading, ± 1 count.

Zero Reference (Initial Reset)— 0000, ± 1 digit.

DC VOLTAGE

Range— 0 to 1.2 kV in five steps (200 mV, 2 V, 20 V, 200 V, and 1.2 kV).

Resolution— 100 μV.

Accuracy—Within 0.1% of reading, ± 1 count.

Input Impedance— 10 MΩ, all ranges. (User has option to remove a wire strap to increase input impedance to approx 1000 MΩ on 200 mV and 2 V ranges.)

Normal Mode Rejection Ratio—At least 60 dB at 50 Hz and 60 Hz.

Common Mode Rejection Ratio—At least 100 dB at dc; 80 dB at 50 Hz and 60 Hz.

Recycle Time—Approx 3.3 measurements/second.

Response Time—Within 0.5 second.

Max Safe Input Voltage— 200 mV and 2 V ranges: ±500 V (dc + peak ac) between + and COMMON inputs. 20 V, 200 V, and 1.2 kV ranges: ± 1200 V (dc + peak ac) between + and COMMON inputs, or between + input and chassis. COMMON floating voltage: ±500 V (dc + peak ac) to chassis.

RESISTANCE

Range— 0 to 20 MΩ in six steps (200 Ω, 2 KΩ, 20 KΩ, 200 KΩ, 2 MΩ, and 20 MΩ).

Resolution— 0.1 Ω.

Accuracy— 200 Ω, 2 kΩ, and 20 MΩ ranges: within 0.75% ± 1 count. 20 kΩ and 2 MΩ ranges: within 0.3% ± 1 count.

Recycle Time—Approx 3.3 measurements/second.

Response Time— 200 Ω through 2 MΩ ranges: within 1 second. 20 MΩ range: within 5 seconds.

Max Safe Input Voltage— 120 V rms between + and COMMON inputs for an indefinite time.

TEMPERATURE
with P6430 (DM43 Only)

Range— −55°C to +150°C in one range.

Accuracy (with constant temperature, infinite heat source, probe calibrated to DM43) —

DM43 Temp.	+15°C to +35°C		−15°C to +55°C	
P6430 Tip Temp	−55°C to +125°C	+125°C to +150°C	−55°C to +125°C	+125°C to +150°C
Accuracy	within 2°C	within 3°C	within 3°C	within 4°C

ENVIRONMENTAL CAPABILITIES

(See respective instrument mainframe characteristics.)

OTHER CHARACTERISTICS

Mainframe	465/475		464/466	
Height	7.2 in (18.3 cm)		7.2 in (18.3 cm)	
	lb	kg	lb	kg
Net Weight (without Panel Cover)	26.5	12.0	28.0	12.7
Net Weight (with Panel Cover Accessories and Accessories Pouch)	29.5	13.4	31.0	14.0
Shipping Weight	37.0	16.7	38.9	17.6

Included Accessories—P6430 probe pkg (010-6430-00), DM43 only; Pair test leads (003-0120-00); Operators manual (depending upon oscilloscope mainframe): Service manual (070-1779-00); and Accessory pouch (016-0594-00).

ORDERING INFORMATION

465 DM40 Oscilloscope/Multimeter **$2385**

465 DM43 Oscilloscope/Multimeter with Temp. **$2470**

475 DM40 Oscilloscope/Multimeter **$3190**

475 DM43 Oscilloscope/Multimeter with temp. **$3275**

464 DM40 Storage Oscilloscope/Multimeter **$3890**

464 DM43 Storage Oscilloscope/Multimeter with temp. **$3975**

466 DM40 Storage Oscilloscope/Multimeter **$4590**

466 DM43 Storage Oscilloscope/Multimeter with temp. **$4675**

(See instrument discussions on following pages for additional instrument options.)

OPTIONAL ACCESSORIES

Test Leads (Order 012-0427-00) **$12**

Retrofit Kits—For 465 and 475 Oscilloscopes with serial numbers starting B25 or higher and 466 and 464 Oscilloscopes starting B05 and higher. For other serial numbers contact your Tektronix field engineer.

DM40 Kit for 465, Order 040-0731-00 ..... **$490**

DM43 Kit for 465, Order 040-0729-00 ..... **$575**

DM40 Kit for 475, Order 040-0735-00 ..... **$490**

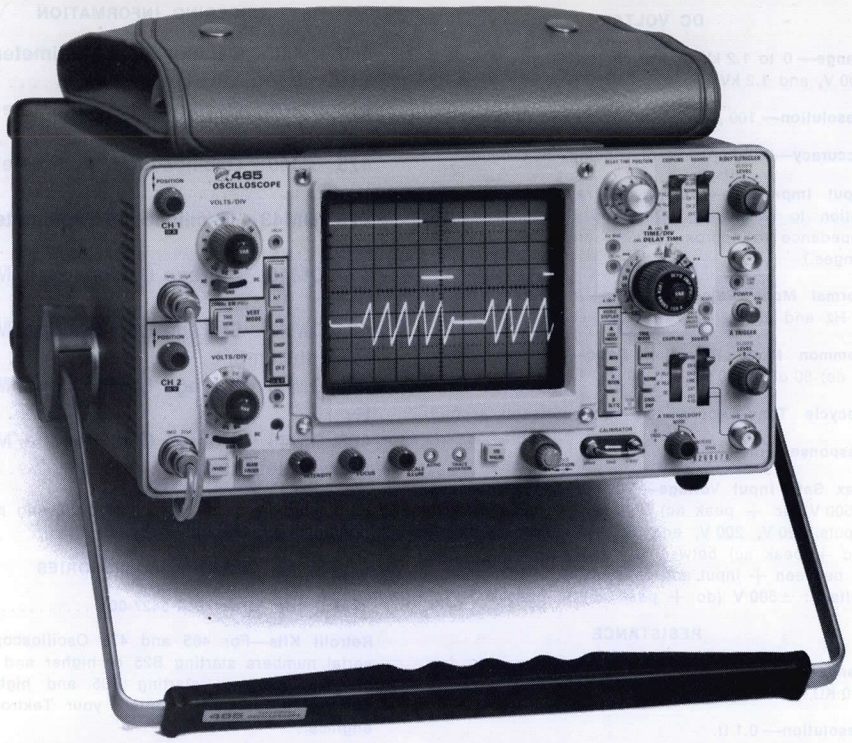
DM43 Kit for 475, Order 040-0733-00 ..... **$575**

DM40 Kit for 466 or 464, Order 040-0738-00 .... **$490**

DM43 Kit for 466 or 464, Order 040-0737-00 .... **$575**

Portable Oscilloscopes

200-MHz and 100-MHz Dual-Trace



465 pictured above is identical in appearance to the 475 (not shown) except the 475 adds the 0.01 and 0.02 μs TIME/DIV and 2 mV VOLTS/DIV switch positions.

200 MHz at 2 mV/Div (475)

1 ns/Div Sweep Rate (475)

100 MHz at 5 mV/Div (465)

5 ns/Div Sweep Rate (465)

8 x 10 cm Calibrated Display

Easy to Operate

Trigger View

Automatic V/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 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 an excellent price/performance value for all portables.

At less than 23 lb, the 465 and 475 Portables are light, short, and easy to carry (25.3 lb with panel cover and accessories). Although lightweight, 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, it is dominated by the crt making these versatile portables easy to use. Operation has been simplified by single-function pushbuttons, control knob design, layout, and color-coordinated front panels.

Troubleshooting circuits and equipment is often more effectively accomplished by 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 pushbutton 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, multitrace 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 pushbutton 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 lightweight, providing a handy solution for making accurate measurements in difficult environments such as conducted emc, 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 rise time at all deflection factors from 50 Ω terminated source

	−15°C to +40°C	+40°C to +55°C
465	Dc to 100 MHz, 3.5 ns	85 MHz, 4.12 ns
475	Dc to 200 MHz, 1.75 ns	175 MHz, 2.0 ns

*Measured at −3 dB down. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling from 50 Ω source

465/475	1X Probe	10 Hz or less
	10X 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 MΩ within 2% paralleled by approx 20 pF.

Max Input Voltage

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

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 (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 max 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 max 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 max 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 X10 Delay Time/Div settings of 200/ns to 0.5 s (minimum delay time is 200 ns).

475—0 to X10 Delay Time/Div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15° 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 X10 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) and B triggerable after Delay Time (runs when triggered). The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

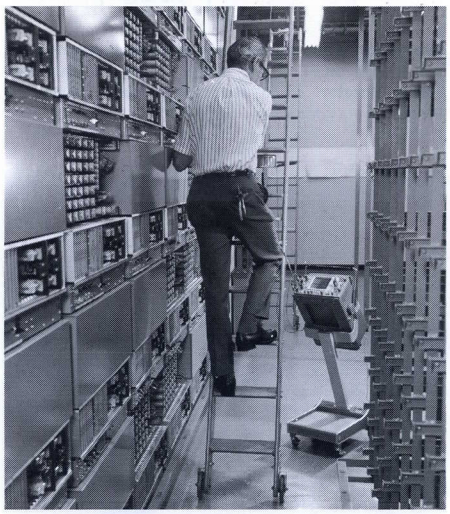
Time Base A and B Trigger Sensitivity

		465		475	
	Trigger Mode	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 pushbutton 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 approx 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 ±20 V in External, through at least ±20 V in External ÷ 10.

External Inputs—R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) max input.

X-Y OPERATION

465

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—5 mV/div to 5 V/div 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 3 MHz. Phase difference between amplifiers is 1° or less from dc to 1 MHz.

CRT

Crt—5 in rectangluar 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 with 5 V or more p-p signal; dc to 50 MHz usable frequency range.

Graticule—Internal, nonparallax; variable edge lighting; markings for measurement of rise time.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. **Nonoperating: −55°C to +75°C. Filtered forced air** ventilation is provided.

Altitude—Operating: to 15,000 ft; max allowable ambient temperature decreased by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration—Operating: 15 minutes along each of the three axes. 0.025 in p-p 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 Compatibility (Option 4 Only)—Meets the emc requirements of MIL-Std-461A, when tested in accordance with the following test methods of MIL-Std-462:

CE-01, CE-03, CS-01, CS-02, CS-06,
RE-02 (limited to 1 GHz), RE-04,
RS-01, and RS-02 (limited to 1 GHz).

Humidity—Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

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) max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 7.

	Cabinet		Rackmount	
Dimensions	**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 (without Panel Cover)	22.8	10.3	29.4	13.3
Net (with Panel Cover and Accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

465

Included Accessories—Two 6 ft P6105 Probes with accessories (010-6105-03); accessory pouch (016-0535-02); blue crt light filter (337-1674-00); clear crt light filter (337-1674-01); ground post (134-0016-01).

More on next page.

475

Included Accessories—Two 6 ft P6075A Probes with accessories (010-6075-13); 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

Emc Environmentalized, Option 4—Includes the features of the 465 and 475; in addition meets electromagnetic compatibility requirements of MIL-Std-461A.

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 12 V dc or a 24 V dc source. For battery operation, Option 7 makes these scopes compatible with the 1106 Battery Pack.

ORDERING INFORMATION

465 Oscilloscope **$2095**
475 Oscilloscope **$2900**
R465 Oscilloscope **$2215**
R475 Oscilloscope **$3020**
465 DM40 Oscilloscope/Multimeter **$2385**
465 DM43 Oscilloscope/Multimeter with temp. **$2470**
475 DM40 Oscilloscope/Multimeter **$3190**
475 DM43 Oscilloscope/Multimeter with temp. **$3275**

INSTRUMENT OPTIONS

Option 4 Emc Environmental ..... **Add $120**
Option 5 Tv Sync Separator (465 Only) ..... **Add $175**
Option 7 Ext Dc Operation ..... **Add $120**
Option 78 P11 Phosphor ..... **No Charge**

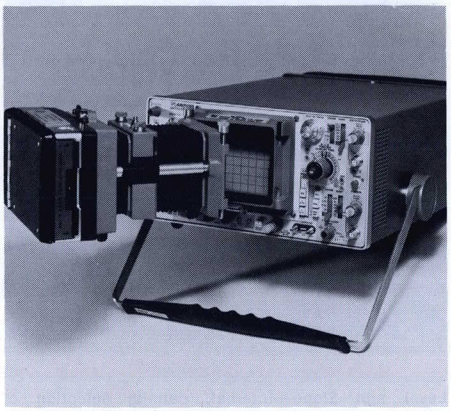
Note: Option 7 cannot be ordered with DM40 and DM43.

OPTIONAL ACCESSORIES

Probes—The probes provided as standard accessories to the 465/475 are recommended as the best choice for general-purpose applications. The probes listed in the table below are frequently used to provide added convenience and measurement capability. For a complete list of available probes, with full specifications and ordering information, consult the "Probes and Accessories" section of this catalog.

Probe Type	Attenuation	Input Impedance	Bandwidth* with 465	Bandwidth* with 475
P6063A 6 ft	Switchable 1X	1 MΩ-105 pF	6 MHz	6 MHz
	10X	10 MΩ-14 pF	90 MHz	145 MHz
P6202 FET Probe 2 Meter	10X	10 MΩ-2 pF	100 MHz	185 MHz
	100X Head	10 MΩ-2 pF	100 MHz	185 MHz
	AC Head	10 MΩ-4 pF	100 MHz	185 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 465**	**Bandwidth with 475**
P6022	1mA/mV 10 mA/mV (Selectable)	.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz	125 MHz

*Bandwidths are measured at the upper —3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.



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 ..... **$665**

Camera Adapter and Corrector Lens—Adapts C-30A to 465 or 475,
Order 016-0301-00 ..... **$ 50**

Option 7 Modification Kit—Converts existing 465 or 475s to the Option 7 version. For 465s with serial No below B042244,
Order 040-0650-05 ..... **$205**

For 475s with serial No below B061174,
Order 040-0665-04 ..... **$210**

For 465s or 475s with serial No above those listed,
Order 040-0666-05 ..... **$210**

Protective Cover—Waterproof, blue vinyl,
Order 016-0554-00 ..... **$ 15**

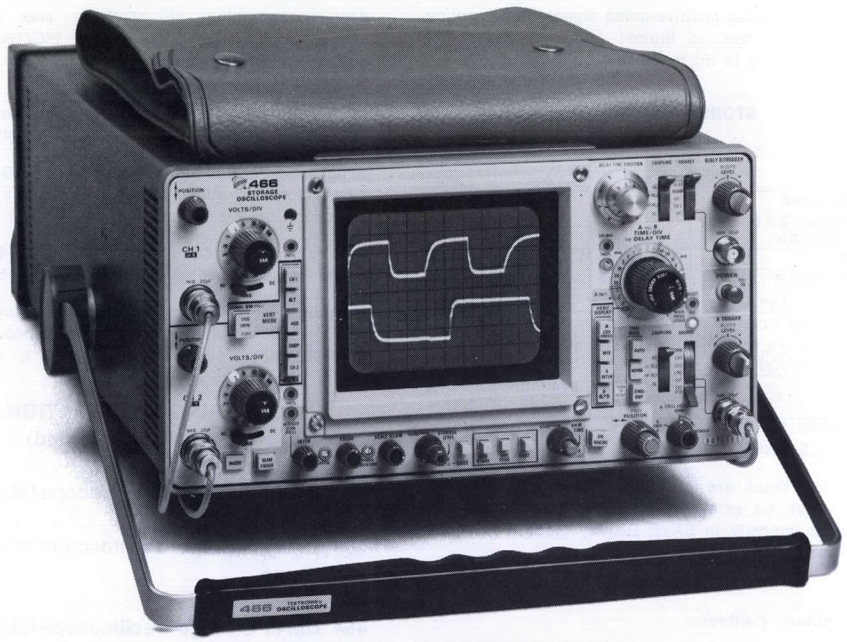
Folding Polarized Viewing Hood—
Order 016-0180-00 ..... **$16.25**

Mesh Filter—Improves contrast and emc filtering,
Order 378-0726-01 ..... **$ 24**

SCOPE-MOBILE® Cart — Occupies less than 18 in aisle space, has storage area in base,
Order 200C **$145**

1106 Battery Pack (for use with Option 7)..... **$350**

1105 Battery Power Supply **$625**



1350 cm/μs Stored Writing Speed (466)

Dc to at Least 100 MHz Bandwidth

5 mV/div Vertical Sensitivity at Full Bandwidth

5 ns/div Sweep Speed

Variable Persistence and FAST Mesh Transfer Storage Modes

Fully Portable—Just 26 lb

Analysis of fast rise time and transient electronic phenomena is no longer the exclusive domain of the laboratory, nor of the designer's work bench. Demanding the same precision, the scientist in research and development goes into the field to measure single-shot events. Electronic service technicians must calibrate and repair equipment in the field using the same exacting standards as the designer on his test bench. The 466 and 464 Portable Storage Oscilloscopes have been designed specifically for such applications requiring laboratory performance in the real world.

Two modes of storage—variable persistence and fast transfer—retain and display hard-to-view phenomena such as single-shot events or low repetition rate pulses. And the 466 with its reduced scan, FAST mode is the fastest writing storage oscilloscope available. Its' cathode-ray tube with 1350 cm/μs writing speed has more than enough speed to capture and retain pulses at the scope's full 100 MHz bandwidth.

Weighing under 30 pounds (with panel cover and accessories, or 26 pounds for the basic instrument), the 466 and 464 are conveniently portable for virtually all field measurement applications. In an Option 7 configuration (external dc operation), they can operate from any 12 V dc or 24 V dc source such as the clip-on 1106 Battery Pack, thus extending stored measurement capability beyond the reach of conventional power. Or the 1106 can isolate these oscilloscopes from noisy or intermittent power sources.

Standard with the 466 and 464 are two TEKTRONIX P6062A Probes. These probes have the added operator convenience of 1X or 10X input attenuation at the probe tip. The correct deflection factor is automatically indicated on the 464 or 466 front panel when the probe attenuation factor is switched.

The trigger signal may be easily viewed without disconnecting leads and resetting controls. The TRIGGER VIEW front-panel pushbutton automatically routes the Time Base A trigger signal to the vertical deflection amplifier.

Operator convenience is further enhanced with the functional groupings of related controls. Switches and indicators for both vertical channels are grouped to the left of the crt. Beneath the crt are grouped all controls for the display and storage modes. And to the right are all controls and indicators for time-base selection.

The bright, burn-resistant crt measures 8 divisions by 10 divisions with 0.90 cm/division. A reduced scan graticule is superimposed over the center of the main graticule, measuring 8 by 10 divisions with 0.45 cm/division. All graticules (with fully adjustable illumination) are etched onto the inner face of the crt to eliminate parallax problems.

If the high writing speed and reduced scan features of the 466 are not required, the 464 at lower cost offers all other features of the 466.

CHARACTERISTICS

All characteristics apply to both the 466 and 464, except where indicated.

VERTICAL SYSTEM

(2 Identical Channels)

Bandwidth* and Rise Time (5 Div Reference)—at all deflection factors from 25 Ω source.

−15°C to +40°C	+40°C to +55°C
Dc to 100 MHz, ≤3.5 ns**	Dc to 85 MHz, ≤4.15 ns

*Measured at −3 dB down. Bandwidth may be limited to approx 20 MHz by bandwidth limit switch.

**Rise time in ns is calculated from the formula, $t_r = 0.35 \div$ bw (in MHz).

Lower −3 dB Point, Ac Coupling from 50 Ω Source—1X probe; 10 Hz or less. 10X probe; 1 Hz or less.

Deflection Factor—5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence); accurate within 3%; continuously variable between steps and to approx 12.5 V/div.

Display Modes—Channel 1; Channel 2 (normal or inverted); Alternate; Chopped (approx 250 kHz); Added; X-Y.

Input R and C—1 MΩ within 2% paralleled by approx 20 pF.

Max Input Voltage—

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)

Cascaded Operation—Bandwidth is dc to at least 50 MHz; cascade sensitivity is at least 1 mV/div.

X-Y OPERATION

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.

HORIZONTAL SYSTEM

Time Base A—0.05 μs/div to 0.5 s/div in 22 calibrated steps (1-2-5 sequence). X10 MAG extends 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 sweep rate to 5 ns/div.

Variable Time Control; Time Base A—Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes—A 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.

More on next page.

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. Accurate 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.

Calibrated Sweep Delay—Continuously variable from 0.2 μs to at least 5 seconds.

Differential Time Measurement Accuracy—

Delay Time Setting	+15°C to +35°C	−15°C to +55°C
over one or more major dial div	±1%	±2.5%
less than one major dial div	±0.01 major dial div	±0.025 major dial div

Delay Time Jitter—1 part or less in 50,000. 0.002% of X10 the A sweep time/div setting.

TRIGGERING A and B

A Trigger Modes—Normal (sweep runs when triggered), Automatic (sweep free-runs in the absence of an adequate triggering signal), 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	To 25 MHz	At 100 MHz
Dc	Int	0.3 div deflection	1.5 div deflection
	Ext	50 mV	150 mV
	Ext ÷ 10	500 mV	1.5 V
	Ac Hf Reject	0.5 div deflection; 100 mV external; with requirements increasing below 50 kHz	1.5 div deflection 300 mV external
	Ac	Requirements increase below 30 Hz	
	Ac Hf Reject	0.5 div with requirements increasing below 30 Hz and above 50 kHz.	

Jitter—0.5 ns or less at 100 MHz and 5 ns/div (X10 Mag).

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 V in External, through at least ± 20 V in External ÷10.

External Inputs—R approx 1 MΩ; 250 V (dc + peak ac) max input.

CRT AND DISPLAY FEATURES

Crt—Internal graticule with variable illumination; 8 x 10 div; 0.9 cm/div (normal); 8 x 10 div, 0.45 cm/div (reduced scan).

Accelerating Potential— ≃8.5 kV normal mode, ≃10 kV reduced scan.

Phosphor—P31.

Z Axis—5 V p-p positive-going signal causes noticeable modulation at normal intensity; useful frequency range is dc to 50 MHz.

STORED WRITING SPEEDS

	466	464	Storage* View Time
Full Scan (Center 6 x 8 div; 0.9 cm/div)			
FAST	150 div/μs	110 div/μs	>15 s
VARIABLE PERSISTENCE	0.5 div/μs	0.5 div/μs	>15 s
Reduced Scan (Center 8 x 10 div; 0.45 cm/div)		Reduced Scan not	
FAST	3,000 div/μs	available on 464	>15 s
VARIABLE PERSISTENCE	3 div/μs		>15 s

*These times are at full stored display intensity; they can be extended at least 25 times using reduced intensity in SAVE Display Mode.

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 V	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency		Approx 1 kHz

Signal Outputs—Positive gates from both time bases (approx 5.5 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, medium range 100 W max at 115 V and 60 Hz. Operation from 12 to 24 V dc is available with Option 7.

Dimensions	in	cm
Height	6.2	15.9
Width (with Handle)	13.0	33.0
Depth (with Panel Cover)	21.7	55.0
Depth (Handle Extended)	23.5	59.7
Weights (Approx)	**lb**	**kg**
Net (without Panel Cover or Accessories)	26.0	11.8
Net (with Panel Cover and Accessories)	29.8	13.5
Shipping	41.5	18.8

Included Accessories—2 P6062A probes; accessories pouch (016-0535-02), crt light filter (337-1674-07), adapter, ground wire (134-0016-01).

INSTRUMENT OPTIONS

Option 4, Emc Environmentalized—Meets the emc requirements of MIL-STD-461A, when tested in accordance with the following test methods of MIL-STD-462:

CE-01, CE-03, CS-01, CS-02, CS-06, RE-02, (limited to 1 GHz), RE-04, RS-01, and RS-02 (limited to 1 GHz).

Option 7, External Dc Operation—In addition to the standard ac line operation, Option 7 permits the 466 or 464 to be powered from a 12 V dc or a 24 V dc source.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Nonoperating: −55° to +75°C. Forced air ventilation is provided.

Altitude—Operating: to 15,000 ft; max allowable ambient temperature decreases by 1°C/1000 ft from 5000 to 15,000 ft. Nonoperating to 50,000 ft.

Vibration—Operating: 15 minutes along each of the three axes. 0.025 in p-p 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 Compatibility (Option 4 only)—meets compatibility requirements of MIL-STD-461A.

Humidity—Operating and nonoperating: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

ORDERING INFORMATION
(Plug-ins not Included)

466 Oscilloscope **$4300**
466 DM40 Storage Oscilloscope/Multimeter ..... ~~**$4690**~~
466 DM43 Storage Oscilloscope/Multimeter with Temp ..... ~~**$4775**~~
464 Oscilloscope **$3600**
464 DM40 Storage Oscilloscope/Multimeter ..... ~~**$3990**~~
464 DM43 Storage Oscilloscope/Multimeter with Temp ..... ~~**$4075**~~

Price 10% higher than actual

INSTRUMENT OPTIONS

Option 4, Emc Environmental ..... **Add $120**
Option 7, Ext Dc Operation (Option 7 cannot be ordered with DM40 and DM43) ..... **Add $120**

OPTIONAL ACCESSORIES

Probes—The probes provided as standard accessories to the 464/466 are recommended as the best choice for general-purpose applications. The probes listed in the table below are frequently used to provide added convenience and measurement capability. For a complete list of available probes, with full specifications and ordering information, consult the "Probes and Accessories" section of this catalog.

Probe Type	Attenuation	Input Impedance	Bandwidth* with 464/466
P6063A 6 ft	Switchable 1X	1 MΩ- 105 pF	6 MHz
	10X	10 MΩ- 14 pF	90 MHz
P6202 FET Probe 2 meter	10X	10 MΩ- 2 pF	100 MHz
	100X Head	10 MΩ- 2 pF	
	AC Head	10 MΩ- 4 pF	

Current Probe	Calibration	Insertion Impedance	Bandwidth with 464/466
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz Increasing to 0.2 Ω @ 120 MHz	85 MHz

*Bandwidths are measured at the upper −3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

OPTIONAL ACCESSORIES

1106 Battery Pack (used with Option 7) **$350**

1105 Battery Power Supply **$625**

Mesh Filter—Improves display contrast in high ambient light. **Order 378-0726-01** **$24**

Protective Cover—Waterproof vinyl. For 464, 466 **order 016-0365-00** **$15.75**

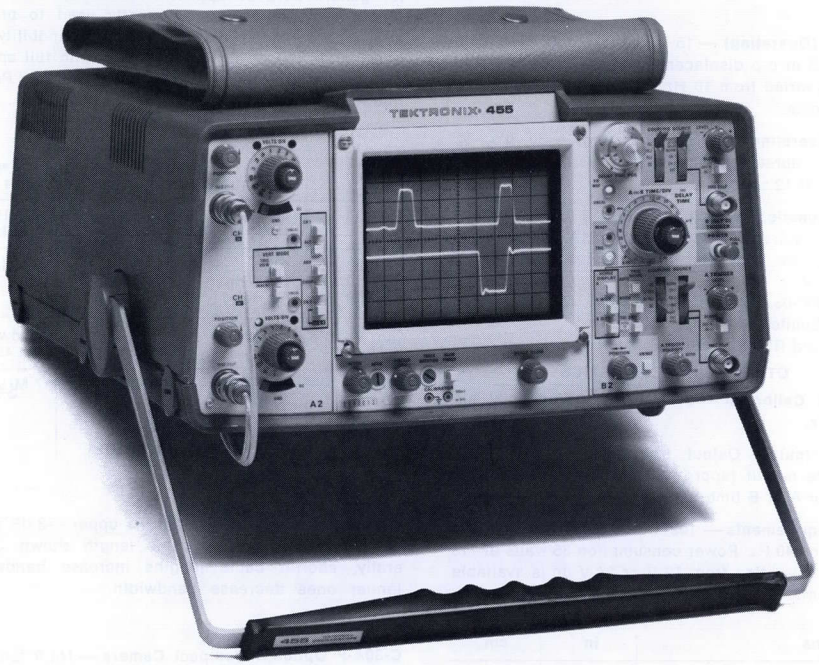
Folding Viewing Hood — Order 016-0592-00 .. **$11.50**

Folding Binocular Hood — Order 016-0566-00 .. **$13**

Polarized Collapsible Viewing Hood— Order 016-0180-00 ..... **$16.25**

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 Camera, C-30A-P Option 1** **$665**

SCOPE-MOBILE® CART— Occupies less than 18 in aisle space, has storage area in base. **Order 200C** **$145**



Portable Oscilloscope
50-MHz Dual-Trace

455

50 MHz at 5 mV/div
5 ns/div Sweep Rate
Delayed Sweep
Trigger View
Variable Trigger Holdoff
Battery Operation (Option)
Modular Construction

The TEKTRONIX 455 is a rugged Portable Oscilloscope with the performance and reliability needed for most general purpose applications. And it's priced to accommodate tight test equipment budgets. Primary features of the 455 include dual traces, 50 MHz bandwidth, 5 mV/div vertical sensitivity, 5 ns/div sweep rate, and delayed sweep.

And there's much more to the value leading 455. Trigger signal presence and timing are checked at the push of a button without moving the probes. Variable trigger holdoff provides stable displays of complex digital signals. Lighted vertical deflection factor readout minimizes errors in amplitude readings. 1X and 10X probes are automatically accounted for by the readout. In the event of damage to the 455's modular probes, the probe tip, cable, or compensation unit can be quickly and inexpensively replaced. A large 8 x 10 cm display permits easy viewing of waveforms from a distance.

Modular design enhances serviceability of the 455. Vertical amplifier and time-base modules are easily removed for ready access to all components and faster, less costly repairs. Lower component count means a less expensive spare parts inventory.

A minimum number of adjustments, made possible by actively trimmed networks, minimizes calibration time.

Well laid out controls make the 455 a remarkably easy instrument to operate. In addition to being clearly labeled and color coded, the controls are arranged in the same functional groups as the 464, 465, 466, and 475. The crt and its related controls are prominently positioned in the center of the instrument face, all vertical amplifier inputs and controls lie to the left of the display, and the horizontal sweep inputs and controls are to the right of the display. This leads to minimum operator training time and easier, faster, more error free measurements.

Options include emc protection, a tv sync separator, and battery power. For applications where ac power is available, the clip-on battery pack detaches for lower weight.

To protect the 455 and keep it operating under the hard use of industrial and field applications, it is housed in a rugged, attractive, mar resistant, reinforced plastic case.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth and Rise Time — Bandwidth dc to at least 50 MHz and rise time 7.0 ns or less, for dc coupling and −15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Deflection Factor — 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 3%. Continuously variable between steps and to at least 12.5 V/div. In cascade mode (CH 2 OUT into CH 1), sensitivity is approx 1 mV/div (at least 20 MHz bandwidth) with CH 1 IN terminated in 50Ω and both channels set to 5 mV/div.

Display Modes — Channel 1, channel 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

Automatic Scale Factor Readout — Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two lighted indicators beside the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C — 1 MΩ ±2%, approx 20 pF.

Max Input Voltage — Dc coupled: 250 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less. Ac coupled: 500 V (dc + peak ac) or 500 V p-p ac at 1 kHz or less.

Delay Line — Permits viewing leading edge of triggering waveform.

HORIZONTAL DEFLECTION

Time Base A — 0.05 μs/div to 0.5 s/div in 22 calibrated steps (1-2-5 sequence) continuously variable between steps and to at least 1.25 s/div. X10 MAG extends fastest 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 fastest sweep rate to 5 ns/div.

Time Base A and B accuracy, full 10 cm

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

More on next page.

455 50-MHz Dual-Trace Portable Oscilloscope

Horizontal Display Modes — A only, A intensified by B, B delayed by A.

A Trigger Holdoff — Adjustable control permits a stable presentation of complex waveforms. A sweep holdoff time can be increased to at least 10X the time/div setting.

CALIBRATED SWEEP DELAY

Delay Time Range — Continuously variable from 0.1 μs to at least 5 sec after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy — ±1.5% for measurements over one or more major dial divisions. ±0.015 major dial divisions for measurements of less than one major dial division.

Jitter — 1 part or less in 20,000 (0.005%) of 10X the A time/div setting.

TRIGGERING A AND B

A Trigger Modes — Automatic (sweep free-runs in the absence of a trigger and for signals below 20 Hz), normal (sweep runs when triggered), single sweep (sweep runs one time on the first triggering event after the single sweep push button is pressed).

B Trigger Modes — B sweep starts automatically after delay time, B sweep triggerable after delay time. The B sweep runs once following the A sweep delay time in each of these modes.

Coupling — Ac (attenuates signals below 60 Hz), ac low frequency reject (attenuates all signals below 50 kHz), ac high frequency reject (attenuates all signals below 60 Hz and above 50 kHz), and dc.

Time Base A Trigger Sources — Normal (internal display), internal channel 1, internal channel 2, line, external, and external ÷ 10.

Time Base B Trigger Sources — Starts automatically after delay, normal (internal display), internal channel 1, internal channel 2, and external.

Time Base A and B Trigger Sensitivity

	To 10 MHz	At 50 MHz
Internal	0.4 div deflection	1.5 div deflection
External	50 mV	250 mV

A Sweep External Trigger View — Momentary push button overrides other vertical controls and displays external A sweep trigger. Provides quick verification of external trigger and time comparison between external trigger and the displayed signal. Deflection factor for approx 50 mV/div (0.5 V/div in external ÷ 10 mode).

Level and Slope — For internal trigger, permits triggering at any point on the positive or negative slopes of the displayed waveform. For external trigger, permits triggering on any level between −2 V and +2 V (−20 V to +20 V for external ÷ 10).

External Inputs — 1 MΩ max voltage 250 V (dc + peak ac) or 250 V p-p ac (1 kHz or less).

Jitter — 0.5 ns or less at 50 MHz and 5 ns/div (X10 MAG on).

X-Y OPERATION
(Ch 1 Horizontal, Ch 2 Vertical)

Sensitivity — 5 mV/div to 5 V/div in 10 calibrated steps, accurate within 4%. Continuously variable between steps and to at least 12.5 V/div.

Bandwidth — X-axis, dc to at least 3 MHz; Y-axis, dc to at least 50 MHz.

DISPLAY

Crt — 5-in, rectangular tube; 8 x 10 cm display; P31 phosphor standard, P11 phosphor optional at no extra cost. Others available.

Graticule — Internal, (non-parallax), illuminated. 8 x 10 cm markings with horizontal and vertical centerlines further marked in 0.2 cm increments. 10% and 90% markings for rise time measurement.

Beam Finder — Limits the display to within the graticule area and provides a visible display when pushed.

Z-axis Input — Noticeable modulation at normal intensity with 0.5 V or more p-p signal. Usable frequency range dc to 20 MHz.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating: −15°C to +55°C. Storage: −55°C to +75°C.

Altitude — Operating: to 15,000 ft; max operating temperature decreased 1°C/1,000 ft above 5,000 ft. Storage: to 50,000 ft.

Humidity — 5 cycles (120 hours) referenced to MIL-E-1640F.

Vibration (Operating) — 15 minutes along each of 3 axes. 0.025 in p-p displacement (4 g's at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute cycles.

Shock (Operating and Nonoperating) — 30 g's, ½ sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks.

Electromagnetic Capability (Option 4 only) — Meets the emc requirements of MIL-Std-461A, when tested in accordance with the following test methods of MIL-Std-462.
CE-01, CE-03, CS-01, CS-02, CS-06,
RE-02 (Limited to 1 GHz), RE-04,
RS-01, and RS-02 (Limited to 1 GHz).

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.3 V ±1%. Frequency approx 1 kHz.

Signal Outputs — Output from channel 2, positive going gate output (approx 5 V) internally selectable from either A or B time base.

Power Requirements — 100 V to 132 V, 200 V to 264 V. 48 Hz to 440 Hz. Power consumption 35 watts at 115 V, 60 Hz. Operation from 12 V or 24 V dc is available with option 7.

Dimensions	in	cm
Height	9.0	22.9
Width (with Handle)	13.7	34.7
Depth (with Panel Cover)	19.5	49.5
Depth (Handle Extended)	21.7	55.2
Weight	**lb**	**kg**
Net (without Panel Cover)	24.0	10.9
Net (with Panel Cover and Accessories)	27.0	12.2
Shipping	34.2	15.5

Included Accessories — Two X10 probes, (P6105, 2 meters long), accessory pouch (016-0339-00), clear crt filter (337-2122-01), blue crt filter (337-2122-00).

INSTRUMENT OPTIONS

Emc Modification, Option 4 — Adapts 455 to meet the electromagnetic compatibility requirements of MIL-Std-461A.

Tv Sync Separator, Option 5 — Adds a tv sync separator for stable triggering from composite video waveforms. Sweep A is automatically triggered at the field or line rate and tv line rate triggering is added to the signal source selection for sweep B. Sync separator accepts sync-positive or sync-negative from channel 1, channel 2, or an external input. Recognition circuits are optimized for 405-525-625 line, 50 or 60 Hz field rate broadcast systems and are compatible with closed circuit systems up to 1201 line, 60 Hz field rate.

External Dc Operation, Option 7 — Adds a dc to ac inverter which permits operation from 12 V or 24 V dc. Protected against damage due to accidental connection to 24 V while in the 12 V mode. Makes the 455 compatible with the 1106 Battery Power Supply.

ORDERING INFORMATION

455/A2/B2 Portable Oscilloscope $1695

Option 4 Emc Modification . . . . . Add $120

Option 5, Tv Sync Separator . . . . . Add $175

Option 7, External Dc Operation . . . . . Add $120

Option 78, P11 Phosphor . . . . . No Charge

OPTIONAL ACCESSORIES

Probes — The probes provided as standard accessories to the 455 are recommended as the best choice for general-purpose applications. The probes listed in the table below are frequently used to provide added convenience and measurement capability. For a complete list of available probes, with full specifications and ordering information, consult the "Probes and Accessories" section of this catalog.

Probe Type	Attenuation	Input Impedance	Bandwidth* with 455
P6062A 6 ft	1X } Switch- 10X } able	1 MΩ-105 pF 10 MΩ-14 pF	6.7 MHz 50 MHz
P6202 FET probe 2 meter	10X 100X Head Ac Head	10 MΩ-2 pF 10 MΩ-2 pF 10 MΩ-4 pF	50 MHz
Current Probe	Calibration	Insertion Impedance	Bandwidth with 455
P6022	1 mA/mV 10 mA/mV	.03 Ω @ 1 MHz increasing to .2 Ω @ 120 MHz	47 MHz

*Bandwidths are measured at the upper −3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

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 . . . . . $665

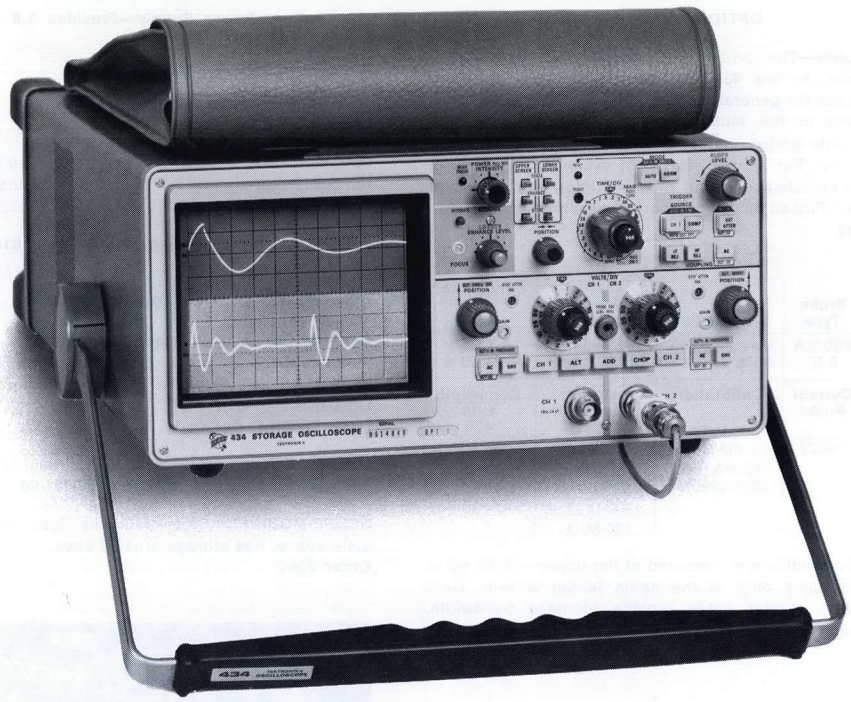
Camera Adapter and Corrector Lens — Adapts to C-30A to 455.
Order 016-0601-00 . . . . . $55

Protective Cover — Waterproof, blue vinyl.
Order 016-0554-00 . . . . . $15

Folding Polarized Viewing Head —
Order 016-0180-00 . . . . . $16.25

Mesh Filter — Improves contrast and emc filtering.
Order 378-0726-01 . . . . . $24

SCOPE-MOBILE® Cart — Occupies less than 18 in of aisle space. **Order 200 C $145**



Deflection Factors to 1 mV/div

Automatic Volts/div Readout

Direct-Reading Wide-Range Magnifier

20¾ lb

5¼ in Rackmount

The 434 gives you bistable split-screen storage and a 25 MHz bandwidth. The 434 is lightweight and compact and will fill many requirements in the field and laboratory.

The split screen operates in 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.

Vertical scale-factor readout is provided by lighted knob skirts which automatically indicate the correct reading, when using the recommended 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 a probe.

A new approach to battery operation is offered with the 1105 Battery Power Supply. The 434 can be powered for 1.8 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.

434 STORAGE

Crt—5 in rectangular tube, 8 x 10 div (1 div-0.98 cm) display area.

Phosphor—Similar to P1.

Accelerating Potential—4 kV.

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 View Time—Up to 4 hr.

Erase Time—300 ms or less.

VERTICAL SYSTEM
(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 Rise Time—(from 505 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 (approx 100 kHz); Added.

Input R and C—1 MΩ ±2% paralleled by approx 24 pF.

Max Input Voltage—Dc coupled: 250 V (dc + peak ac); ac coupled: 500 V (dc + peak ac). In either mode the max ac is 500 V p-p at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

Internal Trigger Source—Composite (displayed signals) or Channel 1 signal only.

*Bandwidth derating to 22 MHz at temperatures above +30°C.

HORIZONTAL SYSTEM

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, X50 max. 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 approx 1 MΩ. Max external input, 250 V (dc + peak ac). External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating, −15°C to +55°C. **Nonoperating, −55°C to +75°C.**

Altitude—Operating, 15,000 ft. Max allowable operating temperature decreases 1°C/1000 ft from 5000 to 15,000 ft.

Vibration—Operating and nonoperating, 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1 minutes.

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 Compatibility—With the optional mesh filter (378-0682-00) installed the 434 meets compatibility requirements of MIL-STD-461A, when tested in accordance with the following test methods of MIL-STL-462.

CE-01, CE-03, CS-01, CS-02, CS-06, RE-02 (limited to 1 GHz), RE-04, RS-01, and RS-02 (limited to 1 GHz).

Humidity—Operating and nonoperating, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

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.

More on next page.

434 25-MHz Dual-Trace Bistable Storage Oscilloscope

Z Axis—Input dc coupled to crt, noticeable modulation at normal intensity with 5 V 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 on all voltages from 90 V to 136 V and 180 V to 272 V, 50 to 400 Hz, 120 VA (75 W) max. Also operates from 105 V dc to 250 V dc.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**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
Shipping	30.0	13.6	49.0	22.2

Included Accessories—Two P6105 probes with accessories (010-6105-03); accessory pouch (016-0165-00).

Option 1, Increased Writing Speed—Increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation.

ORDERING INFORMATION

434 Storage Oscilloscope $2850
R434 Storage Oscilloscope Rackmount Model $2900

Option 1 Increased Writing Speed (434/R434) ..... ADD $30

OPTIONAL ACCESSORIES

Probes—The probes provided as standard accessories to the 434 are recommended as the best choice for general-purpose applications. The probes listed in the table below are frequently used to provide added convenience and measurement capability. For a complete list of available probes, with full specifications and ordering information, consult the "Probes and Accessories" section of this catalog.

Probe Type	Attenuation	Input Impedance	Bandwidth* with 434
P6062A 6 ft	Switchable 1X 10X	1 MΩ-5 pF 10 MΩ-14 pF	6.7 MHz 25 MHz
Current Probe	**Calibration**	**Insertion Impedance**	**Bandwidth with 434**
P6022	1 mA/mV 10 mA/mV (Selectable)	0.03 Ω @ 1 MHz increasing to 0.2 Ω @ 120 MHz	25 MHz

*Bandwidths are measured at the upper —3 dB point, and apply only to the cable length shown. Generally, shorter cable lengths increase bandwidth, longer ones decrease bandwidth.

1105 Battery Power Supply—Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply $625

Mesh Filter—Improves contrast and emc filtering.
Order 378-0682-00 ..... $22

Portable to Rackmount Assembly—Includes hardware for converting standard 434 to 19 in rack installation.
Order 016-0272-00 ..... $90

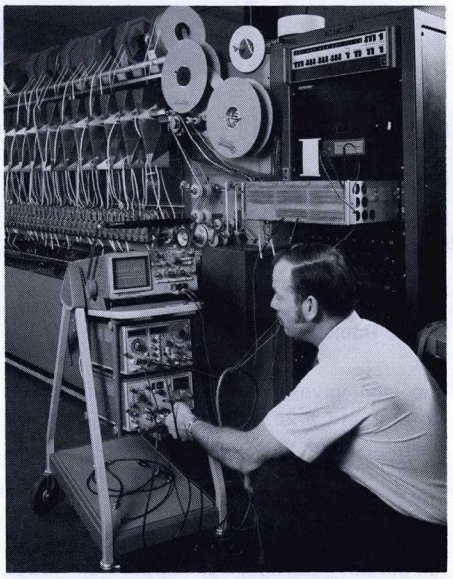
Folding Polarized Viewing Hood—Order 016-0180-00 ..... $16.25

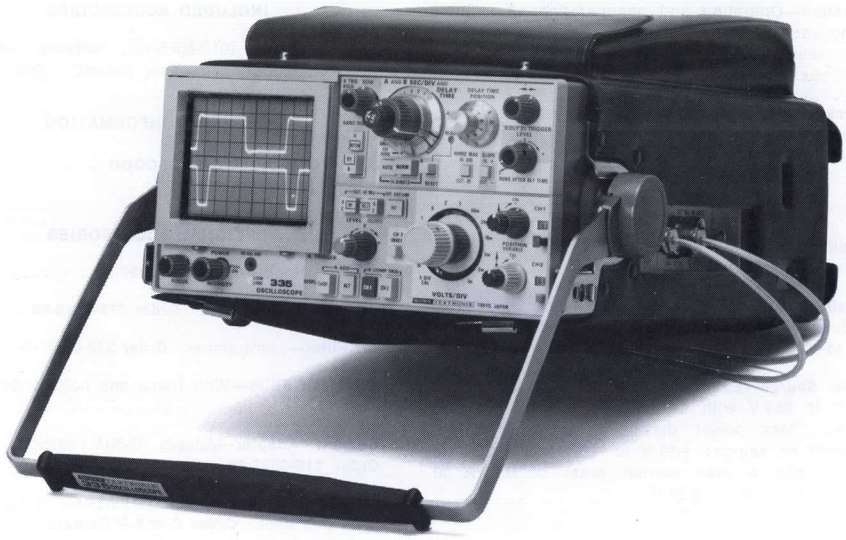
Clear Plastic Crt Filter—Order 378-0677-00 ... $1.90

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 ..... $665

Camera Adapter—Mounts C-30A Series Camera to the 434 Oscilloscope. **Order 016-0301-00 ..... $50**

SCOPE-MOBILE® Cart—Occupies less than 18 in aisle space, has storage area in base.
Order 200C $145





35 MHz, Dual-Trace, Delayed Sweep

Compact (4.4 x 9.3 x 13.6 in, 10.5 lb)

1 mV/div Vertical Sensitivity at 25 MHz

Delay Lines Input

Variable Trigger Holdoff

Rugged Construction

The 335 Portable Oscilloscope provides the fundamental capabilities (35 MHz bandwidth, dual-trace, delayed sweep) for a quite sophisticated level of digital and analog servicing. And these capabilities are provided in an easy-to-carry 10.5 lb package. This easy portability is a great advantage in many troubleshooting applications.

Many additional performance and convenience features enhance the capabilities of the 335. 1 mV/div (at 25 MHz) vertical sensitivity insures that low level signals from magnetic recording leads, optical read heads, or industrial control transducers can be accurately and easily measured. The use of delay lines at the inputs provides for viewing the leading edge of the triggering signal. Variable trigger holdoff makes it easier to obtain stable displays of complex waveforms. By using a composite of channels 1 and 2 as a trigger source, stable displays of non-time-related signals can be obtained. Operation from either ac (90 to 132 V, or 180 to 264 V, 48 to 440 Hz) or dc (+11 to +14 V or +22 to +28 V) sources assures that power can be obtained at nearly any location. The 335 is constructed to withstand the wide range of temperature and humidity and the rough handling encountered in industrial or field environments. An included wrap-around case offers additional protection to the 335 during operation or transit. The case includes a pouch for probe and manual storage and a convenient shoulder strap for carrying.

Color coding and functional layout of the front-panel controls make the 335 easy to operate. Combined function controls and side mounting of probes lead to small size and an uncluttered control panel.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth and Rise Time—For 20°C to 30°C bandwidth is dc to at least 35 MHz and rise time is 10 ns or less for dc coupling and deflection factors from 10 mV/div to 10 V/div. For 1 mV/div to 5 mV/div bandwidth is at least 25 MHz and rise time is 14 ns or less. For ac coupling the lower 3 db point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 3%. Continuously variable between steps and to at least 25 V/div (uncalibrated).

Display Modes—Channel 1, Channel 2 (normal or inverted), alternate, chopped (300 kHz rate), added, X-Y.

Input R and C— 1 MΩ ±2% paralleled by 24 pF.

Max Input Voltage— 500 V (dc + peak ac). 500 V p-p ac at 1 kHz or less.

Delay Line—Permits viewing leading edge of triggering waveform.

HORIZONTAL DEFLECTION

Time Base A Sweep Rate— 0.2 μs/div to 0.5 s/div in 20 calibrated steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div. Sweep rate is continuously variable between steps (uncalibrated).

Time Base B Sweep Rate— 0.2 μs/div to 50 ms/div in 17 calibrated steps (1-2-5 sequence). X10 magnifier extends fastest sweep rate to 20 ns/div.

Sweep Rate Accuracy—(Time base A and B over center 8 div).

	+20°C to +30°C	−15°C to +55°C
Unmagnified	±3%	±4%
Magnified	±5%	±6%

Horizontal Display Modes—A only, A intensified by B, B delayed by A, B triggerable after A.

Variable Trigger Holdoff—For the A sweep an adjustable holdoff control permits a stable display of complex waveforms. Sweep holdoff time can be increased at least X10.

CALIBRATED SWEEP DELAY

Delay Time Range—Continuously variable from 0.2 μs to at least 5 s after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy— ±2% for measurements of 1 or more major dial div or ±0.02 major dial div for measurements of less than one major dial div (for delay time dial settings between 1.0 and 9.0).

Jitter— 1 part or less in 20,000 (0.005%) of X10 the A time/div setting.

TRIGGERING A AND B

A Sweep Trigger Modes—Automatic (sweep free-runs in absence of a signal. Permits normal triggering on signals with a 20 Hz or greater repetition rate). Normal (sweep runs when triggered, does not run in the absence of an adequate signal). Single sweep (sweep runs once on the first trigger signal after the reset button is pushed).

B Sweep Trigger Modes—B sweep starts automatically after delay time. B sweep triggerable after delay time. B sweep runs once following the A sweep delay time in each of these modes.

Trigger Coupling—Ac (blocks dc component of triggering signal and attenuates signals below 60 Hz), ac low frequency reject (attenuates all signals below 40 kHz), ac high frequency reject (attenuates all signals below 60 Hz and above 20 kHz), and dc.

Trigger Source—Internal channel 1, internal channel 2, internal composite (uses a composite of channel 1 and channel 2 signals to produce trigger), external, external divided by 10, and line. The B sweep can also be started automatically at the end of the time base A delay.

External Input Impedance—Approx 1 MΩ paralleled by 24 pF.

Trigger Sensitivity

Coupling		To 10 MHz	At 35 MHz
Dc	Int	0.35 div	1.5 div
	Ext	70 mV	250 mV
	Ext ÷ 10	700 mV	2.5 V
Ac	above requirements increase below 60 Hz		
Ac Hf Rej	Int	0.5 div above 40 kHz	2 div
	Ext	100 mV above 40 kHz	360 mV
	Ext ÷ 10	1 V above 40 kHz	3.6 V
Ac Lf Rej	Int	0.5 div, 60 Hz to 20 kHz	
	Ext	100 mV, 60 Hz to 20 kHz	
	Ext ÷ 10	1 V, 60 Hz to 20 kHz	

More on next page.

335 35-MHz Dual-Trace Portable Oscilloscope

X-Y OPERATION

Input—X axis input is via the external horizontal input connection. Both channel 1 and channel 2 provide vertical inputs. Using chopped mode, two simultaneous X-Y displays can be obtained.

X-Axis Deflection Factors—20 mV/div, 200 mV/div, and 2 V/div from dc to at least 500 kHz.

X-Axis Input Impedance—Approx 1 MΩ paralleled by 24 pF.

DISPLAY

Crt—Rectangular tube with an 8 x 10 div graticule (0.25 in/div). P31 phosphor. 12 kV accelerating potential.

Graticule—Internal (non-parallax) non-illuminated, 8 x 10 div markings with horizontal and vertical centerlines further marked in 0.05 in increments.

ENVIRONMENTAL CAPABILITIES

Temperature—Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude—Operating: 15,000 ft max, decrease max temperature by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: 50,000 ft max.

Humidity—5 cycles (120 hours) referenced to MIL-E-16400 F.

Vibration—Operating and nonoperating 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's at 55 cps) 10 to 55 to 10 cps 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.

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V (±1%) at 1 kHz (±2%) from 20°C to 30°C.

Z-Axis Input— +5 V signal causes noticeable modulation at normal intensity. Useful bandwidth dc to 600 kHz.

Power Source—External ac source: 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a max current drain of 0.2 A at +12 V or 1.0 A at +24 V.

DIMENSIONS AND WEIGHTS

	in	cm
Height	4.4	11.2
Width with Handle	9.3	23.6
Depth, Handle not Extended	13.6	34.7
Depth, Handle Extended	17.6	44.8
	lb	**kg**
Net Weight without Accessories	10.5	4.7
Shipping Weight	17.0	7.6

INCLUDED ACCESSORIES

2 6 ft probes (010-6065-13), carrying case (016-0612-00), external dc cable assembly (012-0406-00).

ORDERING INFORMATION

335 Portable Oscilloscope $1825

OPTIONAL ACCESSORIES

Viewing Hood—Order 016-0297-00 ..... **$3.25**

Crt Filter—Light blue. **Order 378-2016-00** **$1.00**

Crt Filter—Light amber. **Order 378-0843-00** ... **$1.60**

Crt Mesh Filter—With frame and holder. **Order 378-0063-00** **$10.00**

Camera Adapter—Adapts C-30A camera to 335. **Order 016-0327-00** **$42.00**

C-30A-P Camera—General purpose camera with pack film back. **Order C-30A-P Camera** **$650.00**

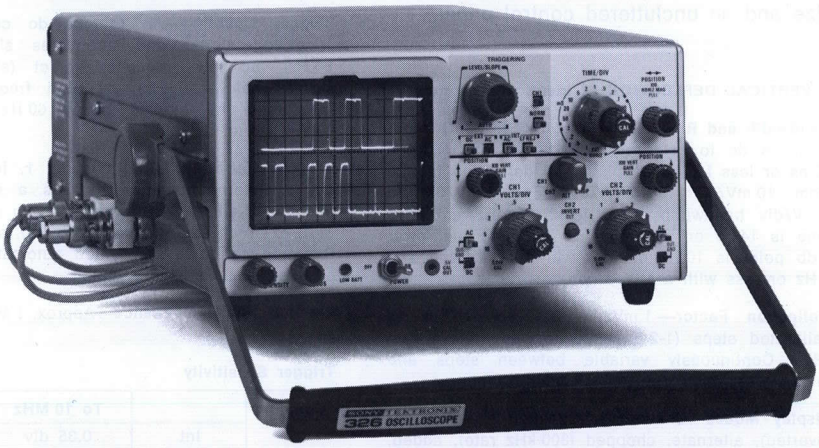
1105 Battery Power Supply **$625**

The SONY®/TEKTRONIX® 335 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 335 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

326 Portable Oscilloscope

10-MHz Dual-Trace

SONY/TEKTRONIX®



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.

Rise Time— 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 MΩ within 2% paralleled by approx 47 pF.

Max 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 div 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—Continuouly 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-output connections are on left side panel, freeing 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 max 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 max 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 ft max; max ambient temperature must be decreased by 1°C/1000 ft from 5000 ft to 15,000 ft. Nonoperating: 50,000 ft.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch p-p displacement (4 gs 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 max at 115 V ac.

Dimensions	in	cm
Height	4.0	10.2
Width with handle	8.7	22.2
Depth, handle not extended		
with charger	15.0	38.1
without charger	12.2	31.0
Depth, handle extended		
with charger	18.2	46.2
without charger	15.8	40.1
Weights	**lb**	**kg**
Net weight without accessories		
with charger	13	5.9
without charger	10	4.5
Shipping weight	19	8.6

Included Accessories—Two P6049B 10X probes (010-6049-11); 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).

326 Oscilloscope, including power pack **$1825**

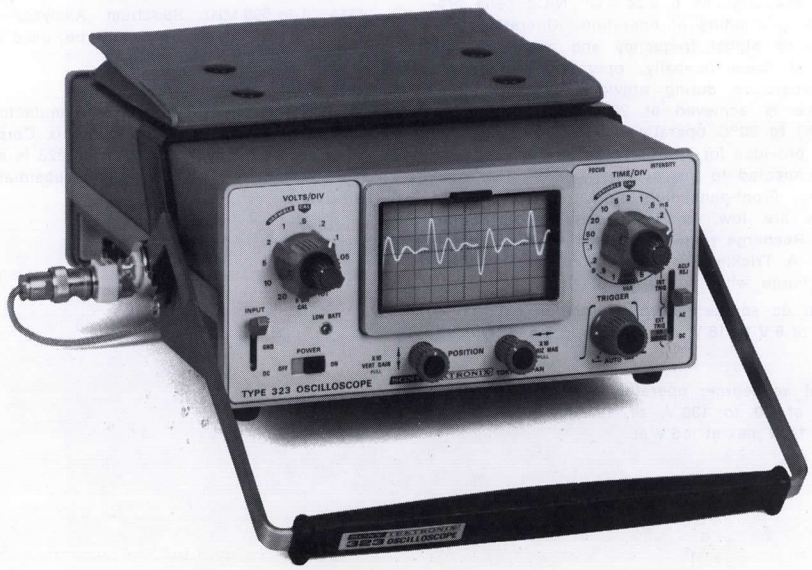
The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Battery Set—Set of 9 NiCd cells, **Order 146-0018-00** **$54**

Battery Pack — Includes 146-0018-00 in battery housing, **Order 016-0296-00** **$85**

SONY/TEKTRONIX®



Portable Oscilloscopes

4-MHz Single Channel

323

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 is 8.5 inches, height is 4.3 inches, weight is ≈7 pounds.

More on next page.

323 4-MHz Portable Oscilloscope

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.

Rise Time—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 MΩ within 2% paralleled by approx 47 pF.

Max 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 div, 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 div, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/idv, 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 max input voltage (combined dc + peak ac).

Amplitude Requirements— 0.3 div deflection or 75 mV external to 400 kHz, increasing to 0.75 div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external ac coupling and below 30 kHz with Ac Lf Rej coupling.

CRT

Crt— 6 x 10 div display area; each div is 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 max input voltage (combined dc + peak ac).

Graticule—Internal, black, nonilluminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼ inch div.

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; max ambient temperature 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 p-p 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.

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 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. Max 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 nonoperating. 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 max at 115 V ac.

Dimensions	in	cm
Height with accessory pouch	4.3	10.8
Width with handle	8.5	21.6
Width with ac power cord	9.3	23.5
Depth with handle not extended	10.6	27.0
Depth with handle extended	13.0	33.0
Weights	**lb**	**kg**
Net without accessories	7	3.2
Shipping	14	6.3

Included Accessories—P6049B 10X probe (010-6049-11); 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).

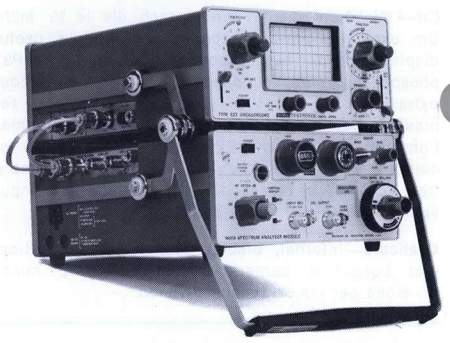
323 Oscilloscope (includes power pack) **$1200**

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 323 can be used during transport or storage, and is constructed of waterproof blue vinyl,
Order 016-0112-00 ..... **$15**

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** **$145**

Battery Set—Set of 6 NiCd cells,
Order 146-0012-01 ..... **$28**



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.

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.

Stored Viewing Time to 4 hrs
10.5 lb Portable Package
Intergrate Mode for Intensifying Fast Rise Time, Low Repetition Rate Signals
1 mV/div Sensitivity at 10 MHz
Designed for Severe Environments
Operates from Ac Line, 12 V Dc, or 24 V Dc

The 314 Portable Storage Oscilloscope provides bistable storage with a 4-hour viewing time, and 1 mV/div sensitivity at 10 MHz in a rugged 10.5 lb package. This low weight (less than one-half the weight of most storage oscilloscopes) is an important consideration where portability is needed.

Long term storage (4 hours) provides the 314 with the capability for unattended monitoring of signal lines where undesired transients are suspected. It also makes it easy to store hard-to-repeat waveforms for later viewing by other personnel. For fast rise time, low repetition rate signals, an integrate mode increases the intensity of the stored trace.

Light-weight (10.5 lb), small size (4.4 in x 9.3 in x 13.6 in), and operation from ac or dc power sources mean that the 314 will easily go wherever there is a need for a storage oscilloscope. And rugged construction assures that it will withstand field operating conditions. Applications for the 314 occur in industrial control systems, biophysical instrumentation, communication terminals, POS terminals, computer peripherals, and communication systems. The 1 mV/div sensitivity is particularly useful for measurement of transducer signals such as those from magnetic recording heads. An auto-erase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer.

Color coding and functional layout of the front-panel controls make the 314 easy to operate. Combined function controls and side mounting of probes lead to small size and an uncluttered control panel.

CRT DISPLAY AND STORAGE FEATURES

Crt — 8 x 10 div display area (0.25 in/div).

Phosphor — P43.

Accelerating Potential — 2 kV.

Graticule — Internal, non-illuminated. Vertical and horizontal center-lines marked in 5 minor div per major ¼ in div.

Display Modes — Direct view, bistable storage, and non-store modes. Enhance mode to increase stored writing rate in the single sweep mode. Auto erase mode to automatically erase stored display after each sweep. Viewing time before auto erase can be varied from 1 sec or less to at least 5 sec. Integrate mode increases stored brightness of very fast repetitive signals.

Stored Writing Speed — At least 80 div/ms. Increases to at least 400 div/ms (250 cm/ms) in enhanced mode.

Storage Viewing Time — Up to 4 hours.

Erase Time — 300 ms.

VERTICAL SYSTEM

Bandwidth — Dc to at least 10 MHz. For ac coupling, low frequency limit is 10 Hz or less; 1 Hz or less with the included 10X probe.

Rise Time — 36 ns or less for a 4 div step input.

Deflection Factor — 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence). All steps accurate within 3%. Uncalibrated, continuously variable between steps and to at least 25 V/div.

Display Modes — Channel 1 only, channel 2 only (normal or inverted), chopped, alternate, added, and X-Y.

Input R and C — 1 MΩ paralleled by 47 pF for oscilloscope alone. 10 MΩ paralleled by 13.5 pF with P6049B probe.

Max Input Voltage — 500 V (dc + peak ac).

Delay Line — Permits viewing leading edge of triggering waveform.

HORIZONTAL DEFLECTION

Time Base — 1 μs/div to 5 s/div in 21 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% from 0.5 s/div to 5 s/div. Uncalibrated, continuously variable between steps and to at least 12.5 s/div.

X10 Magnifier — Operates over all time base ranges, increases fastest sweep rate to 0.1 μs/div. Accurate within 5% over the center 8 divisions from 50 ms/div to 0.5 s/div, within 4% from 0.5 μs/div to 20 ms/div, and within 5% for 0.1 μs/div and 0.2 μs/div.

External Input — Deflection factor continuously variable from 20 mv/div to 20 V/div. Bandwidth, dc to at least 200 kHz.

TRIGGER

Modes — Automatic: minimizes trigger adjustment. Sweep generator free-runs in the absense of a trigger. Normal: sweep generator requires a trigger to generate a sweep. Single sweep: one sweep is initiated by the first trigger after a reset.

Sources — Internal: channel 1, channel 2, or composite. Coupling is ac or ac lf rej. External: coupling is dc, ac or ac lf rej. Max input trigger voltage, 300 V (dc + peak ac). Line: trigger is obtained from a sample of the line voltage applied to the instrument.

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 for ac coupling and below 50 kHz for ac lf rej coupling.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating: −15°C to +55°C. Nonoperating: −40°C to +75°C.

Altitude — Operating: 20,000 ft max, decrease max temperature by 1°C/1,000 ft from 5,000 ft to 20,000 ft. Nonoperating: 50,000 ft max.

Humidity — Nonoperating: Meets electrical performance specifications after 5 cycles (120 hours) of MIL-STD-202D, Method 106C. Omit freezing and vibration. Test performed after a drying period at 25°C ±5°C and 20% to 80% relative humidity.

Vibration — Operating: 15 minutes along each of the three major axes at a total displacement of 0.025 in p-p (4 g's at 55 cps). 10 to 55 to 10 cps 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.

OTHER CHARACTERISTICS

Amplitude Calibrator — 0.5 V accurate within 1% from 20°C to 30°C, within 2% from −15°C to +55°C.

Z-axis Input — Sensitive range +5 V to +20 V (dc coupled) with a 100 kHz or greater usable frequency range. Max input voltage, 50 V (dc + peak ac).

Power Sources — External ac source: 90 V to 132 V or 180 V to 264 V with a line frequency of 48 Hz to 440 Hz. Max power dissipation 29 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a max current drain of 1.6 A at +12 V or 0.8 A at +24 V.

DIMENSIONS AND WEIGHTS

Dimensions	in	cm
Height	4.4	11.2
Width with Handle	9.3	23.6
Depth, Handle not Extended	13.6	34.7
Depth, Handle Extended	17.6	44.8
Weights (approx)	**lb.**	**kg**
Net Weight without Accessories	10.5	4.7
Shipping Weight	17.0	7.6

Included Accessories — Two P6049B X10 probes (010-6049-11), carrying case (016-0612-00) external dc cable assembly (012-0406-00).

314 Storage Oscilloscope $1995

The SONY®/TEKTRONIX® 314 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, the 314 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

Portable Oscilloscope

5-MHz Miniscope

5 MHz Bandwidth

3.5 lb, 3 x 5¼ x 9½ In

Internal Battery Pack

5 mV/div to 100 V/div

Integral 1 MΩ Probe

The 221 has the capability needed for on-site service of today's complex equipment. This versatile miniscope has a 5 MHz bandwidth, 5 MV/div sensitivity, and 0.1 μs/div sweep speed (using X10 magnifier) packaged in an impact-resistant case. Total operating weight is just 3.5 pounds. Internal rechargeable batteries allow at least three hours operation away from external power sources, and the 221 will operate and charge from practically all the world's principal line voltages. Traveler-users can connect the 221 to 90 to 250 V, 48 to 62 Hz ac, or 80 to 250 V dc without making any change to the instrument. The 3 x 5.2 x 9 inch scope fits in a toolbox or briefcase.

The integral 1 MΩ low-capacitance probe minimizes circuit loading and is always there when you need it. Vertical deflection factors extend from 5 mV/div to 100 V/div allowing on-screen measurement of signals up to 600 V dc + peak ac. The 1 μs/div to 200 ms/div time base is enhanced by a X10 magnifier that extends the fastest range to 0.1 μs/div. A variable control will slow the sweep to about 0.5 s/div.

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, the scope triggers 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.

In many industrial applications, it is necessary to "float" the oscilloscope. These scopes can be elevated to 700 V (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.

The physical and electrical characteristics of the 221 make it a valuable and important tool for those involved in servicing computer peripherals, process control equipment, machine tool controls, communication and alarm systems, data transmission equipment, mobile electronics, and many others.

VERTICAL DEFLECTION

Deflection Factor—5 mV/div to 100 V/div in 14 calibrated steps (1-2-5 sequence). Accurate to within 3% from 0°C to +40°C and within 5% from −15°C to 0°C and +40°C to +55°C. Uncalibrated, continuously variable between steps and to at least 300 V/div.

Bandwidth—Dc to at least 5 MHz (−3 dB point) at all calibrated deflection factors. Lower 3 dB down point ac coupled is approx 2 Hz.

Input R and C—Approx 1 MΩ paralleled by approx 29 pF via attached signal acquisition probe.

Insulation Voltage—500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord stored and the plug protected. When operated from an external line, line voltage plus floating voltage not to exceed 250 V rms; or 1.4 x line + (dc + peak ac) not to exceed 350 V.

Max Input Voltage—600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

HORIZONTAL DEFLECTION

Time Base—1 μs/div to 200 ms/div in 17 calibrated steps (1-2-5 sequence). Accurate to within 3% from 0°C to +40°C and within 5% from −15°C to 0°C and +40°C to +55°C.

Sec/Div Variable—Extends minimum sweep rate to approx 0.5 s/div. Continuously variable between calibrated settings.

Horizontal Magnifier—Increases all sweep speeds X10 with a max sweep speed of 0.1 μs/div and gives a horizontal sensitivity of 0.1 V/div in X-Y operation.

External Horizontal Input—1 V/div within 10%, dc to 500 kHz. Approx 0.5 MΩ paralleled by approx 30 pF.

Max External Horizontal Input Voltage—200 V (dc + peak ac), 200 V p-p ac to 500 kHz, decreasing to 20 V p-p ac at 5 MHz.

TRIGGER

Modes—Automatic or manual. Level and slope selected with a single control. Automatic operation minimizes trigger adjustment and provides a bright baseline with no input.

Sensitivity—

Internal 0.5 div from 2 Hz to 1 MHz decreasing to 1 div at 5 MHz.

External 0.5 V from dc to 1 MHz decreasing to 1 V at 5 MHz.

CRT

Crt—6 x 10 div display area, each div is approx 0.2 in. P31 phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

Graticule—Internal, black line, nonilluminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating (battery only) −15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating, −40°C to +60°C.

Altitude—Operating: 25,000 ft, max operating temperature decreased by 1°C/1000 ft above 15,000 ft. Nonoperating, 50,000 ft.

Vibration—Operating and nonoperating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 in p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one minute cycles. Held for three minutes at 55 Hz. All major resonances must be above 55 Hz.

Shock—Operating and nonoperating; 100 g's, ½ sine, 2 ms duration each direction along each major axis. Total of 12 shocks.

Humidity—Operating and nonoperating; 5 days at +50°C, 95% humidity.

OTHER CHARACTERISTICS

Power Sources—Internal dc source contains 10 size "A" NiCd cells providing at least 3 hours operation. Operating time depends on trace intensity, operating temperature, and temperature during battery charge. Max 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 external power line with instrument turned on or off. Battery operation is automatically interrupted when battery charge drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. Extended time charges will not damage the batteries. An expanded scale battery meter indicates full, low, and recharge. External power source, 90 to 250 V ac (48 to 62 Hz) or 80 to 250 V dc, 5 W or less.

Dimensions and Weights

	in	cm
Height	3.0	7.6
Width	5.2	13.3
Depth	9.0	22.8
	lb	**kg**
Net Weight without Accessories	3.5	1.6
Shipping	≃8.0	≃3.6

Included Accessories—Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); and two spare fuses (159-0080-00).

ORDERING INFORMATION

221 Oscilloscope, including batteries and probe **$825**

INSTRUMENT OPTION

Option 76, P7 Phosphor ..... **No Charge**

OPTIONAL ACCESSORIES

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... **$8.00**

Probe-tip to BNC Panel Connector Adapter .....
Order 013-0084-01 ..... **$8.00**

Probe-tip to BNC Cable Adapter .....
Order 103-0096-00 ..... **$8.00**

Power Cable Adapter Assembly—A short length of two-wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... **$3.50**

3.5 lb, 3 x 5¼ x 9½ Inches

Internal Battery Pack

1 mV/div to 50 V/div

Integral 1 MΩ Probe

Dual Trace

Storage (214)

The growing 200 Series of miniscopes represent a breakthrough in portable oscilloscope design. Fully self-contained, these miniature size, ultra lightweight portables are double insulated, permitting floating 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 V (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.

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 capabilities 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.

VERTICAL SYSTEM

Deflection Factors— 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 10X 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—Channel 1 only, Channel 2 only, or Channel 1 and Channel 2 chopped from 500 ms/div to 2 ms/div of time base (approx 40 kHz), and alternate from 1 ms/div to 5 μs/div of time base.

Max Input Voltage (1X probe only)— 1 mV/div to 50 mV/div, 600 V (dc + peak ac), ac not over 2 kHz. 0.1 V/div to 50 V/div, 600 V (dc + peak ac), 600 V p-p ac, 5 MHz or less.

Max Input Voltage Using Optional 10X Attenuator— 1000 V (dc + peak ac).

Channel 1-Channel 2 Isolation — 1000:1 (Signals less than 6 divisions).

HORIZONTAL SYSTEM

Time Base — 5 μs/div to 500 ms/div in 16 calibrated steps (1-2-5 sequence); accurate to within 5%.

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable between settings. Extends max sweep rate to at least 1 μs/div.

External Horizontal Input (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.

TRIGGER

Internal (With Composite Trigger Source)—Triggers on at least 0.2 div, dc to 500 kHz.

Internal (with Channel 2 Trigger Source)—Triggers on 0.2 div from 2 Hz (—3 dB down) to 500 kHz.

External— 1 V to 16 V p-p to 500 kHz. Input R and C, 1 MΩ paralleled by approx 30 pF.

Single Sweep—Sweep generator produces one sweep when trigger is received.

CRT AND STORAGE FEATURES

Crt—Bistable storage, 6 x 10 div display area, each div is approx 0.2 in.

Graticule—Internal, black line, nonilluminated.

Stored Luminance—At least 8 ft lamberts.

Writing Speed—Normal, at least 80 div/ms. Enhanced, increases single-sweep storage writing speed to at least 500 div/ms. Enhance is automatic from 0.1 ms to 5 μs/div in single sweep.

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°C; nonoperating —40°C to +60°C.

Altitude—Operating, 25,000 ft, max operating temperature decreased by 1°C/1,000 ft above 15,000 ft. Nonoperating 50,000 ft.

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.

More on next page.

OTHER CHARACTERISTICS

Power Sources—An internal dc source provides up to 5 hours operation (up to 3.5 hours in 214 stored mode). Operating time depends on trace intensity, operating temperature, and temperature during previous battery charge. Max 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. Battery operation is automatically interrupted when battery charge drops to approx 10 V to protect batteries against deep discharge. Full recharge requires approx 8 hours. Extended charge times will not damage the batteries.

Power Sources—A pilot light battery-charge indicator light will extinguish when oscilloscope has about 10 minutes (5 min. for the 214) of operating time remaining in the batteries.

External Ac Source— 110 to 126 V, 58 to 62 Hz, 3 W. Can be operated at 104 to 110 V with resulting slow discharge of internal batteries. Power options are shown below.

Dimensions	in	cm
Height	3.0	7.6
Width	5.3	13.3
Depth	9.5	24.1
Weight (approx)	**lb**	**kg**
Without Accessories	3.5	1.6
Shipping	7.0	3.2

Included Accessories—Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); 2 fuses (159-0121-00).

ORDERING INFORMATION

212 Dual-Trace Oscilloscope, including batteries **$875**

214 Dual-Trace Storage Oscilloscope, including batteries **$1200**

48-52 Hz POWER OPTIONS

Option 1 for 220-250 V, includes batteries ..... **No Charge**

Option 2 for 90 to 110 V, includes batteries ..... **No Charge**

OPTIONAL ACCESSORIES

10X Attenuator Package—A slip-on tip to provide lower circuit loading (4.4 MΩ, approx 20 pF) and higher max input voltage 1000 V (dc + peak ac) includes: 10X attenuator (010-0378-01); pincher tip (013-0071-00); flex tip (206-0060-00); banana tip (134-0013-00); IC adapter (206-0203-00).
Order 010-0378-01 ..... **$28**

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to 3/8") conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... **$8.00**

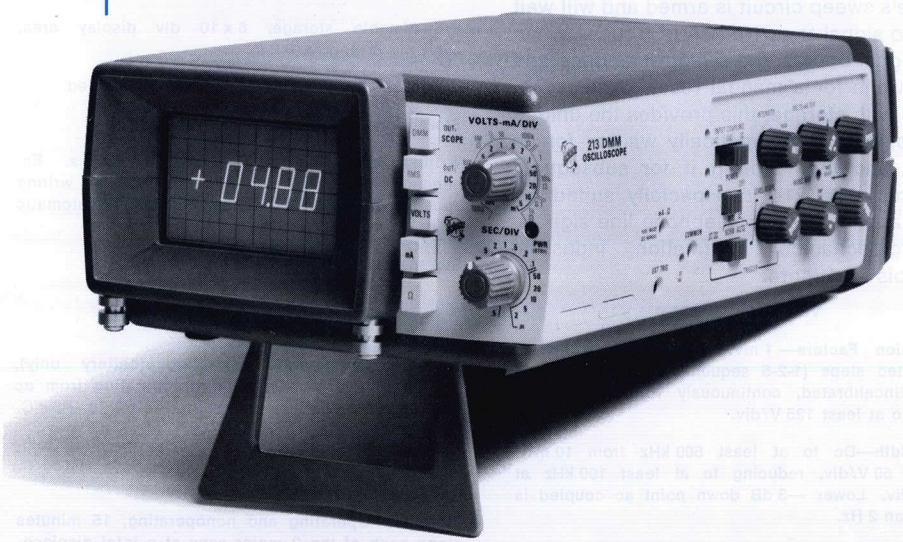
Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... **$8.00**

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... **$8.00**

Power Cable Adapter Assembly—A short length of two wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... **$3.50**

213 Portable Oscilloscope

A 1-MHz Miniscope/DMM



DMM and Miniscope in One Unit
Compact—3.7 lb, 3 x 5.2 x 8.9 in
True Rms Voltage and Current Measurements
Internal Battery
Double Insulation
Rugged Construction

The 213 combines a precision (3½ digit) digital multimeter and a 1 MHz oscilloscope in one extremely compact instrument that will go wherever you have measurements to make. At 3.7 lbs and 3.0 x 5.2 x 8.9 inches, the 213 will easily fit into your briefcase or toolkit. In operation the light-weight 213 can be hand held, rested on the equipment being tested, or carried on a convenient included neck strap.

Small size and internal battery power assure that the 213 can easily make measurements at the top of a ladder, on a catwalk in an industrial processing plant, in a moving vehicle, in office environments, at a remote field location, and at many other locations often inaccessible for measurements with such complete instrumentation. What's more, the 213's rugged construction equips it to withstand hostile industrial or transportation environments as well as the hard use of traveling field service applications. Battery operation and a double-insulated case aid the operator in isolating the 213 from ground or power line when making measurements at elevated voltage.

By combining both DMM and oscilloscope functions, the 213 provides the capabilities required for a wide range of on-site servicing applications. The 213 is the ideal instrument for many troubleshooting applications in industrial control systems, computer peripherals, communications equipment, office machines, point-of-sale terminals, mobile electronics, and hospital equipment.

Operating controls of the 213 are designed to be easily understood and to speed measurements. A single push button is used to select DMM or oscilloscope operation. A second push button selects dc or rms operation, three additional push buttons provide quick selection of voltage, current, or (in the DMM mode) resistance measurement. Scale factor (volts, mA, or ohms) for both oscilloscope and DMM modes is selected with one clearly labeled dial. A second dial is used to select time/div for the oscilloscope mode.

DMM

Provides true rms readings of voltage and current.

DC AND AC VOLTAGE

Range — 0.1 V to 1000 V full scale in 5 ranges.

Resolution — 100 μV at 0.1 V full scale.

Accuracy In Dc Mode — For 25°C ±5°C.

Range (Full Scale)	% of Reading
0.1 V	Within 0.1% of reading ±3 counts. Temp Coef is (within 0.015% of reading +0.04% of full scale) per °C.
1 V	Within 0.1% of reading ±1 count. Temp Coef is (within 0.01% of reading +0.01% of full scale) per °C.
10 V and 100 V	Within 0.15% of reading ±1 count. Temp Coef is (within 0.015% of reading +0.01% of full scale) per °C.
1000 V	Within 0.2% of reading ±1 count. Temp Coef is (within 0.02% of reading +0.01% of full scale) per °C.

Accuracy in Rms Mode—For 25°C +5°. Temperature coefficient (within 0.05% of reading +0.1% of full scale) per °C.

Range (Full Scale)	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 V	2.5%	1.5%	3.5%
1 V, 10 V, and 100 V	2%	1%	1%
1000 V	2%	1%	2%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice indicated limit for crest factor of 5.

Input Resistance — 10 MΩ.

Input Capacitance — 150 pF on 0.1 V to 10 V ranges, 100 pF on 100 V and 1,000 V ranges.

Settling Time — 1.5 seconds within 0.1% of reading in dc mode, 2 seconds within 1% of reading in rms mode.

Max Input Voltage — 500 V (dc + peak ac) for 0.1 V to 10 V ranges dc coupled, 800 V (dc + peak ac) for 0.1 V to 10 V ranges ac coupled, 800 V (dc + peak ac) for 100 V and 1000 V ranges.

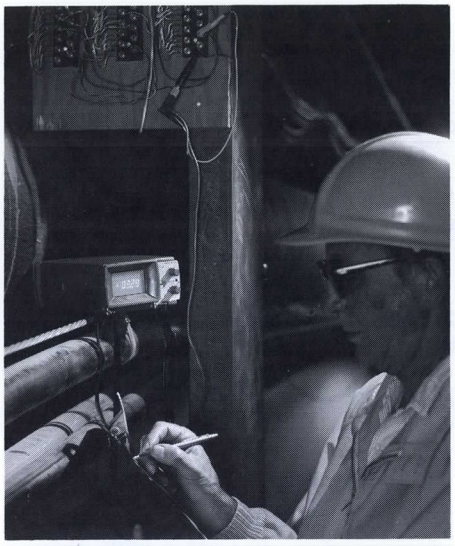
DC AND AC CURRENT

Range — 0.1 mA to 1000 mA full scale in 5 ranges.

Resolution — 100 nA at 0.1 mA full scale.

Accuracy in Dc Mode — For 25°C ±5°C. Temperature coefficient (within 0.02% of reading +0.04% of full scale) per °C.

Range (Full Scale)	Within % of reading shown ±3 counts
0.1 mA	0.5%
1 mA to 1000 mA	0.25%



Accuracy in Rms Mode — For 25° ±5°C. Temperature coefficient (within 0.02% of reading +0.04% of full scale) per °C.

Range (Full Scale)	Within % of reading shown ±5 counts*		
	Dc	40 Hz to 4 kHz	4 kHz to 40 kHz
0.1 mA	2.5%	1.5%	4.5%
1 mA to 1000 mA	2.5%	1.5%	3.5%

*Accuracy limit increases linearly for crest factor greater than 2 up to twice the indicated limit for crest factor of 5.

Settling Time — 1.5 seconds within 0.1% of reading in dc mode, 2 seconds within 1% of reading in rms mode.

Max Input Current — 2 A rms or 3 A peak on any scale (fuse and diode protection).

RESISTANCE

Ranges — 1 kΩ to 10 MΩ full scale in 5 ranges.

Resolution — 1 Ω on 1 kΩ scale.

Accuracy — For 25°C ±5°C.

Range	% of Reading
1 k	0.5% ±3 counts
10 k to 1 M	0.5% ±1 count
10 M	1% ±1 count

Settling Time — 2 seconds within 2 counts.

READOUT

Number of Digits — 3½ digits plus decimal point and sign.

Display Size — 1 cm high by 4 cm wide (5 characters).

Overrange Capability — At least 200% of full scale.

Overrange Indication — Readout displays scrambled characters.

OSCILLOSCOPE

VERTICAL DEFLECTION (VOLTAGE)

Deflection Factor — 5 mV/div to 100 V/div in 14 calibrated steps (1-2-5 sequence). Accurate within ±3%. Uncalibrated; continuously variable between steps and to at least 250 V/div.

Bandwidth — Dc to 1 MHz (−3 dB point) for 20 mV/div to 100 V/div deflection factors. Dc to 400 kHz (−3 dB point) for 5 mV/div and 10 mV/div. Lower bandwidth limit (−3 dB point) for ac coupling is 1 Hz or less.

Input R and C — 10 MΩ paralleled by 150 pF for 5 mV/div through 1 V/div and 100 pF for 2 V/div through 100 V/div.

Max Input Voltage —

Input Condition	Max Input Voltage
Dc coupled, 5 mV/div to 1 V/div	500 V (dc + peak ac) at 1 MHz or less
Ac coupled, 5 mV/div to 1 V/div	800 V (dc + peak ac) 500 V peak ac component
2 V/div to 100 V/div	800 V (dc + peak ac) at 1 MHz or less

VERTICAL DEFLECTION (CURRENT)

Deflection Factor — 5 μA/div to 100 mA/div in 14 calibrated steps (1-2-5 sequence). Accurate within ±3%. Uncalibrated; continuously variable between steps and to at least 250 mA/div.

Bandwidth — Dc to at least 400 kHz (−3 dB point) for 20 μA/div through 100 mA/div deflection factors. Dc to at least 200 kHz −3 dB point) for 5 μA/div and 10 μA/div.

Max Input Current — 2 A rms or 3 A peak for any range (fuse and diode protection).

HORIZONTAL DEFLECTION

Sweep Rate — 2 μs/div to 500 ms/div in 17 calibrated steps (1-2-5 sequence). Accurate within ±5%.

Horizontal Magnifier — Provides continuously variable sweep rate settings between calibrated settings. Extends fastest sweep rate to at least 0.4 μs/div.

TRIGGER

Internal Ac Coupled (Auto) — Triggers on deflection of 0.5 div or more from 7 Hz to 1 MHz. Sweep free-runs in absence of trigger signal or for frequencies below 7 Hz.

Internal Ac Coupled (Normal) — Triggers on deflection of 0.5 div or more from 7 Hz to 1 MHz.

External Dc Coupled — Triggers on signals of 1.0 V or more from dc to 1 MHz.

CRT

6 x 10 div display area, each div is approx 0.2 in. Internal black line, non-illuminated graticule. P43 phosphor is standard.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature — Operating (battery only), −15°C to +55°C. Charging or operating from ac line, 0°C to +40°C. Nonoperating −40°C to +60°C.

Altitude — Operating, to 25,000 ft. Max operating temperature decreased by 1°C per 1,000 ft above 15,000 ft. Nonoperating to 40,000 ft.

Humidity — 80% or less relative humidity at 40°C or less.

Vibration — Operating and nonoperating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 in 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.

OTHER CHARACTERISTICS

Power Sources — Internal Ni Cd batteries provide a typical operating period of 3.5 hours at max trace intensity for a charging and operating temperature between 20°C and 30°C. Internal charger provides for charging batteries any time the instrument is connected to an ac line even if the instrument is turned off. Dc operation is automatically interrupted

when battery voltage drops below 2 V to protect batteries against deep discharge. Full recharge requires approx 16 hours. External operation from 90 to 136 V ac (48 to 62 Hz). Option 1 allows operation from an external 180 to 250 V ac (48 to 62 Hz) or dc supply. Power consumption, 8 watts or less.

Insulation Voltage — 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms or 1.4 × line + dc + peak ac not to exceed 350 V.

Included Accessories — Viewing hood (016-0199-01), carrying case (016-0512-00), 2 test leads (alligator clip to banana jack) (red 012-0015-00) (black 012-0014-00), neck strap (346-0104-00), 2 power line fuses (159-0080-00), power line plug adapter (option 1 only) (161-0077-01).

DIMENSIONS AND WEIGHTS

Dimensions	in	cm
Height	3.0	7.6
Width	5.2	13.2
Depth	8.9	22.6
Weights	**lb**	**kg**
New Weight without Accessories	3.7	1.7
Shipping Weight	8.6	3.9

ORDERING INFORMATION

213 Miniscope/DMM including batteries and probe $1200

Instrument Option

Option 1 provides for operation on 180 to 250 V ac (48 to 62 Hz) or dc (includes batteries and probe) ..... **No Charge**

Optional Accessories

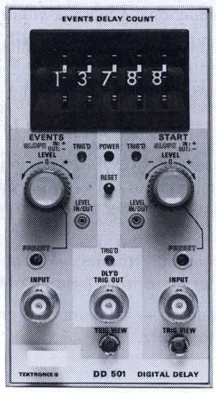
Alligator Clip Kit — A pair of alligator clips that allow connecting the probe and ground lead to large (up to ⅜ in) conductor. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).
Order 015-0231-00 ..... $8.00

Probe-tip to BNC Panel Connector Adapter.
Order 013-0084-01 ..... $8.00

Probe tip to BNC Cable Adapter.
Order 103-0096-00 ..... $8.00

Power Cable Adapter Assembly — A short length of two-wire power cord. One end has a female NEC socket fitting the 200-Series power cords; the other end is left open so that the wires can be attached to a non-NEC male power plug. Plugs not supplied.
Order 161-0077-01 ..... $3.50

Options and Accessories



DD 501 DIGITAL DELAY

The DD 501 is a delay by events counter in a plug-in for the TM 500 line of test and measurement instruments. At the end of an operator selected events count the DD 501 puts out a pulse which can be used as a delayed trigger for an oscilloscope. Because the DD 501 creates its delay by counting pulses rather than by analog timing, stable displays of a group of pulses can be obtained even when they are at the end of a very long pulse train.

Specifications

Events Delay

Count: 0 to 99,999 events.

Max Count Rate: 65 MHz.

Insertion Delay: 30 nsec or less.

Trigger

(All characteristics apply to both events and start triggers)

Input Impedance: 1 MΩ, 20 pF.

Slope: Either + or —, selectable.

Sensitivity: 85 mV p-p to 30 MHz, 120 mV p-p from 30 to 65 MHz.

Trigger Level Range: From —1.0 V to + 1.0 V.

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

Minimum Detectable Pulse Width: 5 nsec.

Output

Width: Events pulse width plus 6 nsec or less.

Voltage: +0.8 V or less to at least +2.0 V for 3 TTL loads (5 mA).

DD 501 ..... $625*

*Also requires a TM 500 Series mainframe priced from $125.

1106 BATTERY PACK

The 1106 is a convenient, snap-on battery power supply for TEKTRONIX 455, 464, 465, 466, or 475 Option 7 Oscilloscopes.

Output Power—22 to 26 V dc; 140 watt-hours from full charge.

Charging Power Source— 90 to 132 V ac, 50 to 400 Hz; or 180 to 264 V ac, 50 to 400 Hz.

Charging Time— 14 to 16 hours.

1106 Battery Pack $350

1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering virtually any portable oscilloscope in the field.

Frequency—Square wave, 60 Hz within 10%.

Amplitude—Approx 108 V peak, operating from 24 V dc external or 22 V internal charge. Approx 137.5 V peak, operating from 28 V dc external or 30 V internal charge.

Amplitude (Option 1)—Approx 216 V peak, from 24 V dc external or 22 V internal charge. Approx 275 V peak, operating from 30 V dc external or 28 V internal charge.

Charging Power Source— 100 to 132 V ac, 48 to 440 Hz (or internal connections expand range). Option 1—200 to 264 V ac, 48 to 440 Hz (or internal connections expand range).

Battery Operating Time—Approx 140 VA hours.

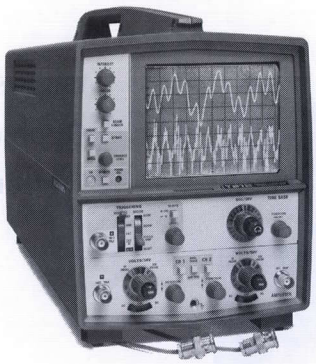
Recommended Max Output Current— 0.9 amp.

ORDERING INFORMATION

1105 Battery Power Supply $625
Option 1, 230 V Operation ..... No Charge

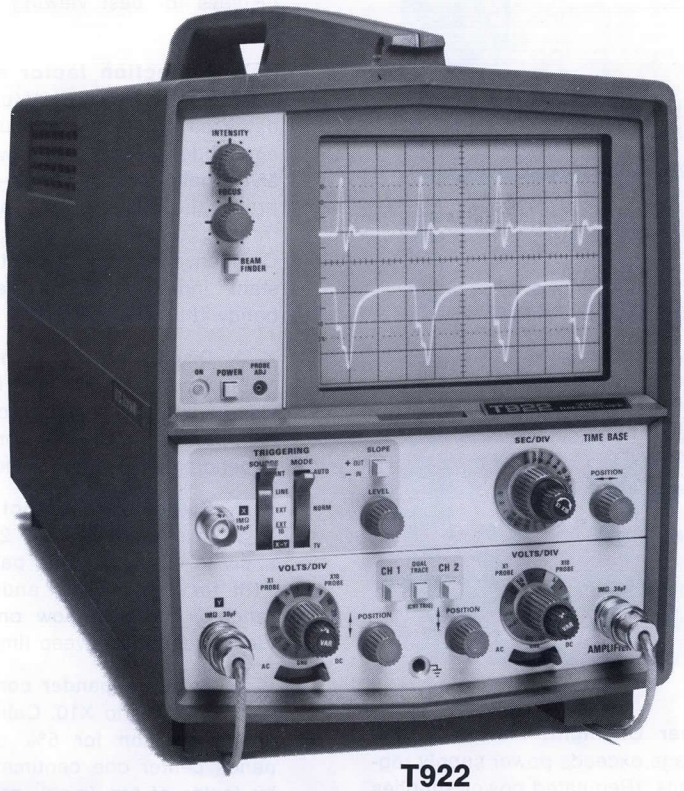
T900-Series Oscilloscopes

T921



T912

Here's an important new line of oscilloscopes for engineers, technicians, and educators who want the quality, reliability, and support associated with TEKTRONIX products — all at a moderate price. T900 Oscilloscopes are designed for convenience and cost savings without sacrifice of basic performance.



T922

Easy to Use

T900 Oscilloscopes are simple to operate. Each has a large, bright (8 x 10 cm) crt, beam finder, single knob trigger control, delay line to enable vewing of waveform leading edge, automatic selection of tv line or frame display, and functionally color-coded control panels. Convenience is further enhanced by a full complement of accessories, including 10X probes (included in price), optional scope stand, camera, and rain jacket. T900 Oscilloscopes are also easy to handle and fit into small spaces. They weigh 15-18 lbs. and measure only 7 in x 10 in x 19 in.

T932

T935

This New Line Includes:

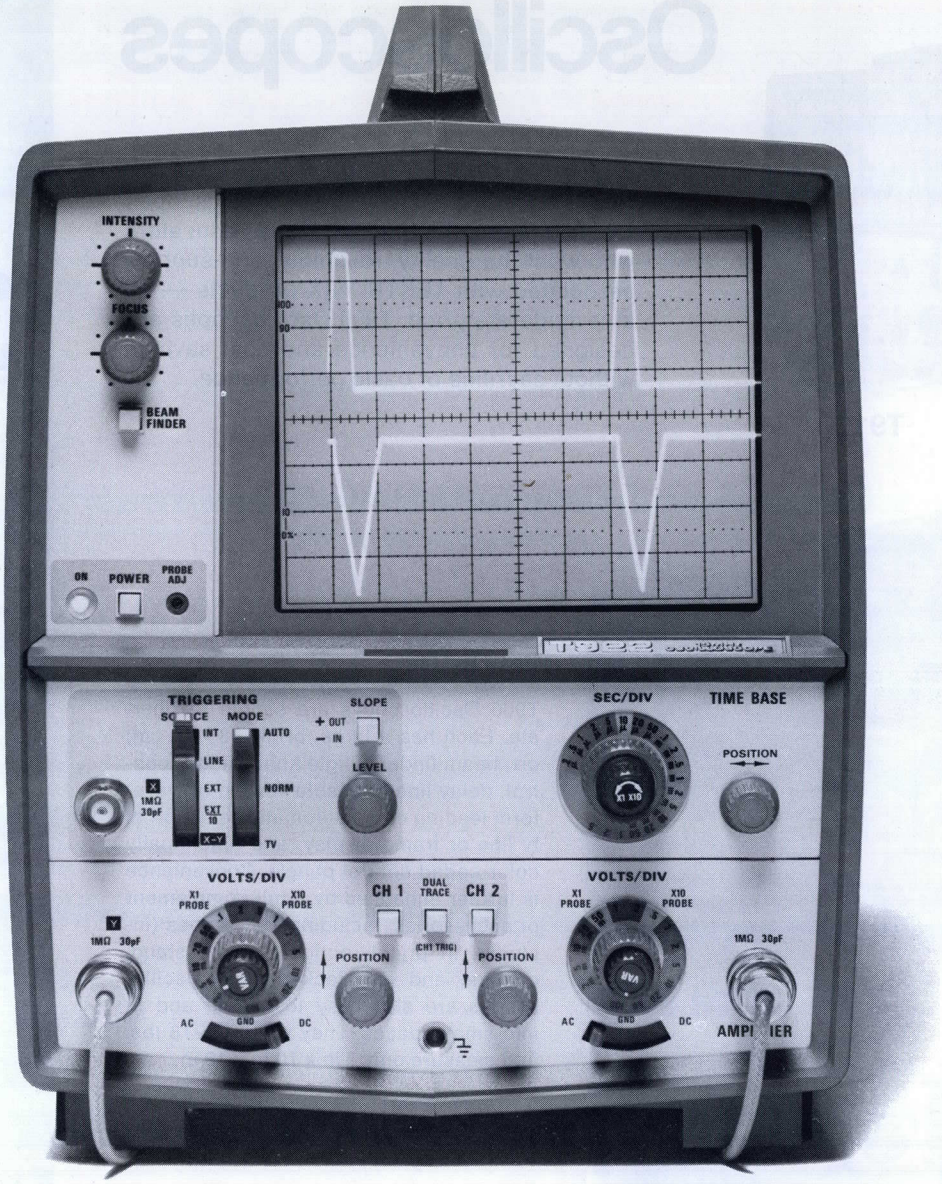
T912 — (Storage Model) Dc to 10 MHz, Dual-Trace, Mono Time Base $1195

T921 — Dc to 15 MHz; Single-Trace, Mono Time Base $695

T922 — Dc to 15 MHz; Dual-Trace, Mono Time Base $850

T932 — Dc to 35 MHz; Dual-Trace, Mono Time Base $1050

T935 — Dc to 35 MHz; Dual-Trace; Dual Time Base with Delayed Sweep $1250



T900-Series Oscilloscopes Features

(1) **12kV, post-deflection-accelerator crt.** Provides bright 8 x 10 cm displays of low-rep-rate signals, even under adverse lighting conditions.

(2) **Internal graticule.** Helps eliminate parallax errors in critical measurements.

(3) **Small, clearly-defined spot.** Ensures sharp traces and high resolution.

(4) **Built-in delay-line.** Let's you see the leading edge of triggering signal.

(5) **Beam-finder.** Quickly reveals presence or absence of input signal and locates the trace position.

(6) **Power ON light.** Flashes if line voltage exceeds power supply regulation limits. (Regulated power supplies help insure 3% accuracy in amplitude and timing measurements.)

(7) **Color-coded controls.** Shorten familiarization time and aid in easy operation. All functionally related controls are colored the same, and grouped for greatest convenience. Green is reserved for triggering controls, blue for mode selectors and red for variable (uncalibrated) controls.

(8) **Automatic trigger mode.** Provides free-running internal trigger in absence of input signal for quick location of sweep trace.

(9) **TV trigger mode.** Automatically provides line or frame-triggered displays for best viewing of composite tv signals.

(10) **Deflection factor switch.** Wide range (2mV to 10V/cm) accommodates all commonly encountered signal amplitudes. Clear windows on switch skirt yield two readings—one for X1 probe, the other for X10 probe. No distracting mental arithmetic to perform. Compensated step attenuator offers constant input impedance across entire bandwidth.

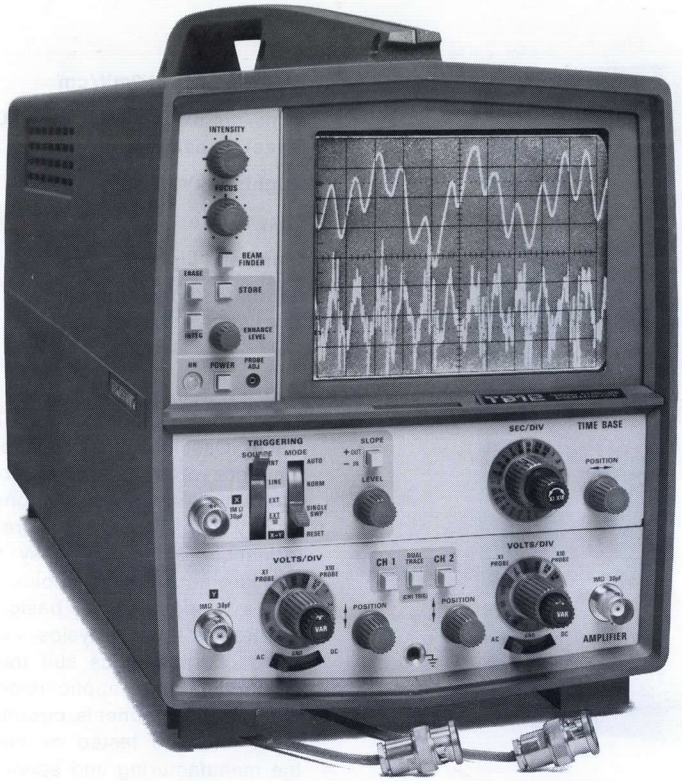
(11) **Display mode switching.** Dual-trace mode (not provided for T921) provides automatic selection of alternate or chopped-sweep displays for best viewing, depending on selected sweep rate.

(12) **Sweep rate selector.** Provides sweep rates from 200 ns to 0.5 s/div in 18 steps. (See pages 116c and 116f for T932, T935, and T912 sweep ranges.) Clear window on switch skirt clearly identifies sweep time/cm.

(13) **Sweep expander control.** Variable from X1 to X10. Calibrated in X10 detent position for 5% accuracy. Expands center one centimeter of display by factor of ten (max), providing maximum equivalent sweep rate of 20 ns/div. (See pages 116c and 116f for T932, T935, and T912 sweep ranges.) For detailed displays of selected waveforms, just position signal to center of screen and turn sweep expander to desired magnification level.

(14) **Impact-resistant case.** Molded from tough, durable Cycoloy KHP. Provides additional structural strength and attractive finish that doesn't wear off.

(15) **Specially designed** T900 accessories add to convenience of use, and protection in transport or storage.



T912 10 MHz Oscilloscope with Storage

50 cm/ms Stored Writing Speed

Dc to 10 MHz at 2mV/cm

50 ns/cm Sweep Rate (With 10X Sweep Expander)

8 x 10 cm Bistable Storage CRT

Small and Lightweight

The T912 Storage Oscilloscope is well suited for a wide range of applications in education and industry. As a training aid in basic electricity and electronics courses, the storage feature is highly useful in creating visual representations of electrical signals. In physics and engineering courses, storage permits the user to capture and display single-shot events like the pressure curve generated in the chamber of an engine or the stress-strain characteristics of a material undergoing destructive testing.

The T912 has similar industrial applications, where it can also be used to compare input vs feedback signals in servomechanisms, shock and vibration analysis, and countless other transducer-aided measurements.

Besides bistable storage, the T912 offers other features seldom found in economy-model oscilloscopes. These include a delay line, which allows you to view the leading edge of fast-rising signals; a 21-step calibrated vertical attenuator; constant bandwidth throughout the sensitivity range of 10 V to 2 mV per centimenter; 18 calibrated sweep rates ranging from 0.5 s to 500 ns/cm; 3% amplitude and timing accuracy; and minimal corner shift over a broad vertical dynamic range.

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings $\geq$ 1 ms/div, alternate for settings $\leq$ 500 μs/div. Trigger is derived from Ch 1 signal only.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C.	Within 3%
0° to +45°C.	Within 4%

Uncalibrated (VAR) Range — Continuously between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 10 MHz (measured at −3 dB).

Rise Time — 35 ns or less.

Chopped Mode Repetition Rate — $\simeq$ 250 kHz.

Input Resistance — $\simeq$ 1 megohm.

Input Capacitance — $\simeq$ 30 picofarads.

Max Input Voltage —

Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.5 μs/div in 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 50 ns/div.

Accuracy —

	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of adequate trigger signal, or one with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Single Sweep — Displays one sweep only. Sweep cannot be triggered again until reset.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.

Single Sweep — Displays one sweep only. Sweep cannot be triggered again until reset.

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.
Input Resistance — $\simeq$ 1 megohm.
Input Capacitance — $\simeq$ 30 picofarads.

POWER SOURCE (AC)

Line Voltage Ranges — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

100-120 V Range — HI: 108 to 132 V rms LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 264 V rms LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 65, amps (max) 0.6, at 120 V, 60 Hz.

CRT STORAGE DISPLAY

Writing Rate — At least 25 cm/ms.

Enhanced Writing Rate — At least 250 cm/ms.

Display Area — 8 x 10 cm, internal graticule.

Storage Phosphor — P1.

Beam Finder — Locates off screen display.

Nominal Accelerating Potential — $\simeq$ 2.76 kV.

PHYSICAL

Weight

With Panel Cover and Accessories — 18.0 lb (8.2 kg).

Without Panel Cover and Accessories — 17.5 lb (7.9 kg).

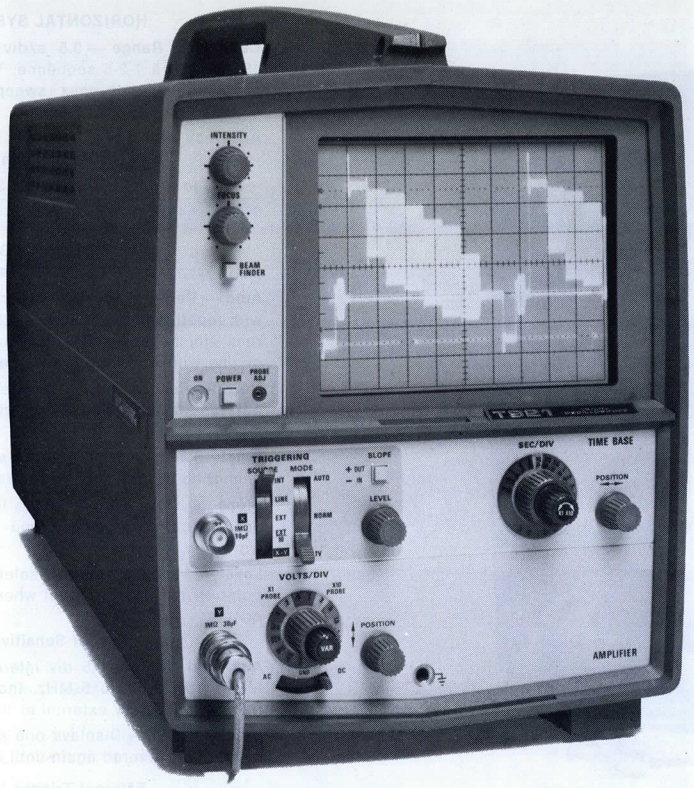
Specifications for X-Y operation, environmental performance, dimensions and accessories, see T922 information page 116e.

ACCESSORIES

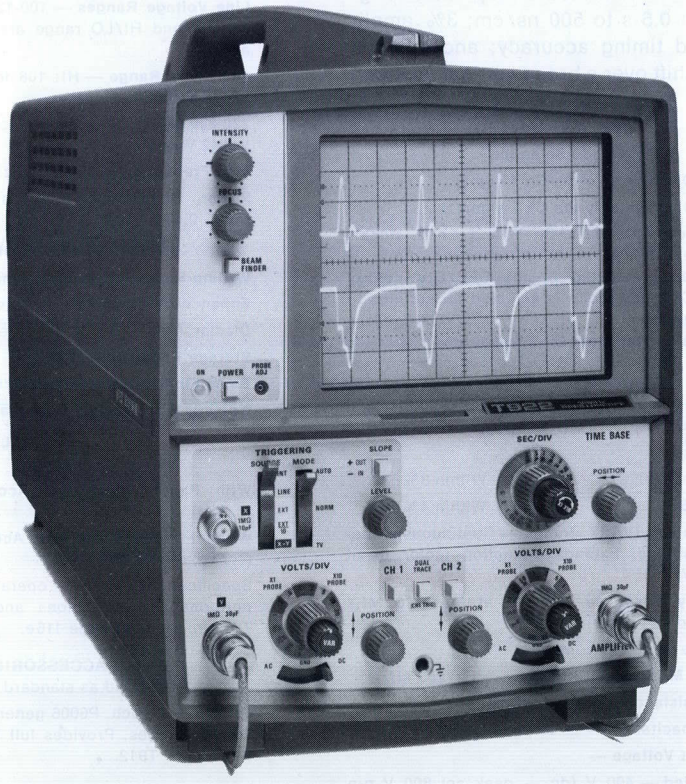
(Included as standard equipment)

Probes — 2 each. P6006 general purpose 10 times voltage probes. Provides full bandwidth capabilities for the T912.

T912 — Dc to 10 MHz, Dual-Trace, Single Time Base Storage Oscilloscope (Includes Two 10X Probes) . . **$1195**



T921 15 MHz Single-Trace Oscilloscope



T922 15 MHz Dual-Trace Oscilloscope

Dc to 15 MHz at 2mV/cm

20 ns/cm Sweep Rate With 10X Sweep Expander

Bright (12kV) Display

Easy to Use

Small and Lightweight

Regulated Power Supplies

The T921 (single-trace) and T922 (dual-trace) Oscilloscopes provide the basic functions of a general-purpose oscilloscope at the lowest price consistent with quality construction and reliable performance. Small and easy to operate, they are an excellent choice for the student's workbench in basic electricity, electronics, and physics classes. The same characteristics suit them well for production line applications wherever electronic components, circuits, or equipment must be tested or calibrated. In the manufacturing and servicing of consumer electronics the T921 and T922 are a cost-effective answer to most test and measurement requirements. As a signal processing, measurement and display device for dynamic transducer measurements, both oscilloscopes offer superior performance at a relatively low cost.

Although light weight (15 lb) and small (7 in x 10 in x 19 in), the T921 and T922 provide an especially bright, high resolution, 8 x 10 cm crt display. Even in high ambient light conditions, low-rep-rate signals are easily viewed. Their features shorten familiarization time and help make day-to-day measurements easier and more accurate. Functionally related controls are color coded for easy identification and grouped together for convenience. Chopped or alternate sweep modes are selected automatically to yield the best display for the selected sweep rate.

Measurement accuracy of the T921 and T922 is superior to most similarly priced oscilloscopes. A twelve-step attenuator provides calibrated deflection factors ranging from 2 mV/cm to 10 V/cm. Both models offer 3% vertical amplitude and sweep timing accuracy, with minimal corner shift over a broad vertical dynamic range.

VERTICAL SYSTEM

Mode Selections

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal (T922 only).

Dual trace (T922 only) — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings $\geq$ 1 ms/div, alternate for settings $\leq$ 500 μs/div. Trigger is derived from Ch 1 signal only.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C	Within 3%
0° to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 15 MHz (measured at −3 dB).

Rise Time — 23 ns or less.

Chopped Mode Repetition Rate (Dual Trace) — $\approx$ 250 kHz.

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 30 picofarads.

Max Input Voltage —

Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 20 ns/div.

Accuracy —	**Unmagnified**	**Magnified**
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Tv — Provides triggering on tv field when SEC/DIV switch is set at 0.1 ms or slower. Trigger on tv line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Triggering Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 5 MHz, increasing to 1.5 div internal or 150 mV external at 15 MHz.

Tv — Composite sync 1 div internal or 100 mV external (about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 30 picofarads.

X-Y OPERATION

Sensitivity, Variable Magnifier — $\approx$ 100/mV/div (X10 mag) $\approx$ 1 V/div X1 mag).

X-Axis Bandwidth — Dc to at least 1 MHz (measured at − 3 dB).

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 30 picofarads.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off screen display.

Nominal Accelerating Potential — $\approx$ 12 kV.

PROBE ADJUST

Output Voltage — $\approx$ 0.5 V.

Repetition Rate — $\approx$ 1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — $\approx$ 10 kΩ.

POWER SOURCE (AC)

Line Voltage Ranges — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 264 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

ENVIRONMENTAL

Temperature

Storage — −55°C to +75°C.

Operating — 0°C to +45°C.

Altitude

Storage — To 50,000 ft.

Operating — To 15,000 ft Max operating temperature decreased 1°C/1,000 ft above 5,000 ft.

PHYSICAL

Weight

With Panel Cover and Accessories — 15.5 lb (7.0 kg).

Without Panel Cover and Accessories — 15.0 lb (6.8 kg).

Dimensions

Height (with Feet and Handle) — 10.0 in (25.4 cm).

Width — 7.09 in (18.0 cm).

Depth —

With Panel Cover — 20.5 in (52.0 cm).

Without Panel Cover — 18.7 in (47.5 cm).

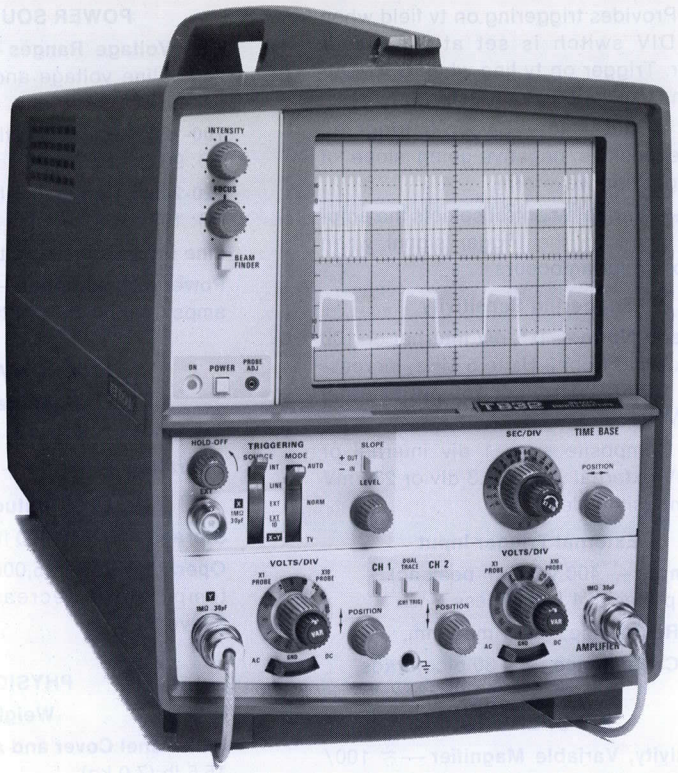
ACCESSORIES

(Included as Standard Equipment)

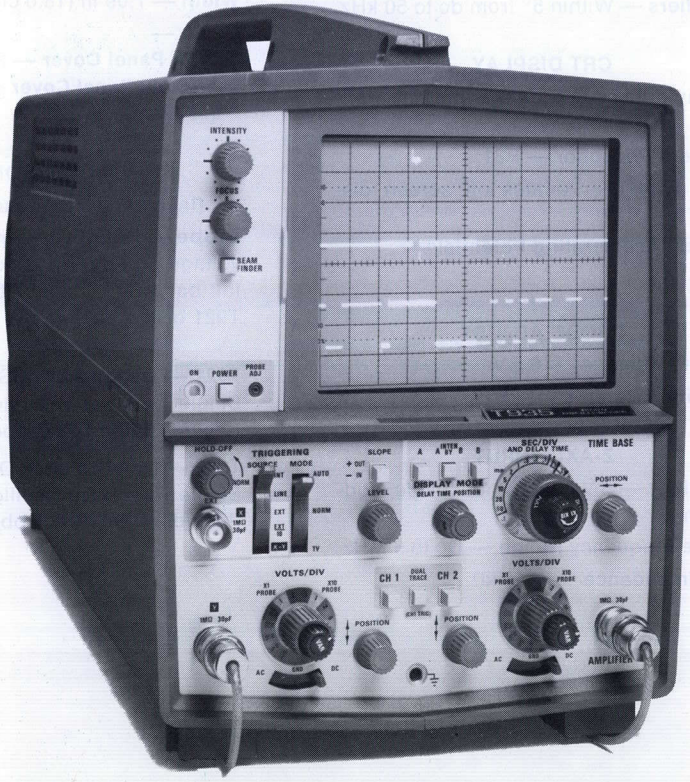
Probe — P6006 general purpose 10X voltage probe for each channel. Provides full bandwidth capabilities for either the T921 or the T922.

T921 — Dc to 15 MHz, Single-Trace, Single Time Base Oscilloscope (Includes One 10X Probe) **$695**

T922 — Dc to 15 MHz, Dual-Trace, Single Time Base Oscilloscope (Includes Two 10X Probes) **$850**



T932 35 MHz Single-Trace Oscilloscope



T935 35 MHz Dual-Trace Oscilloscope

Dc to 35 MHz at 2mV/cm

10 ns/cm Sweep Rate (with 10X Sweep Expander)

Delayed Sweep (T935)

Trigger Holdoff

Bright (12kV) CRT Display

Small and Lightweight

The T932 and T935 Dual-Trace Oscilloscopes are designed for cost-sensitive applications that require greater measurement capability than the T921/T922 Oscilloscopes offer. Typical applications include design, production-line testing and servicing of digital equipment such as computer peripherals, point-of-purchase data processors, numerical machine controls, and digital consumer electronics, as well as communications and telemetry equipment. In these and countless similar applications, the T932 and T935 are the logical choices wherever performance and cost are equally important considerations.

The T932 and T935 are general-purpose oscilloscopes providing performance and convenience seldom offered in their price range. Their small size (7 in x 10 in x 19 in), light weight (15 lb), and impact-resistant cases adapt them equally well to a small space on the laboratory bench, in a car trunk, or under an airplane seat. But they also pack the performance capabilities required for many difficult measurement applications.

Features seldom found in moderately priced oscilloscopes include delayed sweep (T935 only) and trigger holdoff capabilities. Displayed signals that reveal insufficient detail on time-base (A) sweep may be selectively expanded using the delayed sweep feature. The trigger holdoff feature permits adjustment of the sweep repetition frequency without changing sweep time per centimeter. Both features are valuable measurement aids, especially in digital design and service applications.

For applications that require delayed sweep the T935 is a logical choice. Except for this feature, it is exactly like the T932 — and only costs $200 more.

T932 — Dc to 35 MHz, Dual-Trace, Single Time Base Oscilloscope (Includes Two 10X Probes) **$1050**

T935 — Dc to 35 MHz, Dual-Trace, Dual Time Base (with Delayed Sweep) Oscilloscope (Includes Two 10X Probes) **$1250**

VERTICAL SYSTEM

Mode Selection

Ch 1 — Displays only the Ch 1 signal.

Ch 2 — Displays only the Ch 2 signal.

Dual Trace — Displays Ch 1 and Ch 2 signals simultaneously. Alternate or chopped mode is automatically selected by the SEC/DIV control setting. Chopped mode is selected for settings ≥ 1 ms/div, alternate for settings ≤ 500 μs/div. Trigger is derived from Ch 1 signal only.

Deflection Factor

Range — 2 mV/div to 10 V/div in 12 steps in a 1-2-5 sequence.

Accuracy —

+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%

Uncalibrated (VAR) Range — Continuously variable between settings. Extends deflection factor to at least 25 V/div.

Frequency Response — Dc to at least 35 MHz (measured at −3 dB).

Rise Time — 10 ns or less.

Chopped Mode Repetition Rate — ≈ 250 kHz.

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

Max Input Voltage —
Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.
Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac to 1 kHz or less.

HORIZONTAL SYSTEM

Calibrated Range

A Sweep — 0.5 s/div to 0.1 μs/div in 21 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

B Sweep — (T935 only) 50 ms to 0.1 μs/div in 18 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends max sweep rate to 10 ns/div.

Accuracy —	Unmagnified	Magnified
+20°C to +30°C	Within 3%	Within 5%
0°C to +45°C	Within 4%	Within 6%

Delay Time Position Range — (T935 only) 0.5 to 10 div.

Delay Time Jitter — (T935 only).

One part or less in 10,000 (0.1%) of ten times the SEC/DIV switch setting.

TRIGGERING

Trigger Mode

Auto — Permits normal triggering on waveforms with a repetition rate of at least 20 Hz. Sweep "free-runs" in the absence of an adequate trigger signal, or with a repetition rate below 20 Hz.

Norm — Permits normal triggering. Sweep does not run in the absence of an adequate trigger signal.

Tv — Provides triggering on tv field when SEC/DIV switch is set at 0.1 ms or slower. Triggers on tv line when SEC/DIV switch is set at 50 μs or faster.

Slope + Out − In — Sweep is triggered on the positive/negative-going slope of the triggering waveform.

Level — Variable control selects the amplitude point on the trigger signal when sweep triggering occurs.

Trigger Holdoff — Permits adjustment of time interval between end of sweep and next acceptable trigger to achieve stable displays of complex words.

Trigger Sensitivity

Auto and Norm — 0.5 div internal or 100 mV external from 2 Hz to 15 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.

Tv — Composite sync 1 div internal or 100 mV (external about 2.3 div or 230 mV of composite video).

External Trigger Input

Max Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈ 100 mV/div (X10 mag) ≈ 1 V/div (X1 mag).

X-Axis Bandwidth — Dc to at least 2 MHz (measured at −3 dB).

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

Phase Difference Between X and Y Axis Amplifiers — Within 3° from dc to 50 kHz.

CRT DISPLAY

Display Area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off screen displays.

Nominal Accelerating Potential — ≈ 12 kV.

PROBE ADJUST

Output Voltage — ≈ 0.5 V.

Repetition Rate — ≈ 1 kHz.

Z-AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Usable Frequency Range — Dc to 5 MHz.

Input Impedance — ≈ 10 kΩ.

POWER SOURCE (AC)

Line Voltage Ranges — 100-120 V, 220-240 V line voltage and HI/LO range are accessible externally.

100-120 V Range — HI: 108 to 132 V rms. LO: 90 to 110 V rms.

220-240 V Range — HI: 216 to 264 V rms. LO: 198 to 242 V rms.

Line Frequency — 50 to 60 Hz.

Power Consumption — Watts (max) 36, amps (max) 0.35, at 120 V, 60 Hz.

ENVIRONMENTAL

Temperature

Storage — −55°C to +75°C.

Operating — 0°C to +45°C.

Altitude

Storage — To 50,000 ft.

Operating — To 15,000 ft Max operating temperature decreased 1°C/1,000 ft above 5,000 ft.

PHYSICAL

Weight

With Panel Cover and Accessories — 15.5 lb (7.0 kg).

Without Panel Cover and Accessories — 15.0 lb (6.8 kg).

Dimensions

Height (with feet & handle) — 10.0 in (25.4 cm).

Width — 7.09 in (18.0 cm).

Depth —
With Panel Cover — 20.5 in (52.0 cm).
Without Panel Cover — 18.7 in (47.5 cm).

ACCESSORIES

(Included as Standard Equipment)

Probes — 2 each. P6108 general purpose 10X voltage probe provides full bandwidth capability for either the T932 or T935.

T932 — Dc to 35 MHz, Dual-Trace, Single Time Base Oscilloscope (Includes Two 10X Probes) **$1050**

T935 — Dc to 35 MHz, Dual-Trace, Dual Time Base (with Delayed Sweep) Oscilloscope (Includes Two 10X Probes) **$1250**

SCOPE STAND

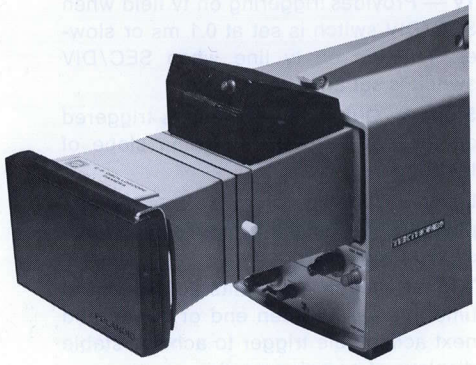
Supports any T900 Oscilloscope at convenient angle for viewing and easy access to controls. Quickly disassembled, it forms a lightweight (3 lb) package that can be neatly attached to the bottom of the oscilloscope for easy carrying. Consists of a molded plastic base, support bracket, and a 15 in aluminum support column.

Order: 209 Scope Stand $50

CAMERA

Recommended for all T900 Oscilloscopes. Attaches directly to front panel without adapters. Uses Polaroid® pack film. Has fixed f/16 lens aperture and mechanically-actuated shutter with speeds of 1/5, 1/10, and 1/25 seconds. Built-in linear xenon tube flashes to illuminate graticule when shutter opens.

C-5A Camera $235



PROTECTIVE COVERS

Front Panel Cover

Snaps over the oscilloscope front panel to protect controls during transport or storage. Molded from high-impact-resistant plastic. Storage compartment for two probes and cables is built into inner side.

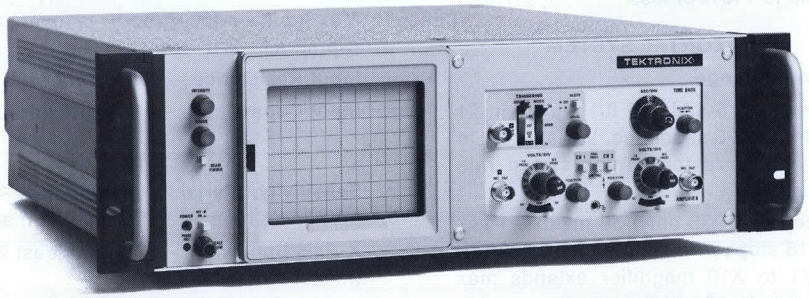
Order: Protective front cover
(016-0340-00) $18

Dust Cover/Rain Jacket (not shown)

Provides protection against dust accumulation when not in use, and against rain and snow during transportation. Constructed of 15 mil tough durable vinyl. An opening at the top allows access to the oscilloscope handle.

Order: Protective cover
(016-0361-00) $18

RACKMOUNT OPTION



T922R

Specifications for T922R rackmount are the same as those for the T922, except for the following features:

7 BNC connectors are located at the rear of the instrument to provide:

Vertical and External Trigger Inputs — These are selected by switches on the front panel.

Z-Axis — This is the same as the bench mount T922 except for internal adjustment for polarity. Adjusted to provide intensification or blanking with a positive-going input. This is a linear Z-axis, regardless of which polarity selection is made.

Sweep Gate — Output voltage is approx 5 V positive-going into 1 megohm, approx 5 V into 50 Ω load.

Vertical Output — A composite of CH 1 and CH 2, with approx 0.5 V output per displayed div into a 1 megohm load. Bandwidth is at least 1 MHz. Output is approx 50 mV/div with a 50 Ω load.

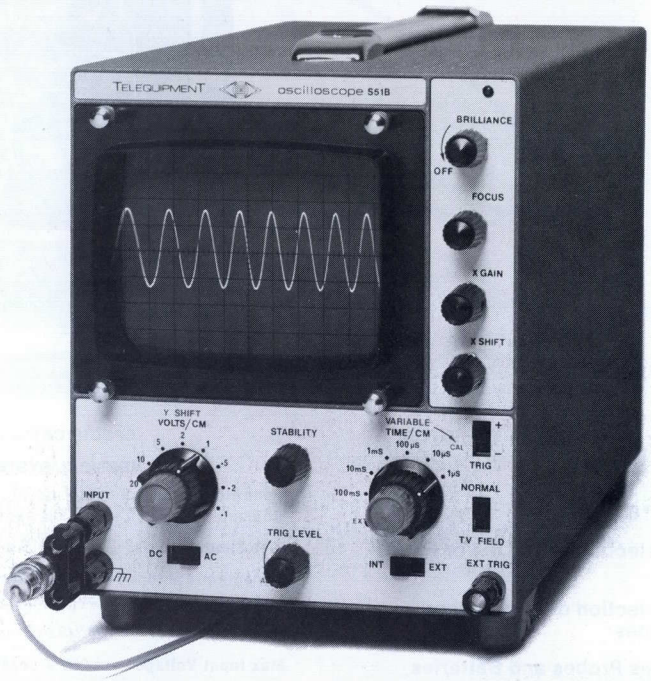
Other Features —
Single Sweep (with LED ready light)
Graticule Illumination
Chop/Alternate is selected by a front panel push-button switch.

Dimensions — Height: 5¼ in. Depth: 17 in. Width: 19 in. Weight: approx 20 lb.

For current price of the T922R, please contact your local Tektronix Field Office.

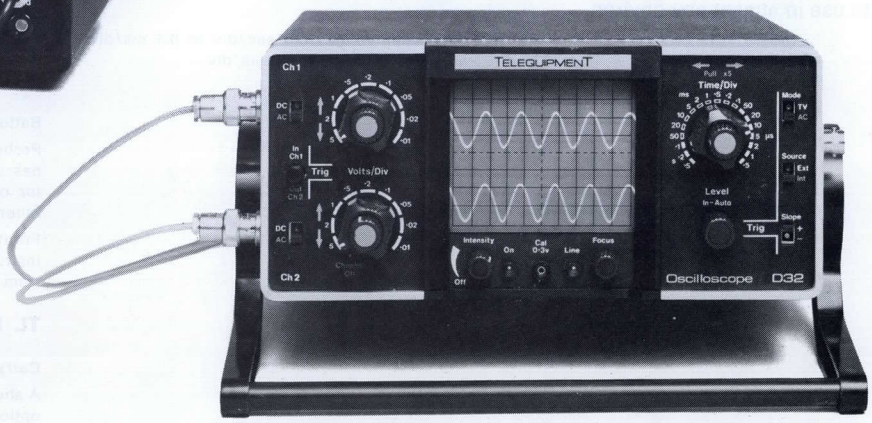
TELEQUIPMENT Oscilloscopes

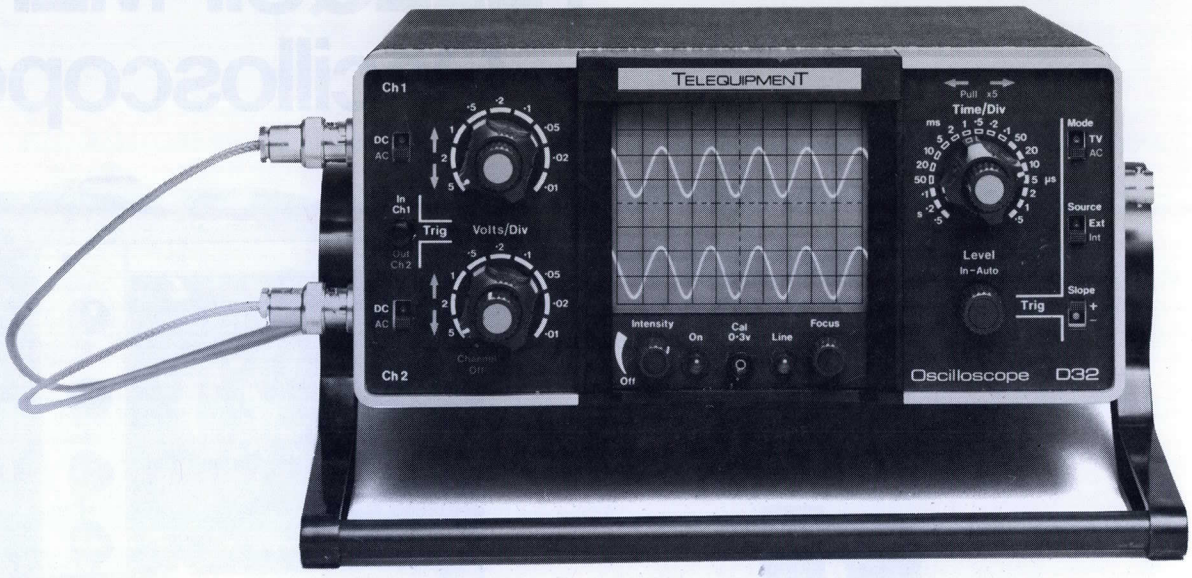
Low cost and a combination of features not normally found in comparably priced oscilloscopes make Telequipment instruments an outstanding economy value. Features such as calibrated sweep rate and vertical step attenuators, variable controls, triggered sweep, probe-calibration outputs, illuminated graticule, and tv or line triggering make these instruments both versatile and easy to use.



Warranty, sales, and service are the same as other TEKTRONIX products.

Telequipment is a division of TEKTRONIX U. K. Ltd., a wholly owned subsidiary of Tektronix, Inc.





Dc to 10 MHz Bandwidth at 10 mV/div

Dual Trace

Weighs only 10 Pounds

Automatic Selection of Tv Line or Frame Display

Automatic Selection of Chopped or Alternate Modes

$1050 Includes Probes and Batteries

D32 is one of the most compact, and most popular oscilloscopes in the TELEQUIPMENT line.

It offers 10 mV/div to 5 V/div sensitivity in 9 calibrated steps, automatic selection of chopped or alternate mode (depending on sweep speed setting), plus automatic selection of tv line or frame display.

Completely portable, the D32 measures only 4 x 9 x 11 inches, weighs only 10 lb, and can be easily carried. AC line or battery operation (up to 4 hours continuous) make the D32 convenient to use in almost any environment.

SPECIFICATIONS

VERTICAL SYSTEM

Bandwidth — Dc coupled dc-10 MHz-3 dB approx. Ac coupled 3 Hz-10 MHz-3 dB approx.

Rise Time — 35 ns.

Deflection Factor — 10 mV/div in 9 calibrated steps (1-2-5 sequence) accurate within ±5%.

Input Impedance — 1 MΩ/32 pF approx.

Max Input Voltage — ±250 V peak.

Display Modes — Channel 1 only, channels 1 and 2 alternate sweep, channels 1 and 2 chopped (at 100 kHz approx), chop or alternate selected automatically.

HORIZONTAL SYSTEM

Sweep Speeds — 19 sweep speeds from 500 ns/div to 500 ms/div in a 1-2-5 sequence. A x5 magnifier operates over the full time base range and increases the fastest sweep speed to approx 100 ns/div.

Time Measuring Accuracy — x1 ±5%. x5 100 ms/div-500 ns/div ±7%. 200 ns/div-100 ns/div ±10%.

Trigger:

Level — Fully variable over 8 div on all waveforms.

Auto — Bright line in the absence of a trigger signal.

Automatic trigger on symmetrical waveforms over 1 div with restricted level control.

Mode — Ac or tv.

Tv field for sweep ranges 0.5 sec/div to 0.1 ms/div and tv line from 50 μs/div to 0.5 μs/div.

Source — Channel 1, Channel 2, or external.

Slope — Positive or Negative.

Sensitivity —

Internal — 0.3 div 40 Hz-2 MHz, 1 div 2 MHz-10 MHz.

External — 500 mV approx 40 Hz-5 MHz, 1 V approx 5 MHz-10 MHz.

OTHER CHARACTERISTICS

Calibrator Output — 300 mV.

Cathode Ray Tube — 8 x 10 div display area, each div is approx 0.7 cm. P31 phosphor supplied. 3 kV accelerating potential.

Power Requirements — Internal rechargeable battery contains 6 x 1.25 V 'D' cells (7.5 V dc) providing up to approx 4 hrs continuous use.

A built in charger allows the batteries to be charged in 14 hrs with the instrument switched OFF or trickle charges the batteries if the instrument is switched ON.

Main-line Voltage — 100-125 V ac 200-250 V ac.

Frequency — 50-400 Hz.

Consumption — 14VA (line) 7VA (battery).

Dimensions and Weight:

Height	Width	Depth	Net Weight
4 in	9 in	11 in	10.1 lbs
105 mm	230 mm	288 mm	4.5 kg

Included Accessories:

Batteries — 6 'D' cell, rechargeable, 1.25 V each.

Probes — 10 times passive probe, 2 each, each probe has a minimum of a 3.5 ft cable with a BNC connector on one end and a spring loaded sheath on the other.

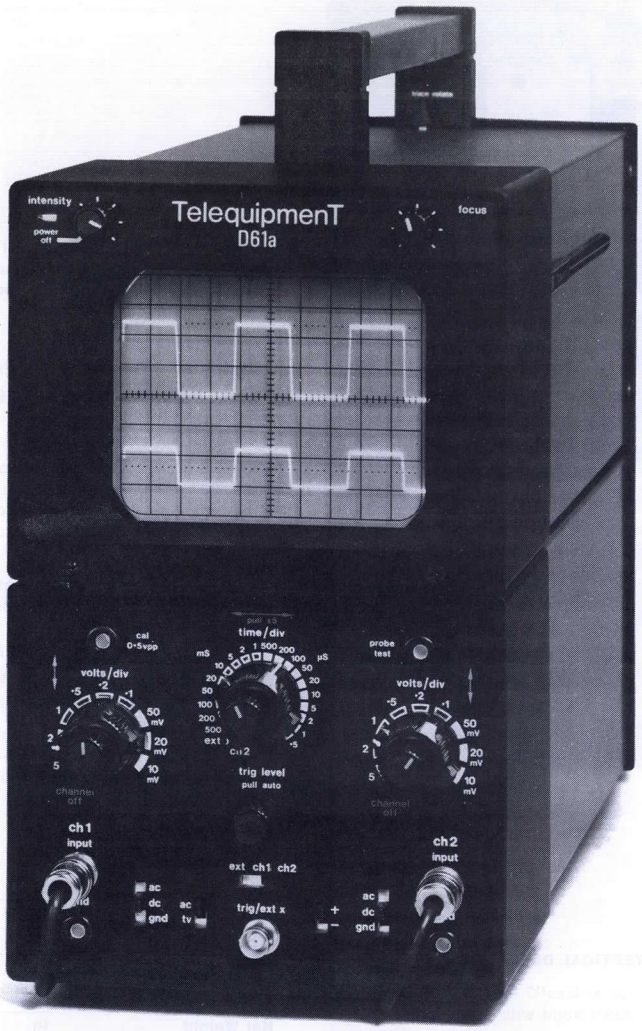
Front Panel Cover — Molded plastic, fits snugly over instrument face to protect crt, knobs and switches from damage during transportation or storage.

TL D32 Oscilloscope $1050

Carrying Case: Optional Accessory

A shoulder strap type carrying case is available as an optional accessory.

Order 016-0601-00 ..... $5



10 mV/div Sensitivity at 10 MHz

Automatic Triggering

Tv Frame and Line Triggering

Can be used in Single Beam, Dual-Trace, X-Y, and Vector Modes

Weighs under 15 Pounds

D61A Oscilloscope is a very economical, 10 MHz dual trace instrument. It is fully transistorized, lightweight, and easy to use. Operation is simplified by automatic selection of chopped or alternate modes. Automatic selection of line or frame displays occurs in the tv position. Two identical input channels provide excellent X-Y capability, useful for displaying vector patterns when aligning and trouble-shooting color tv sets. New users, such as students and technicians will find a D61A extremely easy to view and operate.

VERTICAL DEFLECTION

Bandwidth and Rise Time — Dc to at least 10 MHz (−3-dB down), 35 ns rise time.

Deflection Factor — 10 mV/cm to 5 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within ±5%.

Max Deflection — 8 cm to 5 MHz, decreasing to 5 cm at 10 MHz.

Input R and C — 1 MΩ paralleled by approx 35 pF.

Max Input Voltage — 400 (dc plus peak ac).

HORIZONTAL DEFLECTION

Time Base — 500 ns/cm to 500 ms/cm in 19 calibrated steps (1-2-5 sequence), accurate within ±5%.

X5 Magnifier — Operates over full time-base range, increases fastest sweep rate to 100 ns/cm.

Horizontal Amplifier (External X) — 2 Hz to 1 MHz (at 3-dB down); deflection factor approx 250 mV/cm; input impedance 1 MΩ paralleled by approx 10 pF.

TRIGGER

Modes — Automatic or Normal (Trigger Level).

TV — Triggers on TV field or line; automatically selected by time/div switch.

Sensitivity — Internal, 2 mm deflection 40 Hz to 2 MHz, increasing to 1 cm at 2 MHz. External, 100 mV 40 Hz to 1 MHz increasing to 1 V at 1 MHz.

X-Y OPERATION

Full Sensitivity (Ch 1-Vert, Ch 2-Vert) — 10 mV/cm to 5 V/cm in 9 calibrated steps, accurate within 5%. Bandwidth is dc to at least 1 MHz (−3 dB). Phase difference between amplifiers is less than 1° at 50 kHz.

CRT

CRT — 5 in tube; 8 x 10 div 1.0 cm/div; 3.5 kV accelerating potential.

Z-Axis Modulation — Z-axis input is ac coupled. A 10 V negative-going signal blanks the display with good contrast.

OTHER CHARACTERISTICS

Voltage Calibrator — Line-frequency squarewave, 500 mV p-p accurate within 1%.

Power Requirements — Voltage settings are 100-120 Volts, 48-440 Hz line frequency, approx 25 VA.

Probe Test — Provides a negative going rectangular pulse at time-base frequency to facilitate probe compensation.

Cooling — Convection.

Temperature Limits Ambient — −15°C to +40°C operating; −25°C to +70°C non-operating.

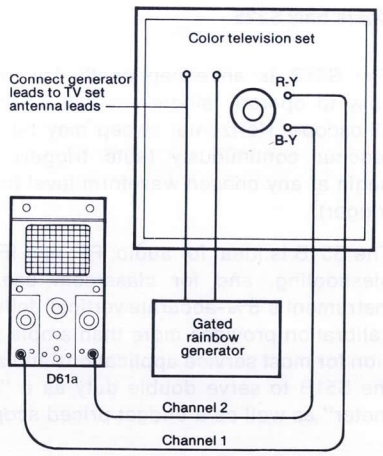
Dimensions and Weights

	in	cm
Height	11.0	28
Width	6.3	16
Depth	16.5	42
	lb	**kg**
Net Weight	14.3	6.5

TL D61A Oscilloscope ..... (Price to be announced)

VECTOR DISPLAYS

The TELEQUIPMENT D61A Dual Trace Oscilloscope is excellent for displaying vector patterns for aligning and trouble-shooting of color TV sets. In a vector display mode it can check phase relationships of color signals.



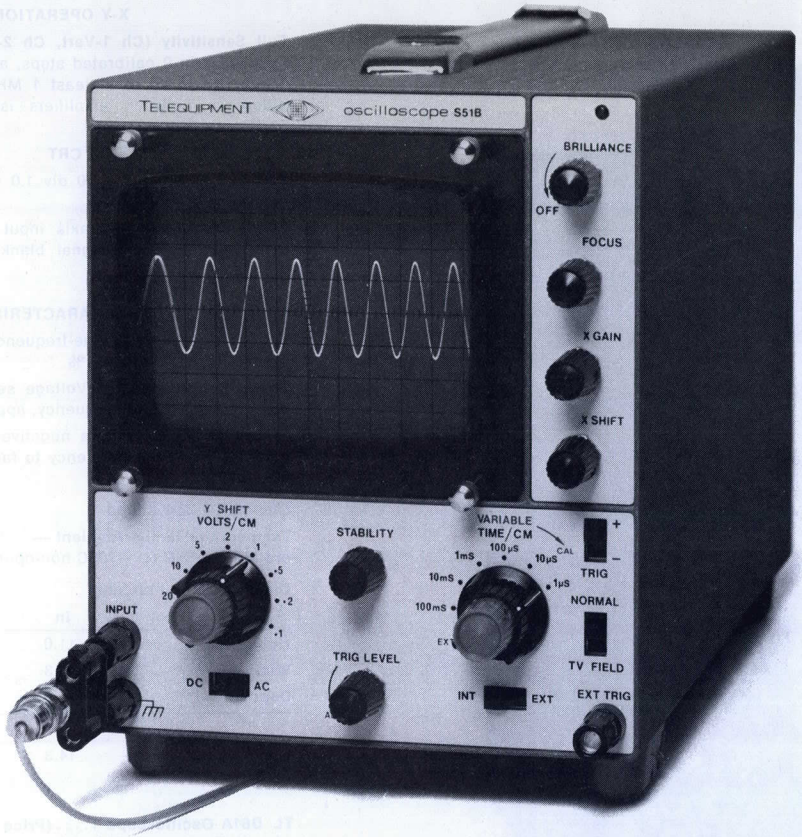
Use the D61A in the "CH 2" mode. Select equal sensitivity settings for both X and Y. Connect channel 1 input to R-Y signal at picture tube. Connect channel 2 input to B-Y signal at picture tube. Generally, X10 probes would be used with vacuum tube sets. 1 with solid state sets.

Two simple connections to the picture tube allow the serviceman to produce meaningful displays when used in conjunction of a gated rainbow generator.

S51B

Oscilloscope

Low Cost 3 MHz Oscilloscope



3 MHz Bandwidth

Auto or Normal Triggering

8 x 10 cm Viewing Area

Dc Coupled Horizontal Amplifier

Costs only $325

The S51B is an exceptionally low priced, easy to operate, single channel 3 MHz oscilloscope. Horizontal sweep may be set to reoccur continuously (auto trigger) or to begin at any chosen waveform level (normal trigger).

The S51B is ideal for audio, RF, and IF troubleshooting, and for classroom use. The instrument's 5%-accurate vertical deflection calibration provides more than ample precision for most service applications and allows the S51B to serve double duty as a "multimeter" as well as a budget priced scope.

VERTICAL DEFLECTION

Bandwidth — Dc to at least 3 MHz at 3-dB down. Low frequency 3-dB down point with ac coupling is 2 Hz.

Deflection Factor — 100 mV/cm to 50 V/cm in 9 calibrated steps (1-2-5 sequence), accurate within 5%.

Input R and C — 1 MΩ, approx 47 pF.

HORIZONTAL DEFLECTION

Time Base — 1 μs/cm to 100 ms/cm in 6 calibrated steps (1-10 sequence). Uncalibrated, continuously variable between steps and to at least 1 s/cm. Accuracy within 5% over center 8 cm (10% over first and last 2 cm in 1 μs/cm range).

X2 Magnifier (Approx) — Operates over full time base.

Time Base Sweep Modes — Auto Trigger (sweep free runs in absence of triggering signal). Normal Trigger.

Horizontal Amplifier — DC to at least 500 k Hz at 3-dB down. Uncalibrated, continuously variable to approx 100 mV/cm deflection factor at mid-position, range approx 2:1. Input R and C, 1 MΩ, approx 100 pF.

TRIGGER

Modes — Automatic or Normal (Trigger Level). Automatic operation useful on signals from 50 Hz to 1 MHz. Trigger Level selection allows triggering at any level on the input waveform.

TV — Triggers on TV field.

Sensitivities — Internal, 5 mm. External, 3 V P-P.

Ext Trig Input Impedance — 1 MΩ, approx 30 pF.

CRT

CRT — 5 in tube; 8 x 10 cm display area, each div is 1 cm. P31 phosphor normally supplied. 3 kV accelerating potential. Z-axis input coupled to the CRT grid; noticeable modulation at normal intensity with approx 15 V.

Graticule — External, detachable green filter improves contrast under high ambient light conditions.

OTHER CHARACTERISTICS

Signal Outputs (Rear Panel) — A negative-going sawtooth (20 V p-p, DC coupled, minimum load 100 kΩ).

Power Requirements — Quick-change line voltage selector provides these ranges: 91-130 V ac and 200-240 V ac in 5-V steps. 50 to 400 Hz, 58 VA.

Cooling — Convection.

Dimensions and Weights

	in	cm
Height	8	20.3
Width	7	17.8
Depth	15	38.1
	lb	**kg**
Net Weight	16	7.3

Included Accessories — Test leads.

AUDIO and RF CIRCUIT ANALYSIS

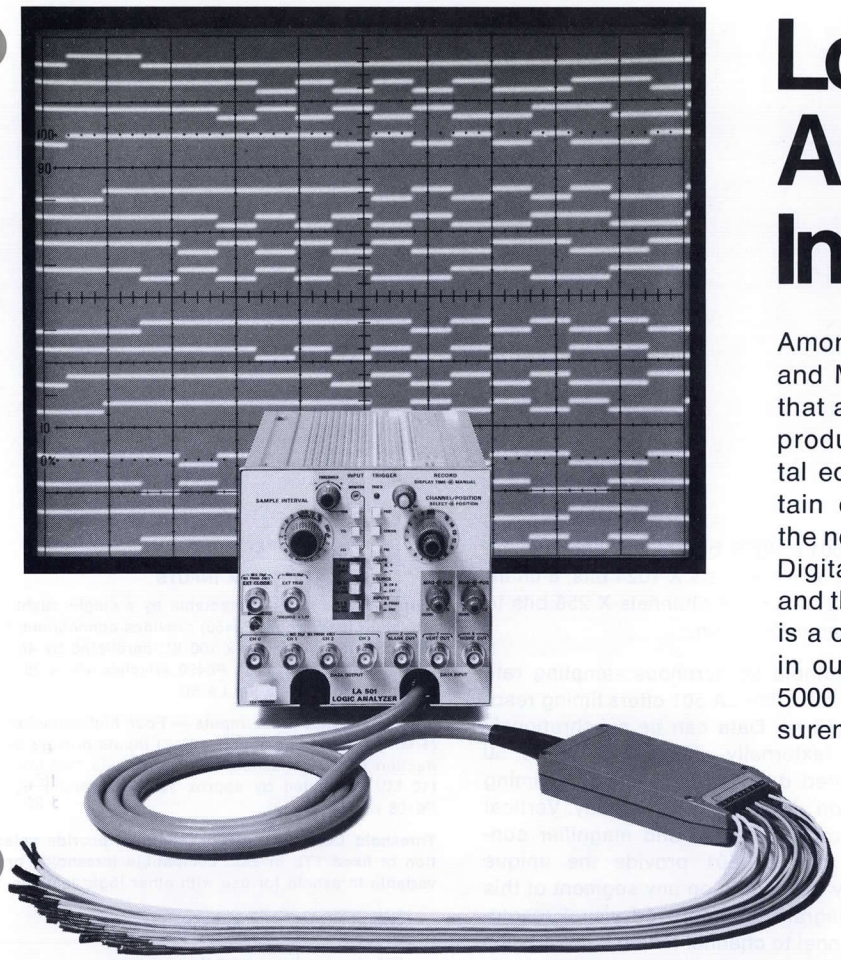
The TELEQUIPMENT S51B Oscilloscope offers all the sophistication that's needed for most fundamental circuit analysis. Audio waveforms can be analyzed for clipping and other sources of distortion. Multivibrator, gating, differentiating, and other pulse handling circuits can be analyzed for their effects on pulse shape, duration, and other characteristics. The S51B offers the versatility most often needed for educational and basic service requirements at a favorable price.

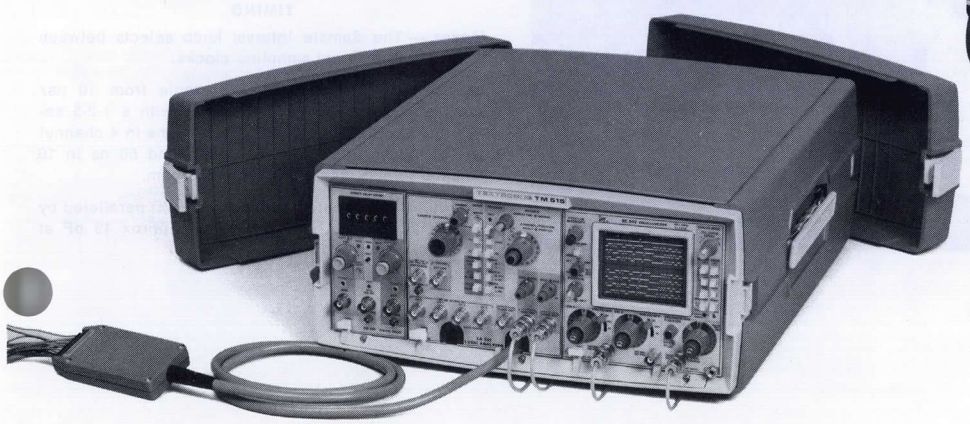
S51B Oscilloscope, Order TL S51B.....$325

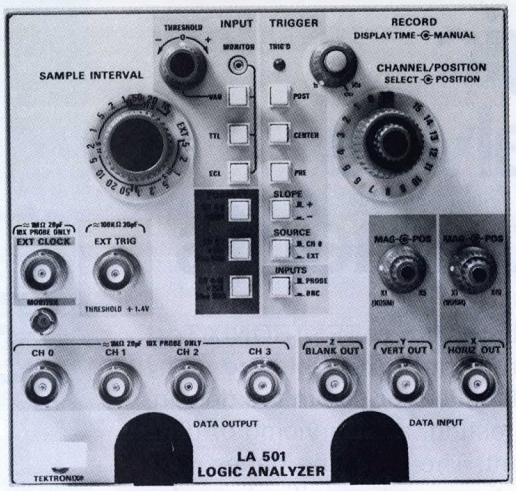
Logic Analysis Instruments

5

Among the broad line of TEKTRONIX Test and Measurement Instruments are many that are well suited for use in the design, production testing, and servicing of digital equipment. The following pages contain descriptions and specifications for the new LA501 Logic Analyzer, the DD501 Digital Delay, the 821 Word Recognizer and the P6401 Logic Probe. Also included is a cross reference to other instruments in our TM 500 Series, 7000 Series, and 5000 Series which are designed for measurements on logic systems.







ACQUIRES 16 CHANNELS SIMULTANEOUSLY

CAPTURES SINGLE SHOT DATA

DISPLAYS DATA PRECEDING TRIGGER

Stores 4096 bits in 4, 8, or 16 Channel Format

Asynchronous Sampling to 100 MHz

16 Channels in a Single Probe

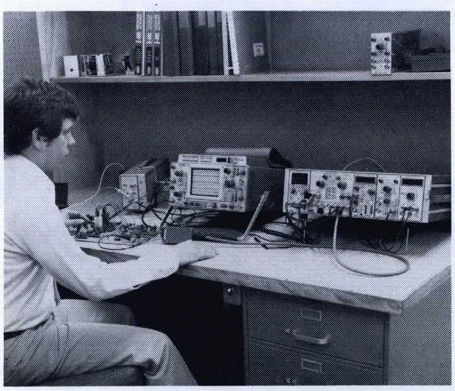
Timing Diagram Display

Selectable Trace Positioning

The LA 501's 4096 bits of storage can be formatted as 4 channels X 1024 bits, 8 channels X 512 bits, or 16 channels X 256 bits to best fit your application.

With selectable asyncronous sampling rate up to 100 MHz, the LA 501 offers timing resolution to 15 ns. Data can be synchronously sampled (externally clocked) at up to 50 MHz. Stored data is displayed as a timing diagram on virtually any x-y display. Vertical and horizontal position and magnifier controls on the LA 501 provide the unique capability to zoom in on any segment of this timing diagram for improved visual resolution. Channel to channel timing comparisons are made easier by the ability to select any one trace and move it vertically.

As a plug-in for any of five TM 500 Mainframes, the LA 501 can be combined in one compact package with a digital trigger delay, counters, pulse generators, multimeters, and a plug-in oscilloscope. Added to this is a choice of benchtop, rackmount, rollabout, or portable configurations to match your application.



SPECIFICATIONS

DATA INPUTS

Data Input Source — Selectable by a single pushbutton. Multi lead probe (P6450) provides connections for 16 data channels (approx 100 KΩ paralleled by 45 pF at the probe head). The P6450 attaches via a 25 pin connector internal to the LA 501.

High-Impedance Data Inputs — Four high-impedance (1 MΩ paralleled by approx 20 pF) inputs provide connection to data channels 0 through 3 via 10X probes (10 MΩ paralleled by approx 13 pF at probe tip — P6108 or equivalent).

Threshold Level — Three pushbuttons provide selection of fixed TTL or ECL compatible thresholds or variable threshold for use with other logic families.

Mode	At Probe Tips
TTL	+1.4 V ±0.2 V
ECL	−1.25 V ±0.06 V
Variable	From at least −10 V to +10 V

Sensitivity at Probe Tips — At least 600 mV p-p.

Max Safe Input Voltage —

At P6450 Probe Head	±50 V
At high-impedance data input connectors	±150 V
At 10X (P6108) Probe Tips	±500 V

Minimum Pulse Width — At least 1 sample width +5 ns is required to insure that pulse (high or low) is recorded.

TIMING

Modes — The Sample Interval knob selects between internal and external sampling clocks.

Internal Sample Interval — Selectable from 10 ns/sample to 5 ms/sample in 18 steps with a 1-2-5 sequence. Shortest sample interval is 10 ns in 4 channel format, 20 ns in 8 channel format, and 50 ns in 16 channel format. Accuracy: Within 50 ppm.

External Clock Input Impedance — 1 MΩ paralleled by approx 20 pF. (10 MΩ paralleld by approx 13 pF at P6108 10X probe tip).

Externally Clocked —

Format	Rate
4 chs x 1024 bits	50 MHz or less
8 chs x 512 bits	50 MHz or less
16 chs x 256 bits	20 MHz or less

External Clock Pulse Width —

Format	Pulse Width
4 chs x 1024 bits	High at least 10 ns, Low at least 10 ns
8 chs x 512 bits	High at least 10 ns, Low at least 10 ns
16 chs x 256 bits	High at least 25 ns, Low at least 25 ns

External Clock Threshold — Same as data inputs or internal switch selects ECL threshold.

External Clock Slope — Data strobed in on positive or negative edge of clock (selectable by internal strap).

Data Timing Requirements — With respect to strobing edge of external clock at P6108 probe tip.

	Time Requirement	
	Set-Up	Hold
At P6108 Probe Tips	2 ns	15 ns
At P6450 Probe Head	11 ns	12 ns

External Clock Monitor — A 10X probe tip jack is provided for compensation of high impedance 10X probes.

TRIGGER

Source — A single pushbutton provides selection between internal (ch 0) and external trigger sources. Internal trigger level is set by the threshold controls. External trigger input has a threshold of +1.4 V ±0.2 V and an impedance of approx 100 KΩ paralleled by 30 pF.

Slope — A single pushbutton determines whether the trigger circuit responds to the positive or negative going edge of a trigger signal.

Modes — Three pushbuttons select between post-trigger, center-trigger, or pre-trigger data storage and display.

Format	Number of Clock Pulses Between Beginning of Memory & Trigger (nominal)		
	Post-Trigger	Center-Trigger	Pre-Trigger
4 chs x 1024 bits	60	508	956
8 chs x 512 bits	30	254	478
16 chs x 256 bits	15	127	239

Indicator — An LED lights and remains lit until reset to indicate that the storage unit has been triggered.

MEMORY FORMATING

4 x 1024 Pushbutton — Selects data from input channels 0 through 3 for storage with 1024 bits per channel.

8 x 512 Pushbutton — Selects data from input channels 0 through 7 for storage with 512 bits per channel.

16 x 256 Pushbutton — Selects data from input channels 0 through 15 for storage with 256 bits per channel.

VERTICAL SYSTEM

Vertical Output (Y) — Provides a means of connecting serial data output to display. Each channel has dc offset to provide a vertical display raster. A variable vertical magnifier magnifies the on-screen display from 1X to 5X. A concentric vertical position control positions the display raster.

Channel Position/Selector — Two concentric rotary controls permit selective vertical positioning of any one of the 16 input channels for comparison with other channels.

HORIZONTAL SYSTEM

Horizontal Output (X) — Provides a means of connecting the LA 501 horizontal sweep to a display. A variable horizontal magnifier magnifies the on-screen display from 1X to 10X. A concentric horizontal position control positions the display raster.

Z-AXIS SYSTEM

Z-Blank Output — Provides a means of blanking crt display during retrace. Amplitude is 0 V to +5 V or 0 V to −5 V (within 1 V) selectable by an internal switch.

DISPLAY

Display Requirements — X-Y display capability of at least 500 kHz bandwidth (An optimum 8 x 10 div display is obtained with a vertical deflection factor of 0.1 V/div and a horizontal deflection factor of 0.05 V/div.

Display Time — A rotary control determines the time for which stored data will be held for display before a new record cycle starts. Variable from approx 1 s to approx 10 s. A detent position provides indefinite storage of data. A Record Reset pushbutton can be used to manually start a new record cycle at any time.

Crt Blanking — Blanks out data of a previous record cycle when record cycle is incomplete and during sweep retrace.

Crt Retrace —

Format	Bits Blanked
4 chs x 1024 bits	2/CH
8 chs x 512 bits	1/CH
16 chs x 256 bits	0.5/CH

DATA OUTPUT CONNECTOR

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

Serial Data — A single pin provides serial access to stored data. ECL levels.

Z-Axis Input — +5 V intensifies display. Used with a DD 501 to generate a cursor.

Other Control Signals — Other timing and mode control input and output signals are provided for remote data acquisition control and output and for multiple LA 501 slaving.

POWER

Line Voltage Ranges — Ranges are determined by the TM 500 Mainframe.

Power Consumption — 32 W at nominal line voltage.

ENVIRONMENTAL

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

Altitude — Operating: To 15,000 ft. Non-operating: to 50,000 ft.

Vibration — Instrument complete and operating. Vibration frequency swept from 10 to 50 to 10 cps at 1 minute per sweep. Vibrate 15 minutes along each of three major axes at 0.15 inch total displacement. Hold 3 minutes at any major resonance, or if none, at 50 cps. Total time, 54 minutes.

Shock — Operating and non-operating. 30 g's, ½ sine, 11 ms duration, 2 shocks in each direction along each major axis for a total of 12 shocks.

SIZE AND WEIGHT

	in	cm
Width	5.3	13.4
Depth	12.1	30.7
Height	4.9	12.5
	lb	**kg**
Weight	4.0	1.8

Note: These dimensions apply to the LA 501 plug-in module which must in turn be housed in a TM 500 Mainframe.

INCLUDED ACCESSORIES

P6450 probe package (010-6450-01) includes two lead sets, probe to hook tip (10 leads/set color coded); two lead sets, probe to 0.025 in square pin (10 leads/set color coded). Three coaxial BNC cables 50Ω, 42 in (012-0057-01).

ORDERING INFORMATION

LA 501 Logic Analyzer ***$3250**
TM 506 Mainframe **$240**
TM 515 Mainframe **$325**
TM 504 Mainframe **$180**
TM 503 Mainframe **$150**

*A TM 500 Mainframe must be used with the LA 501 to obtain a complete operating instrument.

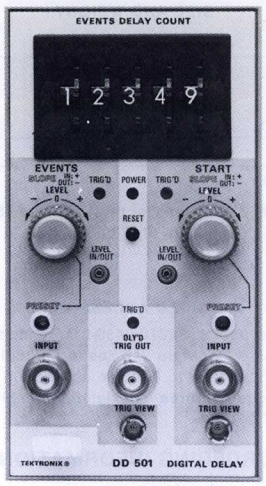
OPTIONAL ACCESSORIES

P6108 Probe — 10X attenuation, 2 meter cable (010-6108-03 ..... **$45**

For External Clock order one P6108 probe. For High Z inputs order four P6108 probes.

DD 501 Digital Delay **$625**

DD501 | Digital Delay



Delay by Events Counting Rate to 65 MHz

Divide by N Mode with Counting Rate to 20 MHz

Separate Controls for START and EVENTS Channels

Delays by Up to 99,999 Events

Companion Unit for LA 501 Logic Analyzer

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

The Logic Analyzer memory window is easily delayed from the trigger by a selected count using the DD 501. The DD 501 can be also used with the LA 501 Logic Analyzer to provide a moveable display cursor. This facilitates time interval measurements.

Because the DD 501 creates its delay by counting a number of pulses rather than by analog timing of an interval, jitter is not a problem even when viewing pulses toward the end of a long train. Events can be counted at frequencies up to 65 MHz, and 'divide by N' operation extends to 20 MHz. With the selected number of events clearly displayed on the thumbwheel dials the operator knows at all times what part of a pulse train he is viewing on the accompanying logic analyzer or oscilloscope. Meaningful measurements can be made on data trains up to 100,000 bits long.

EVENTS DELAY

Count — 1 to 99,999 events.

Max Count Rate — 65 MHz.

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

Recycle Time — 50 ns or less.

Reset — Manually resets delay counter.

INPUT CHARACTERISTICS

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

Input Impedance — 1 MΩ, 20 pF.

Slope — Either + or −, selectable.

Sensitivity — 85 mV p-p @ 30 MHz.

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

Minimum Detectable Pulse Width — 5 ns.

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

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

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

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

TRIGGER OUTPUT

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

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

Light — Indicates output trigger.

GENERAL

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

Altitude — Operating: to 15,000 ft; Non-operating to 50,000 ft.

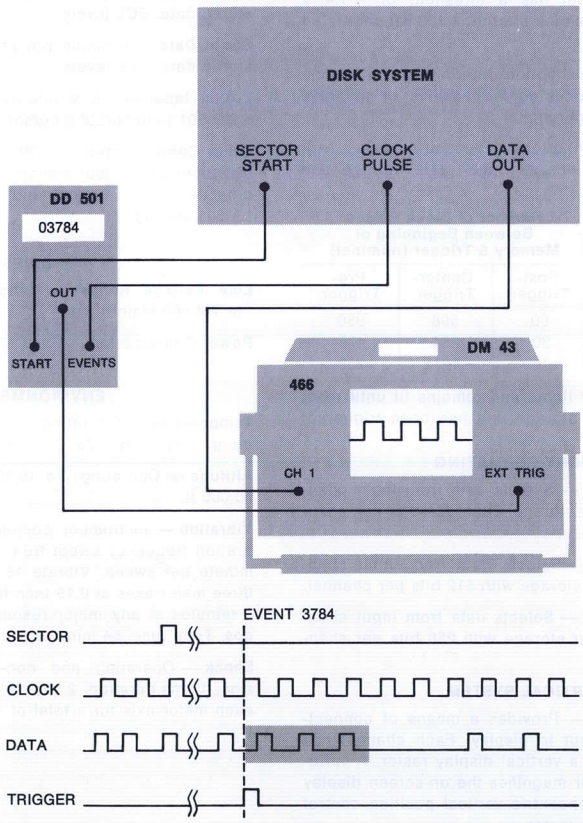
Shipping Weight — 3 lb.

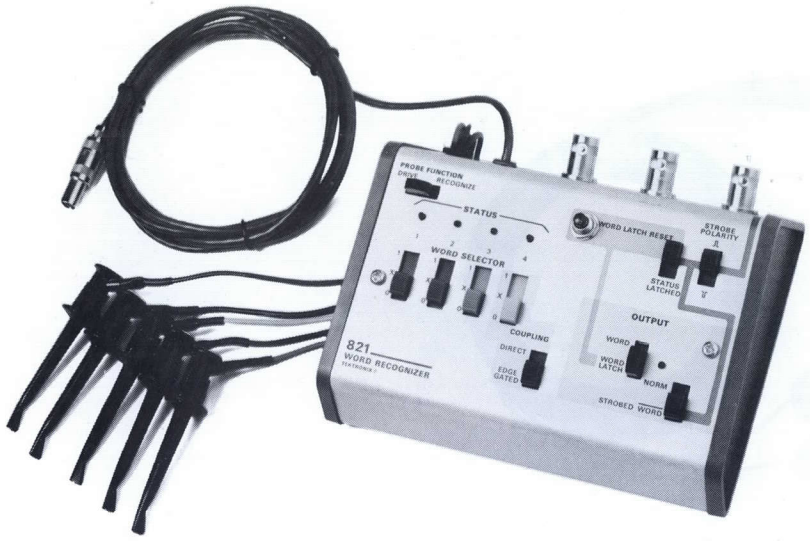
Dimensions — 2.6 in wide, 5 in high, 12.2 in deep (6.6 x 12.7 x 31 cm).

ORDERING INFORMATION

DD 501 Digital Delay	***$625**
TM 506 Mainframe	**$240**
TM 515 Mainframe	**$325**
TM 504 Mainframe	**$180**
TM 503 Mainframe	**$150**
TM 501 Mainframe	**$100**

*The DD501 must be plugged into a TM 500 Mainframe to achieve a working unit.





Four Bit Pattern Trigger for Logic Analyzer or Scope

Pulse or Latch Output

Recognizes Word or $\overline{\text{Word}}$

Expandable Word Length

TTL Compatible

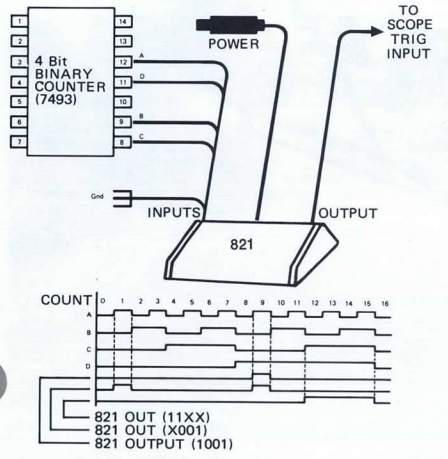
Status Indicators — Logic Probe Function

Static Pattern Generator — Logic Driver

The 821 produces a trigger signal for a logic analyzer, scope digital delay counter, universal counter, or frequency counter each time a selected word occurs. The 821 can also be set up to produce a trigger only the *first* time the word occurs after a strobe or manual reset or to produce a trigger each time the strobe occurs if the selected word is *not* preset.

In addition to producing trigger signals, the 821 also gives visual indications of trigger outputs and data states.

Two or more 821s can be connected together for word lengths of 8, 12, or 16 bits.



The application example illustrated shows an 821 connected to the outputs of a 4-bit counter. The 821 is set to produce a unique trigger at the count of nine (1001). The ladder diagram shows the resulting output for this selected word, plus output waveforms for alternate words (X001, 11XX) using the same inputs.

Modes

Norm — Selected word produces output.

Strobed $\overline{\text{Word}}$ — Absence of selected word during strobe pulse produces output.

Word — Produces trigger output each time the selected word is recognized.

Word Latch — Produces a low to high transition on the output when the selected word is first recognized and a high to low transition when the strobe signal (Word Latch Reset Selected) or the manual word latch reset occurs.

Status Latched — Data present on the word inputs during the strobe pulse is displayed on the status LEDs.

Recognize — Word recognizer operation.

Drive — Word Selector produces static output signals on the word inputs.

Indicators

Status — LEDs show high or low state of each word input as on or off condition. In the Status Latched mode, the data present during the latest strobe input is indicated.

Output — LED flashes for each trigger output or grows steadily when the trigger output rate exceeds 3 per second in Word mode. The LED lights when the selected word has been recognized and extinguishes at the strobe or manual reset in Word Latch mode.

SPECIFICATIONS

Input Characteristics

Word Inputs — Four permanently attached input cables with probe tips interchangeable between spring tips and banana tips. Each input has a selector switch to choose between TTL low (0), high (1), and don't care (X) conditions. Input 4 can be level or edge responsive (edge gated mode).

Other Inputs — Expander input for connecting to the output of another 821 to increase the number of bits recognized. Strobe input for sampling word inputs or resetting latch.

Levels Recognized (All Inputs) — TTL low (0) from −0.3 V to +0.8 V. TTL high from +2.0 V to +5.5 V.

Input Loading — Probes and strobe 1.25 TTL loads (≃2.0 mA). Expander 2.0 TTL loads (≃3.2 mA).

Max Non-Destructive Input Voltage Range — −4.0 V to +9.0 V for probes. −1.25 V to +5.5 V for strobe and expander.

Output Characteristics

Trigger Amplitude — At least 2.0 V into 50 Ω.
Drive Mode Fan Out — 6 TTL loads per probe.

Timing Specifications

Word Mode Propagation Time — 35 ns or less from probe input to output, 28 ns or less from expander input to output.

Word Latch Mode Set Time — 40 ns or less from probe. 30 ns or less from expander.

Word Latch Mode Reset Time — 35 ns or less from strobe input to output.

Strobed Word Mode — Minimum lead time of input before strobe is 10 ns.

Minimum Input Pulse Width — 35 ns for word output, 10 ns for word latch set.

Output Pulse Width — At least 50 ns for an edge gated input.

Input Pulse Edges — Slope must be at least 1 V/μs.

Other Specifications

Power Requirements — +5 V ±5% and approx 300 mA.

Power Source — +5 V can be supplied from 475, 485, or 7000 Series oscilloscope probe power jack (only one 821 can be powered by one oscilloscope) or from a standard +5 V logic power supply.

Operating Temperature Range — 0°C to +50°C.

Non-operating Temperature Range — −40°C to +65°C.

Operating Altitude — to 15,000 ft.

Non-operating Altitude — to 50,000 ft.

Weight — 13 oz.

Dimensions — Height 2.23 in, width 5.34 in, depth 4.30 in.

Standard Accessories — Five packages of interchangeable probe tips. Each package includes banana probe tip, spring probe tip, probe ground lead, miniature alligator clip, and alligator clip cover.

Optional Accessory — Adapter for connecting 821 power cable to alligator clips. For powering the 821 from a +5 V power supply other than an oscilloscope power jack.

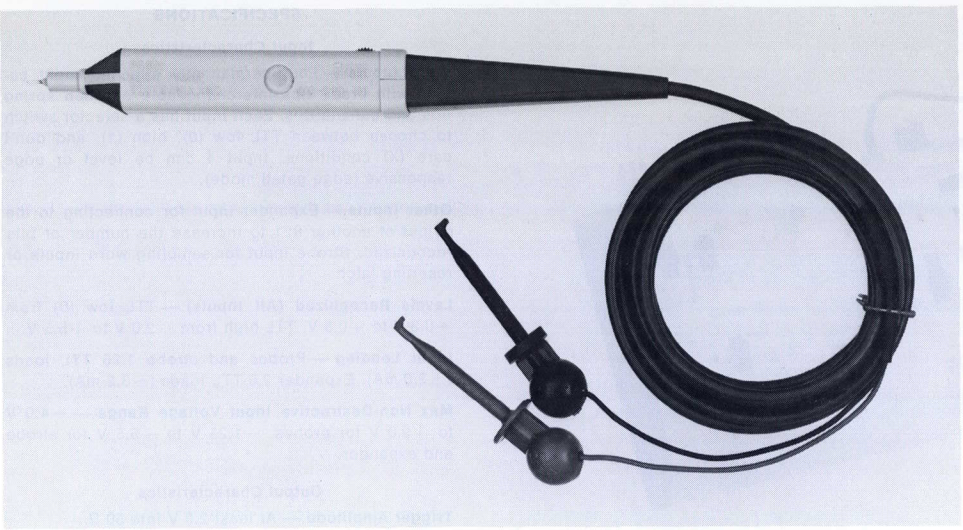
Ordering Information

821 Word Recognizer $200

Optional Power Cable Adapter — Required if probe power is not available from the instrument to be triggered.

(012-0545-00) $18.50

P6401 | Logic Probe



TTL/DTL Compatible

Detects Steady Logic Levels

Detects Trains of Logic Pulses

Detects Abnormal Conditions

Strobed Detection of Logic Pulses

Store Mode

Protected Against Overvoltage

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

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

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

State or Condition	Indication
Steady high state	Steady red light
Steady low state	Steady green light
Pulse trains (normal logic switching)	Blinking red and green light at full intensity
Abnormal state (between high and low)	No lights
Open circuit	No lights
Excessive input voltage greater than 6 V	Both red and green lights lit
Alternating between high state and indeterminate state	Blinking red light
Alternating between low state and indeterminate state	Blinking green light
Single or very low duty cycle logic pulse	Using STORE mode, one light will be on initially. Event has occurred when second light is lit.

SPECIFICATIONS

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

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

Minimum Recognizable Pulse Width — 10 ns.

Impedance — ≃ 7.5 KΩ paralleled by ≃ 6 pF.

Minimum Circuit Resistance for Open Circuit Indication — 10 KΩ.

Max Safe Input — ±150 V (dc or rms).

Minimum Recognizable Strobe Pulse Width — 20 ns.

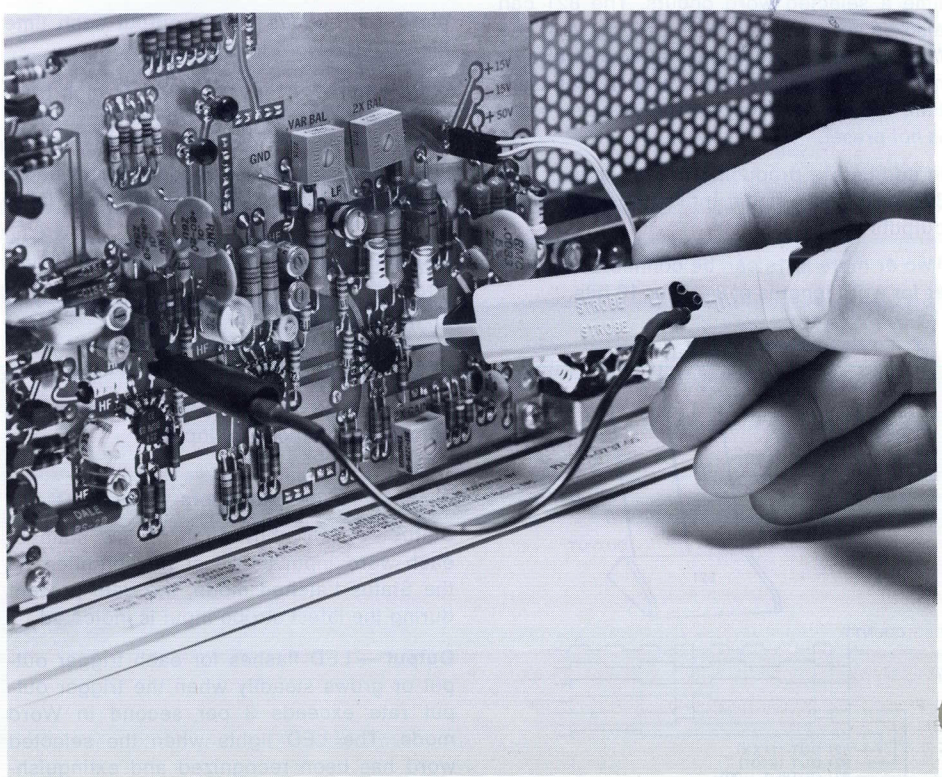
Max Safe Strobe Input — ±30 V (dc or rms).

Strobe Input Impedance — 5.6 KΩ within 20%.

ORDERING INFORMATION

P6401 5 ft Probe (010-6401-01) $90

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



OPTIONAL ACCESSORIES

P6108 — A 10X probe (10 MΩ, 13 pF), for use with the LA 501 or DD 501 Digital Delay. Order four probes for use with the four high speed data channels of the LA 501. For the external clock input of the LA 501, order one additional probe.
(010-6108-03) $45

P6450 Probe Package — Replacement probe for LA 501 Logic Analyzer.
(012-0655-01) $250

Lead Sets — Color coded replacement lead set for the 16 channel P6450 Probe used with the LA 501 Logic Analyzer. 10 leads/set. Connects probe head to 0.025 in square pins.
(012-0655-01) $35

Same lead set with hook tips.
(012-0670-00) $36

BNC Cable — 50Ω, 18 in.
(012-0076-00) $9

Probe Tips

1. Miniature Retractable Hook Tip — Suitable for attaching P6450 to compact electronics.
(206-0222-00) $5

2. Retractable Hook Tip — Suitable for use with P6401 Logic Probe.
(013-0106-00) $4.95

3. Pomona Hook Tip to 6-32 —
(344-0267-00) $2.60

4. Probe Pin Tip — Accepts 0.025 in IBM SLT pin. Slip on.
(206-0209-00) $2.50

5. Probe Tip — Flexible probe tip to fit 0.025 in square pin.
(206-0193-00) $5.00

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

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

8. Probe Pin Tip — Accepts 0.025 in IBM SLT pin. Screw on.
(206-0134-03) $3.00

9. Probe Ground Lead Adapter — #6-32 to 0.025 in IBM SLT square pin.
(206-0137-01) $1.30

10. Miniature Probe Tip Adapter — For testing integrated circuits. Package of 10.
(015-0201-01) $5.00

Lab Cart, Model 3

A rollabout cart which accepts up to two TM 504 Mainframes which in turn house up to eight TM 500 plug-ins such as the LA 501 Logic Analyzer, the DD 501 Digital Delay, and the DC 503 or DC 505A Counters. The top tray accommodates either portable (400 Series) or Laboratory (7000 and 5000 Series) oscilloscopes for the display of logic analyzer timing diagrams as well as real time waveforms.

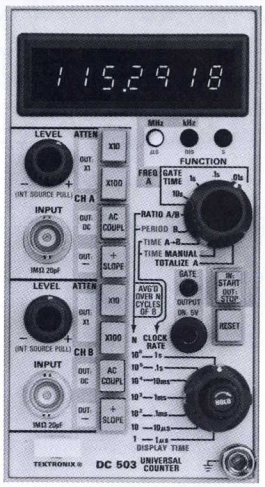
Model 3 Lab Cart $285

OTHER LOGIC ANALYSIS INSTRUMENTS

There are plug-ins for the TEKTRONIX TM 500 Series of Test and Measurement Instruments as well as the 7000 and 5000 Series Laboratory Oscilloscopes which are designed specifically for analysis of digital equipment. These include digital delays similar to the DD 501, digital counters, and pulse generators. Complete details on the instruments listed below can be found on the pages indicated.

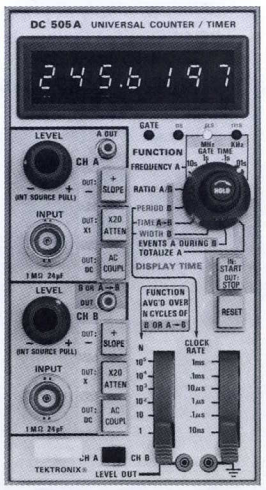
TM 500 Series Instruments

DC 503 Universal Counter



Counting to 100 MHz with six modes: frequency, period ratio, time A-B, time manual, and totalize. Period and ratio averaging for enhanced resolution. P 134.

DC 505A Universal Counter/Timer



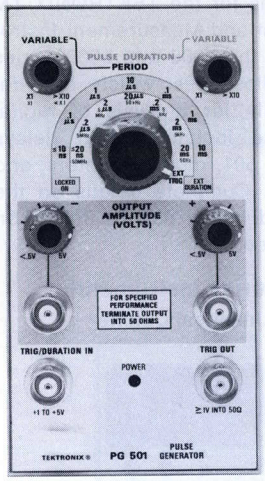
A 225 MHz universal counter offering seven modes: frequency of channel A signal, ratio of channel A to channel B frequency, period of channel B signal, time interval from channel A start to channel B stop, width of channel B pulse, events in channel A during B, and totalize. Time interval averaging with resolution to 100 picoseconds. Features dc trigger level output. P 135.

More on next page

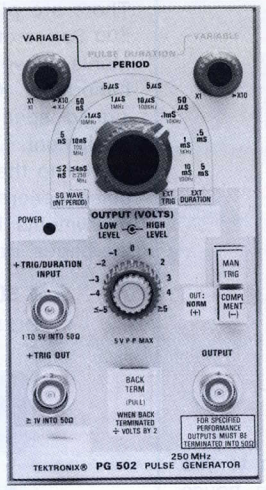
Other Logic Analysis Instruments

TM 500 Series Instruments

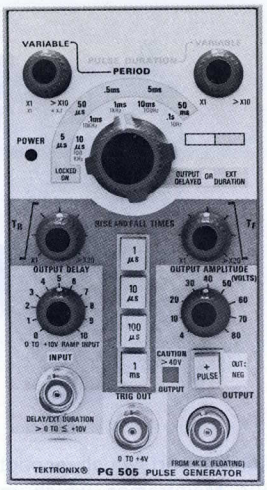
PG 501 Pulse Generator



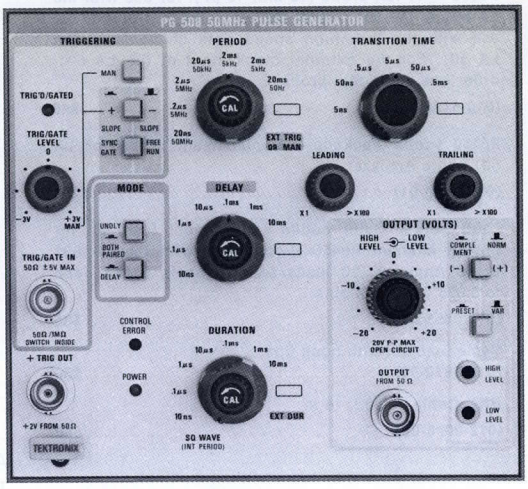
PG 502 Pulse Generator



PG 505 Pulse Generator



PG 508 Pulse Generator



PG 501

Dual output 5 Hz to 50 MHz pulse generator featuring simultaneous plus and minus outputs, independent period and duration controls, 0.5 V to 5 V output, and rise time of 3.5 ns or less. p. 140.

PG 502

5 Hz to 250 MHz pulse generator with 1 ns rise time, high and low output levels independently adjustable from −5 V to +5 V, separate period and duration controls, and switchable 50 Ω back termination. p. 138.

PG 505

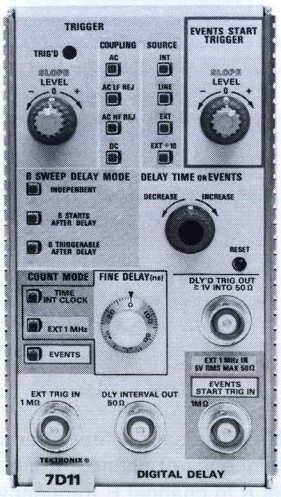
1 Hz to 100 kHz pulse generator with output amplitude to 80 V, independently variable period and duration controls, adjustable rise and fall time, and delay mode (using external 0 to 10 V ramp). p. 138.

PG 508

50 MHz pulse generator with output top and bottom levels independently adjustable from −20 V to +20 V, period and duration separately variable, adjustable rise and fall times, and 1 MΩ trigger input for use with MOS logic. p. 138.

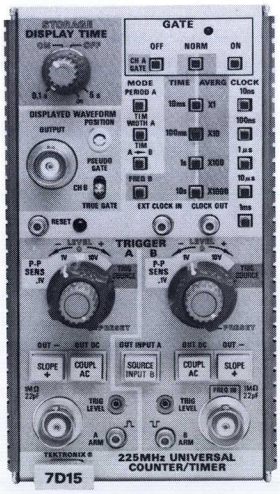
Plug-ins for Laboratory Oscilloscopes

7D11 Digital Delay



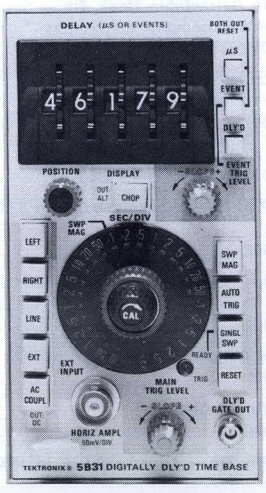
A 7000 Series Oscilloscope plug-in which provides a delay by events trigger by counting pulses from an external source or a delay by time trigger (selectable from 100 ns to 1 sec) by counting pulses from an internal clock. p. 58.

7D15 Universal Counter/Timer



A 7000 Series Oscilloscope plug-in providing six counting modes: time interval, period, frequency (0 to 225 MHz), frequency ratio, totalize, and manual stop watch. p. 62.

5B31 Digitally Delayed Time Base



Pushbutton selection of delay by events (up to 99,999 events) or delay by time (1 μs t 99,999 μs). Plug-in for 5000 Series Oscilloscopes. p. 79.

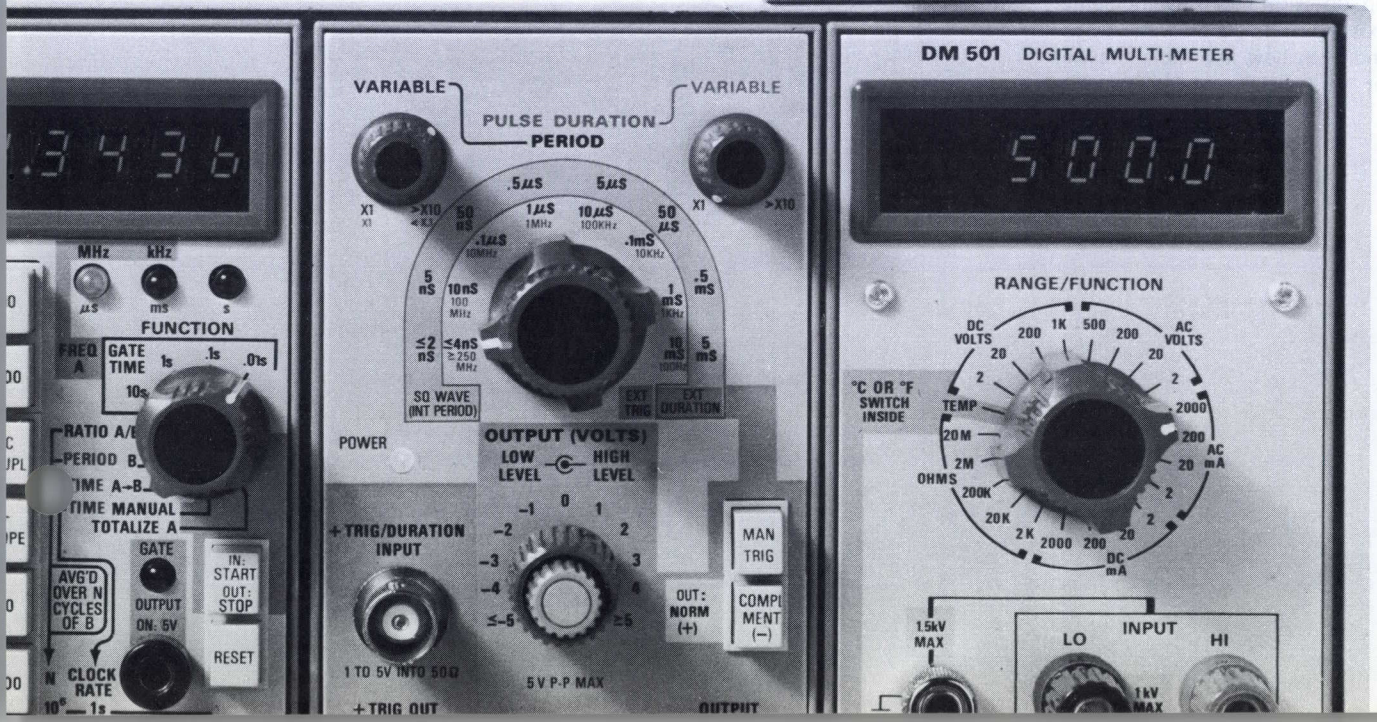
TM 500-Series
modular test and measurement instruments

Counters	**pp 132-135**
Digital Multimeters	**pp 136-137**
Signal Sources	**pp 138-147**
Power Supplies	**pp 148-149**
Signal Processors	**pp 150-152, 157**
Oscilloscopes	**pp 153-156**
Mainframes	**pp 158-160**

TM 500 is a family of plug-in modular instruments, mainframes, and accessories. While any of the instruments can be selected on the basis of its performance as an independent unit, the ability of the TM 500 family to work together through the mainframe interface opens up many benefits to you.

Until you see TM 500 instrumentation, and discover its capabilities for yourself, you cannot fully appreciate how versatile yet compact it is. These instruments offer the quality and multiplicity of functions needed in modern electronics — and all within reach of your fingertips.

Front Panels Here Are Actual Size!



TM 500 Modular Concepts and Features

Designed for Measurement Solutions

Over 30 compact plug-in test and measurement instruments which can work individually or be combined into powerful systems — that's TEKTRONIX TM 500.

TM 500 Plug-in Modular Instruments range from general-purpose devices like multimeters and power supplies to specialized units like oscilloscope calibration units and a digital delay trigger generator. The mainframes come in benchtop, rackmount, SCOPE-MOBILE® cartmounted and portable traveler models, with spaces for one to six plug-ins.

TM 500 allows you to assemble a specialized package of instruments to meet your individual measurement needs, or you can pick one of the standard combinations suggested in this catalog. You can also select an assortment of mainframes and an inventory of plug-in instruments, and then have the freedom to make one kind of measurement today and an entirely different one tomorrow.

Modularity Means More than Plug-Ins

Each TM 500 instrument is *designed* as a plug-in unit, with standard and special connections available at a rear connector as well as on the front panel. Any instrument can be plugged into any TM 500 Mainframe slot, with a few providing extra performance in a special high-power compartment. Plug-ins can be rotated among mainframes or exchanged with supplementary units in seconds.

This add-on capability also means that your TM 500 system can keep up to date without the need to replace the complete investment. New TM 500 units can add the capability to keep up with new developments, while your existing units go on with day-to-day work. And both new and old units will work together, too.

Your TM 500 Can Be A Measurement System

By connecting to the signal and control lines brought out at the rear of each plug-in, the optional mainframe interface board turns a TM 500 package into an integrated measurement system. Both standard and user-defined lines are available, and simple or complex systems can be assembled as the need arises.

Signals and inputs available at the rear connector of each plug-in include most front-panel connections, many internal values, and, on some units, bcd outputs. For automatic logging and calculating, you can connect a plug-in interface for TEKTRONIX Programmable Calculators. And, as the various industry interconnections standards develop, there will be TM 500 interfaces for many of these, too.

Flexible TM 500 Works Anywhere

TM 500 is designed to serve a wide variety of uses. The mainframes come in benchtop, rackmount, and a protected portable travel case style unit. The three and four compartment versions can be fitted to TEKTRONIX SCOPE-MOBILE® carts. With the variety of plug-ins available, this means that TM 500 is at home almost anywhere.

Since you can take TM 500 right to the problem, you can be sure that the measurement you make in the field is the same as the one on the bench. The measurement setup you build in the lab can go into rackmounted TM 500 units on the production line. And, with your traveler mainframe, you can take your instruments along as carry-on luggage when the best choice is to carry your lab equipment right to the problem.

Quality, Value, and Economy

TM 500 was designed to keep costs low and measurement value high. The mainframes include many of the more expensive components, such as the case and primary power supply, so they are shared by several plug-in instruments.

Extensive use has been made of the advanced technology and manufacturing techniques pioneered in TEKTRONIX Oscilloscopes — including the use of many Tektronix manufactured parts ranging from control knobs to integrated circuits.

Because of the wide selection of TM 500 instruments available, you can often tailor a TM 500 system to meet the needs of a special application at far less cost than that of a custom system or collection of the necessary separate instruments that would otherwise be required.

Since TM 500 is backed up by Tektronix, you save money in the long run as well. Worldwide customer assistance and service, quality engineering, and readily available parts are an important part of the value of TEKTRONIX TM 500 equipment.

Production Engineers

Time savings are among the most important reasons to buy TM 500 for production line use: time savings at the design stage, where the interconnection capability of the TM 500 system allows the quick construction of sophisticated measuring systems; time savings at the training and measurement stage, where the easy-to-read digital outputs reduce operator error and fatigue, and where BCD output and a calculator interface make it possible to set up automatic testing and measurement logging; and time savings on repairs, where individual instruments can be unplugged for quick replacement to get the system back in operation immediately, eliminating possible production bottlenecks.

TM 500 rackmounting, portable, and mobile cart mounting options give you a whole range of configurations to choose from. Single-compartment and double-wide compartment circuit card plug-in kits with front panel and internal circuit board make it possible to construct compatible interfaces and custom circuits for further flexibility. And for complex systems and limited areas, the compact size of the TM 500 instruments is also an important factor to consider.

Design Engineers

If you're expected to produce advanced circuit designs, then you need test instrumentation that can match your measurement requirements. That's why TM 500 state-of-the-art capability is a key benefit for design engineering use.

Modularity allows you to add units to keep up with advances in circuitry, while the compact size means that a full complement of instruments can be kept on a crowded workbench. Interconnection capability makes over 30 input and output lines available, so you can build custom test systems for specialized design projects. And flexibility means that TM 500 will keep up with your imagination.

Maintenance Engineers

With portable, cartmounted, rackmount, and desktop versions, TM 500 packages can do the work wherever it needs to be done. For specialized jobs, "solution" oriented instruments make those measurement problems easy to lick.

For example, the TG 501 Time Mark Generator not only provides exact pulses for calibration of oscilloscope and recorder time bases, but it also allows you to match a variable pulse with your existing calibration, and then read the error in percent on the TG 501 display. Since the TM 500 units can be brought to the job, oscilloscopes and recorders can be calibrated on site, eliminating the errors and added down time caused by moving them back to a calibration bench.

For general repair work, the flexibility of the TM 500 line means that any of the more than 30 units can be in place and running in seconds, covering far more of the possibilities than would be possible with a more limited system. You can set up your TM 500 instruments to have the ones you need at your fingertips, and still be able to switch to others in seconds when the problem requires an unexpected measurement.

Educational Use

With TM 500, you can build student lab stations with the full capability of a complete range of instruments, yet assemble them within the stringent limitations of budgets and space that so often apply. You can supply basic TM 500 units to each student, with more specialized instruments rotated among groups as the curriculum requires. This saves the cost of duplicate purchases without limiting vital access to the measurements students need to make.

Although TM 500 equipment is quite sophisticated, it has been designed with human factors in mind. Color-coded front panels, standardization of connectors, and easy-to-read digital displays make TM 500 quite suitable for student use. In addition, the actual hands-on experience with commercial equipment is a valuable experience for students who will later be going on to further study or employment.

Service Engineers

With TM 500's extreme portability, you can concentrate on electronics instead of on the logistics of getting test equipment to where you need it. The traveler five-compartment mainframe will go just about anywhere you might have to go, and the measurement power of the TM 500 instruments it carries assures you that you'll rarely have to make a second call because you couldn't make a vital reading.

With a choice of two oscilloscopes, five counter/timers, and close to a dozen signal generators, you can pick the level of performance you need. The systems capability of the TM 500 line means that you can also assemble a package for repetitive measurements, allowing you to make routine measurements quickly.

Special units, such as the DD 501 Digital Delay and temperature-measuring DM 502 Digital Multimeter, make service work easier and more productive. And the custom interface capability means that you can build that adapter you need right in a blank plug-in, keeping your total measurement package neat and easy to handle.

Digital integrated circuits and modern high-stability quartz crystals have combined to permit time and frequency measurements of a greater accuracy than for any other electrical parameters. The TEKTRONIX TM 500 line of digital counter/timers offers all the versatility, operating ease, compactness, and value available with present state-of-the-art techniques. Five models are available: the DC 501, DC 502, DC 503, DC 504, and DC 505A.

The counters, DC 501 and DC 502, measure frequencies and totalize events from low audio frequencies up through 110 or 550 MHz. The new low-cost DC 504 combines frequency counting and totalizing, plus an rpm capability, with the ability to measure period for higher resolution and accuracy at low frequencies. The DC 503 and DC 505A are fully Universal Counter/Timers which totalize and measure frequency, and also provide single period, period averaging, frequency ratio, and time interval capability. The DC 503 also includes a time-manual (electronic stopwatch) feature. The sophisticated DC 505A provides time-interval averaging, direct pulse width measurements, and a unique events-A-during-B mode.

Applications for the DC 501 and DC 502 frequency counters and the DC 504 period and frequency counter cover many measurements needed in communications work. Typical measurements include carrier and sub-carrier frequencies, modulation frequencies, pulse repetition rates in data communications, center frequency and corner frequencies of tuned filters, frequency of signalling tones, and verification of discriminator linearity. The totalize (event-counting) mode is also useful in industrial control applications or research environments.

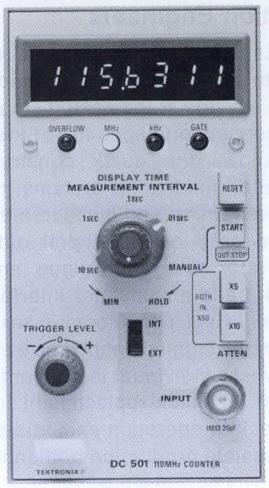
The second channel capabilities of the DC 503 and DC 505A Universal Counter/Timers permit measurement of frequency ratios and, more importantly, time intervals, in addition to the frequency and total events measures of single channel instruments. Time intervals are measured by counting the internal clock pulses which occur between a start event on channel A and a stop event on channel B. Resolution and accuracy are determined by the instrument's clock rate, and by whether time interval averaging is available.

The accuracy of counter/timer measurements is ultimately limited by the accuracy of the internal time base, although at some combinations of input frequency and counter operating controls, resolution may be the limiting factor. Two types of time base are available in the TM 500 family of counters. The standard time base is an uncompensated quartz crystal providing a monthly aging rate and temperature stability of 1 part in 10^5 (0.001%). The option 1 time base is a high stability temperature-compensated quartz crystal which provides a one-hundred-times improvement in aging rate and a twenty-times improvement in temperature stability. Temperature-compensated time bases have an inherent advantage over temperature-controlled (oven) time bases in that they do not require hours or days of warm-up to reach specified accuracy. This is particularly important in portable applications.

DIGITAL COUNTERS — COMPARISON OF CHARACTERISTICS

The following is a comparison of the main characteristics of the DC 501 through the DC 505A. A complete list of specifications appears on the following pages.

	DC 501	DC 502	DC 503	DC 504	DC 505A
Number of Digits	7	7	7	5	7
Frequency Range	110 MHz	550 MHz	100 MHz	80 MHz	225 MHz
Totalize	Yes	Yes	Yes	Yes	Yes
Period	No	No	Yes	Yes	Yes
Period Average	No	No	Yes	No	Yes
Time Interval	No	No	Yes; 1 μs maximum clock rate	No	Yes; 10 ns maximum clock rate
Time Interval Average	No	No	No	No	Yes
Ratio	No	No	Yes	No	Yes
Other	Option 1 FCC type Approved	Option 1 FCC Type Approved	Time Manual	Rpm	Events A During B, single-jack pulse width, dc trigger level out
Price	$650	$995	$750	$395	$1395

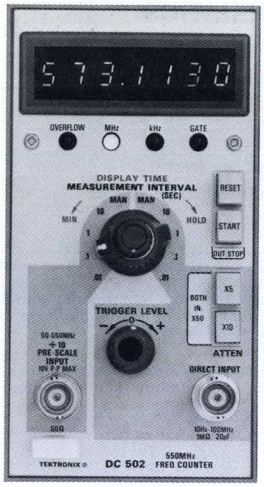


DC 501

Direct Counting to 110 MHz
7-Digit LED Display
Manual Start/Stop (Totalize)
Auto Range and Time Base Options

The DC 501 Digital Counter directly measures frequency from 10 Hz to 110 MHz and totalizes (counts number of events) from 0 to 9,999,999 at a maximum rate of 110 MHz. Measurement readout is provided by seven-segment LEDs in a seven digit display. The decimal point is automatically positioned and leading zeros (to the left of the most significant digit or decimal point) are blanked. Register overflow is indicated by a front-panel LED. Signals to be counted can be applied via a front-panel BNC connector into an impedance of 1 MΩ and 20 pF or via the rear connector into an impedance of 50 Ω and 20 pF. Four gate times of .01s, 0.1s, 1s, and 10s are provided. A standard internal 1 MHz clock is provided with 1 x 10^{-5} accuracy (0° to 50° C) and an aging rate of 1 x 10^{-5} per month. An optional clock with 5 x 10^{-7} accuracy (0° to 50° C) and an aging of 1 x 10^{-7} per month is available at extra cost. Input sensitivity is approximately 300 mV peak-to-peak (100 mV rms sine wave) below 110 MHz. An automatic measurement interval option, also at extra cost, automatically selects the gate time (up to 10 seconds) to obtain maximum resolution with any input signal.

DC 501 Digital Counter **$650**
Option 1 (Time Base) . . . . . **add $150**
Option 2 (Auto Measurement) . . . . . **add $65**
Option 4 (Calculator) . . . . . **add $20**



DC 502

Counts to 550 MHz with ÷10 Prescale (50-Ω Input)

Direct Counting to 110 MHz

7-Digit LED Display

Manual Start/Stop (Totalize)

Time Base Option

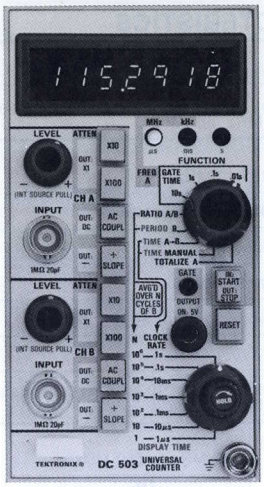
The DC 502 Digital Counter measures frequencies from 10 Hz to 550 MHz or totalizes events up to the register capacity of 10^7-1 at the max rate of 550 MHz. Frequency measurements are accomplished using one of two inputs. The DIRECT INPUT has a frequency range of 10 Hz to 110 MHz, a 1 megohm input impedance, 300 mV peak-to-peak sensitivity (100 mV rms sine wave) and an adjustable trigger level range. The ÷ 10 PRESCALE INPUT has a frequency range from 50 MHz to 550 MHz with a 500 mV peak-to-peak sensitivity (170 mV rms sine wave) and a 50-Ω input impedance. The manual totalizing mode with front-panel start-stop control is available at both inputs; from the prescale input, 1 displayed count per 10 input events will result. Measurement display is accomplished with seven-segment LEDs in a seven-digit readout. The decimal point is automatically positioned by the measurement interval selected, and leading zeros (those to the left of the most significant digit or those to the left of the decimal point) are blanked. LEDs indicate when the gate is armed, and whether displayed numbers are in kHz or MHz, and when register overflow occurs. Four gate times of 0.01s, 0.1s, 1.0s, and 10s are provided. A standard internal 1 MHz clock is provided with 1 x 10^{-5} accuracy (0° to 50°C) and aging rate of 1 x 10^{-5} per month. An optional clock with 5 x 10^{-7} accuracy (0° to 50°C) and aging rate of 1 x 10^{-7} per month is available at extra cost.

DC 502 Digital Counter **$995**
Option 1 (Time Base) . . . . . **add $150**
Option 4 (Calculator) . . . . . **add $20**
Option 7 (for use with TR 502) . . . . **add $200**

COMPARISON OF CHARACTERISTICS

	DC 501	DC 502
DISPLAY	7 digits (7-segment LEDs) storage, leading zero blanked. Overflow, gate open and kHz or MHz indicators.	
DIRECT INPUT Frequency Range	10 Hz to 110 MHz	
Sensitivity	300 mV p-p (100 mV rms sine wave)	
Impedance	1 MΩ, paralleled by 20 pF	
Triggering Level	Adjustable, ±2 V	
Max Safe Input	500 V (dc and peak ac, or p-p ac) at ≤ 1 kHz	
Attenuation	X1, X5, X10, or X50	
Resolution	0.1 Hz with 10 s gate, 1 Hz with 1 s gate, 10 Hz with 0.1 s gate, 100 Hz with 0.01 s gate	
÷ 10 PRESCALE INPUT Frequency Range	Not Applicable	50 MHz to 550 MHz
Sensitivity		500 mV p-p (170 mV rms sine wave), or 1-2 mV rms (see special features below)
Impedance		50 ohms
Max Safe Input		10 V p-p
Resolution		1 Hz with 10 s gate 10 Hz with 1 s gate 100 Hz with 0.1 s gate 1 kHz with 0.01 s gate
STANDARD TIME BASE ACCURACY Temp Stability, 0° to 50°C after Warm-up	Within 1 part in 10^5 (0.001%)	
Long Term Drift	Within 1 part in 10^5 per month (0.001%)	
Setability	Adjustable within 1 part in 10^7 (0.00001%)	
OPTION 1 TIME BASE ACCURACY Temp Stability, 0° to 50°C after Warm-up	Within 5 parts in 10^7 (0.00005%)	
Long Term Drift	Within 1 part in 10^7 per month (0.00001%)	
Setability	Adjustable within 5 parts in 10^9 (0.0000005%)	
FCC Type Approval	Option 1 FCC Type approved for frequency monitoring in am and fm broadcast bands and on tv channels 2-6	Option 1 FCC Type approved for frequency monitoring in am and fm broadcast bands and on tv channels 2-26
Totalize	Counts events from 1 to 9,999,999 at a max rate 110 MHz. Start, stop, and reset commands via front-panel pushbuttons.	Same as DC 501 plus ÷ 10 totalize which counts events to 99,999,990 at a max rate of 550 MHz. Display is 1/10 the number of input events
REAR INPUTS — For routing from other compartments or from rear-panel connectors on Power Modules	Direct count input (50 ohms impedance, resistor may be removed for 1 megohm input), reset, external display scan clock, external time base	Reset, external display scan clock, external time base
REAR OUTPUTS — For routing from other compartments of Power Module or to rear-panel connectors on Power Modules	Bcd serial-by-digit, plus lines for MHz light, decimal point, internal display scan clock, time base out, data ready, etc	
SPECIAL FEATURES	Option 2—Automatically selects optimum measurement interval to fill the display, and displays appropriate kHz or MHz indication. Overflow is indicated for frequencies in excess of 99.99999 MHz	A modification is available to provide 1-2 mV sensitivity from 50-550 MHz. See your Tektronix Field Engineer, Representative, or Distributor for more information.
CALCULATOR INTERFACE	Option 4—Adds appropriate decimal point output data for compatibility with TEKTRONIX 31/53 Calculator Instrumentation System.	

DC 502 Option 7 Digital Counter (for use with the TR 502 Tracking Generator) has all usual characteristics of the DC 502 plus logic circuitry which allows the DC 502/TR 502/7L13 to select and determine unknown signal frequencies within the frequency range of the counter and with the sensitivity of the analyzer; includes the High Stability Time Base. The spectrum display center frequency is indicated by a bright dot on the analyzer crt and is automatically counted by the DC 502 Option 7.



DC 503

Direct Counting to 100 MHz

Six Measurement Functions

Period and Ratio Averaging

Interval Measurement Capability

The DC 503 Universal Counter offers counting to 100 MHz and provides the versatility of six measurement functions: frequency, period ratio, time A→B, time manual, and totalize. The two channels (A and B) have individual BNC inputs and separate trigger level, attenuator, and coupling mode controls. Seven-digit readout is via seven-segment light emitting diodes (LEDs) with automatically positioned decimal point; leading zeros (to the left of the most significant digit or decimal point) are blanked. A flashing display indicates register overflow. The low cost DC 503 offers high performance in a variety of applications. Its interval measurement capability with selectable clock rates is useful for digital equipment design and maintenance, particularly digital control and data communications work. The A-channel frequency range of dc to 100 MHz serves in communication and rf use. High resolution measurements of low frequencies are available quickly in the period mode with averaging up to 1 million periods available. TIME MANUAL provides an electronic stop watch function with selectable clock rates. TOTALIZE counts and displays the total number of input events at rates from dc to 100 MHz.

DC 503 ..... **$750**

Option 1 (Time Base) ..... **add $150**

Option 4 (Calculator) ..... **add $ 20**

COMPARISON OF CHARACTERISTICS

	DC 503	DC 505A
DISPLAY	7 digits (7 segment LEDs)	Storage, leading zeros blanked
FREQUENCY (A input) Range	0 to 100 MHz, dc coupled 10 Hz to 100 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Gate Times	0.01 sec, 0.1 sec, 1 sec, 10 sec	
Accuracy	±1 count ± time-base error	
TIME INTERVAL (A → B) Resolution, Single event	1 μs to 1 sec, selectable	10 ns to 1 ms, selectable
Resolution, averaging on repetitive events	Not Applicable	≤ 100 picoseconds with 10 ns clock and 10^5 averaging. Clock rate selectable, 10 ns to 1 ms. Averaging factor independently selectable from 1 to 10^5. 5 ns minimum pulse width in either channel.
Accuracy	±1 count ± time-base error; other contributions negligible	±1 count ± time-base error ± trigger error CH A* ± trigger error CH B* ± channel delay match error of 2 ns max ± slew rate error*** + 2 counts (10 ns clock rate only). Best absolute accuracy, 3 ns
WIDTH (B input) Resolution, single pulse	Use "tee" connector and Time Interval A→B mode; see specifications above	10 ns to 1 ms, selectable
Resolution, repetitive pulses	Not Applicable	≤ 100 picoseconds with 10 ns clock and 10^5 avg factor. Clock rate selectable 10 ns to 1 ms. Avg factor independently selectable from 1 to 10^5 2 ns minimum pulse width.
Accuracy		±1 count ± time-base error + hysteresis error** ± slew rate error*** + 2 counts (10 ns clock rate only). Best absolute accuracy, 1.5 ns.
PERIOD + PERIOD AVERAGING (B input) Resolution	From 1 μs for single period to 1 picosecond with 10^6 averaging	From 10 ns to 1 ms for single period; to 0.1 picosecond max with 10 ns clock and 10^5 averaging
Accuracy	$\pm 1 \text{ count} \pm \text{time-base error} \pm \frac{\text{trigger error}}{N}$	±1 count ± timebase error ± trigger error† +2 counts (10 ns clock rate only).
RATIO (A/B)	Averaged over 1 to 10^6 cycles of signal at B	Averaged over 1 to 10^5 cycles of signal at B. Accuracy: ±1 count FREQ A ± trigger jitter chan B†
EVENTS A DURING B	Not Applicable	Averaged over 1 to 10^5 occurences of signal at B. Accuracy: ±1 count FREQ A + hysteresis error** ± slew rate error***
TOTALIZE (A)	1 to 9,999,999 at max rate of 100 MHz. Front-panel start, stop, reset control.	1 to 9,999,999 at max rate of 225 MHz. Front-panel start, stop, reset control .
TIME MANUAL	Electronic stop watch; accumulates and displays time following activation of front-panel start button. Clock rates selectable from 1 μs to 1 sec.	Not Applicable
INPUT SPECIFICATIONS Freq Range, A	0 to 100 MHz, dc coupled 10 Hz to 100 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Freq Range, B	0 to 10 MHz, dc coupled 10 Hz to 10 MHz, ac coupled	0 to 225 MHz, dc coupled 10 Hz to 225 MHz, ac coupled
Sensitivity, A and B	300 mV p-p (100 mV rms sine wave)	150 mV p-p (50 mV rms sine wave) below 150 MHz. 300 mV p-p (100 mV rms sine wave) from 150 to 225 MHz
Impedance, A and B	1 MΩ paralleled by 20 pF	1 MΩ paralleled by 24 pF
Triggering Level, A and B	Adjustable ±1.5 V In X1 attenuator position	Adjustable ±2.0 V in X1 attenuator position
Max Safe Input, A and B	500 V (dc + peak ac, or p-p ac) ≤ 1 kHz	50 V (dc + peak ac, or p-p ac) in X1 attenuator position. 250 V (dc + peak ac, or p-p ac) ≤ 1 kHz in X20 attenuator position
Attenuation, A and B	X1, X10, X100	X1, X20
STANDARD AND OPTION 1 TIME BASE SPECIFICATIONS	Same as DC 501/DC 502 (except, no FCC Type approval)	
REAR INPUTS	Same as DC 501	
REAR OUTPUTS	Same as DC 501/DC 502	
CALCULATOR INTERFACE	Same as DC 501/DC 502	

NOTES:

$* = \left(\frac{0.01\text{ V}}{\text{dv/dt of triggering edge}}\right) / \sqrt{N}$

$** = \left(\frac{0.1\text{ V}}{\text{dv/dt stop edge}}\right) \pm \left(\frac{0.01\text{ V}}{\text{dv/dt start edge}}\right) / \sqrt{N}$

***Input amplifier slew rate of 10 ns/volt will produce additional error in

(1) Time A → B mode if A and B level controls are not set for corresponding points on waveforms.

(2) Width B and Events A during B modes if B level control is not set at 50% of input pulse height.

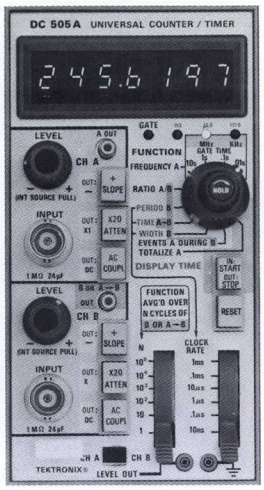
$\dagger = \left(\frac{0.01\text{ V}}{\text{dv/dt triggering edge}}\right) / N$

NOTE 1: Accuracies with averaging are dependent on the laws of statistics in Time A → B, Width B, and Events A during B modes.

SPECIAL FEATURES

A Out: Shaped output, after LEVEL and SLOPE selection, of signal into CH A. This output represents what goes into the display of FREQ A, RATIO A/B, and TOTALIZE A. Propagation delay from CH A INPUT to A OUT is ≈ 15 ns.

B or A→B Out: Shaped output, after LEVEL and SLOPE selection, of either CH B signal or A→B signal. This output represents the continuous signal used in generating the display gating for RATIO A/B, PERIOD B, TIME A→B, WIDTH B, and EVENTS A DURING B. Logic levels out are the same as for A OUT. Propagation delays from the channel INPUTS to B or A→B OUT are ≈ 15 ns.



DC 505A

Dc Trigger Level Output for Accurate Setting with Companion DMM

Direct Counting to 225 MHz

10 Nanosecond Clock Rate

Time Interval Averaging with Resolution to 100 Picoseconds

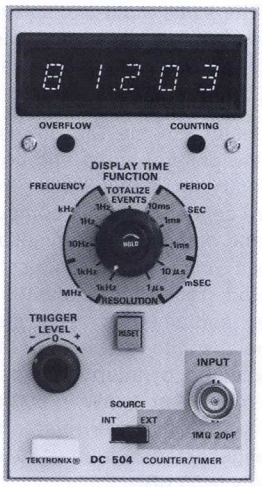
Two Equal Bandwidth Channels for Time Measurements on Narrow Pulses

Events A during B

The DC 505A is a high-performance Universal Counter featuring direct counting to 225 MHz. Both channels, A and B, have equal response for ratio, time interval, and other measurements requiring two channels. This new "A" version provides dc trigger level output both at the front-panel jack and rear interface connector. Any TM 500 Digital Multimeter may be connected via the rear interface to read the DC 505A trigger level setting when the DMM input switch is pushed to the INT position. Alternately, an external voltmeter or oscilloscope may be connected to the front-panel jack to perform this function. The DC 505A can perform virtually any counting-timing function below 225 MHz.

Various functions include conventional frequency operation on channel A, ratio of channel A to B frequency, period of signal B, time interval from channel A start to B stop, width B, events A during B, and totalize. An averaging feature allows measurements to be averaged from 1 to 10^5 times as selected by front-panel controls with the resultant average displayed on the LED readout. Averaging factor and clock rate are independently selectable. Pulse width may be measured directly with single shot resolution to 10 ns. By use of maximum averaging on width or interval measurements of repetitive waveforms, resolution to better than 100 picoseconds is possible. Typical application of the DC 505A is in the design, development, or maintenance of logic circuitry in high speed digital computers. It is a high-performance counter for state-of-the-art design and measurements up to 225 MHz.

DC 505A **$1395**
Option 1 (Time Base) . . . . . **add $150**
Option 4 (Calculator Interface) . . . . . **add $20**



DC 504

Direct Frequency Counting to 80 MHz

Period Measurement for Resolution at Low Frequency

Rpm Counting

5-Digit LED Display

Low Cost

The DC 504 Counter/Timer measures frequency from 0 Hz (with 0.1 Hz resolution) to 80 MHz, period from 1 microsecond to 999.99 seconds, and totalizes events from 0 to 99,999 at a maximum rate of at least 80 MHz. A resolution of 0.1 Hz can be obtained by allowing the more significant figures of the counter to overflow. Five 7-segment light-emitting diodes (LEDs) provide a visual numerical display. The decimal point is automatically positioned and leading zeros (to the left of the most significant digit or decimal point) are blanked. Digit overflow is indicated by a front-panel LED. Signals to be counted/timed can be applied to either a front-panel BNC connector or to the rear interface connector. Internal switches select frequency or rpm operation, internal time base or external standard, and override display storage.

Display — 5 digits, LEDs.

Display Accuracy — ±1 count ± time-base accuracy (± trigger error in period mode only).

Frequency (or rpm) — Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.

Frequency/rpm (Max Resolution) — kHz Positions: 0.1 Hz, 1 Hz, and 10 Hz (1 rpm, 10 rpm, and 100 rpm).* MHz Positions: 0.1 kHz and 1 kHz (1000 rpm and 10 k rpm).*

Sensitivity — 20 mV rms (56.6 mV p-p) below 15 MHz, 35 mV rms (99 mV p-p) at or below 50 MHz derating to typically <175 mV rms (495 mV p-p) at 80 MHz.

Triggering Level — Adjustable over at least −1.5 V to +1.5 V.

Trigger Source — Internal (rear connector interface) or external (front-panel BNC).

Max Voltage — 250 V (dc and peak ac) at 500 kHz or less.

Impedance — 1 MΩ paralleled by approx 20 pF.

Coupling — Dc or ac.

*Assuming transducer output is one pulse per revolution.

Internal Time Base

	Standard	Option 1
Crystal Frequency	1 MHz	5 MHz temperature compensated
Stability (0°C to 50°C) after ½ hour warm-up	Within 1 part 10^5	Within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Setability	Adjustable to within 1 part in 10^7	Adjustable to within 5 parts in 10^9

Totalize Events (Resolution) — 1

Period (Resolution) — m Sec Position: 1 μs and 10 μs. Sec Position: 0.1 ms, 1 ms, and 10 ms.

Display Time — Variable from about 0.1 s to about 10 s. Detent position at cw position of DISPLAY TIME knob provides a HOLD mode.

Data Inputs and Outputs — Available at plug-in connector for intra-compartment routing in any TM 500 Power Module/Mainframe. BCD serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

DC 504 Counter/Timer **$395**

Option 1 (Time Base) . . . . . **add $150**

The digital multimeter, with the capability of measuring voltage, resistance, and current, is the most widely used electronic test instrument employed today, with the possible exception of the oscilloscope. Modern digital techniques have vastly improved the resolution and accuracy of the traditional volt-ohm-milliammeter, simplified instrument use, and reduced the possibilities of human error. The TM 500 Digital Multimeter line consists of two general-purpose instruments, the DM 501 and DM 502 Digital Multimeters. In addition to the usual dc and ac voltage, resistance, and dc and ac current functions, both meters offer an optional temperature measurement function. Applying the tip of the optional temperature probe to a power transistor, integrated circuit, mechanical component, or any other surface provides an immediate digital readout of the surface temperature in degrees Centigrade or degrees Fahrenheit at the user's choice. The DM 502 further extends measurement capability by providing a standard decibel (dB) measurement feature across all ac ranges.

The DM 501 and 502 are similar instruments in many respects. Each measures dc voltage to 1000 volts (extendable to 40,000 volts with the addition of the optional high-voltage accessory probe), ac voltage to 500 volts, both dc and ac current to 2 amps, and resistance to 20 megohms. Optionally, both provide probe measurement of surface temperatures from −55°C to +150°C. The most significant differences lie in the dB capability of the DM 502, the 4½ digits of the DM 501 versus 3½ in the DM 502, and the floating bcd output of the DM 501 (for compatibility with the TEKTRONIX 31/53 Calculator Instrumentation System and other digital readout systems).

Since the DM 501 is a 4½ digit instrument, it can provide significantly more precise values than 3½ digit instruments, including the DM 502. At a given signal level, the 4½ digit instrument can supply 10X better resolution and conversely it can also measure 10X as large a signal at any given resolution level.

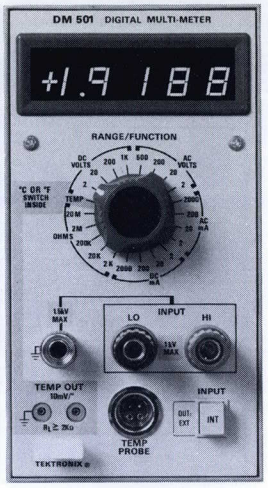
For example, an exact 2.000-volt signal must be measured on the 20-volt range on either instrument, since full scale on the nominal 2-volt range is actually 1.999 or 1.9999 volts. The specified possible error of the DM 502 (display 2.00) is ± 0.1% of reading ± 1 count, equal to ± 12 millivolts, or 0.6% of reading. The same input is displayed on the DM 501 as 2.000, and the possible error of ± 0.1% of reading ± 2 counts is 2.2 millivolts, or 0.11% — almost six times better.

The dB feature of the DM 502 is of great value in the general audio and communications industry: in mobile radio, microwave, telephone communication, computer time-sharing, and other applications of data transmission via voice links, broadcasting, high-fidelity and recording industries, sonar, acoustics, audiometrics, and many other fields. The absolute reference of the DM 502 may be selected, by internal jumper, as dBm (0 dB = 0.775 V or 1 mW in 600 Ω) or dBV (0 dB = 1 V). With either reference, the dynamic range extends from −60 dB to approximately +56 dB.

DIGITAL MULTIMETERS DM 501 AND DM 502 COMPARISON OF CHARACTERISTICS

The following is a comparison of the major characteristics of the DM 501 and DM 502. A complete set of specifications may be found on the following pages.

	DM 501	DM 502
Number of Digits	4½	3½
Dc Volts — full scale	2 V to 1 kV	0.2 V to 1 kV
Ac Volts — full scale	2 V to 500 V	0.2 V to 500 V
Dc Current — full scale	2 mA to 2 A	200 μA to 2 A
Ac Current — full scale		
Resistance — full scale	2 kΩ to 20 MΩ	200 Ω to 20 MΩ
Temperature Probe	Optional	Optional
dB	No	−60 dB to +56 dB
Bcd Output	Full Floating	Nonfloating
Input Impedance	10 M	10 M normal; FET input on 0.2 and 2 volt scales by internal jumper
Price	$450 to $575	$325 to $450



DM 501

0.1% Dc Voltage Accuracy

4½ Digit LED Display

Auto Polarity

Measures Volts, Current, Resistance, Temperature

Fully Isolated Serial Bcd Output

The DM 501 Digital Multimeter measures dc and ac voltage and current, resistance, and temperature. Dc voltage measurement accuracy is 0.1%. The ac functions are average responding and rms calibrated. A single front-panel control selects all functions and ranges. A pushbutton selects front-panel input or optional rear interface connector input. Temperature measurements are made using a TEKTRONIX P6058 Probe or other suitable sensing devices. Front-panel pin jacks provide external temperature readout, at 10 mV per degree, regardless of the position of the function switch. An internal switch selects calibration in degrees Centigrade or Fahrenheit. Readout is a 4½ digit stored display using seven segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch and leading zeros (those to the left of the decimal point or most significant digit) are blanked. Polarity indication is automatic. A blinking display indicates overrange. Serial bcd output is available at the rear interface connector.

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.

Common-Mode Rejection — ≥ 100 dB at dc, 80 dB at 60 Hz with 1 kΩ imbalance.

Step Response Time — <1 s.

Normal Mode Rejection — ≥30 dB at 60 Hz increasing 20 dB per decade.

Input R — 10 MΩ, constant.

AC VOLTAGE

Range — 2 V, 20 V, 200 V, and 500 V full scale (19999 max reading), average responding, rms calibrated.

Accuracy — Within 0.5% of reading ±2 counts from 40 Hz to 10 kHz; 1.0% of reading ±2 counts, 20 Hz to 20 kHz. Usable to 100 kHz. Typically <5% down between 0.4 V and 500 V at 100 kHz.

Resolution — 100 μV.

Response Time — <10 s.

Input R — 10 MΩ paralleled by <100 pF.

AC and 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 ±2 counts from 40 Hz to 1 kHz ±0.6% of reading, ±10 counts, 1 kHz to 10 kHz. Usable to 100 kHz.

Input R — $\frac{0.2\ V}{\text{Range Setting}} + 0.1\ \Omega$

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. The temperature probe functions regardless of the DM 501 mode and provides a front-panel analog signal output of 10 mV/° (into 2 kΩ or greater); thus temperature may be measured simultaneously with any other function. If temperature probe is not desired, order Option 1. If temperature capability is not desired, order Option 2; note: capability cannot be restored at a later date.

Accuracy — Within 1.5°C (2.7°F) from −55°C to +125°C and within 2.5°C (4.5°F) from −55°C to +150°C.

Resolution — 0.1°.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 5 measurements/second.

Max Input Voltage — 1 kV. The front-panel HI and LO connectors may be floated 1.5 kV max above ground, the rear inputs 350 V max. Current measuring functions are fused at 3 A. Ohms ranges are fused at 1/16 A.

Ambient Temperature — Performance characteristics are valid over a temperature range of +15°C to +40°C.

Standard Accessories — 1 Pair Test Leads (003-0120-00), 1 P6058 Temp Probe (010-0259-00).

ORDERING INFORMATION

DM 501 Digital Multimeter **$575**

Option 1 without Temp Probe (P6058) . . . . . **Sub $ 95**

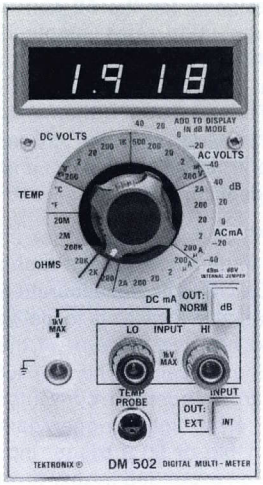
Option 2 without Temp Capability and Probe . . . . . **Sub $125**

Optional Accessories — Deluxe test lead with accessories including push-on spring-loaded hook tip and special IC package tip, high flexibility wire, red, 4 ft.
Order (012-0426-00) **$6.50**

As above except black.
Order (012-0426-01) **$6.50**

Test lead with alligator clip, 4 ft, black.
Order (012-0425-00) **$4.20**

High Voltage Probe to 40 kV
Order (010-0277-00) **$55**



DM 502

Selectable dB Readout

Six Functions Including Temperature and dB

0.1% Dc Voltage Accuracy

Auto Polarity

dB Readings from −60 dB to +56 dB

The DM 502 Digital Multimeter measures dc and ac voltage and current, dBm, dBV, resistance, and temperature. The ac functions are average responding and rms calibrated. A single front-panel control selects all ranges. Front-panel pushbuttons select dB readout of ac functions in lieu of ac voltage or current and front-panel or rear interface connector input. dB is obtained by adding the selected dB scale value to the display reading. Readout in dBm or dBV is chosen by an internal jumper. An internal jumper also permits selection of FET input (>1000 MΩ) or 10 MΩ input impedance on the two lowest dc voltage ranges.

The readout is a 3½ digit display using seven-segment LEDs. The decimal point is automatically positioned by the RANGE/FUNCTION switch. Polarity indication is automatic. Maximum display at stated accuracy is 1999.

Nonfloating bcd output (referenced to the low input), is available at the rear interface connector if user wired.

DC VOLTAGE

Range — 0.2 V, 2 V, 20 V, 200 V, 1000 V.

Accuracy — Within ±0.1% of reading, ±1 count.

Common-Mode Rejection — ≥100 dB at dc, ≥80 dB at 50 or 60 Hz with 1 kΩ imbalance.

Normal-Mode Rejection — ≥80 dB at 50 or 60 Hz.

Step Response Time — ≤0.5 s.

Input R — 10 MΩ (jumper selectable for >1000 MΩ on 0.2 V and 2 V ranges).

AC VOLTAGE

Voltage Range — 0.2 V, 2 V, 20 V, 200 V, 500 V.

Accuracy — Within ±0.5% of reading, ±1 count, 40 Hz to 10 kHz. ±1.0% of reading, ±1 count, 20 Hz to 20 kHz. Usable to 100 kHz. Typically <10% down between 40 mV and 500 V at 100 kHz.

Response Time — ≤5 s.

Common-Mode Rejection — ≥60 dB at 50 or 60 Hz.

Input R — 10 MΩ paralleled by less than 60 pF.

dB VOLTS AND CURRENT

Scales — +40, +20, 0, −20, −40 dB. Reference is dBV (1 V) or dBm (1 mW dissipated in 600 Ω, 0.7746 V), selected by internal jumper.

Display — ±19.99 dB on any scale, except that the total dynamic range is limited to the range −60 dB to approx +56 dB by a 500 V max input specification.

Accuracy

Display Reading	Frequency Range	Max Error
0 to +19.99	20 Hz to 20 kHz	0.5 dB
0 to −10.00	20 Hz to 2 kHz	0.5 dB
	2 kHz to 20 kHz	1.0 dB
−10.00 to −19.99	20 Hz to 2 kHz	0.5 dB
	2 kHz to 7.5 kHz	1.0 dB
	7.5 kHz to 20 kHz	2.0 dB

Response Time — ≤5 s.

Common-Mode Rejection — ≥60 dB at 50 or 60 Hz.

RESISTANCE

Ranges — 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

Accuracy — 200 Ω range, 0.5%, ±1 count, +0.1 Ω; 2 kΩ through 2 MΩ range, ±0.5%, ±1 count; 20 MΩ range, 1.0%, ±1 count.

Response Time — ≤0.5 s; 20 MΩ range, ≤5 s.

Max Output Current and Voltage — 1 mA max; approx 12 V max.

AC & DC CURRENT

Ranges — 200 μA, 2 mA, 20 mA, 200 mA, 2 A.

Accuracy — Dc current 0.2% of reading ±1 count; ac current 0.6% of reading ±1 count 40 Hz to 10 kHz.

Response Time — DC ≤0.5 s; ac ≤5 s.

Input Impedance — $\frac{0.2\ V}{\text{Range Setting}} + 0.1\ \Omega$ (<2 kΩ with 200 μA range)

TEMPERATURE MEASUREMENT

Ranges — Centigrade: −55°C to +150°C. Fahrenheit: −67°F to +200°F.

Accuracy — With probe shipped with instrument ±2°C (±3.6°F). With any P6430 probe prior to calibration with instrument, ±8°C (±14.4°F).

The temperature probe functions in all other modes in °C with analog signal out of 10 mV/° at rear interconnect.

OTHER CHARACTERISTICS

Overrange Indication — Blinking display.

Measurement Rate — 3.33 per second.

Inputs — The max input voltage is 1 kV. The front-panel HI and LO connectors may be floated 1 kV max above ground, the rear inputs 350 V. Current measuring functions are fused at 2.5 A. Ohms functions protected to 120 V rms indefinitely, 250 V rms ½ hour.

Ambient Temperature — Performance characteristics are valid over a temperature range of +15°C to +40°C.

Standard Accessories — 1 pair Test Leads (003-0120-00), 1 P6430 Temp Probe (010-6430-00).

ORDERING INFORMATION

DM 502 Digital Multimeter **$450**

Option 2 without Temp Capability and Probe . . . . . **Sub $125**

Optional Accessories — Deluxe test lead with accessories including push-on spring-loaded hook tip and special IC package tip, high flexibility wire, red, 4 ft.
Order (012-0426-00) **$6.50**

As above except black.
Order (012-0426-01) **$6.50**

Test lead with alligator clip, 4 ft, black.
Order (012-0425-00) **$4.20**

High Voltage Probe to 40 kV
Order (010-0277-00) **$55**

During the recent dynamic growth of digital logic and computers, the pulse generator, long a valuable signal source, has acquired added importance. Pulse generators are especially useful for testing response of wideband systems and for simulating signals from a variety of devices. Pulse generators are also used to provide stimulus to living tissue in physiological and biological research. In addition they are used to drive lasers, simulate data transmission signals, test switching speeds of active devices or memory elements, and for a wide variety of other functions.

The TM 500 line consists of four general-purpose pulse generator modules and a specialized generator. The specialized generator, the PG 506, is intended primarily for oscilloscope calibration. The PG 501 and PG 502 are designed for the 50 ohm systems, and have repetition rates, amplitudes, and transition times compatible with the common digital integrated-circuit families such as TTL, DTL, and ECL. Furthermore, the PG 502, with 250 MHz repetition rate and independent control of the pulse top and bottom levels, is ideal for ECL design and testing.

The new PG 508 is designed for both 50 Ω and higher impedance circuits such as MOS, HTL, and CMOS logic. Its accurate 50 Ω output impedance allows you to deliver clean signals into reactive loads or at the end of an unterminated cable. The PG 508 sets a new standard in operator convenience with its control error light, trigger/gated light, selectable 1 MΩ or 50 Ω trigger input impedance, and an expanded trigger level range.

PULSE GENERATORS — COMPARISON OF CHARACTERISTICS

The following is a comparison of the main characteristics of the PG 501, PG 502, PG 505, and PG 508. A complete list of specifications appears on the following pages.

	PG 501	PG 502	PG 505	PG 508
Rep Rate Range	5 Hz to 50 MHz	10 Hz to 250 MHz	1 Hz to 100 kHz	5 Hz to 50 MHz
Pulse Width Range	10 ns to 100 ms	2 ns to 50 ms	5 μs to 0.5 s	10 ns to 100 ms
$T_r + T_F$	Fixed, ≤ 3.5 ns	Fixed, ≤ 1.0 ns	Variable, ≤ 1 μs to ≥ 20 ms	Variable, 5 ns to 50 ms
Maximum Amplitude	±5 volts across 50 Ω	5 volts in a ±5 V window across 50 Ω	80 volts behind 4 kΩ	20 volts in a ±20 volt window to Hi Z, 10 volts in a ±10 V window to 50 Ω
Output Controls	Independent Amplitude Controls for + and — outputs	Independent pulse top and pulse bottom, complement switch	Amplitude, inversion switch	Independent pulse top and pulse bottom, complement switch
External Trigger and Ext Duration (width)	+1 V, + Slope 50 Ω input Z	+1 V, + Slope 50 Ω input Z	+0.5 V to +10 V, + Slope 10 kΩ input Z	—3 V to +3 V, + or — Slope, 1 MΩ or 50 Ω input Z
Other	Simultaneous Pos and neg outputs, output LOCKED ON mode	Manual trig, Square-wave Mode, selectable internal 50 Ω Reverse Termination	Delay anywhere along 10-volt input ramp, custom timing positions	10 ns to 100 ms delay, double pulse, three-state trigger/gate light, control error light, manual trigger, manual gate, true 50 Ω output Z, custom timing positions, counted pulse burst with DD 501.
Price	**$395**	**$1295**	**$395**	**$1100**

PG 508 Pulse Generator

5 Hz to 50 MHz Plus Custom Range

Independently Variable Rise and Fall Times

Delay and Double Pulse Capability

20 V Output in a ±20 V Window to Hi Z, 10 V to 50 Ω

Independent Pulse Top and Bottom Level Controls

True 50 Ω Output Impedance for Clean Waveforms

Control Error Light Warns of Improperly Set Switch or Variable Controls

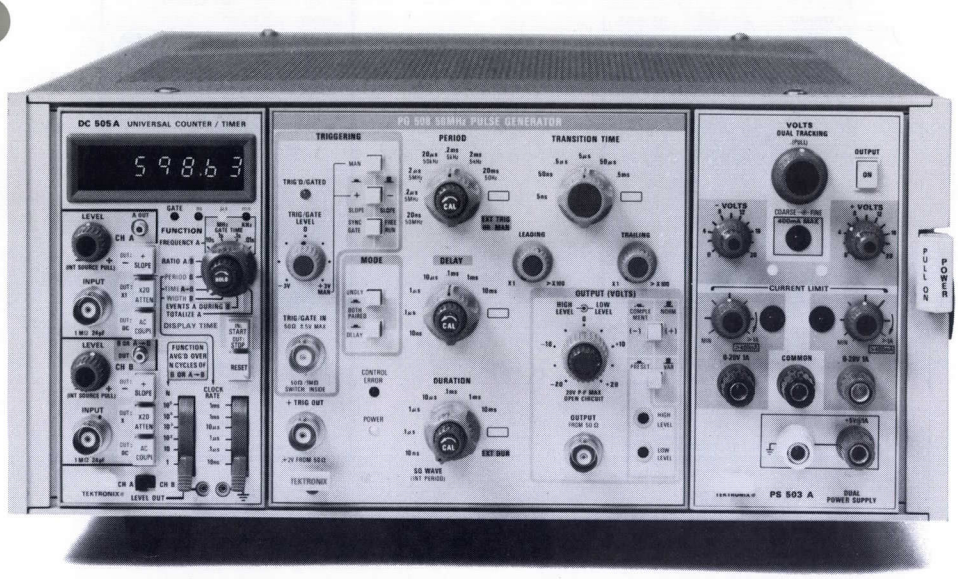
3-State Trigger Light Indicates Proper External Triggering

Selectable 1 MΩ Trigger Input Impedance for Optimum Match to Circuitry — Lets You Use Your Scope Probe

The PG 508 is a high performance 50 MHz pulse generator that occupies two compartments of the TM 500 Series Power Module/Mainframes. While it is primarily intended to be a highly versatile general-purpose pulse generator, it is ideally suited for logic circuit design in MOS, CMOS, TTL, and ECL within the 50 MHz range of the instrument. Its broad ranges of output period, delay, duration, transition times... and its output up to 20 V p-p offer you benefits equalled by few other pulse generators on the market. But when you consider its selectable 1 megohm/50 Ω trigger input impedance, control error light, 3-state trigger/gate light, preset or external control of output voltage levels, and capability of interfacing with other TM 500 Instruments, none surpass the PG 508.

The PG 508 is the only pulse generator on the market with the convenience of preset or external tracking of the output voltage levels. A simple push of the preset button changes the output from variable top and bottom level controls to front panel screwdriver adjustments. Preset can also be used to track external supply voltages. This feature helps avoid the time spent in repeated setup of commonly used voltage levels and also avoids accidental changes in output. Most CMOS logic circuits, for example, can withstand only 0.3 V more input than the supply voltage. The PG 508 is truly designed to help you in your applications. A touch of a button complements the output voltage allowing an effective duty cycle range approaching 100%.

Although the PG 508 is a sophisticated instrument, the planning apparent in its selected control functions, and in the front panel itself, greatly simplifies its use and reduces the chance of error in setup. A control error light indicates improper switch or variable control settings, such as a pulse



DURATION setting greater than pulse PERIOD or excessive delay or transition times.

Independent rise and fall time controls allow the PG 508 user to have up to a 100:1 difference in rise and fall times. Rise and fall times are also not affected by changes in output amplitude levels. The square-wave mode reduces knob twisting when you want to vary the repetition rate over a wide range on test analog circuits.

A unique arrangement of gating, slope, and manual controls allows you to gate the PG 508 on with a positive or negative going signal, or manually gate the instrument on or off by pressing the MAN button. In addition, with the DD 501 you can "dial up" a predetermined number of pulses in a burst from the PG 508. And the MANUAL button and MAN position in PERIOD let you add to that number, one by one. This is particularly valuable for simulating data of a given number of bits, or for checking logic circuitry where a suspected malfunction occurs at a specific number.

With the trigger input switched (internally) to 1 megohm impedance, you can "poke" into the circuitry under test using a 1X or 10X scope probe to trigger the PG 508 just as you would your favorite triggered sweep oscilloscope. In the external duration mode, the PG 508 can be used as a pulse regenerator, logic level translator, or sine wave to pulse converter. With the trigger level adjusted for the appropriate input signal, the output is set for the level of signal desired. The PG 508 provides the output to drive MOS, CMOS, DTL, HTL, I^2L, T^2L, or ECL. Its range of transition time control lets you create a signal accurately duplicating actual circuit drive observed in circuits under evaluation. Its high trigger input impedance makes it the only pulse generator on the market at this writing that can convert from MOS or CMOS logic levels to other logic families.

While the PG 508 is particularly attractive to the logic world, the independent output level controls, external trigger, delay, and double pulse capability make it extremely useful in radar, laser, rf switching, and signal processing applications.

Pulse Period — $\leq$ 20 ns to $\geq$ 200 ms in seven decade steps plus variable, with overlap on all ranges. Periods longer than 200 ms can be obtained in custom range position. Jitter: $<$ 0.1% + 50 ps.

Pulse Delay — (time between leading transitions in the paired pulse mode) $\leq$ 10 ns to $\geq$ 10 ms in seven decade steps plus variable, with overlap on all ranges. Delays longer than 100 ms can be obtained in custom range position. Duty Factor: delays to at least 70% of pulse periods for periods of 0.2 μs or greater, decreasing to at least 50% for a 20 ns period. Jitter: $\leq$ 0.1% + 50 ps.

Pulse Duration — $\leq$ 10 ns to $\geq$ 100 ms in seven decade steps plus variable, with overlap on all ranges. Durations longer than 100 ms can be obtained in custom range position. An additional position provides durations of approx 50% of the period setting for square wave output. Duty Factor: pulse durations to at least 70% of pulse periods for periods of $\geq$ 0.2 μs, decreasing to at least 50% for a 20 ns period. Jitter: $\leq$ 0.1% + 50 ps.

Pulse Transition Times — Independently adjustable leading and trailing transition times from $<$ 5 ns typical ($<$ 7 ns at some offset and amplitude levels) to $\geq$ 50 ms, measured from the 10% point to the 90% point in six decade steps plus variable. Variable controls with 100:1 range (50:1 on 5 ns) provide overlap on all ranges. Transition times longer than 50 ms are obtainable in the custom range position.

Pulse-Transition Linearity — Deviation from straight line $\leq$ 5% between the 10% and the 90% point for transition times greater than 10 ns.

Pulse Amplitude — Pulse high and low levels independently adjustable over a $\pm$20 V range from a 50 Ω low reactance source. Max pulse amplitude into a 50 Ω load is $\geq$ 10 V p-p; minimum is $\leq$ 0.5 V p-p. Max pulse amplitude into an open circuit is $\geq$ 20 V p-p; minimum is $\leq$ 1.0 V p-p. The preset level controls are adjustable over the same ranges.

Pulse Aberrations — $\leq$ 5%, + 50 mV p-p for pulse levels between + and — 5 volts into a 50 Ω load. May increase to $\leq$ 10%, +50 mV p-p for pulse levels outside this range.

Trigger Output — Amplitude $\geq$ + 2 V from 50 Ω. Source Impedance: 50 Ω. Duty Cycle: Internal Triggering: $\simeq$ 50%. External Triggering: determined by duty cycle of triggering signal.

Trigger/Gate Input Sensitivity — 80 mV p-p to $\leq$ 10 MHz; 250 mV p-p to 50 MHz at 50 Ω input impedance. Input Impedance: internally selected, 50 Ω or 1 MΩ paralleled by $\simeq$ 20 pF. Max input: $\pm$5 V peak into 50 Ω, $\pm$20 V peak into 1 MΩ.

Minimum Input Pulse Width — 10 ns. Trigger Level: Polarity: front panel selectable, + or — slope. Range: $\pm$3 V.

Trig'd Gated Light — Flashing: input triggered at greater than approx a 10 Hz repetition rate or following the input signal at slower repetition rates. On: (Logic True) TRIG/GATE IN input potential above TRIG/GATE LEVEL setting with + SLOPE selected or below TRIG/GATE LEVEL setting with — SLOPE selected. Off: (Logic False) TRIG/GATE IN input potential below TRIG/GATE LEVEL with + SLOPE selected or above TRIG/GATE LEVEL with — SLOPE selected.

Synchronous Gate — Rate generator starts synchronously with external gating signal and completes the last output pulse.

Pulse Delay Modes—Undelayed, delayed, and paired. Paired pulse mode limited to 25 MHz. Minimum pulse separation governed by duration duty factor specification.

Fixed Delays — Trigger Out to Pulse Out: $\simeq$ 23 ns. Gate Input to Trigger Out: $\simeq$ 25 ns.

Control Error Light — Steady On: indicates invalid operating mode, output is undefined. Flashing: timing control settings selected do not properly define the output pulse because valid limits have been exceeded. Steady Off: indicates valid operation for most control settings.

Counted Burst (with DD 501) — Max PG 508 repetition rate for exact count: 20 MHz. Usable to 50 MHz. Minimum between bursts: 100 ns.

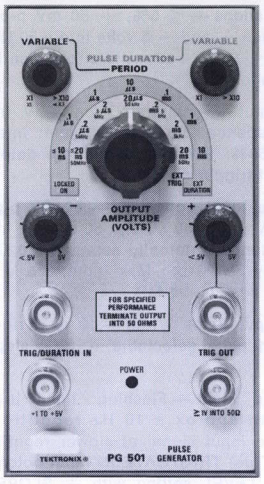
ORDERING INFORMATION

PG 508 50 MHz Pulse Generator **$1100**

PG 508T 50 MHz Pulse Generator **$1250**
(includes PG 508, TM 503 Mainframe, and 016-0195-01 blank panel)

For Counted Burst, order the
DD 501 Digital Delay (page 157) **$625**

Suggested 10 in BNC 50 Ω cable (2 req) for interconnecting PG 508 and DD 501:
012-0208-00 . . . . . **$10.00**



PG 501

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 Rise Time and Fall Time — 3.5 ns or less.

Aberrations — With 3.5% at 5 V amplitude.

Pulse Amplitude — 0.5 V or less to at least 5 V into 50 Ω load.

Pulse Coincidence (+ and − outputs) — Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output — At least +1 V into 50-Ω load, occurring approx 8 ns prior to pulse output. Duty cycle ≃ 50% when using internal period.

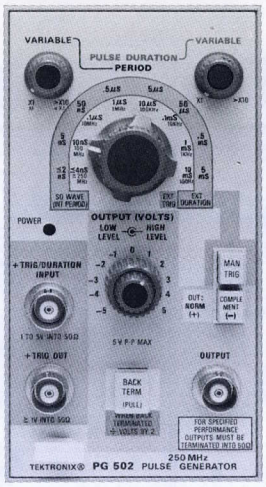
External Trigger/Duration Input — At least +1 not to exceed +5 V (dc + peak ac). Trigger/Duration recognition level, + 1 V or less. Trigger/Duration reset level, +100 mV or less. Minimum on and off time is 10 ns. 50 Ω input impedance.

PG 501 Pulse Generator **$395**

MANUAL (ONE-SHOT) TRIGGER GENERATOR

The Manual (one-shot) Trigger Generator is used for manually initiating a pulse or complete train of events with instruments which do not have a manual trigger button or where a remote operation capability is desired, such as with some oscilloscopes and the PG 501, PG 505, and RG 501.

Order 016-0597-00 . . . . . **$35**



PG 502

10 Hz to 250 MHz

1 ns Rise Time

5 V Output, ±5 V Window

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Termination

Manual Trigger Button

The PG 502 (250-MHz Pulse Generator) features: fast rise and fall time; independent top and bottom pulse levels; and adjustable pulse duration. The fast rep rate makes the instrument ideal for design and testing of fast logic and switching circuits.

Pulse Period — 4 ns or less to 10 ms (within 5% in calibrated positions except 15% on 10 ms range) in decade steps. Continuously variable between steps and to at least 100 ms.

Pulse Duration — 2 ns or less to 5 ms (within 5% in calibrated positions except 15% on 5 ms range) in decade steps. Continuously variable between steps and to at least 50 ms. Square-wave mode approx 50% duty factor.

Duty Factor — At least 50% in normal mode, approx 100% in complement mode. Minimum off time is 2 ns.

Pulse Rise Time and Fall Time — Less than 1 ns.

Aberrations — Within ±5% at 5 V p-p amplitude, except negative transition aberrations may exceed 5% for durations less than 5 ns.

Pulse Top Flatness — Within 2%, beginning 10 ns after transition.

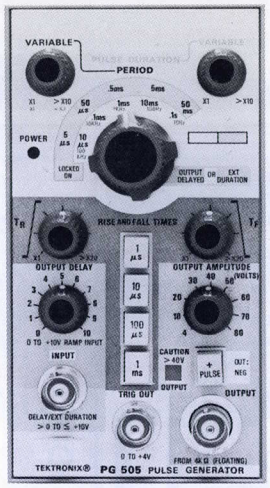
Pulse Amplitude — Pulse high and low levels independently adjustable over a −5 to +5 V range, with pulse amplitude limited between ≥0.5 V and ≤5 V. Complement switch inverts pulse between same two selected voltage levels. Front-panel selectable 50 Ω internal back termination divides output levels by two.

Offset — ±5 V max, depends on amplitude setting.

Trigger Output — At least 1 V into 50 Ω, occurring approx 10 ns prior to pulse output. Duty cycle ≃ 50% when using internal period.

External Trigger/Duration Input — Trigger threshold less than 1 V; reset threshold greater than 0.1 V; max input 5 V. 50 Ω input impedance.

PG 502 Pulse Generator **$1295**



PG 505

1 Hz to 100 kHz

Independently Variable Duration and Period

80 V Output

Variable Rise Time and Fall Time

Delay Mode

The PG 505 Pulse Generator features: floating output; independently adjustable rise and fall times; external control of period or period and duration. A special position on the pulse period and pulse duration controls allows addition of an internal capacitor to custom-select pulse period and duration. When driven from an externally supplied 0 to 10 volt ramp, the delay control of the PG 505 permits the output pulse to occur at any selected voltage point on the ramp, thus providing controllable time delay to any set time along the ramp.

Pulse Period — 10 μs or less to 100 ms (within 5%) in decade steps. Continuously variable between steps and to at least 1 s.

Pulse Duration — 5 μs or less to 50 ms (5 μs to 5 ms within 5%, 50 ms within 20%) in decade steps. Continuously variable between steps and to at least 0.5 s.

Duty Factor — (pulse duration/pulse period), 0 to 100%.

Pulse Rise Time and Fall Time — 1 μs or less to 1 ms in decade steps with T_R or T_F controls set at (X1). T_R or T_F control extends time to at least 20 ms. Accurate within 5% with T_R or T_F set at (X1).

Aberrations — Within 5% at max p-p output into 4 kΩ, 20 pF load.

Pulse Amplitude — 4 V or less to at least 80 V from a 4 kΩ source. Polarity selectable for + or − output.

Isolation of Pulse from Ground — 200 V dc.

Trigger Output — 0 to +4 V into 50 Ω.

External Trigger/Duration Input — Accepts TTL level signals.

Delay Mode — Delay range (with respect to delay signal) 0 to 10 V within 5%.

PG 505 Pulse Generator **$395**

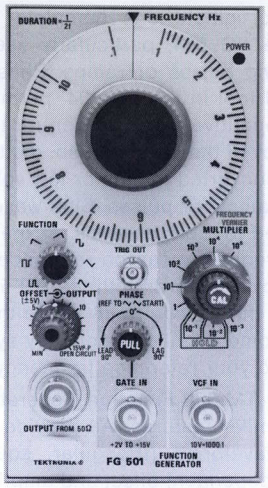
The function generator is one of the most rapidly growing types of signal sources due to its extreme versatility and reasonable cost. It provides a variety of waveshapes, including triangular, square, sine, and, in some cases, pulses and ramps. Triangular waveforms, used in conjunction with oscilloscopes, determine the overload (clipping) point of amplifiers. Square waveforms simultaneously reveal low frequency response (by sag), high frequency response (by rise time), and transient response (by ringing and other aberrations) of amplifiers. Sine waves, universal in the electronics industry, show the full frequency response of various devices. Further, pulses and square waves are used as clock and signal sources in logic circuitry. Ramps and triangles provide time bases for oscilloscopes and paper recorders, and test signals for voltage comparators. The high frequency coverage of modern function generators extends into the audio, video, and radio spectra, and is useful in the telecommunications field as a modulation signal source. Their extreme low frequency range is useful in biological and geophysical simulations, servo systems, mechanical testing and simulations, and other applications. Built-in sweep in the FG 504 or an external ramp applied to the vcf (Voltage Controlled Frequency) input of any TEKTRONIX Function Generator permits the function generator to act as a sweep generator. A full 1000:1 sweep frequency range on TEKTRONIX Function Generators provides convenient testing of broad band amplifiers from subaudio to 40 MHz. Also, the same vcf input, fed from a low-level modulating signal, provides a frequency-modulated carrier. Logarithmic sweep, available in the FG 504, is especially useful when sweeping wide (100:1 or greater) frequency ranges. It spreads out the lower octaves, reduces the time necessary to sweep the full range, and makes Bode plots or graphs easier to read. The gate or burst feature is useful in testing tone-controlled systems, loud-speaker transient response characteristics, and Automatic Gain Control circuits. The FG 501 and FG 504 provide control over the starting phase of the output waveform in the burst mode.

External trigger in the FG 504 allows your signal to initiate one complete waveform from the FG 504, particularly useful when generating pulses or ramps. Phase lock, a powerful tool in the FG 504, permits an external repetitive signal to control the output frequency of the FG 504. Also, digital signals can be converted to high or low voltage sine waves, ramps, or pulses. Sine waves can be converted to digital signals, or the FG 504's output frequency can be referenced to your frequency standard. With the DD 501 Digital Delay in the "divide by n" mode the FG 504 can become a limited frequency synthesizer locked to your reference frequency.

The four TM 500 Function Generators share many similar features. All provide the three basic waveforms (triangular, square, and sine), independent offset and amplitude controls, and a vcf or sweep capability with up to 1000:1 range. The FG 504 provides the highest output frequency and amplitude of the four instruments. Further, the FG 503 and FG 504 feature a custom position on the range switch. The FG 504 is shipped with a capacitor in the custom position, providing 20 Hz to 20 kHz in one range.

	FG 501	FG 502	FG 503	FG 504
Waveforms	Sine, Square, Triangle, Pulse, Ramp		Sine, Square, Triangle	Sine, Square, Triangle, Ramps & pulses with variable symmetry
Variable Symmetry	no	no	no	7% to 93% duty cycle
Frequency Range	0.001 Hz to 1 MHz	0.1 Hz to 11 MHz (pulse, ramp 1.1 MHz max)	1.0 Hz to 3 MHz (usable 0.01 Hz to 5 MHz)	0.001 Hz to 40 MHz 0.001 Hz to nominally 4 MHz with variable symmetry
Custom Frequency Range	no	no	With user-installed capacitor	Shipped with capacitor for 20 Hz to 20 kHz range
Amplitude Open Circuit	15 V p-p max	10 V p-p max	20 V p-p max	30 V p-p max
Into 50 Ω	7.5 V p-p max	5 V p-p max	10 V p-p max	15 V p-p max
Output Step Attenuator	no	no	no	0 to −50 dB in 10 dB steps
Offset	±5 V dc open circuit, ±2.5 V dc into 50 Ω load			±7.5 V dc open circuit, ±3.75 V dc into 50 ohms
Output Impedance	50 ohms			
Amplitude Flatness Sine Wave	±1.5 dB, 0.001 Hz-1 MHz ref 10 kHz	±1.5 dB, 0.1 Hz-11 MHz ref 10 kHz	±2 dB, 0.1 Hz to 3 MHz ref 10 kHz	±0.5 dB, 0.001 Hz to 40 kHz, ref 10 kHz ±2 dB, 40 kHz to 40 MHz, ref 10 kHz
Square, Triangle	±1 dB ref sine	±3 dB ref sine	±1 dB ref sine	Square wave ±0.5 dB to 20 MHz, ±2 dB to 40 MHz, ref 10 kHz
Frequency Stability	≤0.05% for 10 min, ≤0.1% for 1 hour, ≤0.5% for 24 hours			
Sine Wave Distortion	≤0.5% 1 Hz to 20 kHz ≤1.0% 20 kHz to 100 kHz ≤2.5% 100 kHz to 1 MHz	≤0.5% 10 Hz to 50 kHz ≤ −30 dB at all other frequencies	≤0.5% 1 Hz to 30 kHz ≤1.0% 30 kHz to 300 kHz ≤2.5% 300 kHz to 3 MHz	≤0.5% 20 Hz to 40 kHz ≤ −30 dB 40 kHz to 4 MHz ≤ −20 dB 4 MHz to 40 MHz
Square Wave Response	≤100 ns rise and fall ≤5% total aberrations	≤20 ns rise and fall ≤3% total aberrations	≤60 ns rise and fall ≤3% total aberrations	≤6 ns fixed 10 ns to 100 ms variable ≤5% + 30 mV aberrations
Triangle Linearity	Within 1% 0.001 Hz to 100 kHz Within 2% 100 kHz to 1 MHz	Within 1% 0.1 Hz to 100 kHz Within 3% 100 kHz to 1 MHz Within 5% 1 MHz to 11 MHz	Within 1% 1.0 Hz to 100 kHz Within 5% 100 kHz to 3.0 MHz	Within 1% 10 Hz to 400 kHz Within 5% 400 kHz to 40 MHz typ within 2% 0.001 Hz to 10 Hz
Voltage Controlled Frequency	1000:1 max with 0-10 V external signal Max input slew rate, ≥0.5 V/μs			Same except max input slew rate ≥ 0.3 V/μs
Burst/Gate	Input impedance, 1 kΩ. Control signal required +2 V; +15 V max. Bursts are synchronous with gate. Phase continuously variable from −90° to +90°.	Input impedance, 1 kΩ. Control signal required, +2 V; +15 V max. Bursts are synchronous with gate.	Not applicable	Input impedance ≥ 10 kΩ Trigger level +1 V to +10 V Sensitivity 1 V p-p Generator completes integral number of cycles ±80° phase control
Triggered Mode	no	no	no	Single waveform with external or manual trigger
Trigger Output	TTL compatible +2.5 V into 600 Ω	TTL compatible +2.5 V into 50 Ω	TTL compatible +2.5 V into 600 Ω	TTL compatible 0 to ≥ 2 V, 50 Ω Output Z
Phase Lock	no	no	no	50 Hz to 40 MHz
Internal Sweep	no	no	no	1000:1 frequency range Logarithmic or linear 0.1 ms to 100 second duration Separate start-stop frequency dials
Amplitude Modulation	no	no	no	100% with 10 V p-p input
Output Hold Mode	0.001 Hz to 10 Hz	no	no	0.001 Hz to 400 Hz
Price	**FG 501 . . . . . $450**	**FG 502 . . . . . $550**	**FG 503 . . . . . $375**	**FG 504 . . . . . $1200**

FG 501, FG 502, FG 503, and FG 504 Function Generators



FG 501

.001 Hz to 1 MHz

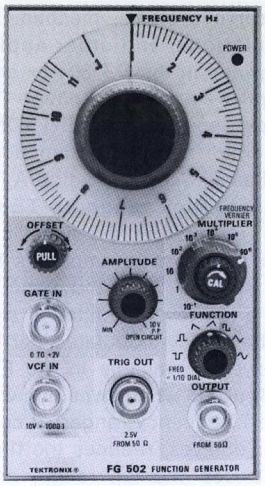
Five Waveforms

VCF and Gated Burst

Hold Mode

The FG 501 produces low distortion sine, square, triangle, pulse, and ramp waveforms from .001 Hz to 1 MHz. An external VCF input permits control of the output frequency from an external voltage source. Frequency sweep up to 1,000:1 ratio may be accomplished by applying a voltage ramp to the VCF input. A hold control allows the operation of the generator to be halted instantaneously at any point in its cycle. Release of the hold will then allow the operation to continue normally. A gate input is provided to allow "burst" or single cycle operation, with the phase of the generator output at the start of the burst controllable over a ±90° range. Output signal voltage is adjustable to 7.5 V p-p into a 50-ohm load, with dc offset also adjustable up to ±2.5 V.

FG 501 Function Generator.....$450



FG 502

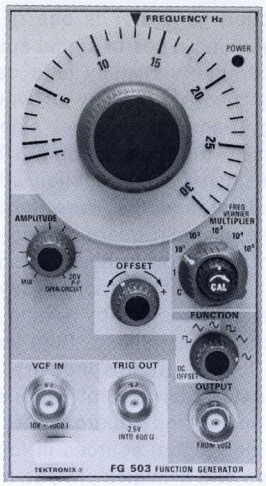
Five Waveforms

0.1 Hz to 11 MHz

VCF and Gated Burst

The FG 502 Function Generator provides low-distortion sine, square, and triangle waveforms, and positive or negative ramps and pulses. Output frequency is continuously variable from 0.1 Hz to 11 MHz. The high frequency range from 1 to 11 MHz permits the versatility of the function generator to be extended into the medium radio frequency range. Voltage controlled frequency input permits the FG 502 to be used as a sweep generator. The external gate input permits the FG 502 output in any of its modes to be controlled by an externally supplied pulse to generate bursts of various output waveforms. This feature has application in wireline or radio remote control equipment and in certain phases of the telephone industry.

FG 502 Function Generator.....$550



FG 503

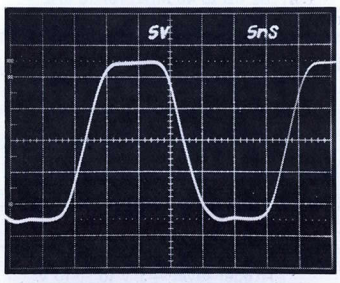
Three Waveforms

1.0 Hz to 3 MHz

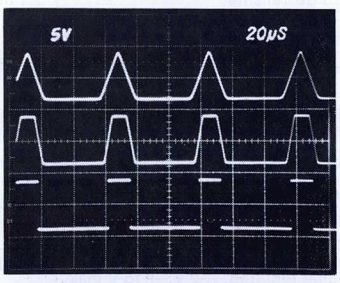
VCF

The FG 503 Function Generator provides high quality low distortion sine, square, and triangle waveforms. Six decade frequency multiplier steps, a custom position for user-determined frequency multiplication, a dial calibrated from 1.0 to 30 (uncalibrated from 0.1 to 1.0), and a frequency vernier control work together to select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1000:1 ratio by an external voltage. Output amplitude and offset controls are provided. A trigger output is available for controlling external devices or equipment. Amplitude up to 10 V p-p can be developed across a 50-ohm load (20 V p-p open circuit). Selectable offset up to 2.5 V dc across 50 ohms (5 V dc open circuit) is also featured.

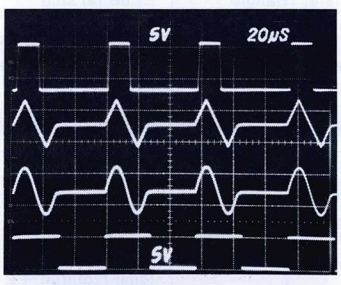
FG 503 Function Generator.....$375



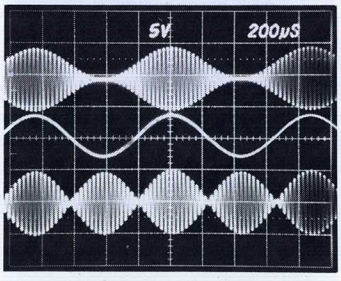
FG 504 30 volt output with 6 ns rise and fall times for superior pulse waveforms.



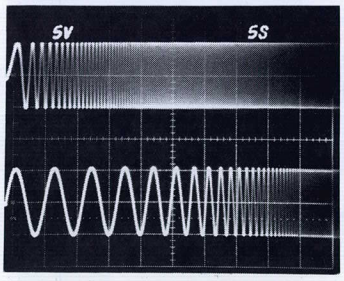
Variable rise and fall times increase pulse waveform flexibility.



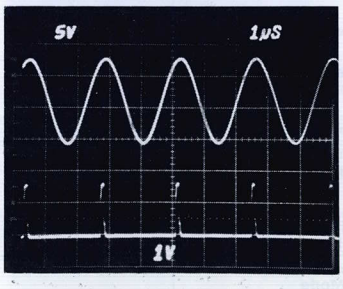
FG 504 completes one waveform when triggered from external signal on bottom trace.



True four quadrant multiplier permits normal AM or double sideband suppressed carrier modulation.



FG 504 both linear or logarithmic sweep available for a wide range of sweep applications.



Phase lock allows the FG 504 output (top trace) to lock to virtually any periodic input waveform.

FG 504 Function Generator

0.001 Hz to 40 MHz

Three Basic Waveforms, Plus a Wide Range of Shaping with Variable Rise and Fall and Symmetry Controls

Logarithmic or Linear Sweep

Separate Frequency Dials Set Lower (START) and Upper (STOP) Limits of Sweep

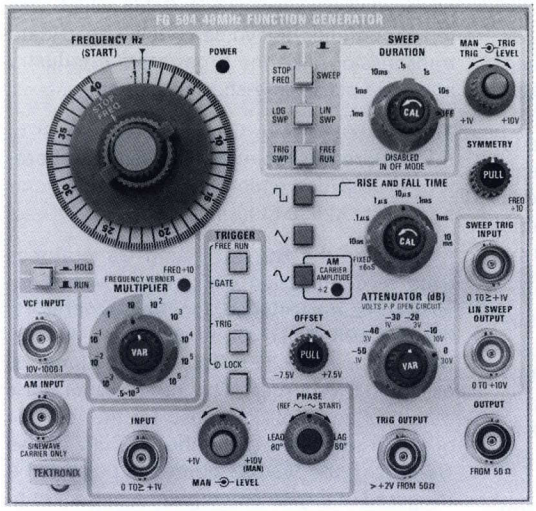
Up to 30 V p-p Output

Built-in Attenuator

Am and Fm

Phase Lock Mode

External and Manual Trigger or Gate



The FG 504 sets new standards in state-of-the-art performance and versatility for function generators. It provides low distortion sine, square, and triangle waveforms, plus waveform shaping through variable rise and fall times and symmetry controls for a greatly extended variety of waveforms. Its frequency range is from 0.001 Hz to 40 MHz in ten decades. An additional frequency range position is also provided for your convenience in routine or most often desired applications. This range is 20 Hz to 20 kHz when shipped from the factory. The frequency dial is a double knob that allows the START and STOP frequencies to be selected in swept frequency modes of operation. The START dial is calibrated from 1 to 40 with an uncalibrated range from 0.1 to 1.

The FG 504 can be swept from the START frequency dial setting to the STOP setting at either a linear or logarithmic rate.

The output of the FG 504 may be phase locked, gated, or triggered by a reference signal, letting you convert from one waveform to another, such as pulses to sine waves, as well as adjust phase relationships. Post attenuator offset enables use of the full ±7.5 V offset range with small signals. And the FG 504 output can be amplitude or frequency modulated by external signals.

The FG 504 also provides trigger output, external voltage control input, and sweep output. (Contact your Tektronix Field Engineer for a data sheet discussing FG 504 applications in detail.)

Note: FG 504 capabilities illustrated at left.

Frequency Range — Sine, Triangle and Square Waveforms: 0.001 Hz to 40 MHz calibrated range. Ramps, Pulses, or Waveforms requiring use of VARIABLE SYMMETRY control: 0.001 Hz to nominally 4 MHz. Multiplier switch has position for user — determined range by capacitor selection. Instrument shipped from factory with capacitor installed for 20 Hz to 20 kHz range.

Variable Symmetry — Duty Cycle Range: 7% to 93%. Actuation of VARIABLE SYMMETRY control divides output frequency by approx ten.

Output Amplitude — 30 V p-p into an open circuit, 15 V p-p into 50 Ω.

Offset Range — ±7.5 V into an open circuit, ±3.75 V into 50 Ω. Signal plus offset may not exceed peak output amplitude of ±15 V into an open circuit or ±7.5 V into 50 Ω. Offset defeatable by front panel control.

Output Attenuator — 0 to −50 dB in 10 dB steps. Accuracy ±0.5 dB/step. 20 dB variable extends minimum signal amplitude to 10 mV. See square wave aberrations specification.

Dial Range — 1 to 40 calibrated, 0.1 to 1 uncalibrated.

Dial Accuracy (+15°C to +35°C) — Start (Main) Dial: within ±3% of full scale from 0.001 Hz to 4 MHz. Within ±6% of full scale from 4 MHz to 40 MHz. Stop Frequency Dial: 5% of the difference between the start and stop frequencies plus the FREQUENCY Hz (START) dial error.

Sine Wave Harmonic Distortion (+15°C to +35°C) — ≤0.5% from 20 Hz to 40 kHz. Greatest harmonic at least 30 dB down from 40 kHz to 4 MHz and 20 dB down from 4 MHz to 40 MHz. Typically ≤1% from 0.001 Hz to 20 Hz. Output terminated in 50 Ω, zero offset, ≤30 dB attenuation and FREQUENCY Hz (START) dial set between 4 and 40.

Square Wave — Rise and fall time (FIXED): ≤6 ns. Aberrations: ≤5% p-p +30 mV into a 50 Ω load.

Variable Rise and Fall Time (Square and Pulse Waveforms) — Range: 10 ns to 100 ms in 7 steps plus variable measured from 10% to 90% points on waveform. Period of waveform must exceed combined rise and fall times by ≥20%.

Internal Sweep — Range: 1000:1 except 500:1 on the 10^6 MULTIPLIER range. Sweep Duration: 100 s to 0.1 ms in six decades. Variable control overlaps decades. Logarithmic Sweep: > three decades of frequency sweep except on the 10^6 MULTIPLIER range. Stop Frequency to Swept Stop Frequency Error: within 2% max from 100 s to 1 ms sweep duration. Within 10% max from 1 ms to 0.1 ms sweep duration. Linear Sweep Output: amplitude, 0 V to +10 V from 1 kΩ. Amplitude Accuracy, within ±5% from 100 s to 1 ms, within ±10% from 1 ms to 0.1 ms. Sweep Trigger Input: input sensitivity, 1 V p-p. Trigger level, 1 V through 10 V. Max input, +20 V. Manual Trigger: front panel control.

Amplitude Modulation Input — A 10 V p-p signal provides 100% modulation of a sine wave carrier from dc to 4 MHz with <5% distortion at 95% modulation when driven from a source impedance of 600 Ω. From 4 MHz to 40 MHz there is ≤10% distortion at 65% modulation. A modulating source impedance of ≤10 kΩ puts the FG 504 in the am mode automatically and reduces the unmodulated output amplitude by one half. Distortion specifications valid for modulating frequencies from 20 Hz to 20 kHz. Modulation frequency bandwidth is dc to 100 kHz.

External Trigger/Gate/Phase Lock Input — Input impedance: ≥10 kΩ. Sensitivity: 1 V p-p. Trigger level: +1 to +10 V. Max input amplitude: +20 V. Trigger mode: (for triggering a single cycle of main generator waveform) minimum period, 75 ns. Max triggered frequency, ≥20 MHz. Generator dial frequency must be higher than trigger input-frequency. Gate mode: (for gating multiple-cycle bursts of main generator waveform) minimum period, 75 ns. Max gated frequency, ≥20 MHz. Duration of gate determines number of output cycles with integral number of cycles completed. Phase lock mode: frequency range, 50 Hz to 40 MHz. Capture range, dial frequency ±10X FREQUENCY MULTIPLIER setting. Phase adjustment range, ±80° from 50 Hz to 4 MHz.

Manual Trigger/Gate — Available at front panel.

Trigger Output — 0 V to ≥ 2 V from 50 Ω.

FG 504 40 MHz Function Generator . . $1200

FG 504T 40 MHz Function Generator . . $1350
(includes FG 504, TM 503 Mainframe, and 016-0195-01 blank panel)

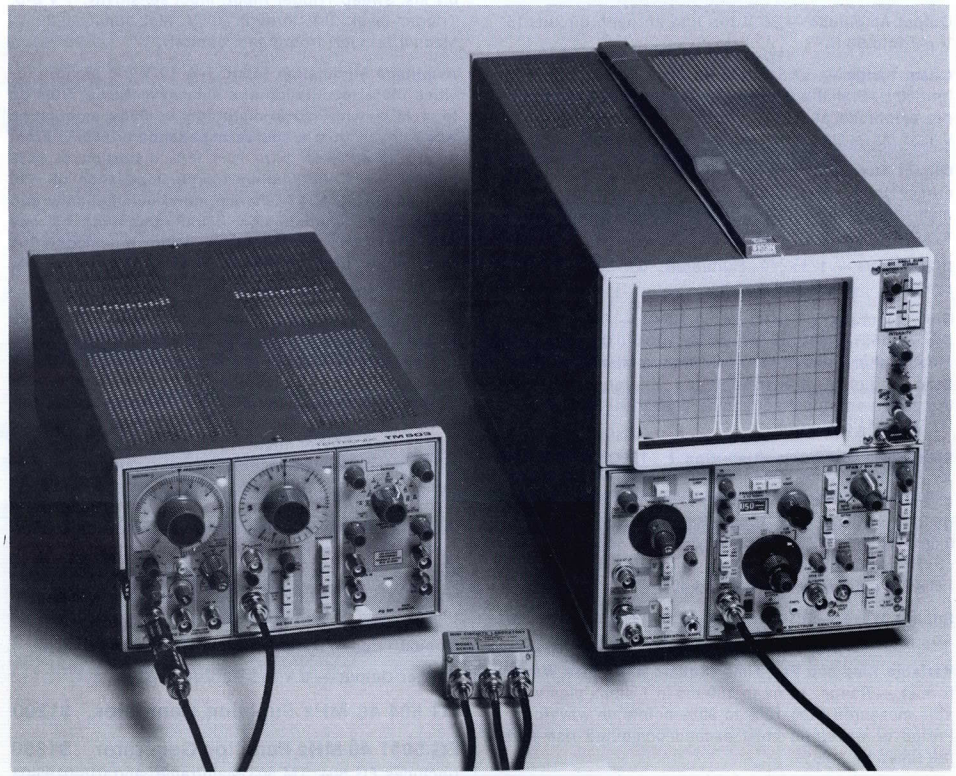
The Sweep, Audio, and Ramp Generators include the SG 502 Audio Oscillator, the SW 503 Sweep Generator, and the RG 501 Ramp Generator. The SG 502 Audio Oscillator features extremely low distortion and wide-range flat response for critical audio and communication systems and component testing. The RG 501 Ramp Generator provides single or repetitive ramps of controllable amplitude and duration, excellent linearity, and short retrace time.

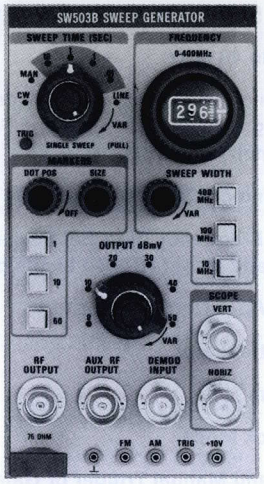
The SG 502 Oscillator is an RC design featuring distortion less than 0.035% over the entire audio range of 20 Hz to 50 kHz. Distortion does not exceed 0.1% over the balance of its 5 Hz to 500 kHz coverage. Output amplitude is flat with ±0.3 dB over the entire range. The output impedance is the 600 ohm audio industry standard. Amplitude control of 70 dB is available in 10 dB steps plus a 40 dB variable attenuator. A fixed-amplitude square wave is present simultaneously.

The SG 502 is used in various applications in conjunction with several other TM 500 instruments. One of these is the Audio Frequency Communications package, as discussed, where it and the DM 502 and DC 504 find ready application in telephonic communications, as well as in fields which use telephone lines for voice or low-speed data transmission, like the broadcasting industry and computer time-sharing industry.

The SW 503 Sweep Generator puts most of the features associated with larger laboratory-type sweep generators in a single compartment TM 500 Plug-in.

Frequently, the RG 501 Ramp Generator is used in conjunction with other TM 500 instruments; for instance, function generators, the PG 505 Pulse Generator, the MR 501 Monitor or other TEKTRONIX Crt Monitors, or an X-Y recorder. The ramp generator's output is an ideal time base for the monitor or recorder. Used with the PG 505 Pulse Generator, the RG 501 permits a pulse to be triggered at any selected point along a ramp: a single PG 505 and RG 501 can generate pulses delayed a controlled time following the RG 501 gate output and multiple PG 505s can be driven from one RG 501 to generate delayed pulse trains of almost any description. With any of the TM 500 Function Generators, where vcf (voltage controlled frequency) input is fed by the RG 501 output, a linear frequency sweep of up to 1000:1 width may be generated.





SW 503 Sweep Generator

1 to 400 MHz Range

1, 10, and 50 MHz Markers Built-in

Continuously Variable Dot Marker System

+10 dBm (+50 dBmV) Output

Remote Programming Capability

The SW 503 Sweep Generator covers a frequency range of 1 to 400 MHz. It has a variable sweep rate, step attenuator, 20 dB vernier attenuator, and a crystal controlled marker generator which provides comb type markers at 1, 10, and 50 MHz.

A unique feature of the SW 503 when used in conjunction with a DC 502 Digital Counter with Option 7 installed, is its ability to provide a variable marker covering the entire 1 to 400 MHz frequency range with the marker frequency read directly on the digital counter.

This combination will also provide a cw output, read to the counter accuracy. This cw signal can be amplitude or frequency modulated by externally applied signals.

The versatility and many features of the SW 503 make it an excellent choice for specialized sweep testing or for general laboratory use.

Center Frequency Range — 1 to 400 MHz. Dial accuracy: ±8 MHz (note 1). Drift: 100 kHz/5 min — 2 MHz/8 hrs (note 2).

Swept Frequency Range — 1 to 400 MHz. Sweep width: 200 kHz min, 400 MHz max. Display linearity: <2%.

Signal Purity—Residual fm: <10 kHz. Harmonic Spurious: >30 dB below output from 10 to 400 MHz, >25 dB below output from 1 to 10 MHz. Non-harmonic Spurious: >40 dB below output.

Output—Impedance: Model 503A 50 Ω, Model 503B 75 Ω. Level: 0.7 VRMS MAX, SW 503A CALIBRATED −40 to +10 dBm 50Ω, SW 503B CALIBRATED 0 to +50 dBmV 75 Ω. Attenuation: Step 50 dB in 10 dB steps, accuracy 0.2 dB/step, vernier 20 dB. Flatness: ±0.25 dB (measured at maximum output).

Blanking—Retrace blanking of the rf output provided for sweep operation, removed for cw operation.

Aux Rf Output— 10 dBm ±1 dB, impedance 50 Ω.

Operating Modes—Repetitive sweep, single sweep, externally triggered sweep, line-lock sweep, manual sweep, cw.

Sweep Time—Continuously variable from 10 ms to 100 seconds in 4 decade steps, plus vernier.

Horizontal Output — 10 volts p-p (output symmetrical to ground reference).

Crystal Markers — Type: birdie-by-pass, comb markers. Marker comb frequency: 1, 10, and 50 MHz. Marker accuracy: 0.005%. Marker width: automatically changes from approx 400 kHz to 50 kHz as the sweep width range is selected. Marker size: adjustable from 1 mV to 1 V p-p. Rectified marker: internal switch removes the negative portion of the birdie for use with x-y recorders. Size varies with detectors output impedance. Max marker size is over 0.5 V.

Variable (Dot) Marker (use in line or 10 ms rate) — When used in conjunction with the DC 502 Digital Counter with Option 7, the variable (dot) marker will stop the sweep wherever the marker is positioned. This in turn gates the counter on to read the frequency. At the end of the counter gate, the SW 503 resumes sweeping. The accuracy of the variable marker is limited to the counter accuracy and the display resolution, ie: reduced sweep width gives greater resolution.

Remote Programming — Front panel jacks provide connections for the remote control of frequency, sweep width, and the 20 dB vernier output control. A jack is also provided to externally trigger the sweep circuit when the instrument is in a single sweep mode. Provisions are also available on the front panel for external frequency and amplitude modulation. External fm: the full frequency range can be modulated at rates up to 4 kHz. With reduced deviation and linearity, modulation rates to 100 kHz are possible. Modulation sensitivity is approx 50 MHz/volt. Input impedance 10 kΩ. External am: 90% modulation can be obtained at modulation frequencies up to 25 kHz. Note: the output level must be reduced at least 6 dB by the vernier output control to obtain 90% modulation. Modulation sensitivity is 1 volt p-p/10% am. Input impedance 10 kΩ.

Note 1. Increased accuracy can be obtained using the crystal markers or the variable (dot) marker in conjunction with the DC 502, Opt 7.

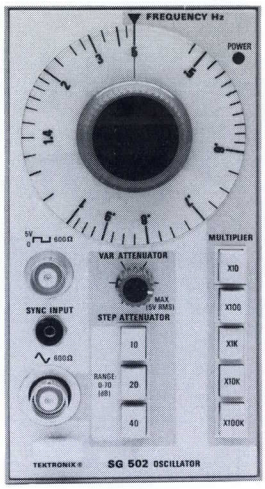
Note 2. After ½ hour warm-up at a constant ambient, and allowing a 5 minute stabilization period after a frequency change.

SW 503A Rf Sweep Generator (50 Ω) . . Price To be announced

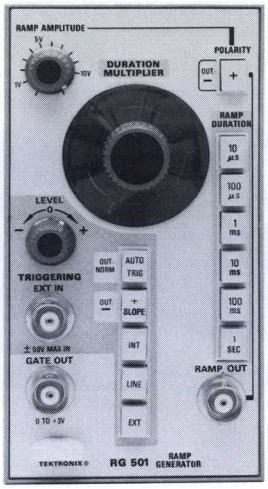
SW 503B Rf Sweep Generator (75 Ω) . . Price To be announced

Recommended accessories: 50 Ω Precision detector (SW 503A), 75 Ω Precision detector (SW 503B).

new nomenclature:
SW503 ←
SW503, opt 1



SG 502



RG 501

5 Hz to 500 kHz Sine and Square Waves

Extremely Low Distortion Sine-wave Shape

5 V Rms Open Circuit—600 Ω Source

0-40 dB Continuously Variable Plus 0-70 dB in 10 dB Steps

SINE WAVE

Frequency Range — 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response — Flatness is 0.3 dB over entire range (1 kHz reference).

Attenuation — Selectable from 0 dB to 70 dB in 10, 20, and 40 dB steps with pushbuttons. Accurate within 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion — Less than 0.035% from 20 Hz to 50 kHz. Less than 0.1% over the remaining frequency range.

Hum and Noise — Less than 0.1% of rated output.

Max Output Voltage — 5 V rms open circuit; 2.5 V rms into 600 Ω.

Output Impedance — 600 Ω, single ended.

SQUARE WAVE

Frequency Range — Same as sine wave. The square wave switches on 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, single ended.

SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency and set frequency, is a linear function of sync voltage.

Input Impedance — 10 kΩ.

Measurements made at rated output and terminated in 600 Ω.

SG 502 Oscillator **$375**

10 μs to 10 s Ramp Duration

Plus or Minus Output

10-V Amplitude

Scope-type Trigger Functions

Gate Out, TTL Compatible

RAMP

Ramp Duration — Decade ranges of 10 μs to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude — Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Gate — From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Fall time is 100 ns or less. Gate source impedance is 160 Ω, within 5%.

Ramp Output Characteristics — Minimum load resistance, 3 kΩ; max load capacitance, 300 pF.

TRIGGERING

Auto Triggering — Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering — Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 kΩ. 50 V (dc + peak ac) max input.

Internal Triggering — Same as external except that the trigger source is via the rear interface.

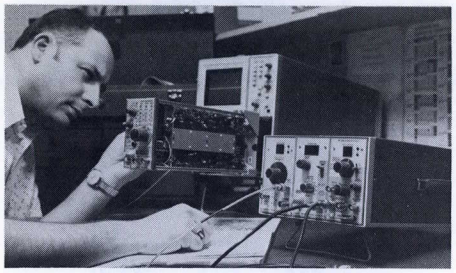
Line Trigger — Triggers at line frequency.

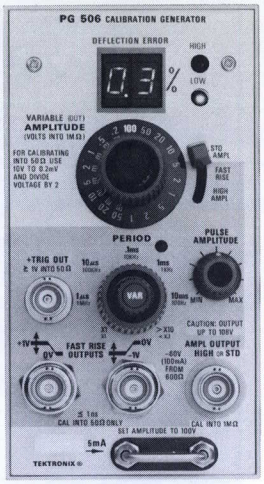
Trigger Level Range — ±1 V.

Optional Accessory — Manual (One-Shot) Trigger Generator.

Order 016-0597-00 . . . . . **$35**

RG 501 Ramp Generator **$250**





PG 506
CALIBRATION GENERATOR

TEKTRONIX TM 500 Oscilloscope Calibration Instruments set the state-of-the-art in every respect in oscilloscope calibration. These instruments provide the widest range of standard amplitude square waves, fastest rise times, lowest aberrations, fastest time marks, and widest frequency range of leveled sine waves available from any calibration equipment.

Furthermore, the TM 500 Oscilloscope Calibration Instruments simplify and speed up verification procedures, assuring a high level of performance and minimum costs. For example, the TG 501 provides a variable mode in addition to its crystal-controlled mode. In the variable mode, the time mark spacing can be quickly adjusted to exactly align with the oscilloscope graticule marks. The resulting percentage timing error is then read directly off the TG 501 digital display. The superior multi-instrument portability of the TM 500 concept lets this rapid verification take place at the oscilloscope usage location, since the entire calibration facility now occupies one small package with a single handle. This on-site verification increases accuracy and time-savings still further.

Three Square-Wave Output Modes

10 Hz to 1 MHz

Direct Readout of Oscilloscope Deflection Error

The PG 506 is a Calibration Generator for oscilloscopes with three modes of square-wave output, selectable dc outputs, and a variable-amplitude output with front-panel digital indication of oscilloscope deflection error. For checking attenuator performance and transient response of oscilloscopes, simultaneous plus and minus low-level, fast-rise (1.0 ns) square waves or high amplitude (60 volt) extremely clean square waves are available at frequencies from 10 Hz through 1 MHz. A 5 milliamp calibration current loop is useful for current probe calibration. In the amplitude calibration mode, a 1 kHz square wave is generated whose peak-to-peak amplitude is selectable in a 1-2-5 sequence from 200 microvolts to 100 volts. In this same mode, amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope vertical graticule divisions; scope deflection error is then read directly off the PG 506 digital display in percentage high or low, permitting rapid verification of oscilloscope performance. An internal switch permits selection of continuous dc instead of the 1 kHz square wave at the 5 milliamp current loop and the amplitude calibration output.

AMPLITUDE CALIBRATOR MODE

Period — Fixed at approx one millisecond.

Amplitude — From 100 V p-p to 200 microvolts p-p in 1-2-5 sequence, accurate within ±0.25% into 1 MΩ. 5 V p-p to 100 microvolts p-p into 50 Ω.

Error Readout Range — ±7.5%.

Error Readout Resolution — 0.1%.

PULSE MODES

Period — One microsecond to 10 milliseconds (within 5%) in decade steps with the VARIABLE control in CAL position. VARIABLE extends period to at least 100 milliseconds.

Symmetry — Approx 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Rise Time — Unterminated: 100 ns or less. Terminated into 50 Ω: 10 ns or less.

Amplitude Range — Unterminated: 6 V or less to at least 60 V. Terminated into 50 Ω: 0.5 V or less to at least 5 V.

Leading Edge Aberrations — Within 2% or 50 mV p-p, whichever is greater, when terminated into 50 Ω.

Polarity — Positive going from a negative potential to ground.

Output Resistance Source — 600 Ω within 5%.

FAST RISE OUTPUTS

Rise Time (Terminated into 50 Ω) — 1.0 ns or less.

Amplitude Range (Terminated into 50 Ω) — 100 mV or less to at least 1.0 V.

Leading Edge Aberrations — 2% or 10 mV p-p, whichever is greater, during first 10 ns.

Flatness — Within 0.5% after first 10 ns.

Polarity — Simultaneous positive and negative going. Positive going is from a negative rest potential to ground. Negative going is from a positive rest potential to ground.

Output Resistance Source — 50 Ω within 3% at + and — output connectors.

Trigger Output (Terminated into 50 Ω) — Positive-going signal of at least 1 V.

PG 506 Calibration Generator $1195

OSCILLOSCOPE CALIBRATION INSTRUMENTS CHART

The following chart is a comparison of the four instruments making up the Oscilloscope Calibration Instruments.

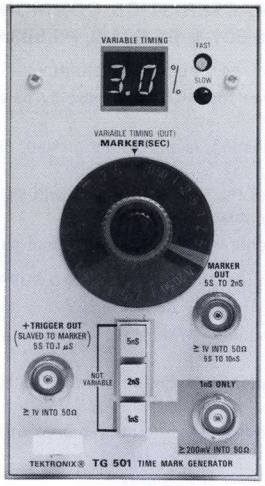
A complete list of specifications appears on the following pages.

	PG 506 Calibration Generator	TG 501 Time Mark Generator	SG 503 Signal Generator	SG 504 Signal Generator
Primary functions	Amplitude calibration 200 μV to 100 V	Time-base calibration 1 ns to 5 sec	Bandwidth calibration 250 kHz to 250 MHz	Bandwidth calibration 245 MHz to 1050 MHz
Secondary functions	Rise time and transient response testing, attenuator compensation testing	Testing oscilloscope nonlinearity	General leveled rf signal source	General leveled rf signal source with frequency modulation capability

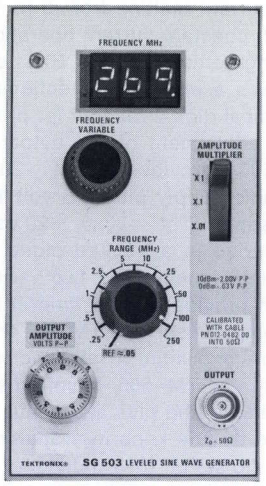
TUNNEL DIODE PULSER

The Tunnel Diode Pulser (067-0681-01) provides a clean, fast-rise pulse for adjusting the transient response of high-frequency oscilloscopes and other instruments. The Tunnel Diode Pulser can be driven by the PG 506 Calibration Generator at repetition rates exceeding 50 Hz. Output amplitude of the pulse is approximately 250 mV into 50 ohms, while rise time is ≤125 ps; aberrations are <1% in a 1 GHz system.

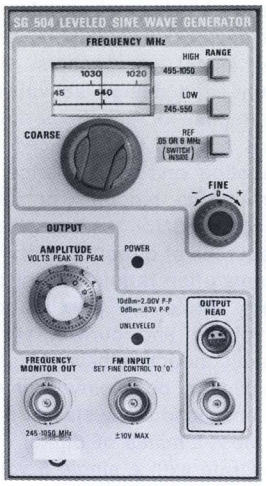
Order 067-0681-01 . . . . . $80



TG 501



SG 503



SG 504

TIME MARK GENERATOR

Marker Outputs, 5 s to 1 ns

Direct Readout of Oscilloscope Timing Error

External Trigger Output

The TG 501 Time Mark Generator provides marker outputs from five seconds to one nanosecond. A unique feature on the TG 501 is a variable timing output with a front-panel two-digit LED display which indicates percentage of timing error between the normal time interval and a variable interval set to line up the marker pulse with graticule or division mark on the display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually estimating error from a display.

Markers — 1 ns through 5 s in a 1-2-5 sequence.

Marker Amplitude — ≥1 V peak into 50 Ω on 5 s through 10 ns markers. ≥750 mV p-p into 50 Ω on 5 ns and 2 ns markers. ≥200 mV p-p into 50 Ω on 1 ns markers.

Trigger Output Signal — Slaved to marker output from 5 s through 100 ns. Remains at 100 ns for all faster markers.

Internal Time Base	Standard	Option 1
Crystal Frequency	1 MHz	5 MHz
Stability (0° to 50° C) after ½ hour warm-up	within 1 part in 10^5	within 5 parts in 10^7
Long-term Drift	1 part or less in 10^5 per month	1 part or less in 10^7 per month
Setability	adjustable to within 1 part in 10^7	adjustable to within 5 parts in 10^9

External Reference Input — Available with internal changes. Acceptable frequencies, 1 MHz, 5 MHz, or 10 MHz. Input amplitude must be TTL compatible.

Timing Error Readout Range — to ±7.5%. Resolution — to 0.1%.

TG 501 Time Mark Generator $895

Option 1, 5 MHz Time Base . . . . . Add $150

SIGNAL GENERATOR

Leveled, Variable Output

250 kHz to 250 MHz

Digital Readout of Frequency

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a leveled output amplitude which is variable from 250 kHz to 250 MHz. The selected frequency is indicated by a built-in autoranging frequency counter with a three-digit LED read-out on the front panel. Accurately calibrated output voltage into 50 ohms is variable from 5 mV to 5.5 V peak-to-peak.

Frequency Range — 250 kHz to 250 MHz, plus 50 kHz reference frequency.

Accuracy — Within ±0.7 of least significant digit of indicated frequency.

Amplitude Range — 5 mV to 5.5 V p-p into 50 Ω termination in three decade ranges.

Amplitude Accuracy — (50 kHz reference) within 3% of indicated amplitude on (X1) range, 4% on (X0.1) range, and 5% on (X.01) range.

Flatness — (p-p) From 250 kHz to 100 MHz, output amplitude will not vary more than 1% of the value at 50 kHz except that up to +1.5%, −1% variation may occur between 50 MHz and 100 MHz on amplitude multiplier X0.1 and X0.01 ranges only. From 100 MHz to 250 MHz, amplitude variation is within 3% of the value at 50 kHz.

Harmonic Content — Second harmonic at least 35 dB down. Third and all higher harmonics at least 40 dB down.

Other — Rear edge card connection available to address the leveling circuit.

SG 503 Signal Generator $895

SIGNAL GENERATOR

Leveled, Variable Output

245 MHz to 1050 MHz

Frequency Modulation Capability

The SG 504 Signal Generator provides a leveled output amplitude that is variable from 245 MHz to 1050 MHz in two bands. Frequency is indicated by a high-resolution tape dial that expands each band over 28 inches. The accurately calibrated output voltage is variable from 0.5 V to at least 4.0 V peak-to-peak into 50 ohms.

Frequency Range — Low band: 245 MHz to 550 MHz. Highband: 495 MHz to 1050 MHz, plus 50 kHz or 6 MHz reference frequency (internally selected).

Frequency Accuracy — ±2% of dial indication.

Amplitude Range — 0.5 V to at least 4.0 V p-p.

Amplitude Accuracy — (at reference) within 3% of indicated amplitude.

Flatness — ±4% of amplitude at reference frequency.

Harmonic Content — 2nd harmonic at least 25 dB down; 3rd and all higher at least 40 dB down.

Fm Input — Frequency range: dc to 100 kHz. Deviation sensitivity: ±9 V produces from ±0.05% to ±0.4% deviation of carrier, depending on output frequency.

Frequency Monitor Output — ≥0.3 V p-p into a 50 Ω load from 245 MHz to 1050 MHz.

Rear Card Edge Connections — Address fm input, frequency monitor output, and amplitude control.

SG 504 Signal Generator (Includes Leveling Head) $1995

Replacement Leveling Head, Order (015-0282-00) $200

Direct current is almost invariably required for active devices, transducers, and many electromechanical components. Research, development, and design activities require supply voltages for the experimental or breadboard circuits and devices involved. Troubleshooting and maintenance, particularly when boards, modules, or sub-assemblies are removed for testing, also require versatile sources of direct current. Measurement systems often require dc for the basic transducers. While the possible combinations of voltage and current are infinite, modern semiconductors have decreased the typical maximum power requirements and have also produced some standardization of voltages. Most families of digital integrated circuits operate with a single 5 volt supply. Many operational amplifier ICs and other types of linear ICs operate with supply voltages in the 12 to 15 volt range, frequently requiring both positive and negative supplies. Complementary MOS (CMOS) logic typically can be powered by potentials ranging from a few volts to almost 20 volts.

The TM 500 line of power supplies features versatility and flexibility, with up to three independent voltages available from a single plug-in instrument. Three of the four power supplies feature a fixed 5-volt-at-1-amp supply for logic circuits or indicators plus one or two variable supplies. Two of these units — the PS 501-1 and PS 501-2 — are basically similar except for their means of voltage adjustment and indication. Each features a floating 0-to-20 volt output and adjustable current limiting from 0 to 400 milliamps with constant current operation above the limiting setting. The PS 501-1 precision supply uses a multiturn potentiometer with a mechanical digital readout for precise setting and adjustment of the output voltage. The PS 503A provides a dual −20, 0, +20 volt variable supply plus a 5 volt 1 A independent supply. The −20, 0, +20 volt supply can be varied in a tracked mode, or each part set individually. The two variable outputs each provide up to 1 amp in the high-power compartment of a TM 504 or TM 506, or 400 mA maximum in all other compartments of any TM 500 Mainframe. In the tracking mode, the plus and minus supplies are varied by one knob in proportion to the voltage ratio set on their individual controls. In the nontracking mode each can be set independently to any voltage from 0 to 20 V. Since all three of the variable supply terminals are floating, any one can be grounded or the two outside terminals used as a 0-to-40 volt supply. Both positive and negative variable supplies have their own current limiting.

In the high power slot (the far right hand compartment) the PS 505 features a floating 3-to-5.5 volt output at up to 4 amperes with adjustable current limiting. In any other compartment, the maximum current available is 1 ampere and the output is nonfloating (negative grounded). A front-panel indicator light shows whether the PS 505 is in a standard or a high-power compartment. The PS 505 is particularly useful for powering TTL and ECL circuitry.

POWER SUPPLIES—COMPARISON OF CHARACTERISTICS

The following is a comparison of the major characteristics of the power supplies. A complete list of specifications may be found on the following pages.

	PS 501-1	PS 501-2	PS 503A	PS 505
Voltage/Current #1	+5 V @ 1 A	+5 V @ 1 A	+5 V @ 1 A	3 —5.5 V @ 4 A*
Voltage/Current #2	0-20 V @ 400 mA	0-20 V @ 400 mA	0 to +20 V @ 1 A*/400 mA**	No
Voltage/Current #3	No	No	0 to −20 V @ 1 A*/400 mA**	No
Current limit	0-400 mA	0-400 mA	0-1 A*/400 mA**	0 —4.0 A
Min resolution	1.6 mV	10 mV	10 mV	—
Foldback current	No	No	No	Yes >4.0* A foldback to <1.5 and latches
Over voltage protection	No	No	Yes	Yes
Line regulation	<5 mV††	<5 mV††	<5 mV†††	<10 mV†
Ripple & noise p-p	0.5 mV††	0.5 mV††	0.5 mV†††	3 mV†
Others	Multiturn pot with digital readout	Meter for voltage or current	+ — outputs independent, or dual tracking at ratio set by individual knobs	
Price	$175	$175	$275	$195

*In high-power (right-hand) compartment of TM 504 or TM 506.
**In any standard mainframe compartment.

†Refers to output #1
††Refers to output #2
†††Refers to output #2 and #3

CHARACTERISTICS COMMON TO PS 501-1, PS 501-2, PS 503A

20 V FLOATING SUPPLY

Primary Power Input — Determined by power module (TM 501, TM 503, etc).

Output — Floating, isolated from ground, 350 V dc + peak ac.

Stability — (0.1% +5 mV) or less drift in 8 hours at constant line, load, and temperature.

Indicator Lights — Voltage variation and current limit.

+5 V GROUND-REFERENCED SUPPLY

Output — 4.8 to 5.2 V dc at 1 A (20°C to 30°C).

Load Regulation — Within 100 mV with a 1 A load change.

Line Regulation — Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A) — 5 mV p-p or less; 100 μV rms or less.

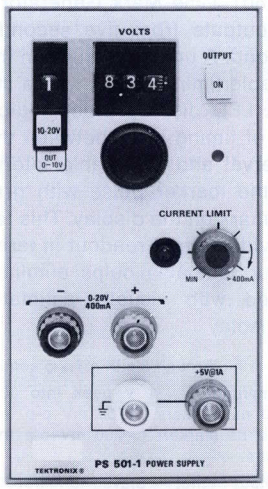
Stability — 0.5% or less drift.

Overload Protection — Automatic current limiting and over-temperature shutdown.

OPTIONAL ACCESSORY

Terminal Access Adapter Kit — For breadboarding and fixturing. Plugs directly onto front of PS 501-1 - PS 505. See accessory section for more details.

Order 013-0152-00 . . . . . $9.75



PS 501-1
POWER SUPPLY

Floating Output, 0-20 V
0 to 400 mA
Precise Regulation
Low Ripple and Noise
Fixed Output + 5 V

Output — 0 to 20 V dc.

Current Limit — 0 to 400 mA.

Line Regulation — Within 5 mV for a ±10% line voltage change.

Load Regulation — Within 1 mV with a 400 mV load change.

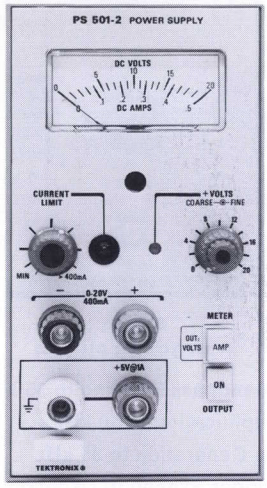
Ripple and Noise — 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Minimum Resolution — 1.6 mV.
Voltage is selectable within 0.5% by a 10 turn potentiometer with a 3 digit in-line dial and range switch.

Transient Recovery Time — 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

PS 501-1 Power Supply $175



PS 501-2 POWER SUPPLY

Floating Output, 0-20 V

0 to 400 mA

Precise Regulation

Low Ripple and Noise

Fixed Output + 5 V

Dual-Range Meter Readout

Output — 0 to 20 V dc.

Current Limit — 0 to 400 mA.

Minimum Resolution — 10 mV.

Line Regulation — Within 5 mV for a ±10% line voltage change.

Load Regulation — Within 1 mV with a 400 mV load change.

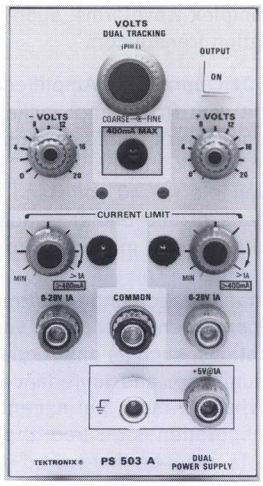
Ripple and Noise — 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient — 0.01%/°C or less.

Transient Recovery Time — 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400-mA change in output current.

Meter — Dual range, 0 to 500 mA or 0 to 20 V dc. Accuracy, ±2% of full scale. Other specifications same as PS 501.

PS 501-2 Power Supply $175



NEW PS 503A TRIPLE POWER SUPPLY

Independent + and — Controls

Dual Tracking Voltage Control

0 to ± 20 V at 1 A

Fixed 5 V at 1 A

Remote Resistance Programming

Over-voltage Protection Standard

The PS 503A features superior dual tracking performance, over-voltage protection, and remote resistance programming of voltage. When operated in the high-power compartment of a TM 504 or TM 506 mainframe, the PS 503A provides up to 1 amp from both + and —, 0 to 20 volt supplies.

±20 V FLOATING SUPPLIES

Output — 0 to ±20 V dc with respect to the common terminal or 0 to 40 V dc across the + and — terminals. Outputs can be varied independently or at a constant ratio.

Tracking Mode Offset Error — If the two supplies are set independently to any given voltage ratio and then varied by use of the VOLTS DUAL TRACKING control, the two supplies will maintain the same voltage ratio as initially set within ±50 mV.

Current Limit — Adjustable 0 to 1 A (high-power compartment) or 0 to 400 mA (standard compartment) on each supply.

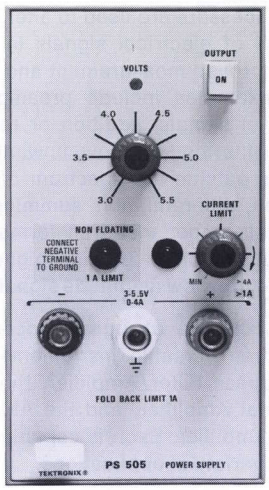
Load Regulation — Within 3 mV for 1 A change (high-power compartment) or 1 mV for 400 mA change (standard compartment).

Ripple and Noise — 3 mV p-p or less at 1 A load (high-power compartment). 0.5 mV p-p or less at 400 mA load (standard compartment).

Indicators — Individual voltage indicators and current limiting indicators for both + and — supplies. Non-high-power compartment (400 mA) indicator.

Other specifications same as PS 501.

PS 503A Power Supply $275



PS 505 POWER SUPPLY

Floating Output

3 to 5.5 V at 4 A

Overvoltage Protection Standard

Remote Resistance Programming of Voltage

The PS 505 is a variable, low voltage, high current, dc power supply. It is designed to operate in the high-power compartment of a TM 504 or TM 503 Power Module. In the high-power compartment, it provides a floating 3.0 to 5.5 V dc at 4.0 A. Operating in a standard compartment of TM 500-Series Power Module, the PS 505 will supply at least 1.0 A non-floating (negative ground).

Line Regulation — Within 10 mV for a ±10% line voltage change.

Load Regulation — Within 5 mV for 0.5 to 4.0 A load change.

Ripple and Noise — 3 mV p-p or less.

Temperature Coefficient — 0.01%/°C or less.

Stability — 0.1% +5 mV of drift in 8 hours.

Foldback Current — When output current exceeds 4.1 A, current folds back to less than 1.5 A and latches.

PS 505 Power Supply $195

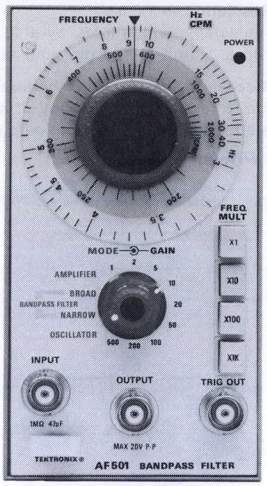
Signal processors are used to alter the characteristics of electrical signals in order to permit improved measurement and analysis. Typical examples include preamplification of low-level signals, addition or removal of dc offset, filtering to remove unwanted noise or signals outside the spectrum of interest, integration, differentiation, summing of multiple signals, impedance transformation, and post amplification to provide higher amplitude drive from low amplitude signal sources.

The TM 500 line of signal processors includes three versatile instruments, the AF 501 Bandpass Filter/Amplifier, the AM 501 Operational Amplifier, and the AM 502 Differential Amplifier. Each is capable of being used in a variety of applications.

The AF 501 Bandpass Filter/Amplifier is an active filter whose center frequency is one-knob tunable over the entire audio range from 3 Hz to 35 kHz. Broad (Q=5) and narrow (Q=15) bandwidths are switch selectable. Flat amplification to 50 kHz is also available. In both filter and flat modes, amplification from 1 to 500 may be selected in a 1-2-5 sequence. The AF 501 also features an oscillator mode where the output frequency is the same as the center-tuned frequency in the filter modes. A signal output pulse, used for driving counters or oscilloscopes or for triggering stroboscopic lamps in study of mechanical systems, is also provided. The AF 501 selectivity permits individual analysis of the fundamental and harmonic components of complex waveforms, such as signals from vibration transducers.

The AM 501 Operational Amplifier is a high-output unit with front-panel jacks for quick and easy change of configurations by selection of feedback components. The output power available (± 40 volts and ± 50 mA across loads of 800 ohms) is adequate for most electronic and many electro-mechanical applications. The AM 501 is ideal for classroom instruction and experimental use; it can be conveniently set up for various useful applications, such as differentiation, integration, summing, and impedance transformation. Where a more permanent use in a given configuration is desired, the feedback components may be hardwired inside the instrument.

The AM 502 Differential Amplifier is a highly flexible instrument giving control of gain, dc offset, low-frequency response, and high-frequency response. It may be used with single-ended input or in differential mode for maximum rejection of common-mode noise signals. High amplification may be used even with low-level signals having a dc component up to one volt, since the variable dc offset of the AM 502 can be used to cancel the signal's dc component. Full bandwidth of the amplifier is 1 MHz: switch-selectable high-pass and low-pass filters permit reducing the noise bandwidth when the full frequency range is not required.



AF 501
BANDPASS FILTER

Tunable Bandpass Filtering to 35 kHz
Signal Amplification to 50 kHz
Sine-wave Generation to 35 kHz
Strobe Trigger Synced to Oscillator or Filter Output
Dial Readings in Hz or Cycles per Minute

The AF 501 is a Bandpass Filter/Amplifier, ac-coupled amplifier and sine-wave generator combined in a single TM 500-Series module. Used alone or in conjunction with other TM 500-Series instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical

SIGNAL PROCESSORS — COMPARISON CHART

The following is a comparison of the main characteristics of the AF 501, AM 501, and AM 502.
A complete list of specifications appears on the following pages.

	AF 501 **Tunable Bandpass Filter/Amplifier**	**AM 501** **Operational Amplifier**	**AM 502** **Differential Amplifier**
Amplification range	1 to 500 in 1-2-5 steps	Depends on feedback components; open loop gain 10,000	1 to 100,000 in 1-2-5 steps
Input impedance	1 Meg	Depends on feedback components	1 Meg normal; FET input by internal jumper
Bandwidth control	Center frequency tunable 3 Hz to 35 kHz; Q=5 or 15	Depends on feedback components; max gain-bandwidth product 5 MHz	Independent switch-selected high-frequency and low-frequency filters
Maximum output	20 V p-p (Bandpass filter)	± 40V, ±50 mA with 800 Ω load	± 5 V, ± 20 mA, output resistance 5 Ω or less
Other features	Functions as audio oscillator, narrow or wide bandwidth tunable filter and flat audio amplifier	Use as inverting or non-inverting amplifier, follower, summing amplifier, integrator, differentiator, etc., by appropriate feedback R and C	Coarse and fine control of up to ± 1 V of internal dc offset, ac or dc coupling, single-ended or differential input, 25 μV equivalent input noise at full bandwidth
Price	$495	$295	$625

easurement domain, the AF 501 can be sed as a manual-sweep spectrum analyzer for complex sound and vibration signals. Single-frequency tuning facilitates isolation of 1X rpm signals in dynamic balancing, or viewing higher order disturbances on a crt monitor. An output pulse, synced to the filter or oscillator output signal, is available for triggering a stroboscope or oscilloscope and for frequency counting. And, of course, the AF 501 can be used in any application calling for a conventional sine-wave generator, ac-coupled amplifier, or bandpass filter.

BANDPASS FILTER

Center Frequency Range — 3 Hz to 35 kHz in 4 decade steps.

Frequency Dial Error — <5% dial setting between 3-20, <10% dial setting between 20-30.

Frequency Multiplier — X1, X10, X100, X1k.

Phase Shift — <10° at tuned frequency below 5 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Max Filter Attenuation — >70 dB.

Filter Selectivity — Q = 5 ± 1 (Broad), Q = 15 ± 5 (Narrow).

Bandwidth at Half-power Points —

$$(-3\text{ dB}) = \frac{\text{center frequency}}{Q}$$

Gain Range — 1-500; 1-2-5 sequence.

Gain Accuracy — ± 3 dB (Broad), ± 5 dB (Narrow).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Max Non-Destruct Dc Input Voltage — ±100 volts.

Output Voltage — 20 V p-p (Max freq times amplitude = 400 V kHz).

Output Current — 20 mA p-p MAX (at 20 V p-p).

Output Impedance — <1 Ω.

AMPLIFIER

Gain — 1 to 500; 1-2-5 sequence.

Gain Accuracy — ±3%.

Bandwidth — <0.5 Hz to >50 kHz (at 3 dB point).

Input Impedance — 1 MΩ ±1% paralleled by ≈47 pF.

Noise — <25 mV rms (referred to output).

Output Voltage — 20 V p-p (Max freq times amplitude = 400 V kHz).

OSCILLATOR

Sine Wave Out Range — 3 Hz to 35 kHz.

Dial Range — 3 to 40 Hz/180-2400 cpm.

Output Ampl — 1, 2, or 5 V p-p ±20%, depending on gain position.

Waveform Distortion — <3%.

Output Current — Max 50 mA p-p.

Output Impedance — <1 Ω (within 50 mA output current limit).

TRIGGER OUTPUT

Pulse Amplitude — >10 volts.

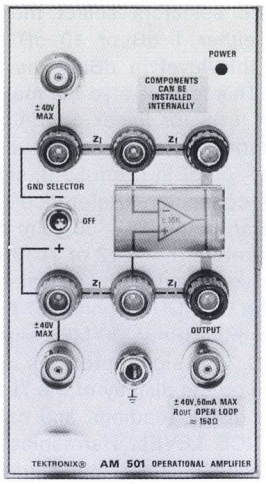
Pulse Duration — 10 ±5 μs.

Min Signal Required — 500 mV, p-p

Rise and Fall Time — <1 μs.

Output Impedance — ≈50 Ω.

AF 501 Bandpass Filter/Amplifier $495



AM 501
OPERATIONAL AMPLIFIER

±40 V, 50 mA Output

Open Loop Gain 10,000

50 V/μs 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 20°C.

Equivalent Input Drift — Less than 100 μV/°C.

Equivalent Input Noise — Less than 10μV rms.

Max Safe Differential Input — 80 V.

OUTPUT

Voltage Range — At least ±40 V.

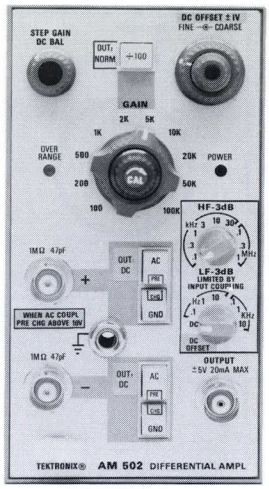
Current Limit — At least ±50 mA.

Open Loop Output R — Approx 150 Ω.

AM 501 Operational Amplifier $295

ACCESSORIES

Terminal Accessory Adapter Kit (013-0146-00) $9.75



AM 502
DIFFERENTIAL AMPLIFIER

1-to-100,000 Gain

100 dB Cmrr

Selectable Upper and Lower −3 dB Points

Dc-to-1 MHz Bandwidth

Adjustable Dc Offset

The AM 502 Differential Amplifier features: wide bandwidth; high cmrr; and selectable calibrated gain and filtering. Well suited for general purpose or laboratory work, it can drive oscilloscopes, monitors, chart recorders, 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 — From dc (if ac coupled, 2 Hz or less at −3 dB point) to 1 MHz within +25%, − 15% with GAIN set to 20 k or less. Upper −3 dB point reduces to 500 kHz at 50 k gain, 250 kHz at 100 k gain.

HF −3 dB POINT — Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. (Also limited by frequency response at gains of 50 k and 100 k.)

LF −3 dB POINT — Selectable in 6 steps from 0.1 Hz to 10 kHz.

Dc Offset — At least + or − 1 V to offset signal dc component.

Normal Mode Cmrr — At least 100 dB, dc to 50 kHz, range, ±5 V.

÷ 100 Mode Cmrr — At least 50 dB, dc to 50 kHz, range, ±50 V.

Max 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. Input impedance can be increased to FET input via a simple internal jumper change.

OUTPUT

Max Output — ±5 V, ±20 mA, output resistance is 5 Ω or less.

Min Load Impedance — 250 Ω.

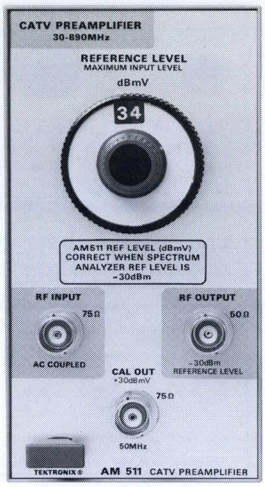
Max Input Gate Current — 50 pA at 25°C.

Max Noise — 25 μV or less (tangentially measured).

Overrange — Front-panel lamp indicates most overrange conditions.

Max Voltage Drift — 100 μV/°C.

AM 502 Differential Amplifier $625



AM 511
CATV PREAMPLIFIER

For Use with 7L12 or 7L13 Spectrum Analyzers

Reference Level Selectable in 1 dB or 10 dB Steps

30 to 890 MHz Frequency Range

The AM 511 is a plug-in preamplifier for use with the 7L12 or 7L13 Spectrum Analyzers. It plugs into a TM 500 power module to meet the need of those who require a preamplifier for use with the 7L13.

The AM 511 applications include signal to noise, radiation, and field intensity measurements to FCC specifications on CATV, television, and FM installations. It is also useful in servicing and making measurements on radio systems and increasing sensitivity for EMI measurements within the 30 to 890 MHz frequency range.

Concentric selectors select the reference level in either 1 dB or 10 dB steps and indicate this level in dBmV via a readout window. This level is also the maximum signal input level for linear operation. A +30 dBmV signal source at the input connector provides −30 dBm (from 50 Ω) signal at the OUTPUT connector. (Reference level readout uses an output of −30 dBm as a reference; therefore the 7L12 or 7L13 Reference Level must be set and calibrated for −30 dBm.) The CAL OUT Connector provides an accurate +30 dBmV, 50 MHz signal source from 75 Ω. This signal provides an absolute reference on the display of the 7L12 or 7L13 to check dBmV readings and calibrate the REFERENCE LEVEL. Harmonics of the 50 MHz provide picket fence markers across the frequency span for accurate frequency and span calibration.

ELECTRICAL CHARACTERISTICS
(with 7L12 or 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — (AM511/7L12) ±1.0 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, −2.5 dB over the full frequency range. (AM511/7L13) +1.0 dB, −1.5 dB, with respect to the level at 50 MHz, over the frequency range of 50 MHz to 300 MHz and +2.0 dB, −2.5 dB, over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode. The following characteristics apply at 50 MHz.

Sensitivity	Resolution Bandwidth
−90 dBmV	30 Hz
−80 dBmV	300 Hz
−73 dBmV	3 kHz
−65 dBmV	30 kHz
−55 dBmV	300 kHz
−45 dBmV	3 MHz

Noise figure for the AM 511 is no greater than 5 dB.

Intermodulation Distortion — (AM 511/7L12 or AM511/7L13) IM products and harmonics from two signals within the frequency span of the AM 511 are 70 dB or more down from the reference level for: 1) Third order intermodulation with two signals at the reference level (full screen), and 2) Second order intermodulation and harmonics, with two signals 10 dB below the reference level.

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV Calibrator at 50 MHz. Max deviation from this reference is 0.2 dBmV +0.01 dBmV per dB deviation from the +30 dBmV AM 511 reference level. This is equivalent to: ± (0.2 dBmV ± 0.01 [dBmV Ref Lvl −30 dBmV]).

Input Impedance — 75Ω with a VSWR of 2:1 or better with 10 dB or more attenuation (between 50 MHz and 300 MHz).

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of ±30 dBmV ±0.3 dB, from 75Ω at 25°C.

AM 511 CATV Preamplifier $575

The ubiquitous cathode-ray oscilloscope is the world's most useful and versatile electronics test and measurement instrument. Tektronix, long identified with the oscilloscope, could hardly develop the TM 500 line of modular instrumentation without including crt display capability.

Three choices of performance level and display size are now available to add waveform display to the digital measurement capabilities of the TM 500 Multimeters and Counters.

The new SC 502 is a full-feature dual-trace 15 MHz oscilloscope packaged as a double-width TM 500 plug-in. It features an exceptionally bright (12 kV) crt with an 8 x 10 division (0.25 in/div) graticule. A delay line allows observation of the full leading edge of waveforms. Vertical sensitivity is selectable from 1 mV/div to 20 V/div in 1-2-5 sequence, and sweep times can be chosen from 1.25 seconds/div to 20 nanoseconds/div. Sophisticated oscilloscope features include peak-to-peak auto trigger for hands-off operation with a wide variety of signals, selectable trigger hold-off for digital circuit applications, trigger view, and an A minus B vertical mode for differential viewing of signals.

The SC 501 is a complete triggered-sweep calibrated time base single-trace oscilloscope. Y channel bandwidth is 5 MHz and sweep rates from 1 second per division to 200 nanoseconds per division are featured. In addition to display and measurement of external signals or waveforms generated by TM 500 signal sources in the same power module, the SC 501 or SC 502 can also be integrated into more complex measurement packages. For example, the horizontal sweep on either oscilloscope also produces a ramp which is available on the rear interface connector, and this signal can be used to control other TM 500-Series instruments. The ramp can be used to sweep the function generator outputs of several TM 500 instruments, or as a delay source for the PG 505 Pulse Generator.

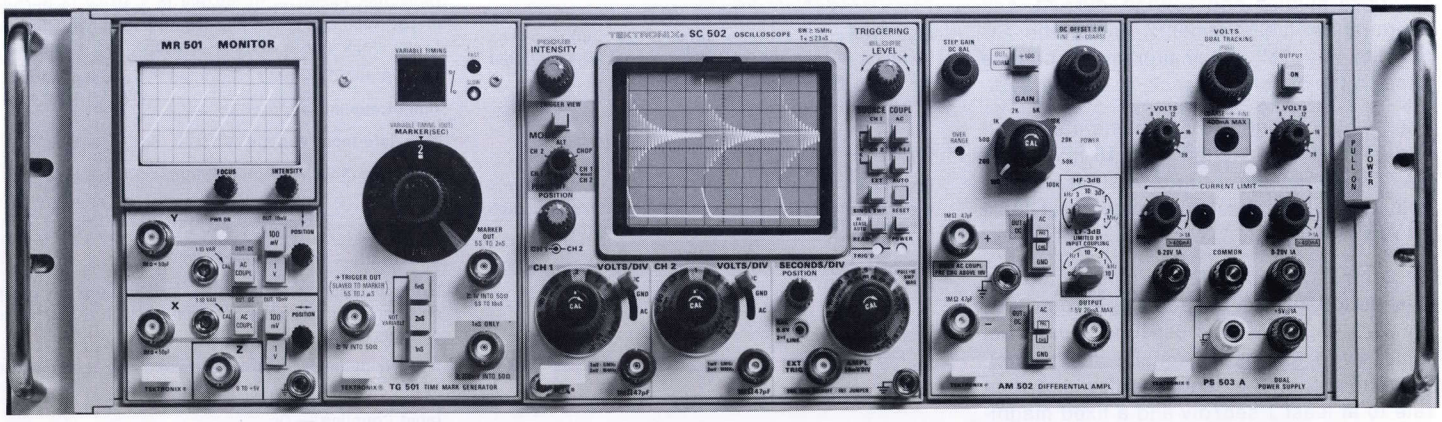
Both the MR 501 and SC 501 have miniature 2.5 inch crt's with an internal 6 x 10 division graticule of 0.203 inches per division. The MR 501 contains no time base and is optimized for X-Y displays. X and Y bandwidths are 2 MHz and the two channels are phase-matched. X, Y, and Z axis inputs all appear on the front panel.

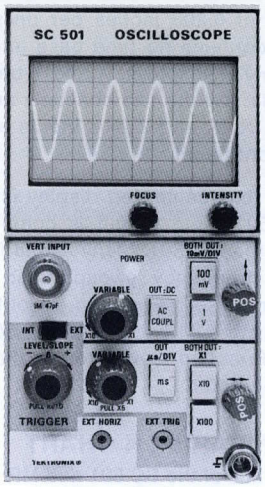
Where a time-calibrated display is required the RG 501 ramp output is compatible for use with the MR 501. Many useful functions, such as frequency sweeps, and delayed pulses or pulse trains, can be obtained by combining the MR 501 and RG 501 with a TM 500 Function Generator or the PG 505 Pulse Generator.

OSCILLOSCOPE AND MONITOR COMPARISON CHART

The following is a comparison of the main characteristics of the SC 501 and MR 501. A complete list of specifications appears on the following pages.

	SC 502	SC 501	MR 501
Crt	8 x 10 div, 0.25 in/div P31 phosphor	6 x 10 div, 0.203 in/div P31 phosphor	6 x 10 div, 0.203 in/div P31 phosphor
Vertical (Y) axis	Dual-trace, 15 MHz, 1 mV to 20 V/div (5 and 10 MHz bandwidth at 1 and 2 mV) alt, chop, and ch 1 minus ch 2 modes	5 MHz bandwidth, 10 mV/div to 10 V/div	2 MHz bandwidth, 10 mV/div to 10 V/div
Horizontal (X) axis	Triggered sweep 200 ns/div to 0.5 sec/div with X10 magnifier, X2.5 variable, normal, p-p auto, ext/int trig, single sweep, external horizontal input, variable trigger hold off	Triggered sweep 1 μs/div to 1 sec/div with X5 magnifier to 200 ns/div, normal/auto trigger, internal/external-trigger, external horizontal input	2 MHz bandwidth, 10 mV/div to 10 V/div, phase matched to Y axis within 1° from dc to 100 kHz.
Other features	Trigger view, 12 kV accelerating potential		
Price	$1200	$695	$495





SC 501 OSCILLOSCOPE

5 MHz Bandwidth

Single Compartment Size

2½ in Crt

Versatile Operating Features

The SC 501 is a single channel 5 MHz plug-in unit oscilloscope with a 2.5 in crt display which occupies a single TM 500-Series plug-in compartment. Oscilloscope capability significantly enhances the application range of the multi-functional TM 500-Series Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500-Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, and temperature measurements. Since the SC 501 fits any TM 500 mainframe it can be used on the bench, in a rack, or on the road.

The single channel SC 501 has a calibrated vertical deflection range from 10 mV/div to 1 V/div, selectable in decade steps. A variable control extends this range to at least 10 V/div.

Calibrated sweep rates are selected by pushbutton logic in decade steps from 1 μs/div to 100 μs/div (microsecond), and from 1 ms/div to 100 ms/div (millisecond range). A variable control extends the slowest sweep rate to at least 1 sec/div and a fixed magnifier extends the fastest sweep rate to 200 ns/div.

A zero to 10 V ramp for all sweep rates (excluding the X5 magnification) is provided at a rear interface connector. This capability may be used for many auxiliary functions such as sweeping a Voltage Controlled Frequency Oscillator or obtaining variably delayed pulses from the PG 505 Pulse Generator.

The triggering circuits allow stable triggering from either internal or external sources. An AUTO triggering mode and manual LEVEL/SLOPE selection is combined in a single control. It is useful above 10 Hz and provides a bright baseline at all sweep rates.

An internal switch converts the horizontal deflection system of the SC 501 to an external horizontal amplifier which is internally calibrated for 100 mV/div deflection factor with a bandwidth of 100 kHz.

VERTICAL DEFLECTION

Bandwidth — Dc to >5 MHz.

Deflection Factors — 10 mV/div, 100 mV/div, and 1 V/div. Accuracy, within 3%. Uncalibrated (variable) range, continuously variable between steps (10:1) and to at least 10 V/div.

Input Coupling — Ac or dc.

Input Impedance — 1 MΩ paralleled by 47 pF.

Max Safe Input Voltage — 350 V (dc + peak ac).

HORIZONTAL DEFLECTION

Time Base — Calibrated sweep rates: 1 μs/div, 10 μs/div, 100 μs/div, 1 ms/div, 10 ms/div, 100 ms/div. Uncalibrated (variable) range: extends slowest calibrated rate to ≥1 sec/div. X5 magnifier (fixed): extends fastest calibrated sweep rate to 200 ns/div. Accuracy (over center 8 div): ≥5% for all sweep rates. Linearity (any two div portion within center eight divisions): ≥5%.

External Horizontal Amplifier — Bandwidth: dc to 100 kHz. Input impedance: ≥100 kΩ paralleled by 25 pF. Max input voltage: ±3 V.

TRIGGER

Normal Trigger Sensitivity (Trigger Level/Slope In) — Internal: dc coupled, 0.4 major div of deflection at dc; increasing to 1.0 major div of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V max from dc to 5 MHz. External trigger input impedance: 22 kΩ paralleled by approx 150 pF.

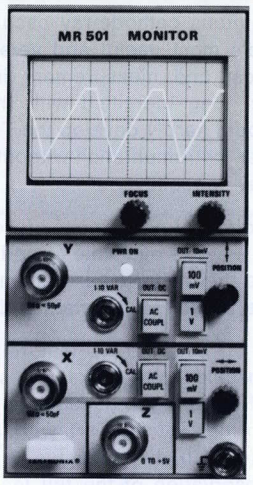
Auto Triggering (Trigger Level/Slope Out) — Sweep free-runs in absence of trigger signal or for trigger repetition rates below 10 Hz.

CRT

Crt Type — T2110.

Graticule — Type: internal black lines, nonilluminated. Area: six div vertical by 10 div horizontal. Each div equals 0.203 in. Phosphor: P31 standard.

SC 501 Oscilloscope **$695**



MR 501 MONITOR

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. Six MR 501s will fit in a single RTM 506 Mainframe, allowing easy construction of large or small multiple displays.

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.

Max 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 (compatible with RG 501 gate output).

Input Impedance — 10 kΩ paralleled by less than 50 pF.

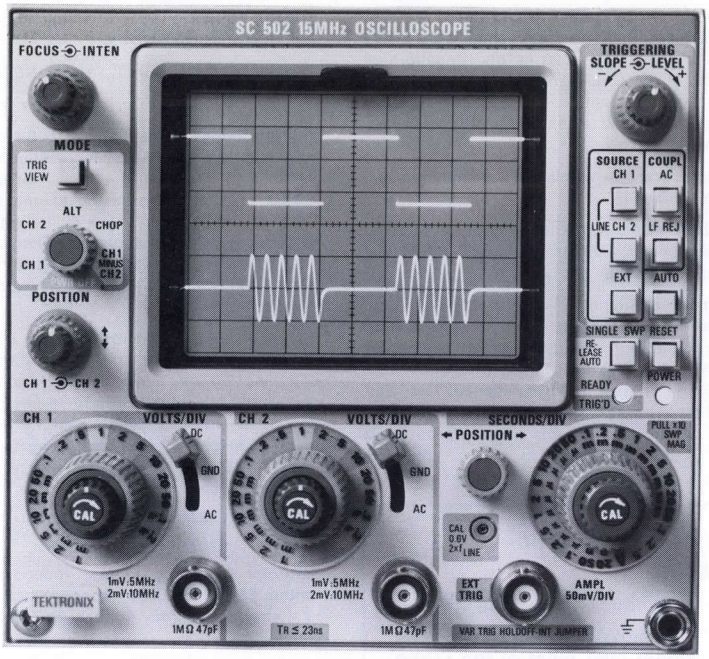
Input Coupling — Dc.

CRT

Graticule — Internal 6 x 10 div, 0.203 in/div.

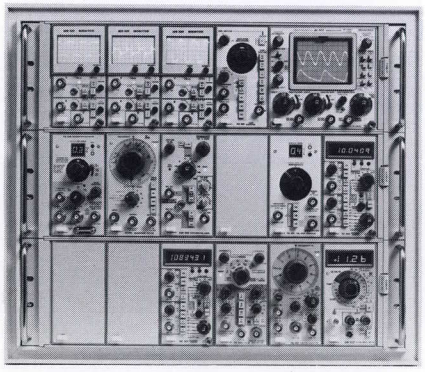
Phosphor — P31.

MR 501 X-Y Monitor **$495**

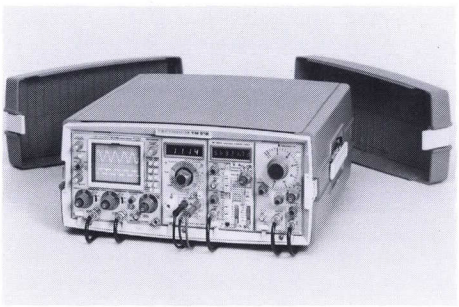


A Full-featured 15 MHz Dual-trace Oscilloscope in a Two-wide Plug-in
20 ns/div Max Calibrated Sweep Rate
1 mV/div Max Sensitivity
Delay Line
Trigger View
Variable Trigger Hold-off
Enhanced Automatic Triggering

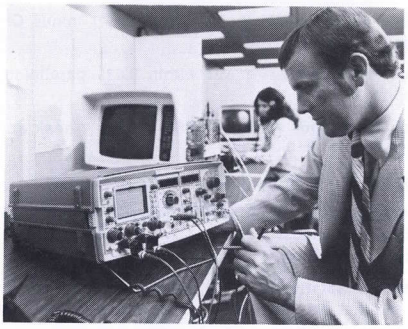
The SC 502 is a general purpose, 15 MHz, dual-trace oscilloscope designed to operate in any two adjacent compartments of TM 500 Power Module/Mainframes. It has a high writing speed, a wide range of sweep rates, a wide range of deflection factors, and versatile triggering, including trigger view and enhanced automatic triggering.



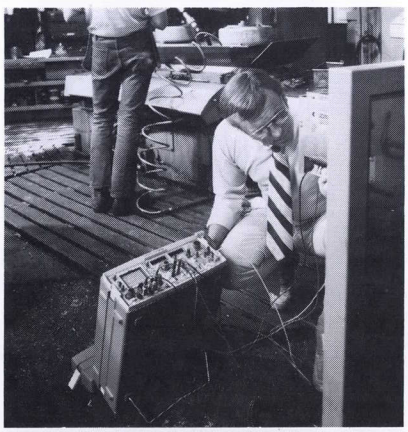
The SC 502 makes many new instrumentation systems feasible, especially in the areas of QA, production testing, maintenance, and field servicing. The rear interface feature of the SC 502 and all TM 500 instrumentation suggests exceptional applicability to systems of built-in test equipment or rack-mounted installations. And the TM 515 Traveler Mainframe with the SC 502 form a nucleus for sophisticated, compact field service "packages."



As with many TEKTRONIX products, the SC 502 features circuits, sub-circuits, and components designed and built by Tektronix to fulfill the special design capabilities of the instrument. Among its many recommended uses, the SC 502 is intended to be a powerful tool in the field servicing of digital equipment, where it would be used in association with disc memories, key-to-tape, printers, plotters, punches, readers, and terminals. The crt of the SC 502, for example, is of new design, offering a high writing speed as an advantage in the display of digital information, while stable, clean triggering is assured by incorporating well-proven circuits. Thus, the SC 502 offers the engineer a unique combination of performance, compactness, and systems capability.



This instrument offers the features most often identified with more expensive monolithic or plug-in oscilloscopes, such as complete dual-trace modes, delay-line, trigger view, 1 mV sensitivity, sweep speeds from 0.5 s/div to 200 ns/div in 1-2-5 sequences, plus X10 sweep magnifier for calibrated sweep speeds to 20 ns/div, single sweep, external horizontal input, probe calibrator, variable trigger holdoff, and an exceptionally bright crt trace as a special advantage in field servicing and production areas where high ambient light levels are often encountered.



The probe recommended for use with the SC 502 is the P6062A, which has selectable 1X and 10X attenuation.

Here is an oscilloscope that allows industry to apply the same measurement system from product research and development, through production, to field servicing.

SC 502 Oscilloscope

VERTICAL DEFLECTION

Bandwidth at −3 dB points — 5 mV to 20 V/div, dc to at least 15 MHz; 2 mV/div, dc to at least 10 MHz; 1 mV/div, dc to at least 5 MHz.

Rise Time — 5 mV to 20 V/div, 23 ns or less.

Ac Low Frequency Response (Lower −3 dB point) — Without probe, 10 Hz: with probe (10X) 1 Hz.

Deflection Factors — Calibrated range: 1 mV to 20 V/div, 14 steps in a 1-2-5 sequence. Accuracy: 5 mV to 20 V/div (+15°C to +35°C) within 2%, (0° to +50°C) within 3%; 1 mV and 2 mV/div within 5%. Uncalibrated (variable) range. At least 2.5:1 range. Continuously variable between calibrated steps. Extends max attenuator step to at least 50 V/div.

Modes — CH 1, CH 2, Alt, Chop, CH 1 minus CH 2. Chop rate at least 250 kHz.

Input Impedance — 1 MΩ within 0.5% paralleled by approx 47 pF.

Max Safe Input Voltage — 350 V (dc + peak ac) or 700 V p-p ac below 1 kHz.

Aberrations — Front corner ± 2% or 3% p-p.

Common Mode Rejection Ratios (CH 1 minus CH 2 mode) — At least 50:1 at 1 MHz when using same attenuator setting.

Channel Isolation — Input isolation: at least 80 dB up to 15 MHz; display related: at least 50:1 up to 15 MHz.

Displayed Noise — 200 μV or less of noise tangentially measured.

Position Range — ±6 div.

Calibrator — Voltage, 0.6 V, ±1%. Frequency, twice the power line frequency.

HORIZONTAL

Sweep Generator — Calibrated Sweep Rates: 0.5 s to 0.2 μs/div 20 steps in a 1-2-5 sequence, plus a X10 magnifier for sweep rates to 20 ns/div. Uncalibrated (variable) Range: the CAL (variable) control provides sweep rates that are continuously variable between the calibrated rates, and extends the slowest sweep rate to at least 1.25 s/div.

Sweep Rate Accuracy — Within 3% unmagnified and within 5% magnified.

Trigger Holdoff — CAL (variable) control, if selected by an internal jumper, increases trigger holdoff time by a factor of at least 20.

External Horizontal Amplifier — Bandwidth: dc coupled, dc to at least 2 MHz; ac coupled less than 50 Hz to at least 2 MHz. Deflection Factor, 50 mV/div within 5%. X and Y Amplifier Phase Difference, less than 3° at 50 kHz or less. Input Impedance, 1 M within 2% paralleled by approx 47 pF. Max Safe Input Voltage, 350 V (dc + peak ac); 350 V p-p at 1 kHz or less.

Enhanced Automatic Triggering

In the automatic mode, the trigger circuit automatically adjusts to spread the p-p signal over most of the range of the triggering level control. This provides more convenient triggering, especially on low amplitude signals.

TRIGGER

Trigger Modes — AUTO (enhanced), NORMAL (auto button out), SINGL SWP.

Trigger Sources — CH 1, CH 2, LINE, EXT.

Trigger Coupling — Dc, ac, ac low freq reject.

Internal Trigger Sensitivity — Dc: 0.4 div of deflection, minimum, dc to 5 MHz; increasing to one div at 5 MHz to 15 MHz. Ac: 0.4 div of deflection minimum, 50 Hz to 5 MHz; increasing to one div at 5 MHz to 15 MHz. Will trigger below 50 Hz with increased deflection. LF REJ: 0.4 div of deflection, minimum, 5 kHz to 5 MHz; increasing to one div at 5 MHz to 15 MHz. Will trigger below 5 kHz with increased deflection.

External Trigger Sensitivity — Dc: 60 mV, minimum, dc to 5 MHz; increasing to 150 mV from 5 MHz to 15 MHz. Ac: 60 mV, minimum, 50 Hz to 5 MHz; increasing to 150 mV from 5 MHz to 15 MHz. Will trigger below 50 Hz with increased signal. LF REJ: 60 mV, minimum, 5 kHz to 5 MHz, increasing to 150 mV from 5 MHz to 15 MHz. Will trigger below 5 kHz with increased signal.

Triggering Level Range — Internal: at least + and −8 div. External: at least + and −1.2 V.

External Triggering Input — Input Impedance: 1 MΩ within 2% paralleled by approx 47 pF. Max Safe Input Voltage: 350 V (dc + peak ac); 350 V p-p ac at 1 kHz or less.

Auto Mode — Sweep free-runs in the absence of a triggering signal. TRIGGER LEVEL range is reduced to approx the p-p range of the triggering signal.

Single Sweep — Triggering requirements same as for normal sweep. When triggered, sweep generator produces one sweep only. AUTO pushbutton must be in the OUT position for operation and for setting triggering controls.

CRT

Phosphor — P31.

Deflection — Electrostatic.

Acceleration Potential — 12 kV.

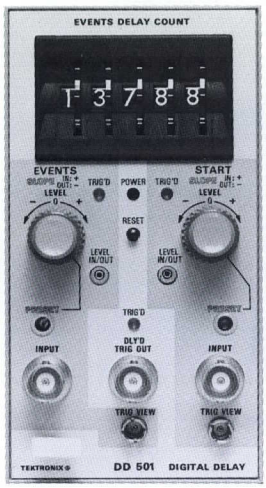
Graticule — Scale, 8 x 10 div with 0.25 in/div.

ENVIRONMENTAL CAPABILITIES

Temperature — Operating, 0°C to +50°C. Storage, −40°C to +75°C.

Altitude — Operating, to 15,000 ft. Storage, to 50,000 ft.

SC 502 Oscilloscope $1200



DD 501 Digital Delay

Digital Events Delay for Oscilloscope Trigger

Delay to 99,999 Events

Divide by N up to 20 MHz

Pulse Counting 65 MHz

Time Delay with Ext Clock

Inputs Compatible with Most Attenuator Probes

The DD 501 is an Events Count plug-in unit. Separate external trigger signals connected to the EVENTS and START INPUT connectors allow up to 99,999 events to be counted. That is, the unit counts a predetermined number of events, from 0 to 99,999, selected by the front-panel thumb-wheel switches. The last event counted generates a trigger pulse to the DLY'D TRIG OUT connector on the front panel. The DD 501 can also function as a frequency divider. A single external trigger signal, connected to both the EVENTS and START INPUT connectors, will be divided by the EVENTS DELAY COUNT switch setting plus one. The quotient output trigger pulse will appear at the DLY'D TRIG OUT connector on the front panel.

The DD 501 provides a digital events delay in a plug-in for the modular TM 500 line of test and measurement instruments.

Delay by event is particularly useful in troubleshooting asynchronous logic systems. It is very difficult for the observer to predict how much time will elapse prior to the pulse group he is interested in observing. The number of "clocking" events preceding the period of interest is, however, usually known and can be easily set on the thumb-wheel switches.

DD 501 Digital Delay $625

See page 124 for complete information.

LA 501 Logic Analyzer

4096 Bits of Storage

Selection of 4 Channel x 1024 Bit, 8 Channel x 512 Bit, or 16 Channel x 256 Bit Formats

Timing Diagram Display

Sampling Rate to 100 MHz

Display of up to 94% of Data before Trigger

Easy Timing Comparison between Channels

Ability to Zoom in on a Segment of Displayed Data

Threshold Compatability with all Logic Families

The LA 501s 4096 bits of storage can be formatted as 4 channels x 1024 bits, 8 channels x 512 bits, or 16 channels x 256 bits to best fit your application.

With a selectable sampling rate up to 100 MHz, the LA 501 offers the timing resolution needed in examining high speed computer systems. Stored data is displayed as a timing diagram on virtually any X-Y display. A unique capability to zoom in on any segment of this timing diagram for full screen display provides greatly improved visual resolution.

Channel to channel timing comparisons are made easier by the ability to select any one trace and move it vertically.

As a plug-in for any of four TM 500 Power Mainframes, the LA 501 can be combined in one compact package with a digital trigger delay, counters, pulse generators, multimeters, and a plug-in oscilloscope. Added to this is a choice of benchtop, rackmount, rollabout, or portable configurations to match your application.

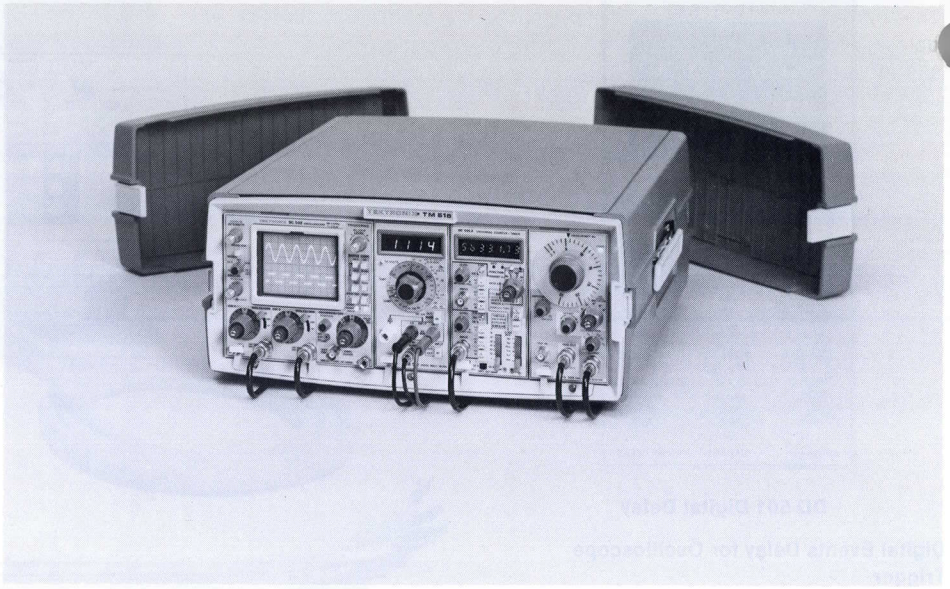
LA 501 Logic Analyzer (Including Standard Accessories) $3250

See page 122 for complete information.

The Mainframes

One of the major elements in the wide appeal of TEKTRONIX TM 500 is its extreme flexibility and versatility of configuration. Most test instrument manufacturers by now have taken advantage of integrated circuits, LED displays, and other aspects of miniaturization technology to make more compact instruments. Tektronix, however, also combined advanced technology with a modular plug-in system to provide highly flexible test instrument configurations for use almost anywhere.

The "classical" benchtop environment is served by 1, 3, 4, and 6 compartment mainframes with tilt bails and handles. These same mainframes can be easily carried about for portable use. The new TM 515 luggage-styled 5 compartment travel mainframe was designed especially for portable applications where ruggedness and resistance against moisture and dust are necessary.



For mobility of an entire "benchfull" of instruments, Tektronix offers the new TEK LAB CART Model 3. This new cart allows you to configure your own rollabout test, maintenance, or calibration station. The TEK LAB CART Model 3 will mount virtually any TEKTRONIX Oscilloscope on the top of the cart and two TM 500 Mainframes, either 3-compartment or 4-compartment, on two under-mounted trays.

For rackmount applications, TM 500 fits up to six instruments into one standard rack width. Yet, the plug-in feature lets a rack installation be instantly re-configured or permits an instrument to be replaced to keep a critical test facility "on the air" even during maintenance or calibration of individual instruments.

In all configurations — bench, portable, rollabout, and rackmount — TM 500's internal interconnect feature lets commonly used connections between instruments be made only once and then stay hidden for simpler, uncluttered test setups. Then, at the touch of a switch, a counter can monitor the frequency of a signal source or a DMM can measure trigger level setting of a counter or voltage of a power supply.

Benchtop

The four TM 500 benchtop mainframes are the TM 501, TM 503, TM 504, and TM 506.

The TM 500 system concept provides significant benefits when multiple instruments are involved, but the TM 501 was provided for cases when only a single instrument is needed. The TM 503 is the most compact of the multi-compartment mainframes; it is only 15.3 in deep, 6 in high, and 8.7 in wide.

The TM 504 and TM 506 are both heavy-duty units. Each features a high power compartment at the right-hand end to also supply greater current to TM 500 instruments that are designed for added performance or higher output power levels. The six compartment TM 506 also incorporates a quiet fan for optimum cooling. The TM 504 and TM 506 are slightly deeper than the TM 503.

All four benchtop models have feet, tilt bails, handles, and front-panel power switches. All operate from normal 110 or 220 V ac, 48 - 440 Hz.

Portable

All of the benchtop models can be used for portable operation as well. Carry handles and sturdy rear cord-wrap feet, plus optional accessory protective front covers (available for all but the TM 501) permit them to be used in many moderate applications. However, the new TM 515 was designed from the ground up for superior multi-instrument portability. In its carrying configuration it is a handsome piece of luggage with molded-in feet on the bottom and a comfortable luggage-type carrying handle. It is extremely moisture and dust resistant, and designed to withstand the rigors of transport in car trunks and pickup trucks. Once at the destination, the rear cover pops off to give access to the power cord, power switch, and allow air flow from the built-in fan. The front cover is removed to uncover up to five operating instruments from the broad TM 500 line. The result, a total electronics superlab disguised as a mild-mannered suitcase.

A wire bail stowed in the cover can be snapped into the front feet as a conventional tilt bail for benchtop use, or into the rear feet to support the TM 515 in a nearly vertical attitude on the floor with all instruments visible to a standing operator. Test lead storage is also provided inside the rear cover. The TM 515 operates from nominal 110 or 220 V, 48 - 60 Hz with the standard fan, and 48 - 440 Hz with optional universal fan.

Rollabout

Rollabout test laboratories are combinations of TM 503 or TM 504 Mainframes, TM 500 Instruments, TEKTRONIX Plug-in or Monolithic Portable Oscilloscopes, and the TEK LAB CART Model 3. The TEK LAB CART Model 3 will hold a 5100, 5400, or 3 or 4 Plug-in 7000-Series, or a Portable such as the 434, 464, 465, 466, 475, or 485. Two TM 503s or TM 504s can be mounted on two adjustable mounting trays beneath the cart. A large storage drawer, which can be padlocked, is provided at the bottom of the cart to hold accessories and Plug-ins. In each case, the result is a highly mobile lab on wheels which can be rolled out onto a production floor, over to large installations needing maintenance or calibration, into narrow quarters like x-ray control booths, or down laboratory aisles to aid in conserving bench space.

Rackmount

The new RTM 506 rackmounting mainframe is electrically identical to the TM 506 benchtop model but features a slide-out assembly and handles, plus a higher power fan than the bench version in recognition of the high ambient temperatures often found in enclosed racks and consoles.

It is also possible to convert two TM 503s into a rackmount assembly with a kit; this kit has the advantage of requiring four inches less depth than the RTM 506 for space-critical applications, but lacks the fan and high power compartment, and requires assembly by the user. Other kits are available to rackmount a single TM 503, or a TM 503 with a 603, 604, or 605 monitor.

The TM 515 Traveler Mainframe accommodates five TM 500 plug-in modules, yet it is as attractive as quality, fashionable flight luggage. With a typical complement of TM 500 plug-in modules it weighs approximately 30 pounds. And it will go under the seat in most commercial aircraft. At last, the engineer on the go can take along a truly portable instrumentation package, one that goes as a unit, that is attractive, and that can be optimized for his instrumentation needs.

A typical application for the TM 515 could be digital field service, in which the likely plug-ins might be: an SC 502 dual-channel, 15 MHz (two-compartment wide) Oscilloscope, a DD 501 Digital Delay, and a DC 515A/DM 502 Combo, offering Universal Counter and full-function DMM capabilities plus readout of trigger level at the touch of the INT pushbutton, once interface connections are made.

All plug-ins in the TM 515 mainframe can "talk" to each other and work together through a common interface circuit board. A factory-installed option (Option 5) allows TM 515 users to interconnect the plug-in instruments within the mainframe without making soldered junctions.

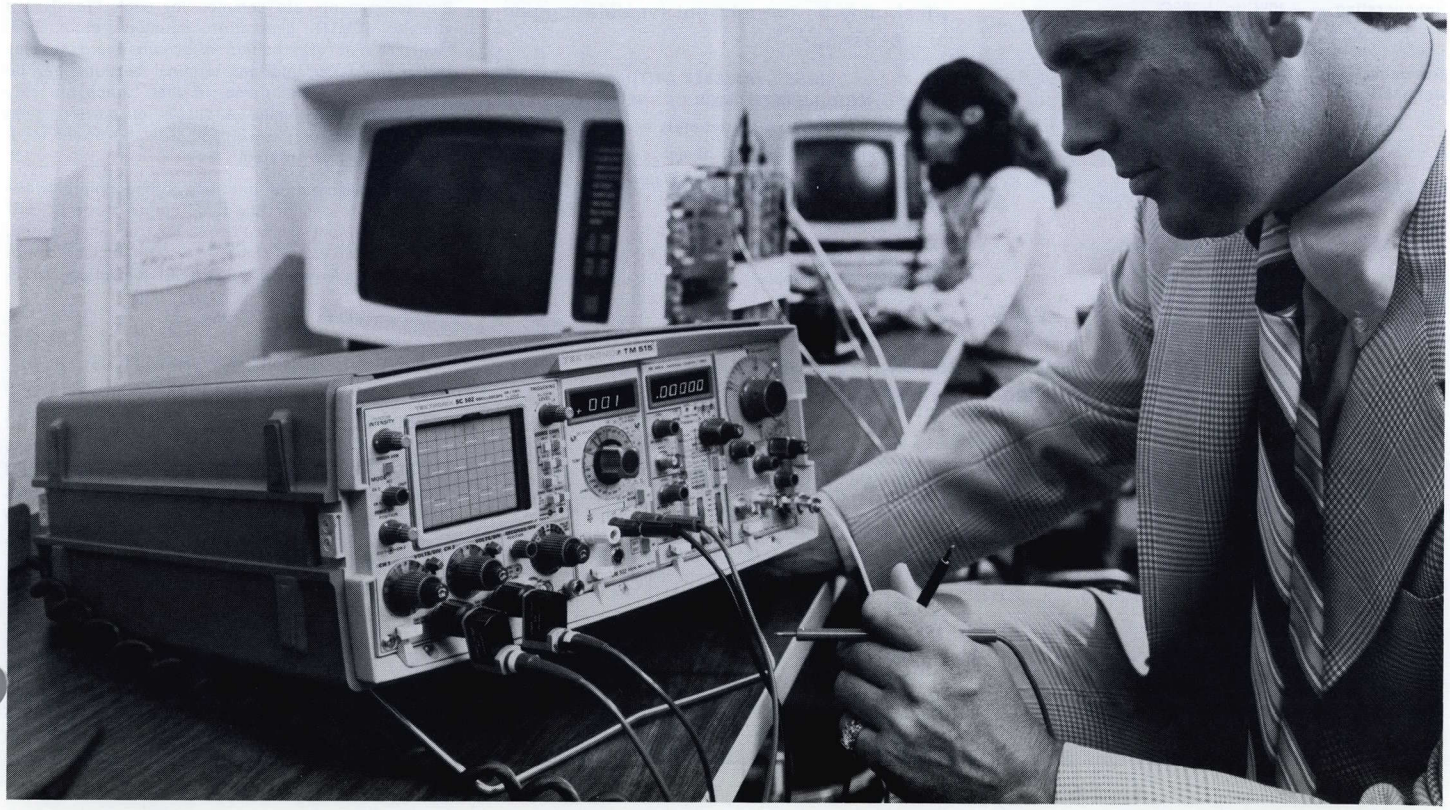
As in all TM 500 Power Module/Mainframes the power transformer of the TM 515 mainframe accommodates 100, 110, 120, 200, 220, and 240 V ac and 48 through 440 Hz. However, the range of line frequencies of the TM 515 (and TM 506) is limited to 48-60 Hz by the electrical characteristics of the ventilating fan. Operating the TM 515 at the various line voltages is accomplished with quick-change line-selector blocks, but operating it at line frequencies outside the 48-60 Hz range requires the optional ventilating fan, since "forced air" is required. An optional 48-440 Hz fan is available.

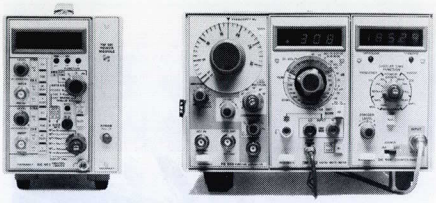
Significant cost savings are available through the use of TM 500 instrumentation systems in place of collections of monolithic instruments, mainly because TM 500 plug-in instruments share a common power supply and enclosure.

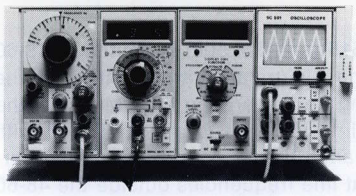
The TM 501 single-compartment, TM 503 three-compartment, TM 504 four-compartment, TM 515 five-compartment, and TM 506 six-compartment Power Module/Mainframes provide the necessary power supply components (transformer, rectifier, and filter) to operate any of the TM 500 modular plug-ins. Low-level regulator circuitry is included in each individual instrument, with high-dissipation power transistors mounted on heat sinks in the rear of the power module, so each instrument is supplied with the exact voltage necessary for optimum performance. All plug-ins are connected in the power unit by a common interface board. A matrix of signal interconnection possibilities produces extensive multifunction capabilities to reduce cabling clutter.

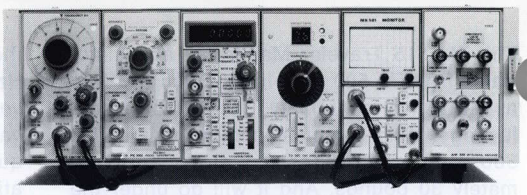
The TM 504 and TM 506 provide one high-power compartment, which is located on the

extreme right adjacent to the power switch. (Typically it is used to accommodate a power supply plug-in, such as the PS 503A, which can provide 1 amp 0 to 40 V dc in the high-power compartment.) The TM 506 is available either for bench use with a carrying handle for convenience, or in a rack-mounting version with mounting ears and slide-out tracks. Factory-installed options add 25-mil square-pin connectors on the rear of the interface circuit board and supply a kit of jumpers with mating square-pin connectors. These allow TM 500 users to easily inter-connect the plug-in instruments within the mainframe without making soldered junctions.









POWER REQUIREMENTS

Line Voltage Ranges — Universal Transformer: 100, 110, 120, 200, 220, 240 V ac, all within 10%. Range changing for transformer accomplished with quick-change line-selector block.

Line Frequency Ranges — Universal Transformer: 48 Hz to 440 Hz.

NOTE: The ventilating fans on the TM 506 and TM 515 operate on 48-60 Hz only.

Power Consumption — Max primary power approx: 35 W for TM 501, 120 W for TM 503, 200 W for TM 504, 320 W for TM 506 and 240 W for TM 515 . Actual power consumption depends on plug-in selection and operating modes.

SUPPLIES (UNREGULATED)

Shared by All Compartments — +33.5 V dc and −33.5 V dc. TM 501 −500 mA max. TM 503 −1 A max. TM 504 −1.4 A max. TM 506 −2.1 A max. TM 515 −1.8 A max.

Low Power Compartments — Two 25 V ac windings, 500 mA each, supplied to each compartment, independently. 17.5 V ac and +11.5 V dc shared in any combination between these two supplies and among all low-power compartments. TM 501 −1 A max. TM 503 and TM 504 −3.6 A max. TM 506 −6.5 A max. TM 515 −6.5 A max.

High Power Compartments — (nearest to switch in TM 504 and TM 506): two 25 V ac windings, 1 A each. 17.5 V ac and + 11.5 V dc, 4 A max, shared in any combination between these two supplies.

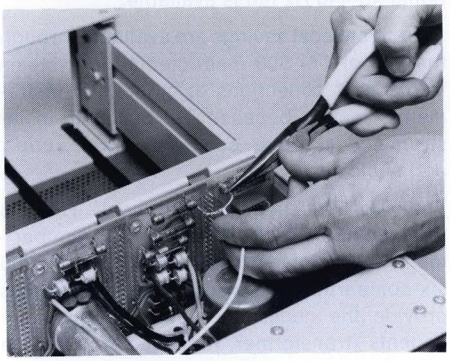
TEMPERATURE RANGE

Operating — 0°C to +50°C.
Nonoperating — −40°C to +75°C.

ALTITUDE RANGE

Operating — To 15,000 ft.
Nonoperating — To 50,000 ft.

OPTIONAL INTERFACE



The TM 500 line is designed so that connections between modules and/or external equipment can be made by the mainframe rear interface board and optional rear-panel connectors.

Each plug-in has selected lines brought to its interface, some parallel to front-panel connections, others 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.

LINES AVAILABLE AT THE MODULE INTERFACE CONNECTOR

Digital Counters

- BCD serial by digit
- Range code (except DC 502)
- Scan clock out
- Scan clock in and internal scan disable
- Reset
- Time slot zero
- Data good
- Signal in (selected by front-panel switch) (except DC 502)

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 data is scanned.

Digital Multimeters

- Scan clock out
- Decimal point
- BCD serial by digit
- Least significant digit
- Most significant digit
- Data transfer
- Polarity

Power Supplies

- Supply output through rear connection
- Remote sense
- Remote analog voltage control
- Remote analog current limit control

Amplifiers

- Signal Out, Signal In

Monitor

- X, Y, and Z inputs

Oscilloscope

- Ramp out, Gate out

NOTE: If the power module is ordered with Option 2, it will be delivered with a rear-panel multipin connector, mating cable connector, and one BNC connector per plug-in compartment installed. The user may wire these to the interface board as desired. Option 2 (and option 5 of the TM 515) 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.

Pin assignments are common for each "family" of modules (DMMs, generators, counters, etc.). 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 accepts only plug-ins of one family. A supply of barriers (and square-pin jumpers) is shipped with the power module if option 2 is ordered.

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 502 for frequency sweep. The output of a power supply can be measured with the interface feature of the DM 501 for voltage monitoring.

POWER MODULE DIMENSIONS & WEIGHTS (without Plug-ins)

CABINET

	TM 501		TM 503		TM 504		TM 506		TM 515	
Dimensions	in	cm	in	cm	in	cm	in	cm	in	cm
Height	6.0	15.2	6.0	15.2	6.0	15.2	6.0	15.2	6.8	17.3
Width	3.9	9.9	8.7	22.1	11.0	27.5	17.4	44.1	15.0	38.1
Length	15.3	38.8	15.3	38.8	20.0	50.0	20.0	50.0	20.0	50.2
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	5.4	2.4	9.5	4.3	20.5	9.3	29.0	13.2	22.5	10.2
Domestic Ship	13	5.9	17	7.7	26.0	11.8	41.0	18.7	30.0	13.6

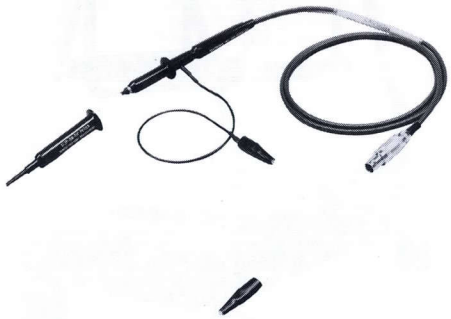
ORDERING INFORMATION (Plug-ins Not Included)

TM 501 Power Module $100
with Option 2 Interface . . . . . add $55
TM 503 Power Module $150
with Option 2 Interface . . . . . add $75
TM 504 Power Module $180
with Option 2 Interface . . . . . add $100
TM 506 Power Module $240
with Option 2 Interface . . . . . add $150
RTM 506 Power Module (rackmount version) $295
with Option 2 Interface . . . . . add $150
TM 515 Traveler Mainframe $325
with Option 5 Interface . . . . . add $75
with Option 6 48-440 Hz fan . . . . . add $150

Option 7 — For operating TR 502 and DC 502 Option 7 in a TM 503, TM 504, TM 506, or TM 515 . . . . **add $25**

This group of accessories adds to the versatility and performance of the TM 500 test and measurement system. Convenient cases and covers offer mobility and protection. The provision for user options with special purpose hardware adds flexibility. Adapters and blank panels can be supplied, as well as extender cables, coaxial cables, special probes, and devices designed to operate with various plug-ins for specific applications.

P6058 TEMPERATURE PROBE



The P6058 Temperature Probe is used with the DM 501 for sensing temperature from −55°C to +150°C. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. P6058 probes are interchangeable among all DM 501s without requiring recalibration since probes and DM 501s are held to tight tolerances. Besides measuring temperature, the P6058 can function as an electrical probe for resistance, current, and voltage measurements to 500 V. To obtain the full probe kit with ground lead and push-on electrical contact tip, order 010-0260-00 below. A simple modification of the DM 501 is also required. For temperature-only measurements, order 010-0259-00.

The temperature probe consists of the temperature sensor, a four foot, 4 wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 501. The unit weighs approximately five ounces.

P6058 Temperature Probe,
Order 010-0259-00 . . . . . $95

P6058 Temperature Voltage Probe,
Order 010-0260-00 . . . . . $100

P6430 TEMPERATURE PROBE

The P6430 Temperature Probe is used with the DM 502 for sensing temperature from −55°C to +150°C. The temperature sensing element consists of a transistor and is installed in the probe's nose tip. Temperature is measured by applying the flat surface of the probe's tip to the device being measured. The probe can be immersed vertically, approximately two inches in a liquid, for temperature sensing and still retain water tightness.

The temperature probe consists of the temperature sensor, a six foot, 2 wire coaxial cable, and a connector for attaching to the existing front-panel receptacle of the DM 502. The unit weighs approximately five ounces.

To meet full accuracy specifications a specific P6430 and DM 502 multimeter must be calibrated as a pair.

P6430 Temperature Probe,
Order 010-6430-00 . . . . . $95

HIGH VOLTAGE PROBE FOR USE WITH DMMs

The High Voltage Probe will measure voltages from 1 kV to 40,000 volts with an accuracy of 1% at 25,000 volts. The division ratio is 1000:1. Common uses include measuring anode voltages on monitors or oscilloscopes.

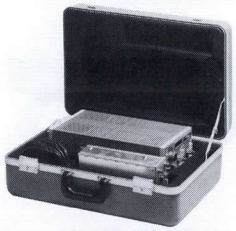
This probe plugs directly into the front end of either multimeter.

CHARACTERISTICS

Voltage range	1 kV to 40 kV
Input resistance	1000 MΩ
Division ratio	1000:1
Overall accuracy	20 kV to 30 kV 2%
Upper limit accuracy	Changes linear from 2% at 30 kV to 4% at 40 kV
Lower limit accuracy	Changes linear from 2% at 20 kV to 4% at 1 kV
Input Z at meter	10 MΩ required

Order Number: 010-0277-00 . . . . . $55

TM 500 CARRYING CASE



These luggage-type carrying cases for TM 500 equipment are molded of high strength glass-epoxy. The TM 503 model weighs 12 pounds empty and measures 23½ in long by 8½ in thick by 15½ in high, including rubber feet, lockable latches, and handle. Inside, the resilient polyurethane foam insert is molded to accept a TM 503 (with or without the protective front cover) plus either a spare TM 500 family module or a 200-Series miniscope. A third compartment in the foam accepts miscellaneous cables, accessories, or small tools.

The TM 504 case has a molded foam insert which will accept the TM 504 (with or without the protective front cover) but has no provisions for spare modules or tools. It is 24 in long by 8½ in thick by 17½ in high and weighs approximately 14 pounds empty.

TM 503 Carrying Case,
Order 016-0565-00 . . . . . $110

TM 504 Carrying Case,
Order 016-0608-00 . . . . . $115

PROTECTIVE FRONT COVER

A snap-on front cover, molded of high impact plastic, is available for the TM 503 (shown above), TM 504, and TM 506 mainframes. While particularly valuable when the TM 503 or TM 504 (full of instruments) is carried into the field or in a vehicle, the cover is also good insurance against damage to instrument knobs and jacks during normal handling in the lab, or when a mainframe full of instruments is stored. The cover adds 1¾ in to the length of the TM 503, TM 504, and TM 506 mainframes, and clears the longest knob projections on any of the instruments.

TM 503 Front Panel Cover,
Order 200-1566-00 . . . . . $11.75

TM 504 Front Panel Cover,
Order 200-1727-00 . . . . . $11

TM 506 Front Panel Cover,
Order 200-1728-00 . . . . . $14.50

ACCESSORY POUCH

While the TM 501, TM 503, TM 504, and TM 506 Mainframes were optimized for bench use, they are frequently carried away for service elsewhere. Taking along the probes, cables, terminators, and other accessories usually required can then be a problem. The soft vinyl accessory pouch neatly solves this problem; sturdy snap-around straps let the pouch be secured to the carrying handle of any TM 500 Mainframe or TEKTRONIX Oscilloscope, or the straps may be snapped together to form a carrying handle for the pouch to be used independently. A convenient side zipper lets accessory items be removed or stored without removing the pouch from the mainframe handle. Dimensions approx 9¼ in L x 5¾ in W x 2 in D.

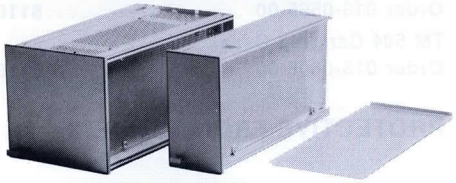
Order Number 016-0351-00 . . . . . $14.50

TM 500 BLANK PANEL

When operating the TM 500 instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Blank Plug-in Panel,
Order 016-0195-01 . . . . . $7.50

TM 500 CUSTOM PLUG-IN KITS



Single and double compartment sizes

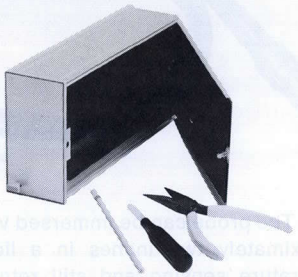
A complete test and measurement set-up for many typical jobs requires at least one non-standard item. Such items commonly include relay circuits or manual switches for routing signals; test oscillators at pre-set frequencies for alignment purposes and markers; digital logic circuits for sequencing, timing, and control; special processors or converters such as log amps, multipliers, and analog-to-digital converters; and a variety of other system elements which are usually not available or economical as complete commercial instruments. The construction and packaging of these special items is always a problem, and the sheet metal work and provision for necessary power supplies often far exceed the cost of the functional elements.

This is why the TM 500 line includes custom plug-in kits. The kits provide perforated main circuit boards which allow rapid construction and wiring of circuits using both discrete components and integrated circuits. Also included are top and bottom rails, side cover, front sub-panel, and a blank dress panel, and the latch mechanism. An instruction sheet details the voltages and currents available in the power module. Standard voltage regulator IC's can be used to provide exact voltages for most individual power supply requirements. The finished special-purpose circuitry or instrument is physically compatible with the other TM 500 instrumentation.

Custom Plug-in Kit (single compartment)
Order 040-0652-01 . . . . . $28

Custom Plug-in Kit (double compartment)
Order 040-0754-00 . . . . . $75

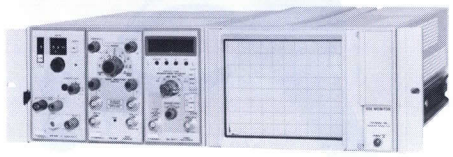
PLUG-IN STORAGE COMPARTMENT



An electronic engineer or technician away from his bench seldom has enough storage space for probes, cables, "tees" and accessories, and small tools. The Plug-in Storage Compartment is a useful adjunct to many rollabout and Travel Lab configurations. If all five compartments in your TM 515 Traveler Mainframe are not used for a particular field application, stuff in a plug-in storage compartment for extra convenience. Put plug-in storage compartments in unused storage bins of your 203 or 204 SCOPE-MOBILE®. Even a rackmount TM 500 installation might profit by readily-available terminators or attenuators in a presently unused compartment. Compatible with all TM 500 Mainframes, 5000-Series Oscilloscope Mainframes, and 203 and 204 SCOPE-MOBILE® plug-in storage bins; inside dimensions 9⅞ in L x 2 in W x 4¼ in D.

Order Number 016-0362-00 . . . . . $22

CABINET-TO-RACKMOUNT CONVERSION KITS AND MONITORS



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 040-0616-01 . . . . . $60

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a single TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.

Order 040-0617-01 . . . . . $95

Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.

Order 040-0618-01 . . . . . $30

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 and a 603, 604, or 605 in a standard rack width. For information about these monitors, including storage models, see your local Tektronix representative.

Order 040-0624-00 . . . . . $55

MONITOR ORDERING INFORMATION

603 Storage Monitor $1300
with Option 4 Time Base . . . . . add $150

604 Monitor $900
with Option 4 Time Base . . . . . add $150

605 Storage Monitor $1695
with Option 4 Time Base . . . . . add $150

TEK LAB CART MODEL 3

This Lab Cart is especially designed for rollabout configurations combining TM 500 instrumentation with the TEKTRONIX Oscilloscope of your choice. It features pistol-grip tilt control and a large accessor drawer in the base. The top tray accepts any TEKTRONIX 7000-Series, 5000-Series, or Portable Oscilloscope. The MODEL 3 comes standard with one lower shelf that will support either a TM 503 or TM 504 with plug-ins. Additional shelves are available as optional accessories. Max capacity of the lower shelf area is two TM 503s or TM 504s, stacked, or up to a TEKTRONIX 7000-Series Oscilloscope in size — with TM 500 packages placed on the tray at your option. The power distribution module at rear underside of the top tray provides four power outlets and a 15-foot line cord.

International modification (Option 1) deletes power distribution module.

Tek Lab Cart Model 3 . . . . . $285

with Option 1 (International Modification) . . . . . price on request

Additional Lower Shelf,
Order 436-0132-01 . . . . . $25

Safety Belt to secure Oscilloscopes or TM 500 to top tray or lower shelves (not needed for 5000- or 7000-Series on top tray)

Order 346-0136-01 . . . . . $15

ADAPTER KITS FOR EARLIER SCOPE-MOBILE® CARTS

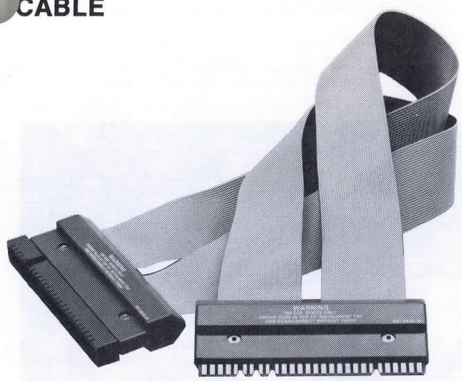
TM 504 Adapter Kits — Includes hardware to attach TM 504 to 203 or 204 SCOPE-MOBILE® Cart.

For 203, Order 016-0348-00 . . . . . $30
For 204, Order 016-0349-00 . . . . . $3

TM 503 Adapter Kits — Includes hardware to attach TM 503 to 203 or 204 SCOPE-MOBILE® Cart.

For 203, Order 016-0583-00 . . . . . $36
For 204, Order 016-0584-00 . . . . . $36

TM 500 FLEXIBLE EXTENDER CABLE



Designed to couple a TM 500 plug-in with the mainframe rear interface board connection. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-01 . . . . $60

50 Ω PRECISION COAXIAL CABLE

For use with the PG 502, PG 506, and SG 503. These instruments are internally calibrated for use with this 3 ft 50 Ω coaxial cable into a 50 Ω load.

50 Ω Cable, Order 012-0482-00 . . . . . $16.00

RISE TIME LIMITER

For use with the PG 502 Pulse Generator which has a pulse rise and fall time of less than one nanosecond. In some applications, such as TTL logic where slower rise time is needed, this fast pulse can be limited to six nanoseconds by using the rise time limiter.

Rise Time Limiter, Order 015-0249-00. . . $39

MANUAL (ONE SHOT) TRIGGER GENERATOR RG 501, PG 501, AND PG 505

The Manual (one shot) Trigger Generator is a self-contained, battery-operated, hand held device for manually generating a single pulse. This adapter is used to start a pulse, ramp, sweep, or complete sequence of events on instruments which do not have a manual trigger button or where a remote operation capability is desired, such as some oscilloscopes and the PG 501, PG 505, and RG 501.

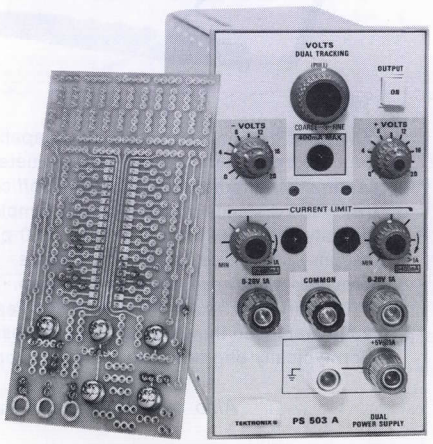
The internal trigger generator circuitry eliminates contact bounce, but will generate pulses as rapidly as the operator can manually cycle the pushbutton.

The output pulse is nominally two milliseconds in width and three volts in amplitude with a rapid rise and fall. Output impedance is low (50 Ω); the pulse amplitude drops from about 3.8 to 1.5 volts when changed from a high impedance to a 50 Ω termination. The battery is a 5.4 V dry cell.

Applications for the trigger generator also include stepping or sequencing of digital systems, analog control systems, mechanical devices, as well as obtaining "single shot" operation from many types and brands of instruments. Biological and physical experiments, where manual triggering is required as a part of the stimuli, are also common applications.

Order Number 016-0597-00 . . . . . $35

FRONT-PANEL CIRCUIT BOARD ADAPTER KIT PS 501 AND PS 503A



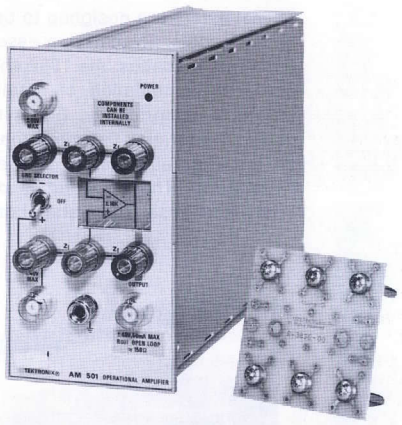
The front-panel circuit-board kit is a convenient way to mount small experimental circuits or fixtures right on the front of a TM 500 power supply.

Typical applications for the adapter are as a device tester (test fixture), educational demonstrator (especially IC's), and in temporary systems functions, e.g., OR'ing and AND'ing two signals. This adapter will supplement the blank plug-in kit for simple or temporary applications.

The adapter kit provides a convenient platform for building up circuits; its pin holes are pre-solder-flowed and some are interconnected. Discrete devices can be readily attached to the adapter kit board, stored, and easily reattached to the "banana jack" plugs on the face of the PS 501 and PS 503A. Circuit clips for inter-connected pin holes are available from Tektronix. The adapter kit is 2½ inches wide.

Order Number 013-0152-00 . . . . . $9.75

AM 501 AUXILIARY CIRCUIT BOARD KIT



The AM 501 Auxiliary Circuit Board Kit attaches to the input and output terminal plugs on the front of the AM 501 Operational Amplifier. The kit is approximately 2½ inches square. The kit is a pc board which has six terminal studs for attachment to the amplifier's banana jacks. This permits the designer to build a circuit of resistors, capacitors, and other components for use in conjunction with the AM 501s input, output, or feedback circuits. With several boards, the AM 501 Op Amp circuit can be changed instantly in configuration from integrator to differentiator to amplifier.

An additional advantage of the kit is that it does not interfere with the other connectors on the face of the AM 501.

Order Number 013-0146-00 . . . . . $9.75

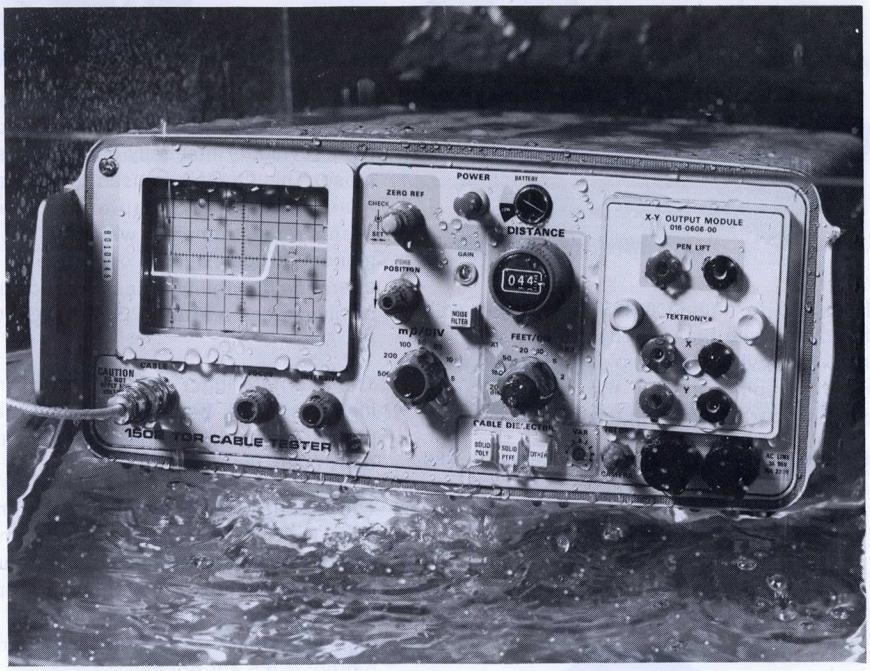
TDR Cable Testers

Portable—Battery Powered, Self Contained, Light (18 pounds), Small (5 x 12½ x 18½ in)

Rugged—Designed to MIL-T-28800, Type II, Class 2, Style A

Versatile—Test Any Type Cable

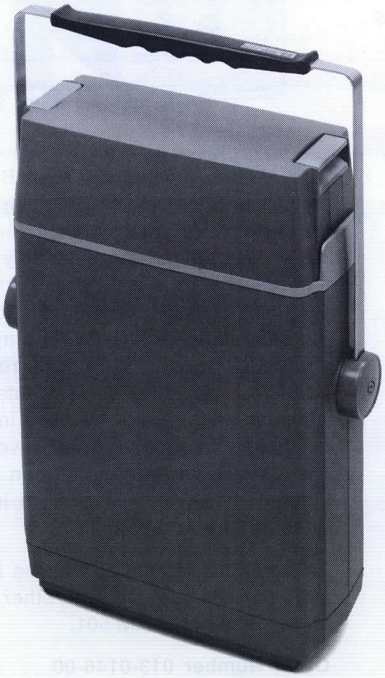
Easy to Use—Produces Results with Minimum Operator Training



The small, portable, rugged, battery-powered 1502 and 1503 TDR Cable Testers are extremely simple to operate and will test any type cable, from lamp cord to coax, under virtually any conditions, from dust to rain, from desert to sea to mountain top. The high resolution (to a fraction of an inch), moderate range (to 2000 feet) 1502 is appropriate for testing coax and other cables in aircraft, ships, radar sites, etc. The long range (to 50,000 feet), moderate resolution (to 3 feet) 1503 is appropriate for testing long runs of coax or twisted pair cables in telephone and other communications applications. These units use Time Domain Reflectometry (TDR), a simple, proven, well established technique, to precisely locate and identify cable faults.

These testers are designed to be field maintenance tools. For carrying ease and operation in tight spaces, the 1502 and 1503 offer an ideal combination of small size, light weight, and portability. Either tester is capable of operation for more than five hours on the internal batteries before recharging is required. The crt used is designed for both visual observation and photography.

Since permanent records are extremely useful in cable maintenance, the optional plug-in Y-T Chart Recorder is available for self-contained hard copy capability. The standard plug-in X-Y Output Module can drive an external X-Y recorder. In addition, an optional adapter for a C-30 camera is available.



1502

This unit has the high-resolution capability of a laboratory time domain reflectometer. It is directly calibrated in reflection coefficient (rho) and distance and is thus very simple to operate. The 1502 uses ultra-fast (110 picosecond), step-type excitation signals, and provides fault resolution to 0.6 inch. The 1502 performs excellently at distances to 2000 feet, even though rise time and resolution typically degrade with increasing cable length. The 1502 is matched to 50 ohm cables, but may be used on other cables by adjusting the front-panel GAIN control or using optional impedance adapters.

1503

The limited bandwidth and relatively high losses common to long cables (particularly twisted pair) require special high-energy, controlled-bandwidth test signals. For these applications, the 1503 provides 10 volt, ½-sine-shaped pulses and is calibrated in decibels for direct reading of return loss. Range of the 1503, dependent upon cable type, is up to 50,000 feet; resolution capability provides for resolving faults as close together as 3 feet. Impedance levels of 50, 75, 93, and 125 ohms are selectable with the press of a button.

Also see 7S12 TDR/Sampler plug-in unit on page 65.

NOTE: Where specifications are different for the metric version, Option 5 (in many cases, the metric specification is not a direct conversion from English measure), or where conversion to metric is appropriate, the metric specifications are shown in italics and are set in brackets.

1502 Characteristics

TEST SIGNAL

Incident Rise: ≤0.055 ft *[≤1.7 cm]* (≤100 ps).

Reflected Rise: ≤0.07 ft *[≤2.1 cm]* (≤140 ps).

Aberrations: ±5% during 1st 10 ft *[300 cm]* after rise. ±0.5% peak beyond 10 ft *[300 cm]* NOISE FILTER "out." ±0.2% peak beyond 10 ft *[300 cm]* NOISE FILTER "in."

Jitter: ≤0.02 ft *[0.6 cm]* (≤40 ps) for X0.1. ≤0.1 ft *[≤3 cm]* (≤200 ps) for X1.

Termination: 50Ω, within 2%.

Pulse Amplitude: 22 mV nominal (into 50 Ω load).

VERTICAL SYSTEM

Deflection Factor: 5 mρ/div to 500 mρ/div.

Accuracy: within ±3%.

Gain: ≥3.5:1 from calibrated point.

Displayed Noise: ±5 mρ or less, NOISE FILTER switch "out."

Low Noise Operation: ±2 mρ or less, NOISE FILTER switch "in."

Test Connector:

Type: bnc.

Coupling: dc.

Max Input: DO NOT APPLY EXTERNAL VOLTAGE.

HORIZONTAL SYSTEM

Distance Controls:

Distance Dial:

Range: 0 to 100 ft *[0 to 25 m]* for X0.1. 0 to 1000 ft *[0 to 250 m]* for X1.

Accuracy: within ±2% ±0.05 ft *[±2% ±0.05 m]* for X0.1. Within ±2% ±0.5 ft *[±2% ±0.5 m]* for X1.

FEET/DIV Control:

Range: 0.1 to 20 ft/div *[0.025 to 5 m/div]* for X0.1. 1 to 200 ft/div *[0.25 to 50 m/div]* for X1.

Accuracy: within 2%.

Dielectric Scales:

SOLID PTFE $\frac{V_p}{V_{air}} = 0.70$

SOLID POLY $\frac{V_p}{V_{air}} = 0.66$

VAR-OTHER $\frac{V_p}{V_{air}} = 0.55$ to 1

VAR is calibrated for air when turned fully cw. Accuracy is within ±2%.

Sweep Repetition: 40 Hz within ±10% with NOISE FILTER switch "out." 4 Hz within ±20% with NOISE FILTER switch "in."

1502 Included Accessories: Watertight front cover, TDR Slide Rule — 003-0700-00, 50 Ω BNC Terminator — 011-0123-00, Precision 50 Ω Cable — 012-0482-00, Viewing Hood — 016-0297-00, X-Y Output Module — 016-0606-00, Replacement Fuses (for front panel) 117 Vac — 159-0029-00 or 234 Vac — 159-0054-00, Power Cord — 161-0066-00, Mesh Filter (CRT) — 378-0055-00, BNC Female-to-Female Adapter — 103-0028-00.

1503 Characteristics

TEST SIGNAL

Duration: 10 ns, 100 ns, 1000 ns ±20%.

Amplitude: 10 V ±20% unterminated. 5 V ±20% terminated.

Shape: ½ sine ±20%.

Termination: 50Ω, 75Ω, 93Ω, or 125Ω, within 1%.

Jitter: 0.2 div max.

VERTICAL SYSTEM

Display:

Range: +6 to −18 dB from reference.

Accuracy: ±3%.

Display Reference:

Range: 0 to 60 dB, 7 steps, 10 dB increments.

Accuracy: ±0.1 dB.

Variable: 0 to 18 dB additive to step increments.

Displayed Noise:

Aberrations: −30 dB p-p.

Random: −80 dB rms.

Low-Noise Operation: −86 dB rms, random.

Test Connector:

Type: bnc.

Coupling: ac.

Max Input: ±400 V (dc + peak ac max frequency of 440 Hz).

HORIZONTAL SYSTEM

Distance Control:

Range: 0 to 50,000 *[0 to 10,000 m]*.

Scales: 5 ft/div to 5000 ft/div *[1 m/div to 100 m/div]*.

Accuracy: ±2%.

Scale Multipliers: X10 and X100 *[X1 and X10]* within 2%.

Distance Dial:

Range: 0 to 2500 ft at X10 setting *[0 to 500 m at X1 setting]*. 0 to 25,000 ft at X100 setting *[0 to 5000 m at X10 setting]*.

Accuracy: ±2% + 1 digit on control setting.

Dielectric Scales:

SOLID POLY $\frac{V_p}{V_{air}} = 0.66$

FOAM $\frac{V_p}{V_{air}} = 0.81$

VAR-other $\frac{V_p}{V_{air}} = 0.31$ to 1.0

VAR is calibrated for air when turned fully cw. Accuracy is within ±2%.

Sweep Repetition: 40 Hz within ±10% (except in camera mode) with NOISE FILTER switch "out." 20 sec/sweep in chart recorder mode (dependent upon chart recorder).

1503 Included Accessories: Watertight front cover, Replacement Fuses (for front panel) 117 Vac — 159-0029-00 or 234 Vac — 159-0054-00, Power Cord — 161-0066-00, Viewing Hood — 016-0297-00, 50 Ω BNC Terminator — 011-0123-00, X-Y Output Module — 016-0606-00, Mesh Filter (CRT) — 378-0055-00.

Common Characteristics

POWER SYSTEM

Line Voltage: 117 Vac ±20%, 48 to 410 Hz. 234 Vac ±20%, 48 to 410 Hz.

Battery Pack:

Operation: At least 5 hr (+20°C to +25°C charge and discharge temperature) including 20 chart recordings.

Full Charge Time: 16 hr.

Typical Charge Capacity:

Charge Temperature	Discharge Temperature		
	−15°C	+20°C to +25°C	+55°C
0°C	40%	60%	50%
+20°C to +25°C	65%	100%	85%
+40°C	40%	65%	55%

EXTERNAL RECORDER INTERFACE (STANDARD X-Y MODULE)

Horizontal: 0.1 V/div, source impedance is 10 kΩ.

Vertical: 0.09 to 0.13 V/div (adjustable), source impedance is 10 kΩ.

PHYSICAL CHARACTERISTICS

Weight: 18 lb *[8.2 kg]* with front cover and standard accessories. 16 lb *[7.3 kg]* without front cover and accessories.

Domestic Shipping Weight: 24.4 lb *[11.1 kg]*.

Export Shipping Weight: Approx 36 lb *[16.4 kg]*.

Height: 5.0 in *[12.7 cm]*.

Width: 12.4 in *[31.5 cm]* with handle. 11.8 in *[29.9 cm]* without handle.

Depth: 16.5 in *[41.9 cm]* including front cover, handle not extended. 18.7 in *[47.4 cm]* handle extended.

ORDERING INFORMATION

1502 TDR Cable Tester $2885
(NSN 6625-01-003-5561)

Option 4 (with recorder) ..... Add **$475**
Option 5 (metric version) ..... no extra charge
Option 6 (234-V version) ..... no extra charge

1502 Optional Accessories

Chart Recorder — 016-0506-01 ..... **$575**
Chart Paper (roll) — 006-1658-00 ..... **$8.00**
006-1658-01 ..... **$4.20**
Camera Adapter — 016-0327-00 ..... **$42.00**
Impedance Adapter —
50/75Ω — 017-0091-00 ..... **$55.00**
50/93Ω — 017-0092-00 ..... **$55.00**
50/125Ω — 017-0090-00 ..... **$55.00**

1503 TDR Cable Tester $2885

Option 4 (with recorder) ..... Add **$475**
Option 5 (metric version) ..... no extra charge
Option 6 (234-V version) ..... no extra charge

1503 Optional Accessories

Chart Recorder — 016-0506-01 ..... **$575**
Chart Paper (roll) — 006-1658-00 ..... **$8.00**
006-1658-01 ..... **$4.20**
Camera Adapter — 016-0327-00 ..... **$42.00**
Isolation Network (for balanced lines)
013-0169-00 ..... **$125**

Digital Photometer/Radiometer

Portability and Versatility

J16 Photometer/Radiometer (Fig 1)

3½-Digit Light-Emitting Diode Readout

Portable

Complete Probe Interchangeability without Recalibration

Available with Metric Readout

The J16 is a portable photometer/radiometer that is equally at home in the lab or in the field. It weighs 3.3 lb, measures 2.4 x 4.6 x 8 in, and comes with a shoulder strap and rechargeable nickel-cadmium batteries. The J16 has excellent long-term calibration stability. It is environmentalized to operate from −15°C to +40°C and meet MIL specs for humidity.

Available for the J16 are eight quickly interchangeable, precalibrated silicon probes, an ac power supply, probe cable (for separate operation of the probes), and analog and bcd outputs.

All J16 Probes

Rugged, Stable Silicon Sensor and Glass Spectral-Correction Filter

Hold Switch to Store Reading

Calibration Accuracy of Reading 5% ± One Digit

No Fatigue or Saturation Effects

Excellent Calibration Stability

J6511 Illuminance Probe (Fig 2)

Accurate Photopic (Color) Correction

Accurate Cosine Correction (180° Field of View)

Measures 0.001 to 1999 Footcandles (0.01 to 19,990 Lux*)

Resolution 0.0001 Footcandles (0.001 Lux*)

5% Accuracy even with Low-Pressure Sodium Lighting

25-Ft Cable Attached

Built-in Bubble Level

Use for OSHA Standards, Office Lighting, Highway Lighting, Automotive Lighting, Medical Lighting

J6523 1° Luminance Probe (Fig 3)

1° Acceptance Angle

Optical Sighting and Viewing System

Accurate Photopic (Color) Correction

Measures 0.1 to 19,990 Footlamberts (1 to 199,900 Nits*)

Resolution 0.01 Footlamberts (0.1 Nits*)

Measures a Spot as Small as 0.23 in at 18-in Distance (up to Ten Times Less with Standard Photographic Close-up Lenses)

Focus Range of 18 in to Infinity

5% Accuracy even with Low-Pressure Sodium Lighting

Use for Highway Lighting, Television, Photographic Equipment

**Metric version.*

Fig 1 Fig 2 Fig 3 Fig 4 Fig 5

J6502 Irradiance Probe (Fig 4)

Flat Spectral Response within ±7% from 450 to 950 nm

Measures 1 nW/cm² to 1.999 mW/cm² (0.01 to 19,900 mW/M²*)

Resolution 0.1 nW/cm² (0.001 mW/M²*)

1-cm² Sensor Allows Direct Reading of Laser Power in Watts

Acceptance Angle Approximately 120°

Use for Lasers, Environmental Research, Tv Monitor Color Temperature Adjustment, Ir LEDs

J6503 8° Luminance Probe (Fig 4)

Accurate Photopic (Color) Correction

Measures 0.1 to 199,900 Footlamberts (1 to 1,999,000 Nits*)

Resolution 0.01 Footlamberts (0.1 Nits*)

Use for Television, Illumination, Photographic Equipment, Cathode-Ray Tubes

J6501 Illuminance Probe (Fig 4)

Same Characteristics as J6511 Except No Cosine Correction; Construction Similar to J6502. (When using 014-0047-00 LED Adapter, the ranges are the same as those for the J6505.)

Use for Green and Yellow LEDs, Lamp Testing, and Other Point Light Sources

J6505 Red LED Probe (Fig 4 and 5)

Accurately Matches Photopic Curve from 600 to 710 nm

Measures 0.01 Millicandela to 199.9 Candelas at 3.8 in (Higher at Greater Distances)

Resolution 0.01 Millicandela

Includes Snap-on LED Adapter to Position LED and Exclude Room Light

Use for Red LEDs, Red Automotive, and Aircraft Lights

J6512 Irradiance Probe (Similar to Fig 2)

Same Characteristics as J6502; Construction Similar to J6511

Use for Lasers, Environmental Research

J6504 Uncorrected Probe (Fig 4)

Spectral Response: Uv-Enhanced Silicon Curve (250 to 1200 nm)

Highest Sensitivity (No Filters Are Used to Modify Spectral Response)

Relative Reading Only

Use for Periodic Tests of Photoresist Exposure Equipment, Uv Light Sources

ORDERING INFORMATION

Photometer/Radiometer without Probes

Readout Units	Power Source	Voltage	Order† Information	Price
US	Battery	115 V, 60 Hz battery charger	J16	$660
US	Battery	230 V, 50 Hz battery charger	J16 Opt 1	$660
US	Ac	115 V, 50-400 Hz	J16 Opt 3	$660
US	Ac	230 V, 50-400 Hz	J16 Opt 4	$660

†For a J16 with metric readout, specify Option 2 In addition to above ordering information. No additional charge.

INCLUDED ACCESSORIES

For Battery-Operated J16—Battery charger, shoulder strap, manual.

For Ac Operated J16 — Shoulder strap, manual.

For probes with metric readout, specify Option 2 at no additional charge.

J6511 Illuminance Probe.....$330

J6523 1° Luminance Probe $850

J6502 Irradiance Probe $330

J6503 8° Luminance Probe $330

J6501 Illuminance Probe $330

J6505 Red LED Probe $380

J6512 Irradiance Probe $400

J6504 Uncorrected Probe $330

ACCESSORIES

42-in Probe Extension Cable for J6501, J6502, J6503, J6504, and J6505.
Order 012-0414-02 (Longer on Special Order).....**$45**

Light Occluder (for Color Tv Monitor Setup).
Order 016-0305-00 .....**$16**

Filter Holder — Mounts 1-in Diameter Filters to J6501, J6502, J6503, J6504, and J6505.
Order 016-0527-00 .....**$12**

Filter Holder — Mounts 2-in Diameter Filters to J6512.
Order 352-0380-00 .....**$1.75**

Tripod, Order 016-0253-00 .....**$50**

Ac Power Supply, 115 V, 50-400 Hz.
Order 119-0404-00 .....**$125**

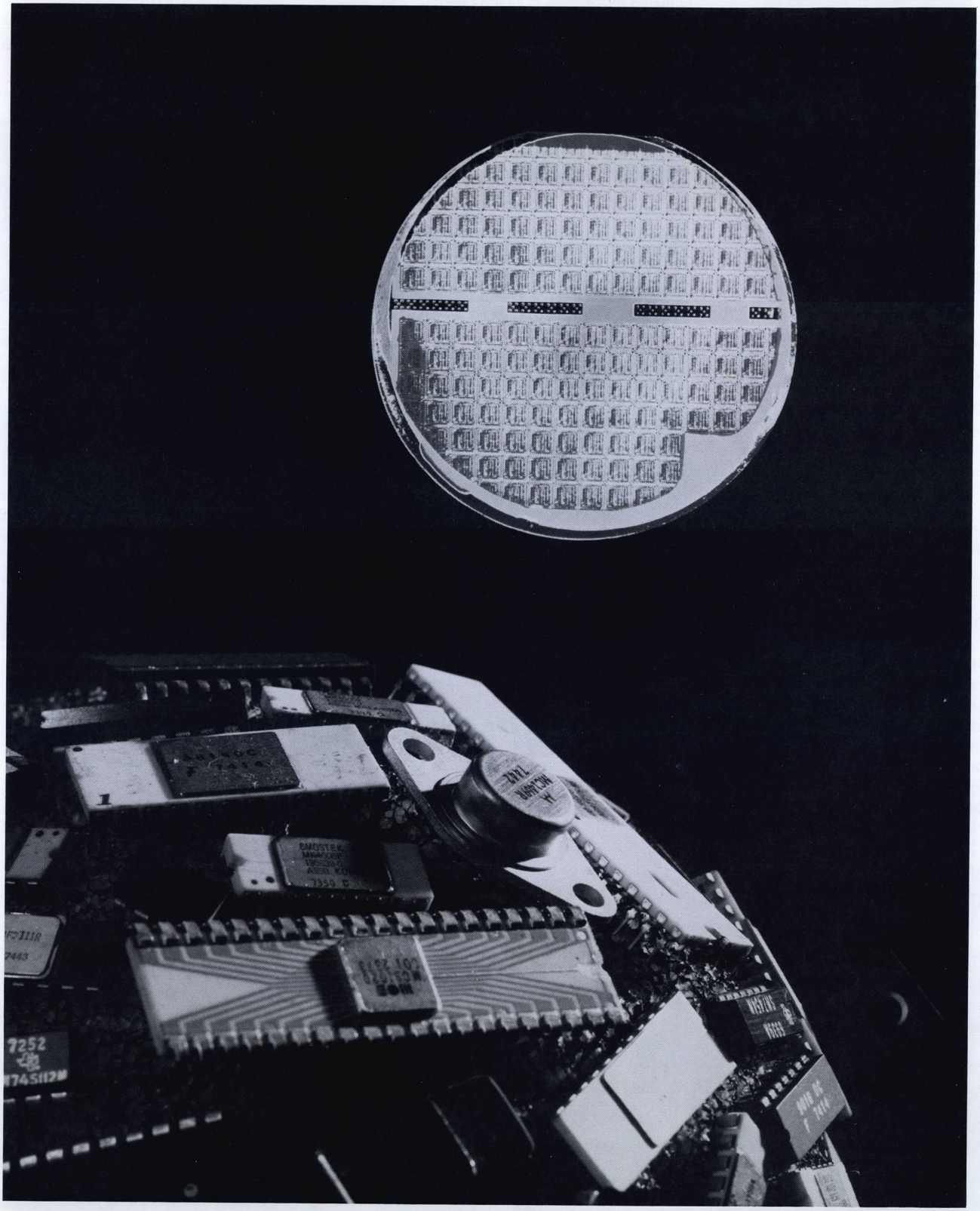
Ac Power Supply, 230 V, 50-400 Hz.
Order 119-0404-01 .....**$125**

LED Adaptor (Included with J6505).
Order 014-0047-00 .....**$ 55**

For a complete brochure and application notes on the J16 please return the reply card attached to the catalog or see your Tektronix field representative.

Semiconductor Device Test Systems

8



Automatic Test Systems Summary

IC device users buy TEKTRONIX Automatic Test Systems for:

Device Evaluation

Failure Analysis

Incoming Inspecton

IC Manufacturers buy TEKTRONIX Automatic Test Systems for:

Device Characterization

Failure Analysis

Quality Control

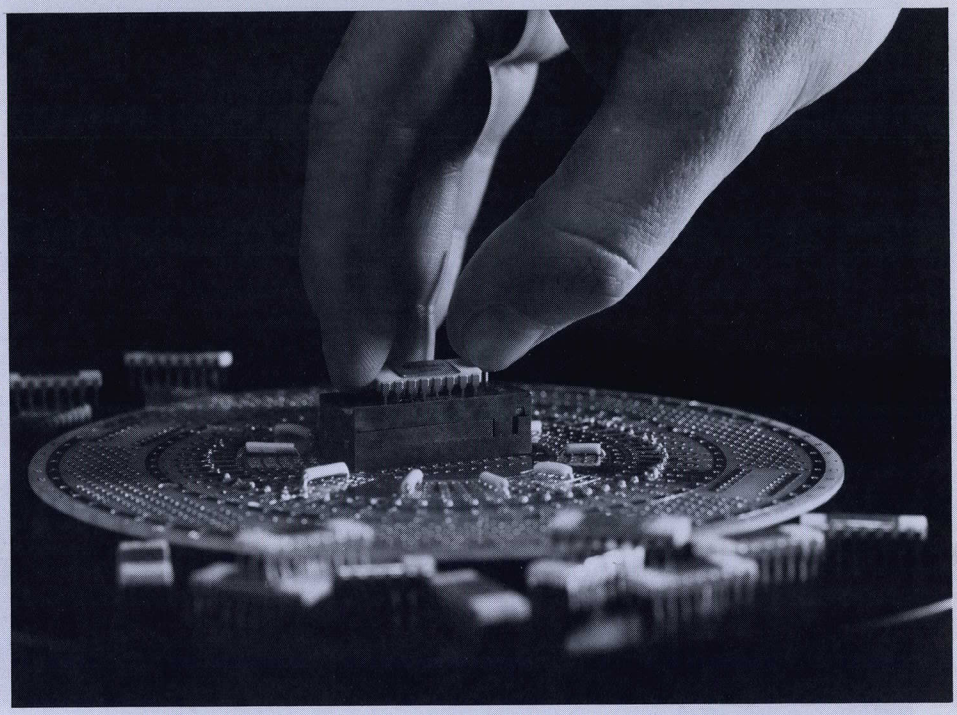
Outgoing Inspection

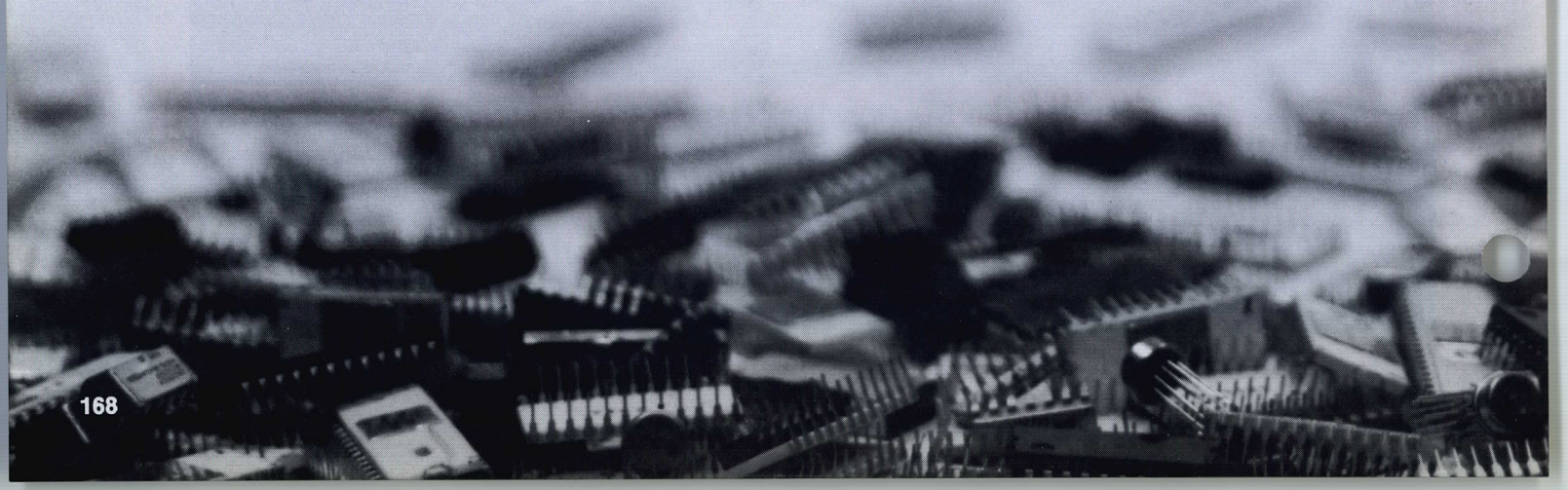
Name a Technology:	**Name a Device:**
PMOS	Microprocessors
NMOS	UARTs
CMOS	ALUs
Hybrid	Programmable Logic Arrays
	Peripheral Interface Circuits
	Shift Registers
	RAMs
	ROMs
	PROMs

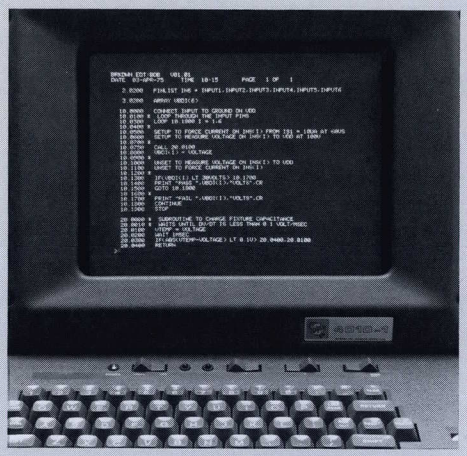
Tektronix has a test system to test them ALL.

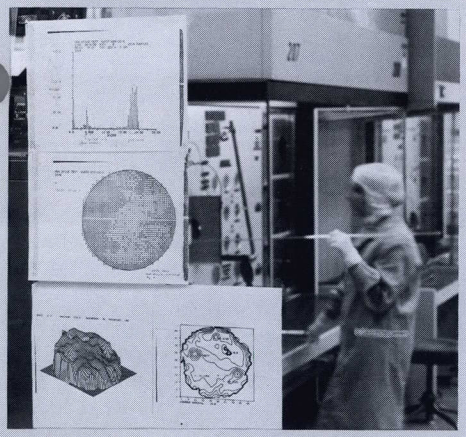
Tektronix Test Systems combine the capabilities of a sophisticated automatic test system with a data processing system — providing a totally integrated package that both acquires and processes test and measurement data. This provides IC users and manufacturers with a powerful tool capable of acquiring information (related to devices and device manufacturing processes) that was heretofore either impractical or impossible to obtain.

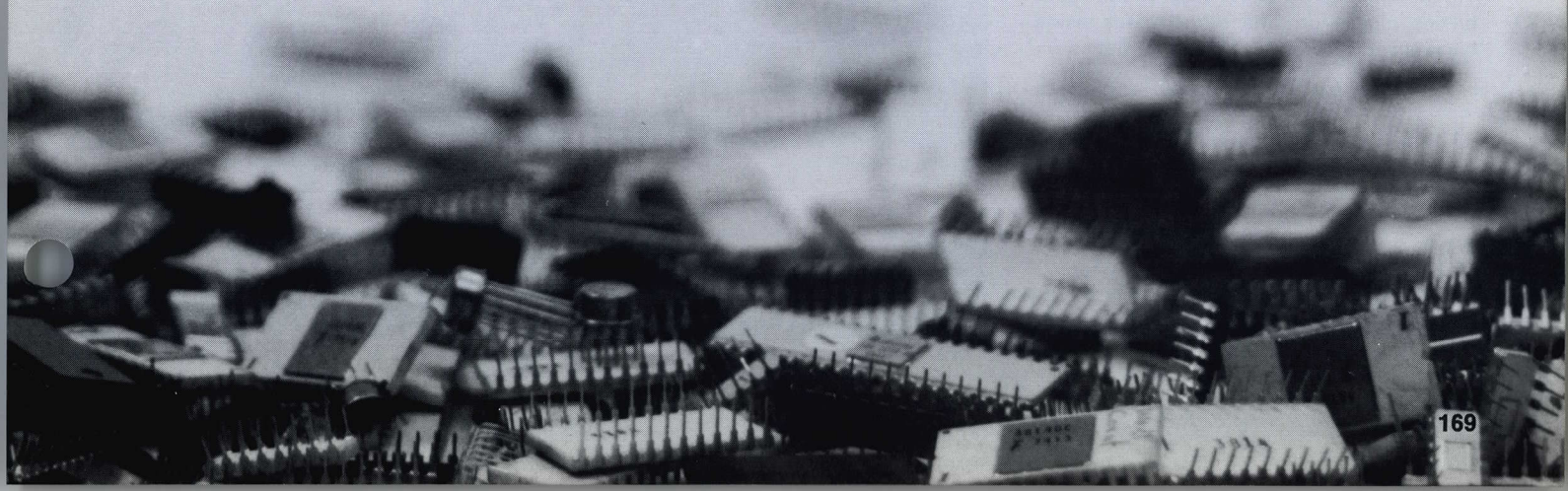
To learn more about TEKTRONIX Automatic Test Systems use the reply card, inside back cover, and request more information on Automatic Test Systems; or for faster action call your local Tektronix Field Office and ask for the TEKTRONIX Sales Engineer specializing in Automatic Test Systems.











Curve Tracer Summary

Semiconductor device users buy TEKTRONIX Curve Tracers to:

Evaluate Devices

Improve Circuit Designs

Troubleshoot Prototype Circuits

Screen Incoming Devices

Semiconductor device manufacturers buy TEKTRONIX Curve Tracers for:

Device Characterization

Process Control

Failure Analysis

Quality Control

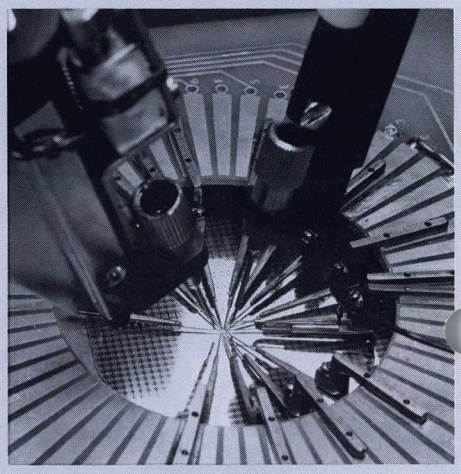
Outgoing Inspection

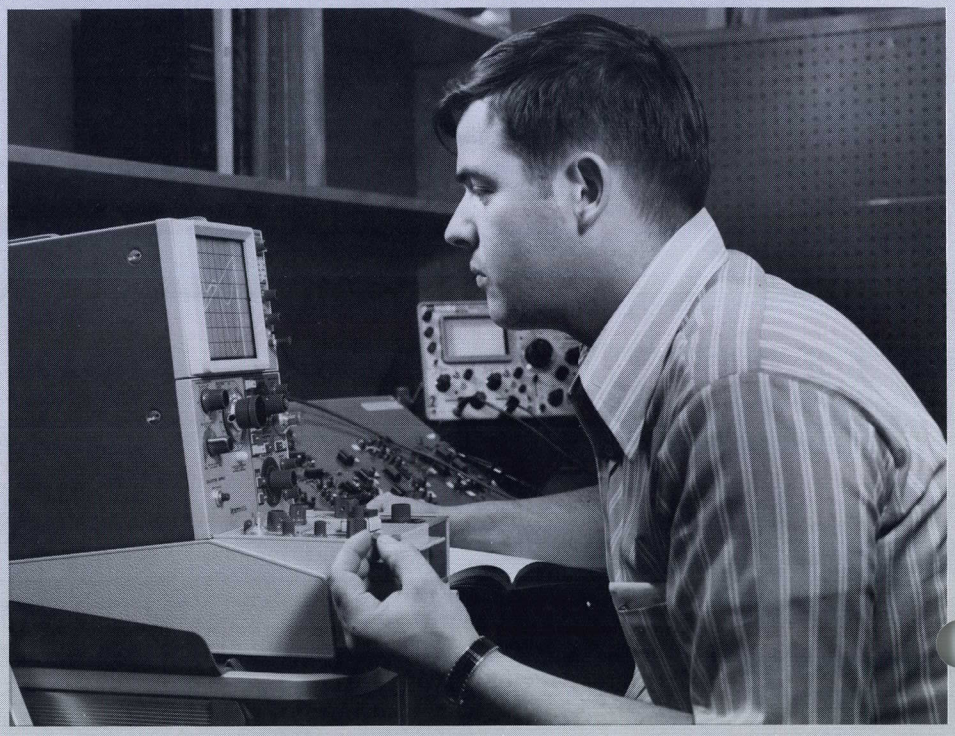
Curve Tracers display one or more of the characteristic curves of two- and three-terminal semiconductor devices and integrated circuits. Unlike an oscilloscope, the Curve Tracer display is voltage vs current rather than voltage vs time. A few of the typical measurements performed with a Curve Tracer are:

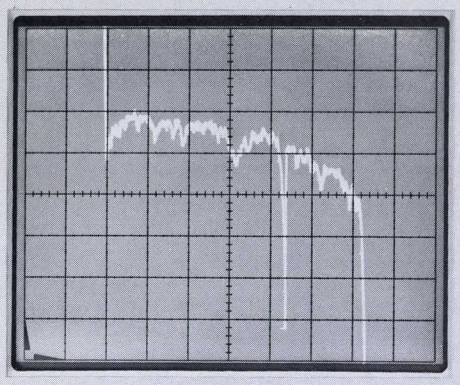
Two and Three Terminal Devices	Breakdown Voltages Leakage Currents Gain Saturation Voltages Forward Voltage and Current Reverse Voltage and Current and more.
Linear ICs	Offset Voltage Input Currents Gain CMRR PSRR and more.
Digital ICs	Output Voltages Input Voltages Output Currents Input Currents Supply Currents and more.

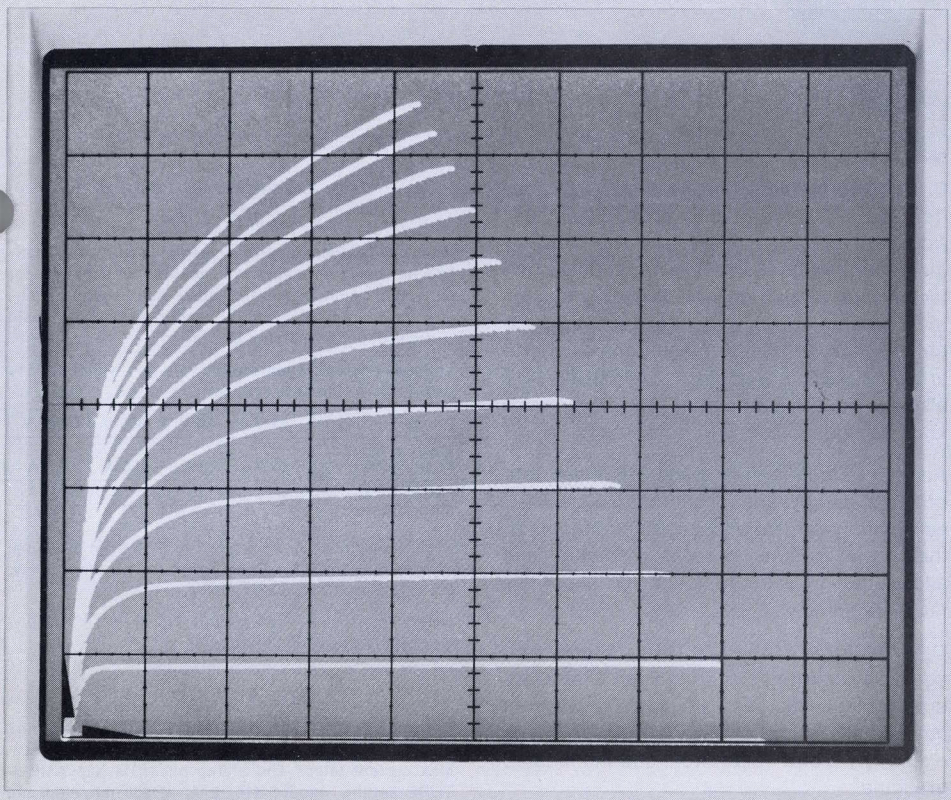
For a more complete discussion of Curve Tracer applications and measurement capabilities please use the return card, inside back cover, to write for more information on Curve Tracer Systems. In response, we will send you a Curve Tracer brochure, application notes, and other materials to help you choose the Curve Tracer System for your requirements. If you are well acquainted with Curve Tracers, you will find the Curve Tracer System descriptions (pp 172-182) helpful in choosing the system that best meets your requirements.

TEKTRONIX Curve Tracer Systems are configured around two basic mainframes — the 576 and the 577. Both mainframes are general purpose Curve Tracers; however, the 577 is the only mainframe offering a storage display. To provide a variety of capabilities, each of these mainframes employs plug-in test fixtures. With a 576 Curve Tracer System you may choose from the three test fixtures. The 577 Curve Tracer System offers two. Between the test fixture and the device under test (dut) is a socket adapter. It provides the interface between the Curve Tracer System and the dut. Thus, each Curve Tracer System is composed of a mainframe, test fixture, and a socket adapter (see diagram).









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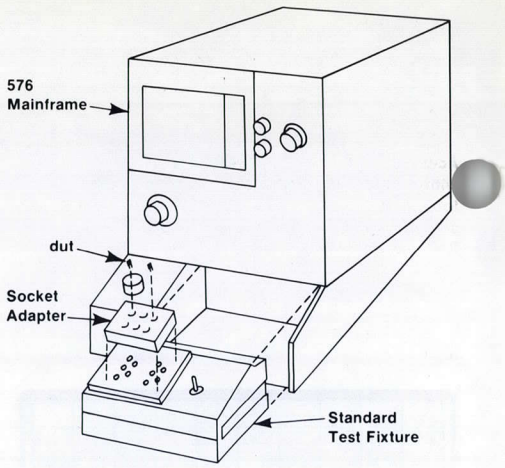
Curve Tracers

General Purpose System with Digital Readout Available



The TEKTRONIX 576 Curve Tracer System continues to hold the title "standard of the industry." The 576 accepts three different test fixtures: the Standard Test Fixture, 172 Programmable Test Fixture (described on pg 174), and the 176 Pulsed High-Current Fixture (described on pg 175). The 576 is an excellent general purpose Curve Tracer System that performs well in applications where high current testing is required.

With the Standard Test Fixture, the Collector Supply of the 576 delivers up to 220 watts peak to the dut. The Step Generators can deliver up to 2A in both its current and voltage modes of operation. Of course, with the 176, the 576 is capable of pulsed collector operation up to 200 amps peak.

One of the features that sets the 576 apart from the 577 is the display area READ-OUT. Adjacent to 576's crt are alphanumeric indicators of vertical and horizontal deflection factor, step amplitude, and Beta/div or gm/div. The Beta or gm readout saves the operator from the arithmetic usually necessary to arrive at these parameters. The READ-OUT also provides a permanent record of major knob settings in 576 crt photographs.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows the operator to make more precise measurements.

Other features of the 576 Curve Tracer are: adjustable current limiting in the Step Generator, either 300 μs or 80 μs pulse width in pulsed base operation, pushbuttons to check display zero and calibration, and illuminated graticule.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes — NORM: positive or negative full wave rectified ac (line frequency); dc: positive or negative dc; LEAKAGE: emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

Voltages — Peak open circuit voltages within +35% and −5% of indicated range.

Range	15 V	75 V	350 V	1500 V
Max Continuous Peak Current	10 A	2 A	0.5 A	0.1 A
Peak Pulse Mode Current	≥20 A	≥4 A	≥1 A	≥0.2 A

Series resistance is from 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak power limit setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock — Protects operator from 75 V, 350 V, and 1500 V collector voltages.

STEP GENERATOR

Current Mode — Step/offset amplitude range is 5 nA/step (with 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 pushbutton.

Step Family — REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps — Digitally selectable between 1 and 10.

DEFLECTION CONTROLS

Display Accuracies — As percentage of highest on-screen value.

		OFFSET and MAGNIFIED with CENTERLINE VALUE from:		
NORM and DC MODES	**NORMAL**	**100-40 div**	**35-15 div**	**10-0 div**
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20, or 2 nA	3% plus 50 mV/vert div			
500, 50, or 5 nA	3% plus 125 mV/vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor — Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

Horizontal Deflection Factor — Collector volts; 50 mV/div to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step generator; 1 step/div.

Displayed Noise — 1% or less or:

RANGE	15 V	75 V	350 V	1500 V
Vertical—Collector	1 μA	1 μA	2 μA	5 μA
Vertical—Emitter	1 nA	1 nA	2 nA	5 nA
Horizontal—Base	5 mV	5 mV	5 mV	5 mV
Horizontal—Collector	5 mV	5 mV	20 mV	200 mV

Calibrator (CAL) — Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls — Fixed 5 div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset — 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

CRT and READOUT

CRT — 6½ in rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied.

Readout — The readouts, adjacent to crt, are digital indicators of the following parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mA/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

STANDARD TEST FIXTURE

Description — A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

OTHER CHARACTERISTICS

Power Requirements — Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-charge line-voltage range selector accommodates 90 V ac to 136 V ac or 180 V ac to 272 V ac (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature — Performance characteristics are valid over an ambient temperature range of +10° C to +40°C.

Dimensions and Weights

	in	cm
Height	15.0	38.1
Width	11.5	29.2
Depth	23.0	58.2
	lb	**kg**
Net Weight	70.5	32.0
Shipping Weight	≈107	≈48.5

INCLUDED ACCESSORIES

Transistor adapter (013-0098-02), FET adapter (013-0099-02). TO3 adapter (013-0100-01), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), large in-line adapter (013-0138-00), small in-line adapter (013-0139-00), and protective cover (337-1194-00).

ORDERING INFORMATION

576 Curve Tracer with Standard Test Fixture $4825

The 576 Option 1 deletes the parameter readout module but maintains provisions for insertion of the module # (020-0031-00) at any time.

Order Option 1 ..... Sub $400

Auto Seal-Factor Readout Module Order 020-0031-00 ..... $610

OPTIONAL ACCESSORIES

Camera — See Oscilloscope/Camera Adapters chart in camera section of this catalog.

SCOPE-MOBILE® Cart — Tek Lab Cart Model 3.
Order Model 3 ..... $285

Test Set-up Chart — Package of 250.
Order 070-0970-01 ..... $6.50

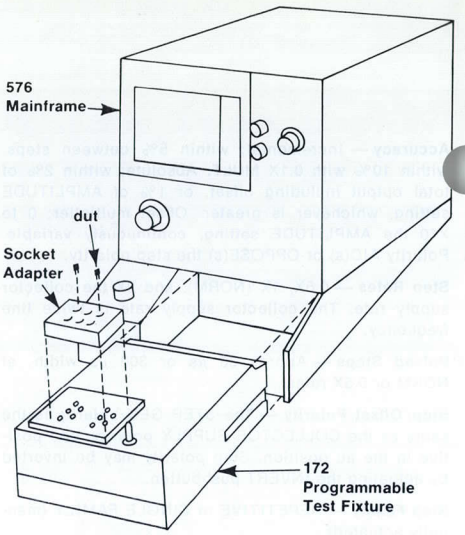
172 Test Fixture ..... See page 174

176 Test Fixture ..... See page 175

Socket Adapters ..... See page 180

Curve Tracers

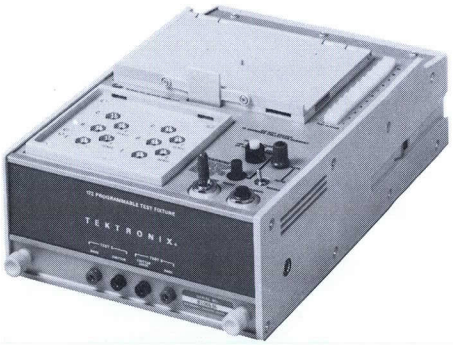
Programmable Test Fixture for the 576



The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program a sequence of tests of 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.

The 172 sequences through the various tests either automatically or manually. A variable RATE control is provided for the operator to set the test sequence at a rate which is best for him. A new operator requires more time per test, but with experience he will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.



TESTS THAT CAN BE PERFORMED ON:				PROGRAMMABLE CAPABILITIES
Test	Xstr	J FETs	Diodes	
1*	H_{FE}, $V_{CE(sat)}$	V_P	V_F	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V.
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (other conditions same as Test 1).
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA. When testing J 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 V dc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is nA/div.
6	I_{CBO}	I_{GSS}		Same as #5.
7	I_{EBO}		I_R	Same as #5.
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 100 mA dc for breakdown voltage measurements to 50 V.
9	$V_{(BR)CES}$			Same as #8.
10	$V_{(BR)CBO}$	BV_{GSS}		Same as #8.
11	$V_{(BR)EBO}$		V_R	Same as #8.

*All of the test conditions for Test 1 are controlled by the 576 front-panel controls. Test 2 has the same conditions as for Test 1 except the horizontal amplifier is connected to the emitter-base terminals, and the horizontal deflection factor is controlled by the programming card.

For the remaining tests the only 576 controls that are functional are the Polarity and crt controls such as INTENSITY, FOCUS, DISPLAY OFFSET.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies — The same as the 576 Curve Tracer with its included Standard Test Fixture.

Vertical Deflection Factor — Test 1 and 2 (Collector or Emitter Current): 1_C, 1 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1μA to 0.5 A/div in 18 steps. Test 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1, 2, 5 sequence.

Horizontal Deflection Factor — Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for test 2, at least 100 MHz at 100 mV/div and 200 mV/div. 1 MΩ (within 2%) at 0.5 V/div, 1 V/div, and 2 V/div. Tests 3 and 4 (Collector Voltage): 100 mV/div to 2 V/div in 5 steps. Test 5 through 11 (Breakdown or Leakage Voltage): 100 mV/div to 50 V/div in 9 steps. All steps are in a 1, 2, 5 sequence.

Collector Sweep Voltage — At least 2 V open 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

	in	cm
Height w/cover	6.5	16.5
Width	7.8	19.8
Depth	12.4	31.4
	lb	**kg**
Net weight	11.5	5.2
Shipping weight	≈18.0	≈8.2

Included Accessories — One protective cover, five programming cards, 250 programming card pins, five crt overlay limit cards.

ORDERING INFORMATION

172 Programmable Test Fixture $2025

OPTIONAL ACCESSORIES

Programming Cards — Package of 25 programming cards without pins or limit cards.
Order 016-0198-01 . . . . . **$50**

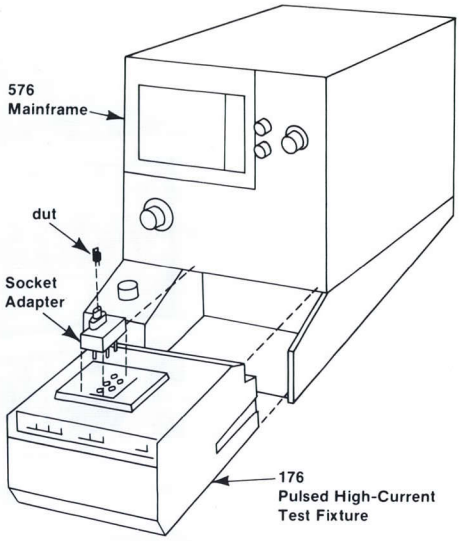
Crt Limit Cards — Package of 25 limit cards without programming cards or pins.
Order 016-0510-01 . . . . . **$24**

Programming Pins — Package of 1000 programming pins without programming or limit cards.
Order 016-0519-01 . . . . . **$32**

Foot Switch — For manually sequencing the programmed test.
Order 260-1189-01 . . . . . **$27**

Programming Accessories Package — Includes one programming card, one CRT limit card, and 50 programming card pins.
Order 016-0518-00 . . . . . **$6**

Program Set-up Charts — Package of 250.
Order 062-1615-00 . . . . . **$7**



The 176 Pulsed High-Current Fixture provides the 576 Curve Tracer with pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously considered impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over dissipation. The 176 test fixture fits in place of the 576 Standard Test Fixture. The collector pulse is slaved to the 576 in regard to width and repetition rate. The pulse width is selected by depressing the 300 μs or 80 μs pushbutton on the 576 mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT pushbutton on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP pushbutton on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP pushbuttons provide inputs to the fiberoptic readout to display actual values.

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width — 300 μs or 80 μs determined by 576.

Repetition Rate — Power-line frequency.

Polarity — + or − determined by 576 polarity control.

Amplitude — Ranges are 15, 75, 350 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.

Max Peak Watts — Three illuminated pushbuttons select 10, 100, 1000 watts max peak power.

STEP GENERATOR

Current Ranges (X10 STEP selected) — Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.

576 Offset Multiplier — 0 to X100 576 AMPLITUDE switch setting.

Step Rate — Power-line frequency.

Pulsed Steps — 300 μs or 80 μs wide.

Step/Offset Polarity — The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT pushbutton.

Accuracy (Current steps including offset) — Incremental is within 5% between any two steps; within 10% with 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

	in	cm
Height	4.6	11.8
Width	7.9	20.0
Depth	11.4	28.9
	lb	**kg**
Net weight	12.8	5.8
Shipping weight	18.0	8.2

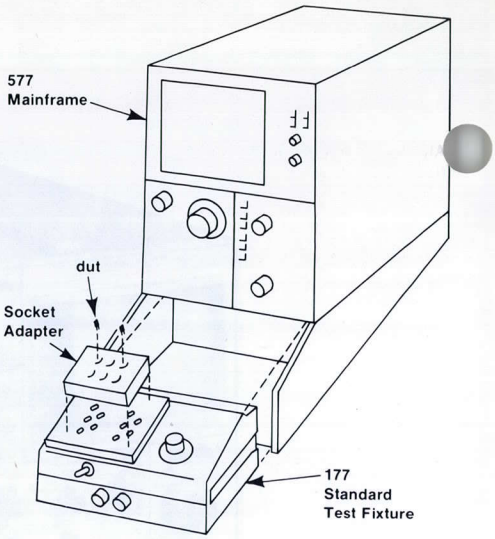
Included Accessories — TO-36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective shield (337-1194-00).

ORDERING INFORMATION

Order 176 Pulsed High-Current Fixture $2325

Curve Tracers

General Purpose System with Storage Display Available



The 577 Curve Tracer System, when used with the 177 Standard Test Fixture, is a smaller and lighter configuration that retains many of the important features and performance of the 576. The 577 also accepts the 178 Linear IC Test Fixture. The major features that separate the 577 from the 576 are storage and the emphasis on low current measurements.

The 577's storage crt may be used to overlay the characteristic curves of one device on top of the stored characteristics of another. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the crt while in the Storage Mode. A good example of a dot display occurs in Op Amp testing because the open-loop 3-db bandwidth of many Op Amps is so low that the curves must be plotted slowly. Linear ICs such as Op Amps may be tested with the 577 by using the 178 linear IC Test Fixture (see page 178).

In the 577/177 Curve Tracer System several features facilitate low current measurements; they include: small current sensing resistors (which result in less capacitive looping), current sensing that always takes place in the Collector Supply lead (which permits measurements on three terminal active devices at the lowest current ranges and eliminates the need for a correction to the horizontal deflection factor), and a display filter (which reduces vertical deflection noise).

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available, 10 A continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the Step Generator, an uncalibrated bias supply, independent magnifiers that increase resolution on either or both crt axes, and a beam finder.

CHARACTERISTICS

All characteristics are for the 577 Curve Tracer mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Modes — Five modes of Collector Supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc, or negative dc.

Voltage — The voltage is variable to the max peak volts selected.

Max Peak Volts Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

Series Resistance — 14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains max peak power to the device-under-test when changing voltage ranges.

Safety Interlock — Protects operator from 100-, 400-, and 1600-volt ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Current Mode — Step amplitude range is 5 nA/step (with STEP X0.1) to 200 mA/step, in a 1-2-5 sequence. Available current is at least 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%.

Step Rate — Selectable at 1X (SLOW), 2X (NORM), or 4X (FAST) line frequency.

Pulsed Steps — Steps can be gated for a duration of approx 300 μs for testing at low duty cycle.

Step/Offset Polarity — With NORM POLARITY selected the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with STEP/OFFSET POLARITY control or from the test fixture.

Offset — The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either AID or OPPOSE steps. Max range of offset is 10 full-amplitude steps.

Step Family — Repetitive or single family.

Number of Steps — Selectable from 1 to 10 full-amplitude steps. Selectable up to approx 95 steps when using STEP X0.1 multiplier.

DEFLECTION CONTROLS

Display Accuracies — As a percentage of highest on screen value.

Display Mode	Normal	Magnified
Vert Collector Current	3% ±1nA	4% ±1nA
Horiz Collector Volts	3%	4%
Horiz Base Volts	3%	4%
Horiz Step Gen	4%	5%

Vertical Deflection Factor — Collector current is 2 nA/div to 2 A/div, 28 steps in 1-2-5 sequence (0.2 nA/div to 0.2A/div with x10 magnification).

Horizontal Deflection Factor — Collector volts; 50 mV/div to 200 V/div, 12 steps in a 1-2-5 sequence (5 mV/div to 20 v/div with X10 magnification). Base volts; 50 mV/div to 2V/div, 6 steps in a 1-2-5 sequence (5 mV/div to 0.2 v/div with X10 magnification). Step generator; 1 step/div (0.1 step/div with X10 magnification).

Automatic Scale Factor Readout — Change in deflection factor is indicated by lights behind the knob skirt when using X10 MAG.

Automatic Positioning — Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert — Single control inverts display and repositions trace.

Display Filter — Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

Crt — Rectangular 6½ in with an 8 x 10 div (1.27 cm/div) parallax-free internal graticule. Two display modules are available for the 577. The D1 display unit has a split-screen storage crt with phosphor similar to P1. The D2 display unit has a nonstorage crt with P31 phosphor. Accelerating potential is 3.5 kV.

Beam Finder — Compresses off-screen trace to within graticule area.

177 TEST FIXTURE

Device Lead Selection — Switch provides six different lead configurations. Three positions for EMITTER GROUNDED measurements provide STEP GEN, OPEN (OR EXT) and SHORT base terminal connections. Two positions for BASE GROUNDED measurements provide STEP GEN and OPEN (OR EXT) emitter terminal connections. One position provides for EMITTER BASE BREAKDOWN or leakage measurements up to 25 volts.

Left-Right Switch — Selects left or right test connections. Off in center position. Test connection area accepts all TEKTRONIX Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation — Reduces display loops due to test adapter capacitance and some device capacitance.

Variable Voltage Supply — Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements — 100, 110, 120 Vac or 200, 220, 240 V ac all within ±10%. 50 to 60 Hz, 155 watts max at 110 V ac and 60 Hz.

Ambient Temperature — Performance characteristics are valid over an ambient temperature of +10°C to +40°C.

Dimensions and Weights

	577/D1 or 577/D2		177	
	in	cm	in	cm
Height	19.8	50.3	4.0	10.2
Width	8.8	22.4	7.9	20.1
Depth	23.0	58.4	6.0	15.2
	lb	kg	lb	kg
Net Weight	40	18.1	2.5	1.1
Shipping Weight	50	22.7	6	2.7

Note: When the 577 and 177 are ordered together their combined shipping weight is: domestic ≃53 lb or ≃24 kg.

INCLUDED ACCESSORIES

Transistor adapter for most bipolar-transistors and some MOS FETs (013-0098-02), axial lead diode adapter with Kelvin sensing terminals (013-0111-00), protective shield for test connection area (337-1194-00).

ORDERING INFORMATION

577/D1 Storage Curve Tracer Mainframe $2625

577/D2 Nonstorage Curve Tracer Mainframe $2300

177 Standard Test Fixture $500

Option 10, 10 x 10 cm Graticule; available with either storage or nonstorage mainframe ..... **Add $35**

OPTIONAL ACCESSORIES

178 Linear Test Fixture; see following page for complete description **$1325**

Camera — C-5A, see pg 225 for complete description **$235**

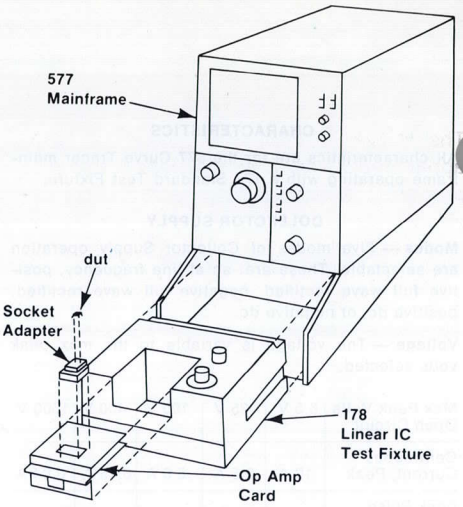
SCOPE-MOBILE® CART — Tek Lab Cart, Model 3 (see pg 262)
Order MODEL 3 ..... $285

Test Set-up Chart — package of 250
Order 070-1639-00 ..... $7.50

Device Adapter Sockets: see pages 180 & 181 for complete description.

577/178 Curve Tracers

A Linear IC Test Fixture for the 577



Tests Single, Dual, or Quad:

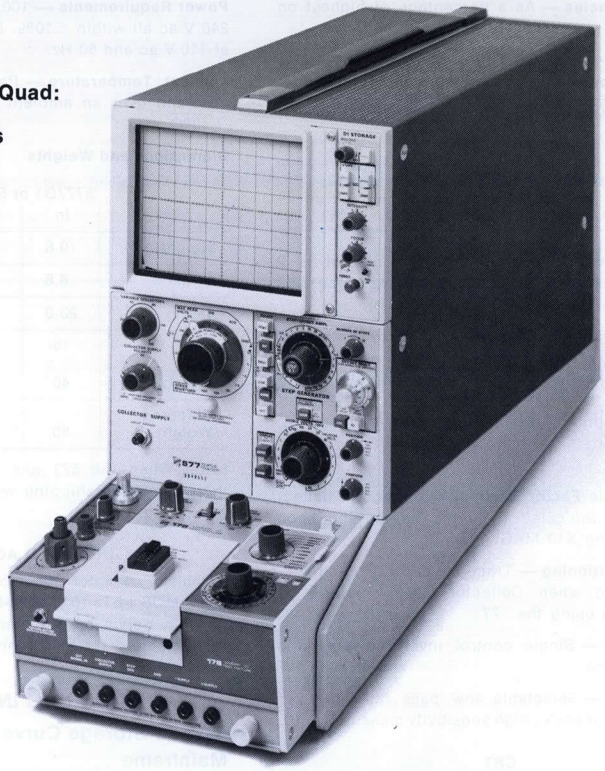
Operational Amplifiers

Comparators

Differential Amplifiers

Regulators

and More



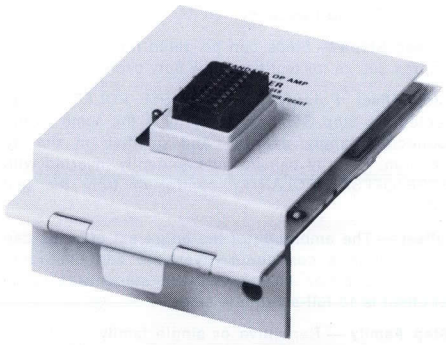
Since linear ICs are typically tested under very low current conditions, the 577/178 Curve Tracer System is ideally suited to the task. The 178 linear IC Test Fixture provides the necessary accurate low current measurement capability, Test Cards set up the measurement function, and the 577's storage crt allows the operator to transform the dot display (usually seen under low current dc conditions) into a complete characteristic curve by slowly sweeping the dot across the crt while in the Storage Mode.

A 577/178 Curve Tracer System is composed of a 577 mainframe, 178 Linear IC Test Fixture, appropriate Test Cards (choose from three Op Amp Cards and two Regulator Cards), and the proper Socket Adapter (see page 181) that interfaces the system to the device-under-test.

Test Cards, which slide into the 178, define the measurement function of the 178 Test Fixture. Two families of Test Cards are available: Op Amp Cards and Regulator Cards. Op Amp Cards are used for testing standard and special Op Amps, Comparators, Differential Amplifiers, Video Amplifiers, etc. Regulator Cards are used for testing positive and negative three terminal voltage regulators.

OP AMP CARDS

There are three types of Op Amp Cards: the Standard Op Amp Card, Hardwire Card, and the Multiple Op Amp Card.

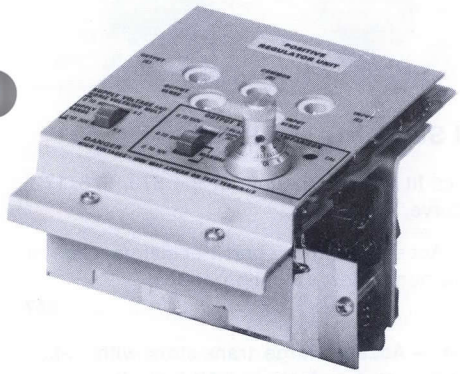


The **Standard Op Amp Card** is designed to test devices that require single or dual power supplies, have two (differential) high-impedance inputs, and a single output. Common measurements include: offset voltage, positive and negative input current, cmrr, gain, positive and negative psrr, positive and negative supply current, and collector supply current.

The **Hardwire Card** is designed for those applications where there is an advantage in preparing individual cards for specific devices so that they may be quickly switched to accommodate a change in the type of device-under-test. The Hardwire Card also offers a greater degree of freedom to the knowledgeable designer in testing special devices.

The **Multiple Op Amp Card** allows the operator to test up to four Op Amps in a single package by simply operating a four-position switch. The four-position switch selects the Op Amp (in a multiple Op Amp package) or the section of a linear IC to be tested. The measurements performed are the same as those available with the Standard Op Amp Card.

Socket Adapters for Op Amp Cards — The device-under-test socket on the Standard and Multiple Op Amp Cards accepts several types of socket adapters using the Amphenol-Barnes adapter system. This system accepts most of the standard package configurations (T05, DIP, flat pack, etc.). Sockets for these cards are shown on page 181.



REGULATOR CARDS

There are two types of Regulator Cards, positive and negative. These cards are used primarily in measuring parameters of three-terminal voltage regulators. Parameters measured include: output voltage, load regulation, line regulation and ripple regulation, and quiescent and common terminal current.

Socket Adapters for Regulator Cards — Socket adapters for both positive and negative three terminal regulators are the same as the Kelvin Sensing Sockets used on the standard curve tracer (see page 181).

CHARACTERISTICS

VERTICAL DEFLECTION (1-2-5 Sequence)	NORMAL	MAGNIFIED
Input Voltage or Δ Input Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy	3% ±50 pA	4% ±50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy	3% ±0.1 μA	4% ±0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy	3% ±1 nA	4% ±1 nA

Accuracies are a percentage of highest on-screen values.

Power Supplies — Positive and negative supplies are adjustable from 0 to 30 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 to the device under test.

Zero — Single pushbutton provides a zero reference to the crt display and, in certain functions, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

THREE TERMINAL REGULATOR TEST CARD CHARACTERISTICS

Device under Test Input Supply

INPUT VOLTAGE — Two ranges, 0-30 V and 0-60 V. 0-30 V is within ±2% ±200 mV of dial setting, and 0-60 V is within ±2.5% ±300 mV of dial setting.

REGULATION — Within 200 mV.

INPUT SWEPT FREQUENCY — Dc to 1 kHz.
300 μs PULSED CURRENT — 5 mA to 2 A.

SHORT DURATION DC CURRENT (One minute) —

Supply Voltage	Current
0 - 10	700 mA
10 - 20	350 mA
20 - 40	300 mA
40 - 60	120 mA

Device under Test Current Load — 5 mA to 2 A within ±3% of 0 to 1.25 mA.

Device under Test Comparison Output Dc Voltage Accuracy — 0-10 V range within ±1% ±20 mV; 0-100 V range within ±1% ±150 mV.

OTHER CHARACTERISTICS

Dimensions and Weights

	in	cm
Height	4.5	11.4
Width	7.9	20.1
Depth	7.8	19.8
	lb	**kg**
Net Weight	3.3	1.5
Shipping Weight	8	3.6

Included Accessories — Dual-in-line 16 pin IC socket (136-0442-00). Standard Op Amp Card with cover and ten patch cords (013-0149-00), interchangeable nomenclature panel for function switch (333-1770-00).

ORDERING INFORMATION

178 Linear IC Test Fixture $1325

Standard Op Amp Card — (One included with 178)
Order 013-0149-00 . . . . . $100

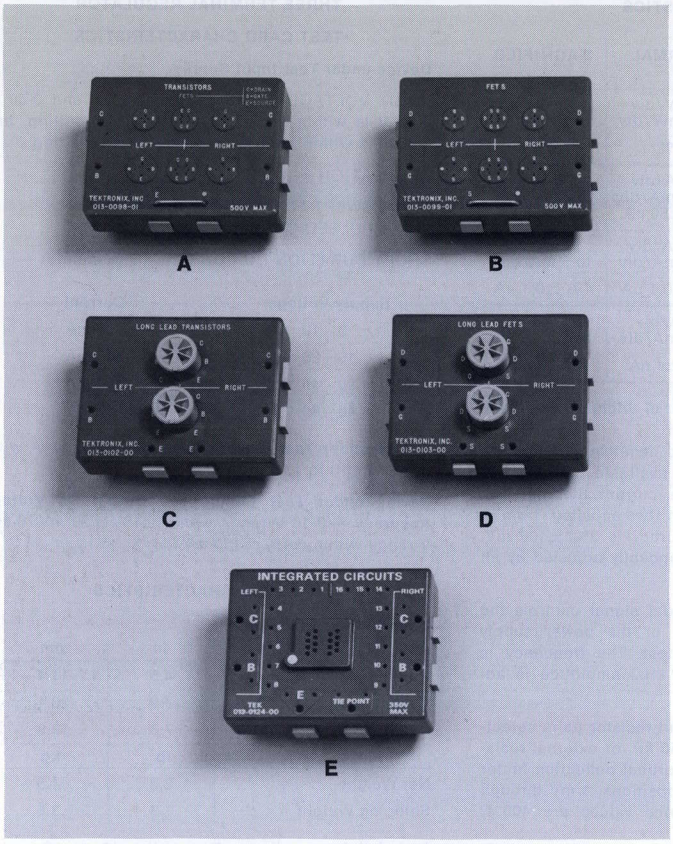
Hardwire Card
Order 013-0150-00 . . . . . $75

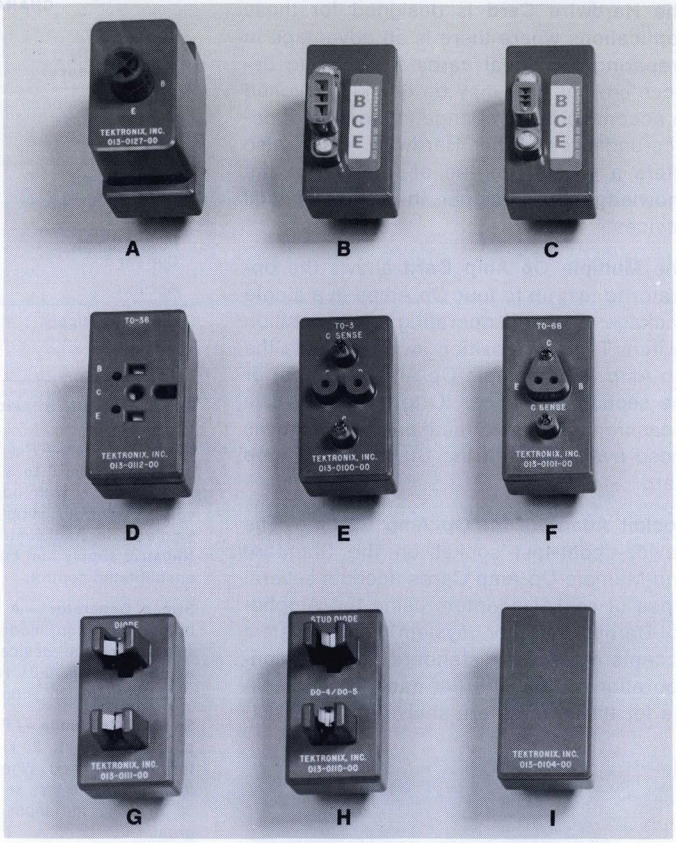
Multiple Op-Amp Card (013-0155-00) $200

Positive Regulator Card
Order 013-0147-00 . . . . . $300

Negative Regulator Card
Order 013-0148-00 . . . . . $300

Socket Adapters





DUAL WIDTH ADAPTERS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172, and 577/177 Curve Tracers.

A. Transistor Adapter — Useful for most single and dual bipolar transistors and some MOS FETs.
Order (013-0098-02) **$55**

B. FET Adapter — Useful for most single and dual FETs.
Order (013-0099-02) **$55**

C. Long Lead Transistor Adapter — Accepts dual or single transistors with untrimmed leads.
Order (013-0102-00) **$44**

D. Long Lead FET Adapter — Accepts dual or single FETs with untrimmed leads.
Order (013-0103-00) **$44**

E. Integrated Circuit Adapter — Allows connection to multipin device packages. The appropriate multi-lead 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 multi-lead Socket listed separately.
Order (013-0124-01) Includes 8 each 4-inch test leads..... **$90**

KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176, and 577/177 Curve Tracers.

A. Transistor Adapter — Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order (013-0127-00) **$27**

B. 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) **$30**

C. 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) **$30**

D. TO36 Adapter — Order (013-0112-00) **$27**

E. TO3 Adapter — Can be rewired to accommodate nonstandard configurations.
Order (013-0100-01) **$27**

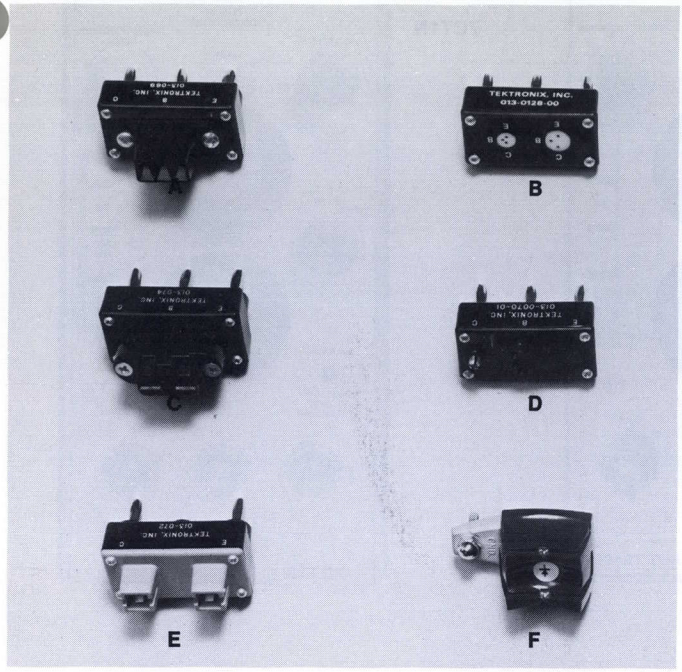
F. TO66 Adapter — Order (013-0101-00) **$27**

G. Axial Lead Diode Adapter — Order (013-0111-00)..... **$27**

H. Stud Diode Adapter — Order (013-0110-00)..... **$27**

I. Blank Adapter — For mounting special sockets.
Order (013-0104-00) **$14**

J. Power Transistor Adapter —
Order (013-0163-00) (not shown) **$32**



3 PIN ADAPTERS

The following accessories may be used with any of the TEKTRONIX Curve Tracer products. They do not have Kelvin sensing contacts.

A. Long Lead Transistor Adapter — Order (013-0069-00)...$12.00

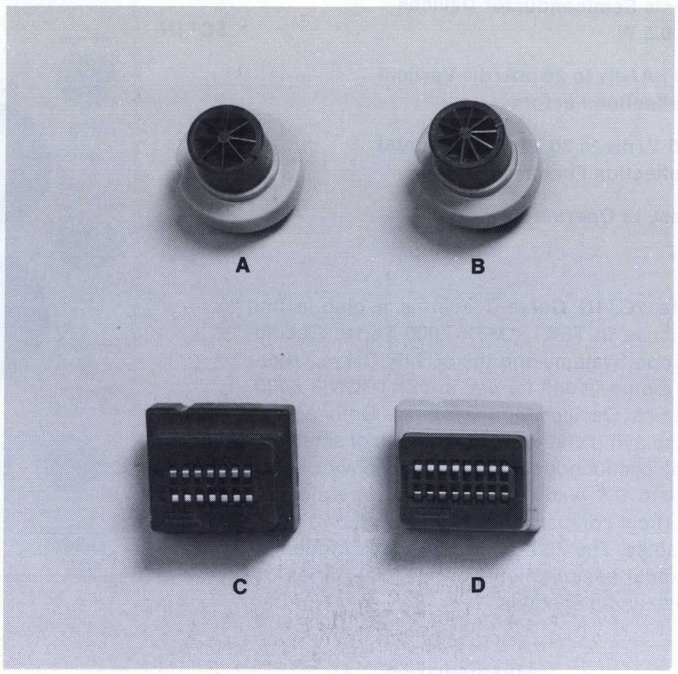
B. TO5 or TO18 Transistor Adapter — Order (013-0128-00) $15.00

C. Blank Adapter — For mounting special sockets.
Order (013-0073-00) $7.00

D. TO3 or TO66 Transistor Adapter — Order (013-0070-01) $14.50

E. Diode Test Adapter — Holds axial-lead diodes.
Order (013-0072-00) $10.75

F. Diode Test Adapter — Magnetically holds steel axial-lead diodes.
Order (013-0079-00) $75



MULTI-LEAD SOCKETS

These sockets are used with the integrated Circuits Adapter (013-0124-01) listed under Dual Width Adapters, and with the 178 Test Fixture.

A. 8 lead TO package — Order (136-0444-00) $15

B. 10 lead TO package — Order (136-0441-00) $16

C. 14 lead dual-in-line package — Order (136-0443-00) $11

D. 16 lead dual-in-line package — Order (136-0442-00) $11

(These four sockets are the most commonly required in curve tracer applications. Additional socket configurations, including zero insertion style, are available from Amphenol Sales Division, 2875 South 25th Avenue, Broadview, Illinois 60153, OR from Textool Products, Inc., 1410 W. Pioneer Dr., Irving, TX 76061.)

5CT1N
7CT1N

Curve Tracer

Plug-ins for the 5000 and 7000 Series Oscilloscopes

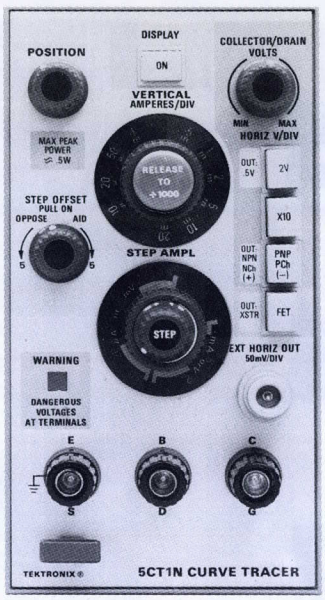
Tests Semiconductor Devices to 0.5 W

10 nA/div to 20 mA/div Vertical Deflection Factors

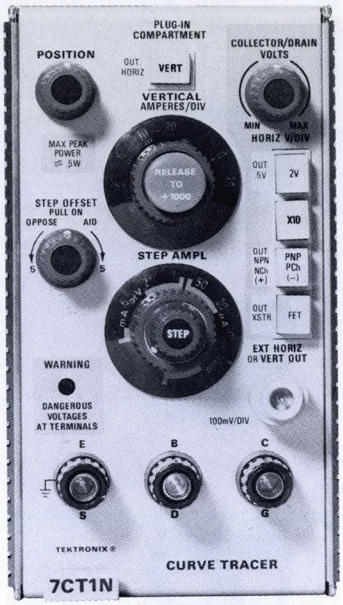
0.5 V/div to 20 V/div Horizontal Deflection Factors

Easy to Operate

5CT1N



7CT1N



The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 5000-Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000-Series Oscilloscope Systems.

CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Max Open Circuit Voltage — Within ±20%. Max short circuit current, within 30%.

Series Resistance — Automatically selected with horizontal 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. Max current (steps plus aiding offset) is X15 amplitude setting. Max voltage (steps plus aiding offset) is at least 13 V. Max opposing offset current is at least X5 amplitude setting.

FET Mode — Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V max. Source impedance is 1 kΩ ± 1%.

Accuracy — Incremental; within 3% between steps. Absolute; within ± (3% + X0.3 amplitude setting).

Step Polarity — The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps — Selectable in one-step increments between 0 and 10.

Offset — Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors — 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy — Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal 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
Shipping	4	1.8	6	2.7

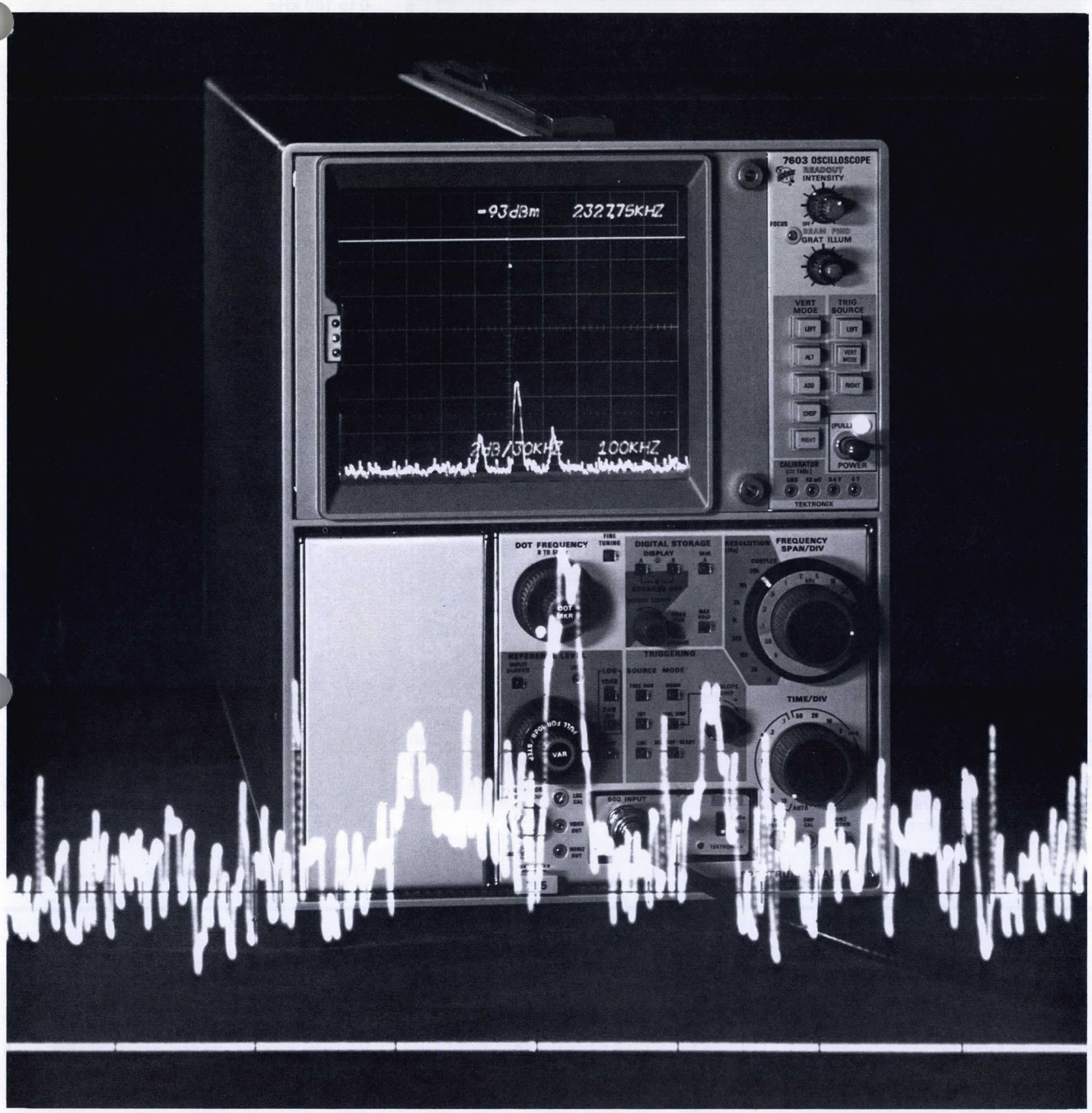
Included Accessories — Test Adapter (013-0128-00) with two sets of test terminals, one with TO-5 basing and the other with TO-18 basing.

Order 5CT1N Curve Tracer $600

Order 7CT1N Curve Tracer $720

For optional accessories see 3 pin adapters on page 181.

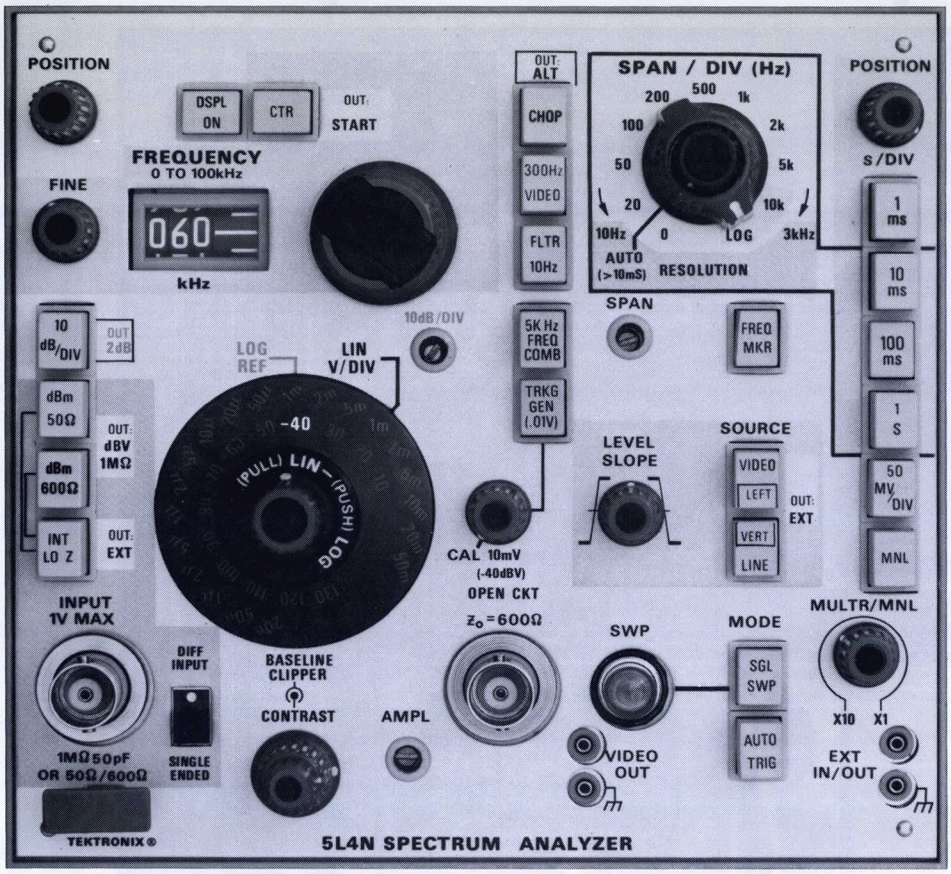
Spectrum Analyzers



New 7L5 above shows overlay of the peak-average noise display capability.

20 years ago the spectrum analyzer was a laboratory curiosity. Today the modern spectrum analyzer may well be one of the most powerful tools available to the electronics industry.

Early spectrum analyzers were nothing more than indicators, giving a representation of frequency and amplitude. Often called panoramic indicators, these early units were used with radio receivers to show other signals close to the one being received. The introduction of the amplitude calibrated spectrum analyzer 10 years ago triggered the development of the instrument into the measurement tool it is today.



0 to 100 kHz

Selectable Impedance

Calibrated Appropriate to Impedance Selected

Single-Ended Input

Differential (Balanced) Input

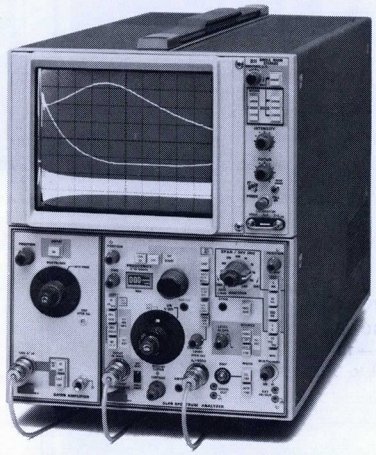
Dynamic Range 80 dB (Full 8 div)

Intermod >70 dB Down

Resolution Bandwidth 10 Hz to 3 kHz

Auto Resolution

Built-in Tracking Generator
20 Hz to 20 kHz Log Sweep*



A dual-trace oscilloscope and analyzer display of frequency response using the 5L4N in a 5103/D11 Mainframe with 5A15N Vertical Amplifier.

**100 Hz to 100 kHz also available.*

The 5L4N is a 0- to 100-kHz spectrum analyzer that offers both high performance and economy. The analyzer features selectable input impedances, 80 dB of dynamic range, and a built-in tracking generator.

This analyzer is especially suited for noise and distortion studies in the audio range and comes equipped for 20 Hz to 20 kHz log sweeps.

What Is A Spectrum Analyzer?

A spectrum analyzer draws a graph, theoretically little more. This graphic representation has 2 axes: frequency and amplitude, much as an oscilloscope graphs time and amplitude.

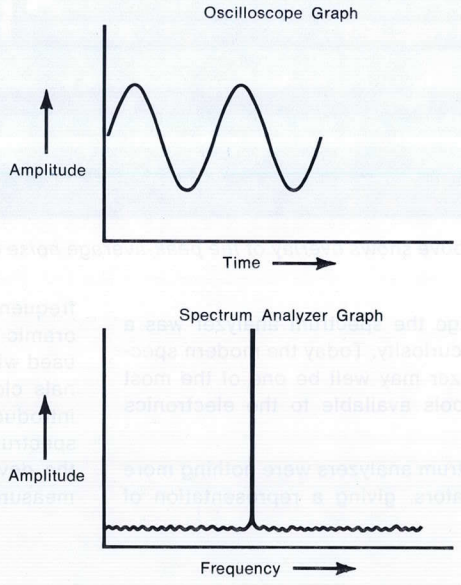


Fig 1. Difference between Oscilloscope Display and Spectrum Analyzer Display.

Various display modes are available such as Log and Linear amplitude, and various frequency spans can be selected.

Basically a spectrum analyzer is a tuned receiver, with selectable frequency ranges and spans, selectable IF bandwidths, and a linear or log detector — all coupled to a cathode ray type display.

Many educators prefer this economical analyzer to teach frequency related theory and demonstrate practical application in the areas of speech, sound, music, vibration, audio, broadcasting, and many others.

The 5L4N can be used with any 5000-Series Oscilloscope Mainframe. Only two compartments are occupied by the analyzer so that, with the addition of a vertical plug-in, basic oscilloscope functions may be obtained. We recommend the use of a 5111 Storage Oscilloscope for maximum utilization of the analyzer.

FREQUENCY CHARACTERISTICS

Range — 0 to 100 kHz. Accuracy ±3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Resolution Bandwidth — The resolution bandwidth is continuously variable from 3 kHz to 10 Hz. An AUTO mode provides the best resolution for the frequency scan and sweep rate selected. Signal level change over the resolution bandwidth range is 2 dB or less. Line frequency modulation of 50 Hz or more can be resolved up to 70 dB below the signal level. In the log sweep mode the resolution bandwidth changes with frequency giving an effect similar to octave bandwidth sweeps.

Stability — Within 30 Hz over a 10 min period, at a fixed ambient temperature.

Incidental FM — 2 Hz (p-p) or less.

AMPLITUDE CHARACTERISTICS

Reference Level Range —

Log 10 dB/div:
from —10 dBm/dBV to —70 dBm/dBV, within 0.4 dB/10 dB to max of 1 dB at —70 dBm/dBV.

Log 2 dB/div:
from —10 dBm/dBV to —130 dBm/dBV within 0.4 dB/10 dB to max. 1.0 dB at —70 dBm/dBV and 2 dB at —130 dBm/dBV.

Linear:
from 50 mV/div to 20 nV/div within 5% decade.

Cw Sensitivity (Signal Level + Noise = 2X Noise) — The following characteristics are applicable with the input internally terminated, or with a 600 Ω or less source impedance.

Display Mode	Resolution Bandwidth 3 kHz	Resolution Bandwidth 10 Hz
dBV	—123 dBV	—147 dBV
dBm 50 Ω	—110 dBm	—134 dBm
dBm 600 Ω	—121 dBm	—145 dBm
LINEAR	680 nV	45 nV

Flatness (20 Hz-100 kHz) — Flatness remains within ±0.2 dB, over any selected frequency span, with respect to the level of —40 dBV signal at 5 kHz. Intermodulation Distortion — with two signals, within any frequency span, that are less than or equal to the reference level :

—10 dBm/dBV	≥70 dB down
≤ —20 dBm/dBV	≥75 dB down

Internal Spurious Signals — Equal to or less than —130 dBm/dBV referred to in the input. Line related spurii less than —120 dBm/dBV.

Dynamic Range — 80 dB (8 div).

INPUT CHARACTERISTICS

Selectable impedance — 1 megohm/47 pF or 600 Ω or 50 Ω (single-ended or differential).

Differential Input Characteristics — Full screen limit is approx 300 mV to 400 mV. Common mode rejection ratio is 70 dB or more.

Single Ended Input Characteristics — Max single input for linear operation: —10 dBm/dBV or 0.316 V rms.

SWEEP CHARACTERISTICS

Linear Frequency Span — 20 Hz/div to 10 kHz/div, 10-5-2 sequence. 4% accuracy.

Log Frequency Span — 100 Hz to 100 kHz internally reprogrammable to 20 Hz to 20 kHz.

Zero Frequency Span — Analyzer operates as a fixed tuned receiver for time-domain displays.

Internal Sweep sources — Time base 1 s/div to 1 ms/div (increased up to 10X with multiplier).

Triggering — Internal at least 0.1 div, External at least 250 mV. Slope and level selection are provided. Auto Trigger provides a sweep baseline when a trigger signal is absent. Single sweep provided.

Manual Sweep — Provided.

External Sweep — Require 0 V to 500 mV ±50 mV; from a 1 kΩ or less source to sweep the full span.

OUTPUT CONNECTIONS

Tracking Generator — 600 Ω source. Calibrated output level is —40 dBV ±0.2 dB (10 mV) open circuit, or —46 dBV when terminated into 600 Ω. Output level can be varied from approximately .001 volt to 0.1 volt open circuit.

5 kHz Freq Comb — 600 Ω source of 5 kHz. ±.005%, markers for span calibration.

Video Out — provides 250 mV ±5% of video signal per display division (0 V to 2 V). Source impedance is about 1.0 kΩ.

Ext In/Out — Provides 500 mV ±25 mV, per div of span, from 0 to 5 volts, when using internal or manual sweep.

ORDERING INFORMATION

5L4N Spectrum Analyzer $2350

We recommend that the Plug-in 5L4N be ordered with a storage mainframe.

5111 Storage Oscilloscope, Order 5111 (Cabinet) $1250

R5111 Storage Oscilloscope, Order R5111 (Rackmount) $1250

OPTIONAL PLUG-INS FOR TIME DOMAIN USE

5A15N Single Trace Amplifier..... $145

5B10N Time Base Amplifier..... $225

OPTIONAL ACCESSORIES

175-1178-00 BNC to PIN Jack Adapter Cable..... $21

010-0160-00 10X Probe P6006 (6 ft) $38

016-0195-00 Blank Plug-in Panel..... $7.50

013-0076-00 BNC to Alligator Clip Adapter..... $9

Why Use A Spectrum Analyzer?

Many measurements now performed by more cumbersome and time consuming means can be best performed with the spectrum analyzer. Measurements of waveforms, distortion, signal to noise, and amplitudes of complex components are easy with spectrum analysis.

The communication industry was first to take advantage of the spectrum display machines because there was just no other way to work with the higher frequencies involved.

In the past, spectrum analyzer cost and complexity encouraged use of the oscilloscope, not only for time domain measurement, but in areas where the spectrum analyzer is 10-, 100-, or even 1000-times more powerful. Some industries developed so many specialized instruments for measurements not then feasible by other means that they have not yet been able or willing to generally apply modern instrumentation.

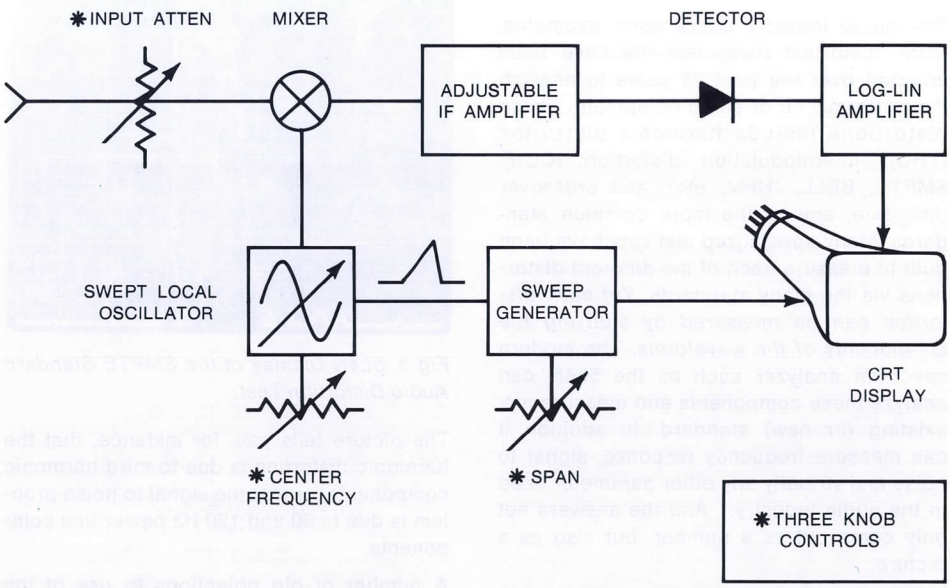
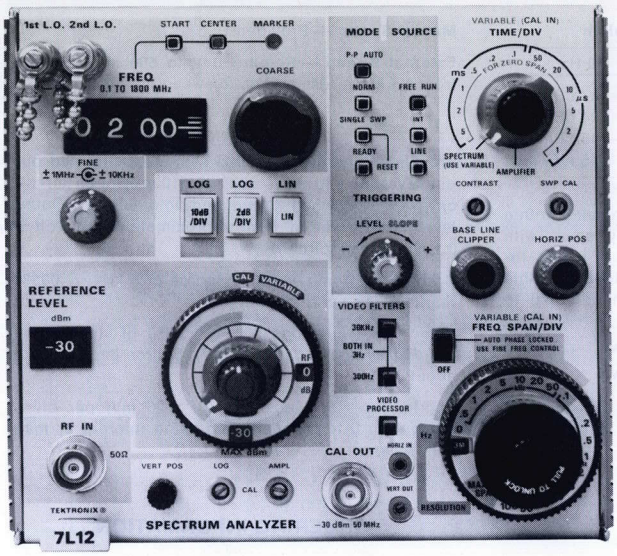


Fig 2. Simplified Block Diagram of a Modern Swept Front-End Three Knob Spectrum Analyzer.

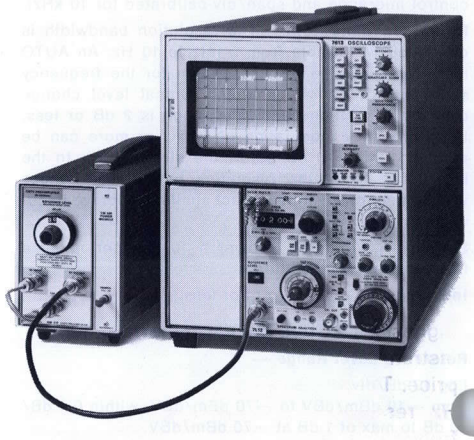


100 kHz to 1800 MHz in One Display
Fully Calibrated Displays
300 Hz to 3 MHz Resolution
4:1 Resolution Bandwidth Shape Factor
70 dB Dynamic Range
IM Distortion 70 dB below Full Screen
Spurious Free Operation
Automatic Phase Lock
—115 dBm Sensitivity

The 7L12 Spectrum Analyzer is a modern, high performance, swept front end type of analyzer covering the frequency range up to 1.8 GHz. The unit employs phase lock stability and an ample selection of resolution bandwidths in an economical field or laboratory instrument.

The unit has a 3 MHz resolution mode for accurate measurement of pulse phenomena; the zero-span mode may be used to present a demodulated display of a signal for time domain measurements. A 4:1 resolution bandwidth shape filter introduced by TEKTRONIX permits close-in measurements not possible with conventional filters. Noise measurements are also easily made due to the high sensitivity, video filters, and equivalent resolution and noise power bandwidth of the instrument.

The 7L12 fills two holes in any 3- or 4-hole 7000-Series Mainframe and features a complete time base so that other oscilloscope or time domain plug-ins may be used simultaneously. As with all 7000-Series Plug-ins, CRT READOUT will display the major parameters. For the 7L12, these include: reference level, dB/div, frequency span, and resolution.



The 7L12 is shown in a 7613 Variable Persistence Mainframe connected to the AM-511 vhf preamplifier for extra sensitivity.

Spectrum Analyzer Applications

The audio industry offers good examples. Many distortion measurements have been adopted over the past 25 years to analyze the performance of audio equipment. These distortions include harmonic distortion (THD), intermodulation distortion (CCIF, SMPTE, BELL, IHFM, etc), and crossover distortion, among the more common standards. Many specialized test sets have been built to measure each of the different distortions via the many standards. *Yet each distortion can be measured by studying the components of the waveforms.* The modern spectrum analyzer such as the 5L4N can analyze these components and measure any existing (or new) standard. In addition it can measure frequency response, signal to noise and virtually any other parameter used in the audio industry.* And the answers not only come out as a number, but also as a picture.

**Audio cookbook available*

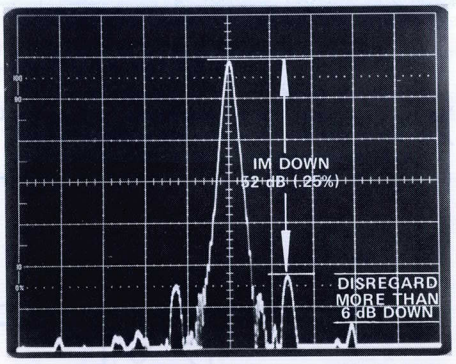


Fig 3. 5L4N Display of the SMPTE Standard Audio Distortion Test.

The picture tells you, for instance, that the harmonic distortion is due to third harmonic components, or that the signal to noise problem is due to 60 and 120 Hz power line components.

A number of old objections to use of the spectrum analyzer as a universal tool are still heard today. Probably one of the prime objections was price.

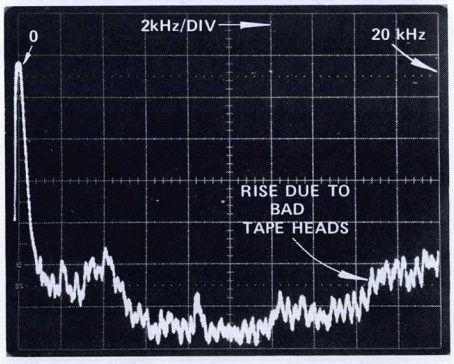
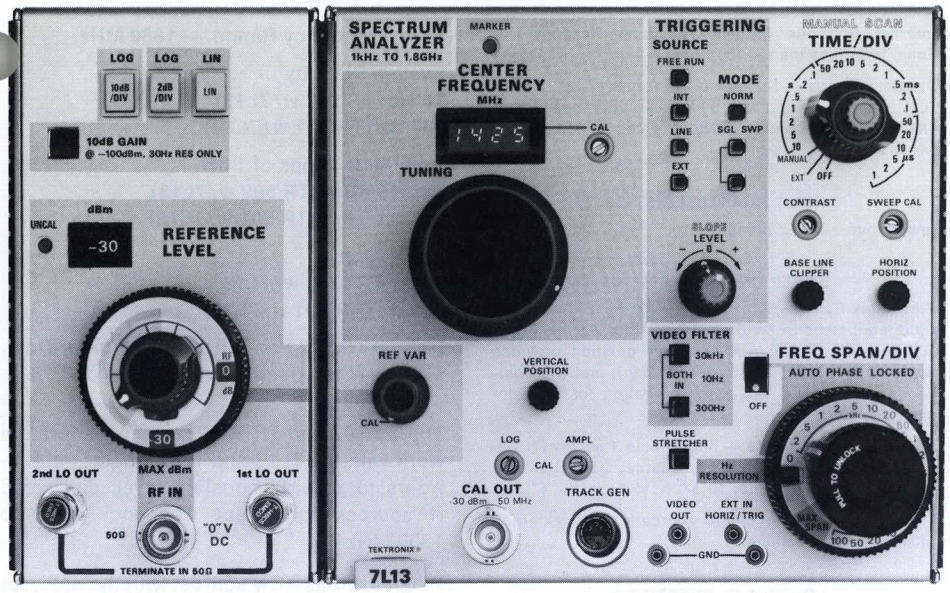


Fig 4. An Audio Signal to Noise Measurement on a Tape Deck.

Through modern technology, the 5L4N audio spectrum analyzer can be purchased f much less than the other equipment normally found in an audio shop, such as two distortion analyzers (THD and IM), an ac voltmeter, and an oscilloscope. An oscilloscope



1 kHz to 1800 MHz in One Display

Fully Calibrated Displays

30 Hz to 3 MHz Resolution

4:1 Resolution Bandwidth Shape Factor

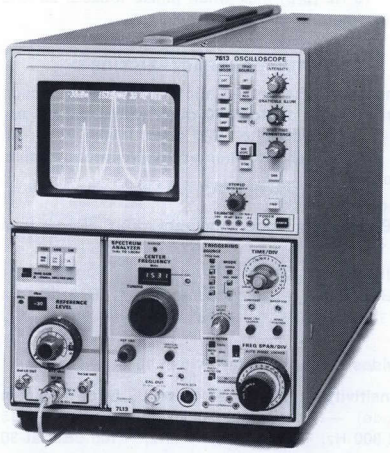
70 dB Dynamic Range

IM Distortion 70 dB below Full Screen

Spurious Free Operation

Automatic Phase Lock

—128 dBm Sensitivity



The 7L13 Spectrum Analyzer represents the highest performance possible today in an instrument of this frequency range and price. The fm stability is 10 Hz, making 30-Hz resolution possible across the entire frequency range.

This analyzer is a high quality laboratory instrument. In addition to incorporating the standard features of the 7L12, it has crt readout of the center frequency, and an UNCAL light to indicate incorrect settings of the sweep rate or resolution controls.

The 7L13 in a 7613, a mainframe featuring variable persistence. Variable persistence is recommended for maximum utilization of the capabilities of the 7L13.

is normally part of a Tektronix Spectrum Analyzer. The flexibility and time savings normally realized with the modern analyzer, help make the analyzer less expensive, usually, than the crowd of older single purpose instruments.

Another objection was complexity. (One expects a new device to be different.) Many of the complexities of the early spectrum analyzers have been eliminated. High school and college students first learning to make measurements often prefer the analyzer over any of the other instruments. And instruments like the 5L4N provide many real conveniences such as Log sweep 20 to 20 kHz, 600 ohm balanced input, automatic controls on some functions, and others.

The Field of Communications

The communications industry still includes the largest users of spectrum analysis. Vital measurements such as occupied bandwidth, frequency separation, percentage of modulation or frequency deviation, signal to noise, harmonics and im distortion are easily handled with the modern analyzer.

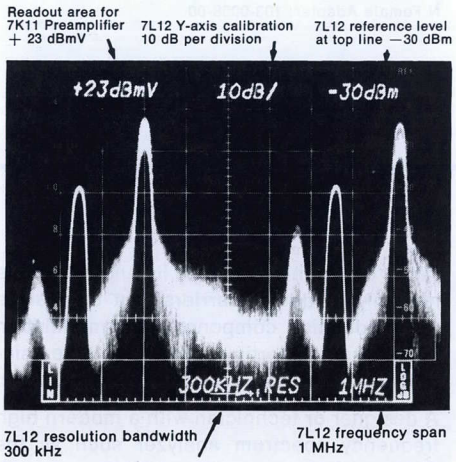


Fig 5. Display of a Standard NTSC Color TV Signal.

Prime users are: the microwave industry, the CATV industry (using analyzers for yearly proof of performance and day-to-day measurements), am and fm broadcasters, Avionics shops, two way radio repair shops, radio common carrier services, and military services.

Most radio services have many things in common. Frequency ranges differ, but the transmitting and receiving systems are all characterized with the same requirements. The need to measure oscillator purity and stability, and to measure performance of multipliers, mixers, modulators, amplifiers, and filters, are requirements shared by the communications industry.

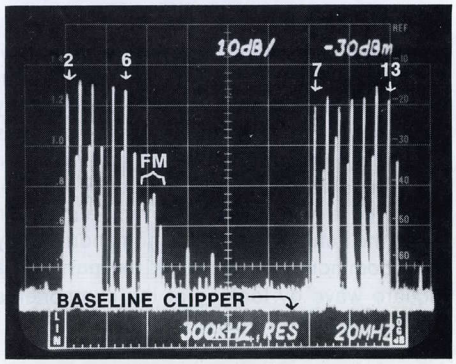


Fig 6. Display of a 12 Channel CATV System.

CHARACTERISTICS

apply to both 7L12 and 7L13 except where noted.

FREQUENCY CHARACTERISTICS

Range — 7L12 range is 100 kHz to 1.8 GHz. 7L13 range is 1 kHz to 1.8 GHz.

Resolution Bandwidth — Resolution bandwidth selections from 300 Hz to 3 MHz (7L12) and 30 Hz to 3 MHz (7L13). Shape factor 60 dB to 6 dB is 12:1 or better for 30 HZ resolution and 4:1 or better for 300 Hz to 3 MHz resolution.

Stability — (7L12) After 2 hour warm-up, within 50 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. (7L13) After a 2 hour warm-up, 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.

Incidental FM (7L12) — 200 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked. (7L13) —10 Hz (p-p) max when phase locked. 20 kHz (p-p) max when not phase locked.

AMPLITUDE CHARACTERISTICS

Reference Level Range — Calibrated levels in decade steps from —100 dB to +30 dBm, within ±2 dB extended to —110 dBm to +30 dBm, in the 7L13. An UNCAL indicator shows when excessive sweep speeds are selected.

Log 10 dB/div:
—70 dB dynamic range. Accuracy ±0.1 dB/dB to a max of 1.5 dB.

Log 2 dB/div:
—14 dB dynamic range. Accuracy ±0.4 dB/2 dB to a max of 1.0 dB.

Linear:
— Provides a linear display, within 10%.

CW Sensitivity — (Signal + noise = twice noise in LIN Mode) —128 dBm at 30 Hz (7L13 only), —115 dBm at 300 Hz, —108 dBm at 3 kHz, —100 dBm at 30 kHz, —90 dBm at 0.3 MHz, —80 dBm at 3 MHz. Sensitivity may decrease 2 dB at 1.7 GHz and 4 dB at 1.8 GHz.

Flatness — ±1.5 dB over any frequency span.

Intermodulation Distortion — Third order down 70 dB or more from two —30 dBm signals within any frequency span. Second order down 70 dB or more from two —40 dBm signals.

Internal Spurious Signals (Residual Response) — Equal to or less than —100 dBm.

Dynamic Range — Range 70 dB for 7L12, 80 dB for 7L13, when operating with 30 Hz resolution bandwidth. The VARIABLE control provides gain adjustment between any two 10 dB steps.

INPUT CHARACTERISTICS

Impedance — 50 Ω, nominal.

SWEEP CHARACTERISTICS

Frequency Span — 500 Hz/div to 100 MHz/div (7L12). Calibrated steps in 1-2-5 sequence from 200 Hz/div to 100 MHz/div (7L13). A MAX SPAN position provides approx 1.8 GHz (180 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.

Sweep Modes and Rate — 5 ms/div to 1 μs/div (7L12). Selection of an external sweep source, manual sweep, or calibrated time base, 10 s/div to 1 μs/div (7L13).

Triggering — Trigger signal source can be external, internal, or line voltage.

OUTPUT CONNECTIONS

Calibrator — 50 MHz, —30 dBm from 50 Ω.

Vert Out — (Video Out on 7L13) Approx 2 V full screen.

Horiz In — (and Trig on 7L13) For use with chart recorder.

Tracking Gen (Logic) 7L13 — For use with tracking generator (5V TTL).

1st LO — For use with tracking generator or 1405 Sideband Analyzer.

2nd LO — For use with tracking generator.

ACCESSORIES

Included — Spectrum Analyzer Graticule. Clear plastic implosion shield with LOG, LIN, REF, and f (frequency) direction markings.

337-1439-01 for 7403N and 7603 Oscilloscopes and 337-1159-02 for other 7000-Series Oscilloscopes. Amber Light Filter: 378-0684-01; 50 Ω Coaxial Cable, with BNC connectors, 6 foot: 012-0113-00; BNC Male to N Female Adapter: 103-0058-00.

Wide Frequency Range — 1800 MHz

System Stability
10 Hz (TR 502 w/7L13)
200 Hz (TR 501 w/7L12)

Amplitude Steps of 1 dB
to —59 dBm (TR 502 w/7L13)
to —11 dBm (TR 501 w/7L12)

Resolution
30 Hz (TR 502 w/7L13)
300 Hz (TR 501 w/7L12)

Plus — TR 502 Has Automatic Counter Dot Marker When Used with DC 502 and 7L13

The TR 502 and TR 501 Tracking Generators work with the 7L13 and 7L12 Spectrum Analyzers to provide constant level, calibrated rf sources for swept frequency tests to 1800 MHz.

When used as a cw source, with the analyzer in a zero span (nonswept) mode, the TR 502/7L13 system has 10 Hz stability. (The TR 501/7L12 system has 200 Hz stability.) This exceptional stability enhances the dynamic range capability of the analyzer, tracking generator combination.

The Tracking Generator Aux RF output may be used to drive a frequency counter. Frequencies up to 1800 MHz may be measured accurately in the presence of high level adjacent signals to the sensitivity limits of the analyzer. TR 502/7L13 sensitivity is —128 dBm at 30 Hz resolution bandwidth. (TR 501/7L12 sensitivity is —115 dBm at 300 Hz resolution bandwidth.) When the TR 502 is used with the 550 MHz DC 502 frequency counter the spectrum display center frequency, indicated by a bright dot, is automatically counted.

Even though most of these industries have specialized tests sets, the spectrum analyzer is rapidly becoming the universal testing and troubleshooting tool.

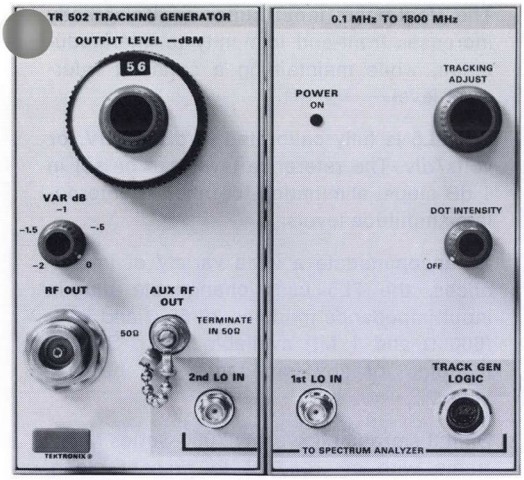
Improved instruments mean more capability. As analyzers improve in stability and resolution, theoretical measurements of yesterday become day-to-day practice. Most engineers of today were taught Fourier analysis as a theoretical study of the frequency components of a wave. We believed, almost on faith, the actuality of the phenomenon. Today it is commonplace to check the purity of a square wave by looking at the components with a spectrum analyzer.

In the communication field it is now possible not only to detect carriers, but to analyze the modulation components for modulation percentage, distortion of the transmitted signal, and signal to noise ratio, to name a few.

A designer or technician with a modern high frequency spectrum analyzer such as the 7L12 or 7L13 is capable of testing or evaluating practically any radio device up to the 1.8 gHz frequency limit of the analyzer.

The Tracking Generator

The tracking generator is a signal source that follows the tuning of the spectrum analyzer. This instrument combination is ideal for making frequency response measurements. Because of the narrow bandwidth of the spectrum analyzer, the noise floor of an



The Tracking Generator sweep rates are controlled with the spectrum analyzer, and the output level is controlled from the Tracking Generator. The output frequency of the Tracking Generator is the same as the frequency of the analyzer at any instant of the sweep.

The Tracking Generator is a two-wide unit compatible with the TM 500 Modular Instrument Series. When powered by a TM 503, there is room for a 550 MHz DC 502 or other counter.

CHARACTERISTICS

apply to both the TR502/7L13 and TR501/7L12 except where noted.

FREQUENCY CHARACTERISTICS

Range — 0.1 MHz to 1800 MHz.

Resolution Bandwidth — 30 Hz to 3 MHz (TR502/7L13). 300 Hz to 3 MHz (TR501/7L12).

Stability — 10 Hz p-p (TR502/7L13). 200 Hz p-p (TR501/7L12).

AMPLITUDE CHARACTERISTICS

RF Output Amplitude — 0 dBm to −59 dBm in 10 and 1 dB steps plus 2 dB vernier (TR502/7L13). 0 dBm to −11 dBm in 1 dBm steps plus 2 dB vernier (TR501/7L12).

Auxiliary Output Level — 0.1 V RMS in 50 Ω.

Flatness — ±2.0 dB (TR502/7L13). ±3.0 dB (TR501/7L12).

Spurious Output —
Harmonic: >20 dB below carrier.
Nonharmonic: >40 dB below carrier.

Dynamic Range — >110 dB (TR502/7L13). >100 dB (TR501/7L12).

SWEEP CHARACTERISTICS

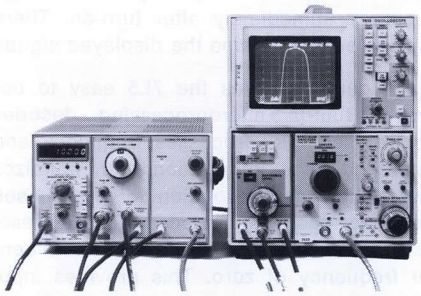
Frequency Span — 200 Hz/div to 180 MHz/div (TR502/7L13). 500 Hz/div to 180 MHz/div (TR501/7L12).

OUTPUT CONNECTORS

RF Out — 50 Ω nominal impedance, vswr 2:1 or less.

Aux RF Out — For use with frequency counter.

Note about Mainframes, 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). 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. Storage mainframe is recommended for high resolution displays or variable persistence.



The TR 502 Tracking Generator is used with the Tektronix 7L13 Spectrum Analyzer to make swept frequency tests and precise frequency measurements.

ORDERING INFORMATION

7L12 Spectrum Analyzer **$4995**

7L13 Spectrum Analyzer **$7500**

7603 Mainframe **$1800**
Option 77 P7 Phosphor and Internal S A Graticule ..... No Charge

7613 Variable Persistence Mainframe **$2850**
Option 6 Internal S A Graticule $50

TR 502 Tracking Generator **$4500**

Suggested Complementary Items

TM 503 Option 7 Power Module $175

DC 502 Option 7 (includes Option 1 High Stability) Digital Counter $1195
or
016-0195-01 Blank Panel $7.50

TR 501 Tracking Generator **$3500**

Suggested Complementary Items

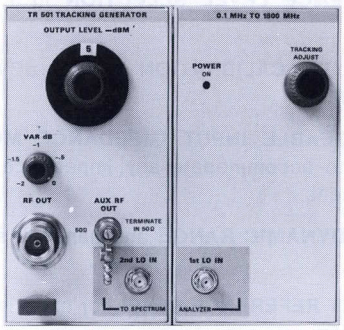
TM 503 Power Module $150

DC 502 Digital Counter $995

016-0195-01 Blank Panel $7.50

015-1002-00 14 dB, 3mm attenuator; (used in the 2nd L.O. input line to improve TR 501/7L12 isolation) $120

Note: Existing 7L12 Spectrum Analyzers, if not already factory equipped for use with the TR501, may be modified at a customer cost of $400 FOB Beaverton, Oregon.



amplifier or system is reduced, allowing measurements with a dynamic range in excess of 120 dB. The tracking generator can also be used for precise frequency measurements, and is especially useful for measuring low level signals in the presence of other higher level signals. The tracking generator derives its signal from the spectrum analyzer by mixing a local oscillator in the generator with the sweeping oscillators in the Spectrum Analyzer. A tracking generator is locked to the analyzer and can, by design, be no better than the analyzer in stability or drift.

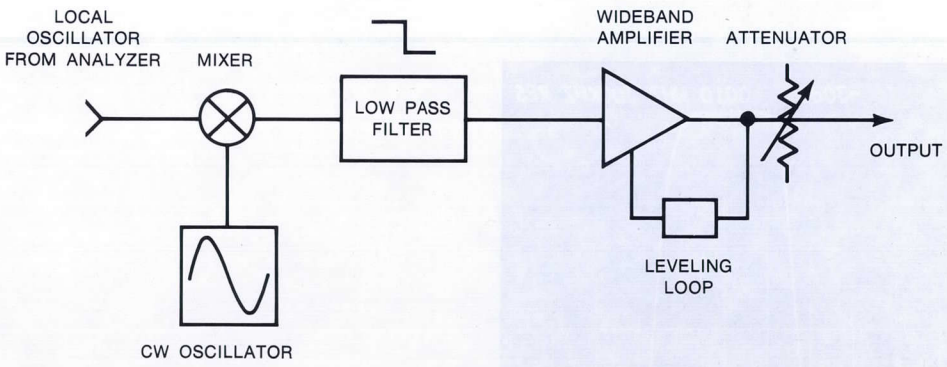
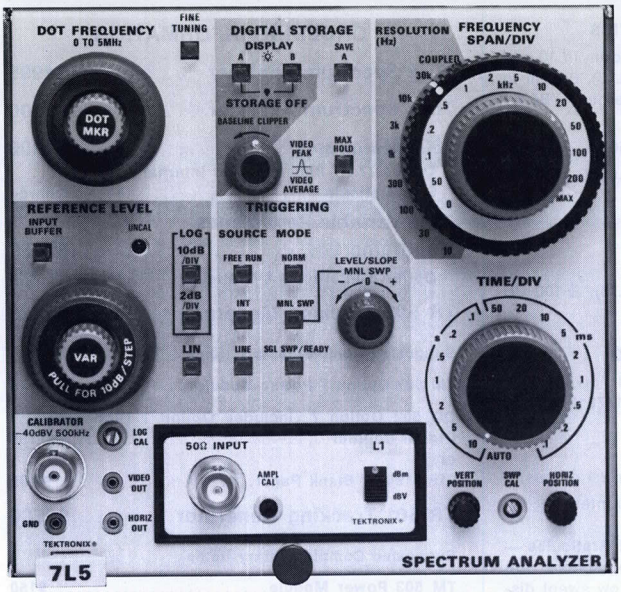


Fig 7. Simplified Block Diagram of a Tracking Generator.



THREE-KNOB OPERATION makes the 7L5 the world's easiest-to-use Spectrum Analyzer.

SYNTHESIZER STABILITY for six-digit accuracy of center frequency setting with virtually no drift.

DIGITAL STORAGE & AVERAGING of display signals.

REFERENCE LEVEL SELECTION in 1 dB steps.

ABSOLUTE CALIBRATION in dBm, dBV or volts/div.

CHANGEABLE INPUT IMPEDANCE MODULES to accommodate any impedance requirement.

WIDE DYNAMIC RANGE and nanovolt sensitivity.

PRESET REFERENCE LEVEL for extra input protection.

CRT READOUT of all major parameters.

The 7L5 is a 5-MHz Spectrum Analyzer with exceptional frequency accuracy, achieved through a unique combination of synthesizer and digital technology.

Synthesizer stability and digital tuning let you set the center frequency with six-digit accuracy immediately after turn-on. There is no need to fine tune the displayed signal.

"Intelligence" makes the 7L5 easy to operate. Built-in microprocessing decodes control settings, processes frequency and reference level information and optimizes sweep time and resolution for the chosen frequency span. At turn-on, the 7L5 is preset to a reference level of +17 dBm and a center frequency of zero. This provides input attenuation to protect the front end and a marker to verify correct operation.

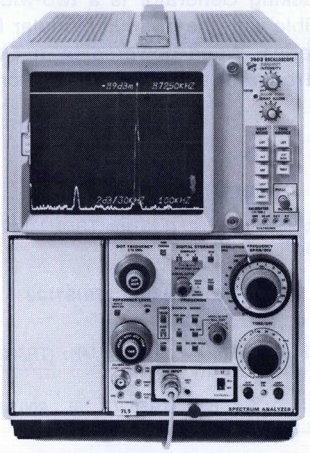
The 7L5 has a full 80 dB spurious-free dynamic range for measuring wide relative amplitudes. Nanovolt sensitivity lets you measure very low-level signals and noise.

The front-panel input buffer control greatly increases front-end immunity to intermodulation, while maintaining a constant reference level.

The 7L5 is fully calibrated in dBm, dBV, or volts/div. The reference level can be set in 1 dB steps, eliminating the need to interpolate amplitude levels.

To accommodate a wide variety of impedances, the 7L5 uses changeable plug-in input impedance modules, of 50 Ω and 75 Ω (600 Ω and 1 MΩ available later). Special modules for any impedance can be provided.

Digital storage allows any 7000-Series Mainframe with crt readout to present clean, easy-to-photograph displays. The entire display is stored electronically and updated during each sweep. Two complete displays can be held in memory for comparison. Two display modes are available: a conventional peak display, or a digitally averaged display.



New TEKTRONIX 7L5 5 MHz Spectrum Analyzer combines synthesizer with digital technology for exceptional frequency accuracy. It is shown in a 7603 Mainframe.

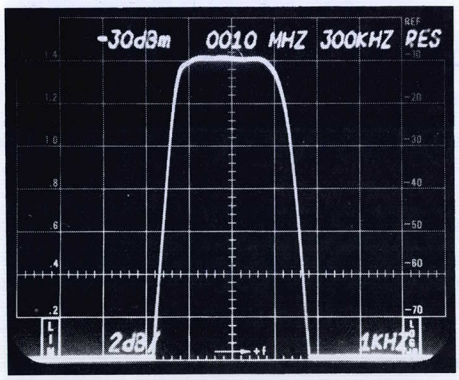


Fig 8. Response of a TV Bandpass Filter as Displayed with a Tracking Generator Spectrum Analyzer Combination.

The Next Generation

As spectrum analyzers are becoming more commonplace, they are becoming more useful as well. Many improvements are being made to increase the utility of the instrument. The 7L5 represents some of these improvements.

For special measurements, such as signal-to noise, these two modes can be used simultaneously by setting the continuously adjustable peak/average threshold, indicated with the crt cursor (see figure C). A maximum hold control lets you store maximum signal levels for checking long-term amplitude and frequency drifts.

CRT readout displays center frequency, reference level, resolution bandwidth, dB per division, and frequency span.

The 7L5 has a triggerable time base for time-domain displays in zero-span modes. The 7L5 leaves one plug-in space in 7000-Series Mainframes for a scope-type vertical amplifier.

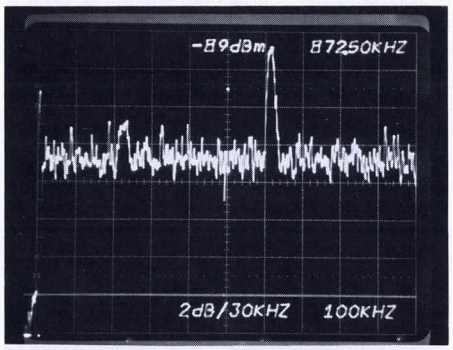


Figure A

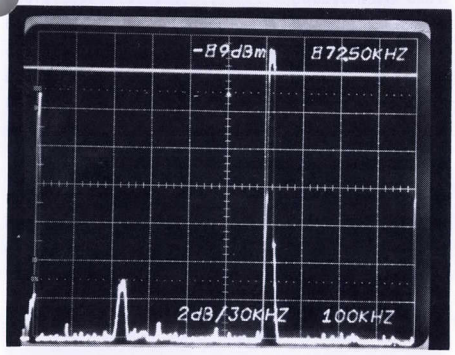


Figure B

Digital Averaging — Figures A and B show two small signals in the presence of noise. In Figure A, both signal and noise are peak detected (peak/average cursor is one division from the bottom of the crt). The smaller signal (which appears to be about —94 dBm) is almost completely obscured because the amplitude of the display is really the level of signal and noise combined. In Figure B the noise is digitally averaged (peak/average cursor is one division from the top of the crt). The noise level is reduced, showing the signals more clearly and giving a true indication of the small-signal amplitude at —102 dBm.

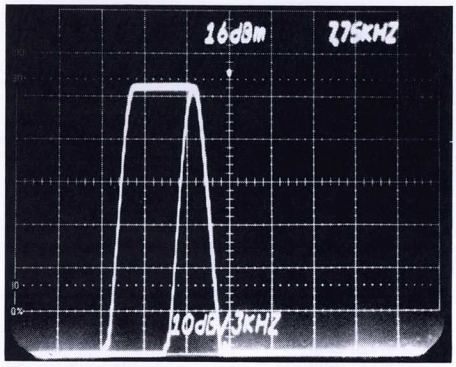


Figure C.

Maximum Hold — The 7L5 maximum hold function lets you check for signal drift. It is also useful for detecting short-duration signals. In this mode, the maximum amplitude at any frequency is stored and displayed even if the signal is only there for an instant. Figure C shows a split memory display with MAX HOLD on. The flat top pedestal shows the frequency excursion of an oscillator as it shifted about one and one half divisions across the screen. The second half of the memory displays the oscillator signal frequency at the time the photo was taken.

FREQUENCY CHARACTERISTICS

Range — Input frequency range is 10 Hz through 5.0 MHz. Dot frequency range is 0 Hz through 4999.75 kHz. Dot accuracy: 0°C to 50°C ±(20 Hz + 10^{-5} of dot frequency); 20°C to 30°C ±(5 Hz + 2X 10^{-6} of dot freuqency).

Drift — Frequency drift is ≤ 5 Hz/hour.

Residual Incidental FM — Residual fm is ≤ 1 Hz (p-p) for frequency spans of 50 Hz/div to 2 kHz/div. Residual fm is ≤ 40 Hz (p-p) for frequency spans of 5 kHz/div to 500 kHz/div.

Resolution Bandwidth — 8 resolution bandwidths range from 30 kHz to 10 Hz. COUPLED switch position electronically couples resolution to span/div selection so that both are controlled by the same knob. Bandwidth accuracy @ 6 dB down is within 20% of selected resolution. Shape factor (60 to 6 dB ratio) is 10:1 or better for 10 Hz to 1 kHz and 5:1 or better from 3 kHz to 30 kHz. Amplitude change between resolution bandwidths is ≤ 0.5 dB for 30 kHz — 100 Hz and ≤ 2.0 dB for 30 kHz — 10 Hz.

SWEEP CHARACTERISTICS

Frequency Span—Provides calibrated frequency spans from 50 Hz/div to max (500 kHz/div) within 2% in 1-2-5 sequence.

Horizontal linearity is within 5% over the entire 10 div display.

A 0-Hz/div position is provided for time domain operation.

Sweep Rate — Time per div is selectable from 10 s/div to 0.1 ms/div in 1-2-5 sequence. An AUTO position permits automatic selection of optimum time/div depending on resolution and span/div settings.

Sweep rate accuracy is within 5% of the rate selected.

Triggering — Provides two triggering sources, INT (internal) and LINE, in addition to a FREE-RUN position.

When INT is selected, ac coupled signal components from the mainframe TRIGGER SOURCE (left or right vertical amplifiers) are used.

When LINE is selected, ac coupled sample of mainframe ac line voltage is used.

Three triggering modes are NORM (normal), SGL SWP/READY (single sweep), and MNL SWEEP (manual sweep).

Trigger level is ≥ 0.5 div of internal signal for both NORM and SGL SWP modes over the approx frequency range of 30 Hz to 500 kHz.

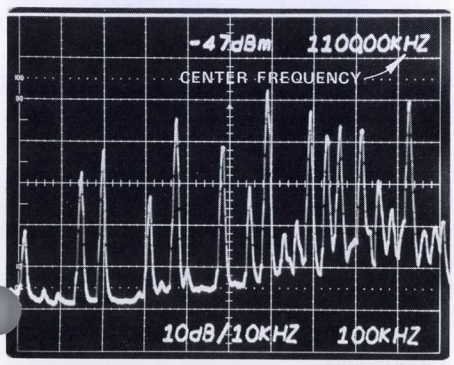


Fig 9. Waveform Photo of the AM Broadcast Band taken on the 7L5.

Direct Frequency readout – the logical step in a truly calibrated instrument would be exact frequency selection. The 7L5 uses frequency synthesis to obtain center frequency readout with counter accuracy.

Digital storage — a true spectrum analyzer would display all frequencies at once without sweep effects such as flicker and distortion. The use of digital storage permits the closest approach yet to true theoretical spectrum displays of time and frequency.

Three knob control — the true key to simple acceptance of spectrum analysis is simplicity and uncomplicated operation. The 7L5 offers true 3 knob control. Select the frequency, the span, and the input attenuation and the display is ready to view.

Stability — through the use of phase-locked oscillators and/or frequency synthesis, the analyzer can be used to measure the instability of the device under test. An important criterion of any analyzer would be the ability to turn on the unit and instantly, with no drift, be able to tune onto a signal. The 7L5 can be tuned almost immediately after turn-on and will remain tuned to the frequency selected indefinitely.

7L5 Spectrum Analyzer

OUTPUT CONNECTORS

Video Out — Front-panel pin jack connector supplies the video (vertical) output signal at an amplitude of 50 mV/div +5% (about the crt vertical center) with source impedance of 1 kΩ.

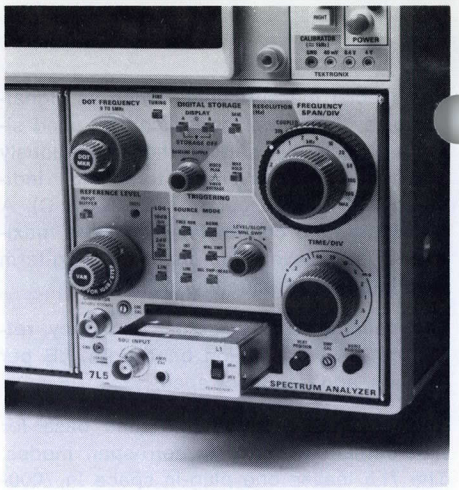
Horiz Out — A front-panel pin jack connector supplies horizontal output signal (negative-going sawtooth that varies from 0.0 Vdc to —5.2 Vdc with a source impedance of 5 kΩ).

Calibrator — Front-panel BNC connector supplies a calibrated 500 kHz square wave output signal (derived from the analyzer's time base). Output amplitude is within ±0.15 dB of —40 dBV into the plug-in impedance.

CHARACTERISTICS WITH PLUG-IN INPUT IMPEDANCE MODULE

INPUT CHARACTERISTICS		L1	L2
Input Impedance —		50Ω	75Ω
Input Power — Max input power for reference levels:	above 0 dBm	+20 dBm	+21 dBm
	below 0 dBm	+10 dBm	+10 dBm
AMPLITUDE CHARACTERISTICS			
Residual Response — Internally generated spurious signals (referred to input mixer).		—130 dBm or less	—130 dBm or less
Sensitivity — Equivalent input noise for each resolution bandwidth setting is measured in VIDEO AVERAGE mode with 10 s/div sweep rate and INPUT BUFFER Control off. Equivalent Input Noise for resolution bandwidth of:		(equal-to or less-than)	(equal-to or less-than)
	10 Hz	—140 dBm	—135 dBm
	30 Hz	—137 dBm	—133 dBm
	100 Hz	—134 dBm	—130 dBm
	300 Hz	—130 dBm	—125 dBm
	1 KHz	—125 dBm	—120 dBm
	3 KHz	—120 dBm	—115 dBm
	10 KHz	—115 dBm	—110 dBm
	30 KHz	—110 dBm	—105 dBm
Sensitivity is further degraded 8 dBm with INPUT BUFFER on. Noise level increases approx 10 dB operating in VIDEO PEAK mode.			
Intermodulation Distortion — Within any frequency span, Intermodulation products for two, on screen, signals:			
of —30 dBm or less:	3rd order products	75 dB down	75 dB down
	2nd order products	72 dB down	72 dB down
of —40 dBm or less:	2nd and 3rd order products	at least 80 dB down	at least 80 dB down
with INPUT BUFFER on:	2nd and 3rd order products	at least 80 dB down	at least 80 dB down
Display Flatness — With respect to display amplitude @ 500 KHz, over any selected frequency span.		±0.25 dB	±0.5 dB
Reference Level* — In LOG mode, reference level refers to top horizontal graticule line.		Calibrated in 1-dB and 10-dB steps	Calibrated in 1-dB and 10-dB steps
Range —	LOG 2 dB/DIV mode	—128 dBm to +21 dBm	—128 dBm/—139 dBV to +21 dBm/+10 dBV
	LOG 10 dB/DIV mode	—70 dBm to +21 dBm	—70 dBm/—81 dBV to +21 dBm/+10 dBV
	LIN mode	10 nV/div to 200 mV/div within 5%, in 1-2-5 sequence	20 nV/div to 200 mV/div within 5%, in 1-2-5 sequence
Accuracy — When calibrated @ —40 dBV in LOG mode.		Within 0.15 dB/dB and max of 0.25 dB/10 dB change in reference level	Within 0.2 dB/dB and max of 0.25 dB/10 dB

**Note: A > sign is displayed by the reference level readout when the reference level is not calibrated and the UNCAL light is on.*



The 7L5 is shown with L1 50 Ω plug-in input impedance module.

Changeable modules permit the 7L5 user to adapt to new measurement requirements. Modules now available are the 50 Ω L1 and 75 Ω L2. Others are planned for 600 Ω and 1 MΩ (probe compatible). The module you select calibrates displays for the impedance in use.

Included Accessories — Graticule, Spectrum Analyzer 337-1159-02 (7000 Series), Filter, light amber 378-0684-00, Cable, coaxial, 50 ohm, BNC/BNC, 6 ft 012-0113-00.

ORDERING INFORMATION

7L5 Spectrum Analyzer **$4500**
(Spectrum Analyzer Requires L Plug-in Module.)
L1 Plug-in Module (50 Ω) **$300**
L2 Plug-in Module (75 Ω) **$300**
***7603 Oscilloscope** ..... **$18[illegible]**
***R7603 Oscilloscope (Rackmount)** **$1900**
Option 6 Internal S A Graticule ..... **No Charge**
***7704A Oscilloscope** **$2900**
R7704 Oscilloscope **$3450**
Option 6 Internal S A Graticule ..... **No Charge**

OPTIONAL ACCESSORIES

2701 50 Ω Step Attenuator **$245**
2703 75 Ω Step Attenuator **$295**
011-0112-00 — 75 Ω to 50 Ω Min Loss Attenuator (Ac Coupled) **$35**

*Suggested Mainframe. See Catalog for oscilloscope specifications and options.

Choosing Your Analyzer

To be useful as a quantitative measuring tool, your analyzer must have these five major abilities:

1. Capable of calibrated amplitude measurements.
2. Capable of accurate frequency measurements.
3. Able to operate over a wide calibrated dynamic range.
4. Capable of adequate calibrated resolution.
5. Capable of sensitivity adequate for the measurements required.

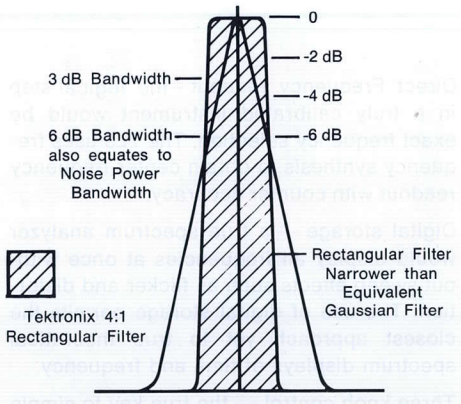


Fig 10. Comparison of the Tektronix Exclusive Rectangular Filter Shape Factor to the Widely Used Gaussian Filter.

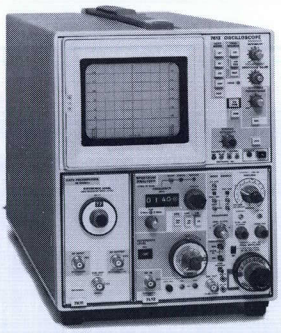
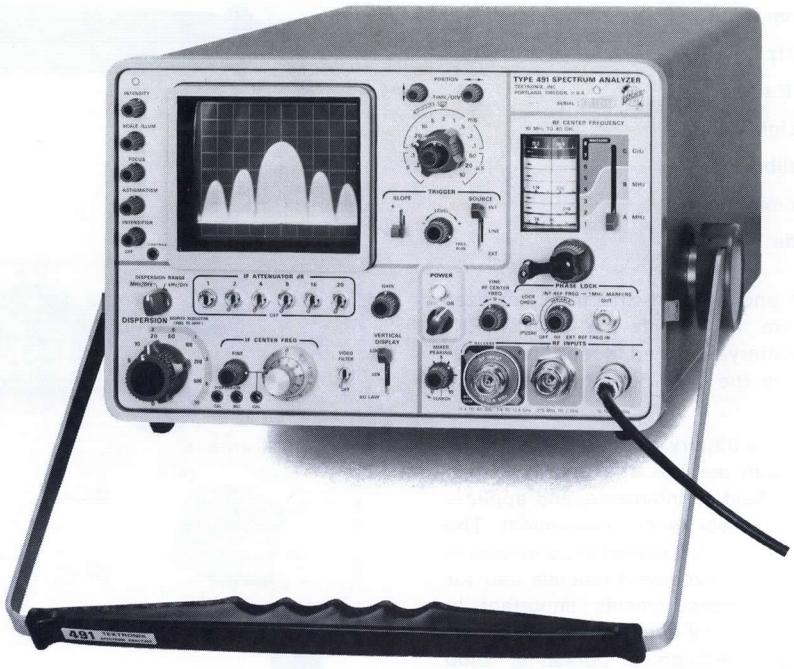


Fig 11. 7K11 Preamplifier Plug-in next to a 7L12 to Increase the Measurement Sensitivity.

Additional important parameters include:
1. Portability
2. Flexibility
3. Method of display.

The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is easy to carry, weighing less than 40 pounds complete with accessories. The R491 is electrically identical and requires only 7 inches of rack height.



FREQUENCY CHARACTERISTICS

Range

10 MHz to 40 GHz

Option 1
10 MHz to 2000 MHz

Option 2
1.5 GHz to 40 GHz

Resolution — 1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

Frequency Stability — ±200 kHz after 1 minute.

Incidental FM — Less than 300 Hz at fundamental, with Phase Lock.

AMPLITUDE CHARACTERISTICS

Display Flatness — Max amplitude variation over 100 MHz dispersions up to 12.4 GHz is 3 dB or less, except over 50 MHz dispersion in Band 1. Above 12.4 GHz the max amplitude variation (100 MHz dispersion) is 6 dB or less.

Max Input Power — −30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

Vertical Display (8 Div) — Log — ≥ 40 dB dynamic range. Linear. Square Law — ≥ 13 dB dynamic range.

IF Attenuator — 51 dB in 1 dB steps, ±0.1 dB/dB.

IF Gain Control — > 50 dB range.

Sensitivity — Greater than — 100 dBm to 8.2 GHz
Greater than — 90 dBm to 18 GHz
Greater than — 70 dBm to 40 GHz

INPUT CHARACTERISTICS

50 Ω Input

SWEEP CHARACTERISTICS

Sweep Range — The 491 uses a complete triggered oscilloscope type time base with 15 calibrated steps from 10 μs/div to 0.55/div.

Calibrated Dispersion — 1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div and MHz/div).

CRT AND DISPLAY FEATURES

Crt — 8 x 10 div display area (each div = 0.8 cm); P7 phosphor.

ENVIRONMENTAL CAPABILITIES

The 491 meets MIL-I-6181D specs for EMI, operates up to 15,000 ft with temperatures from −15°C to +55°C and can stand a 30 g shock.

Weight —	Rackmount	41 lb	18 kg
	Portable	30 lb	13.6 kg

ORDERING INFORMATION

491 Spectrum Analyzer **$6200**

R491 Spectrum Analyzer (Rackmount) $6300

Option 1 (10 MHz to 2 GHz) Subtract..... **$1395**

Option 2 (1.5 GHz to 40 GHz) Subtract..... **$1195**

1105 Battery Power Supply **$625**

Additional specifications are available through your local TEKTRONIX Field Office.

Closing

Spectrum analysis is still in its infancy—not because of present analyzer capability, but because of lack of acceptance as the powerful and universal measuring tool it is.

Tektronix has developed training programs and books to help speed this learning process, and we will continue. Application notes are available on a variety of subjects: Audio, Cable Television, Television, etc. A school lab program based around the spectrum analyzer with a demonstrative approach to Fourier Analysis is available to schools to help train students to think in terms of frequency and amplitude.

Other industries are becoming aware of the need for spectrum analysis. One example is the computer industry, long thought of as a digital world. As the data rates increase in speed and system performance must be optimized, square waves and symetrical pulses no longer behave as at slower speeds. As clocks jitter and transients become critical, a few far-looking pioneers are beginning to apply the long-overdue spectrum analyzers (with a great deal of success) to their problems.

Spectrum analysis is with us to stay, and the sky is the limit as far as applicability. Let a Tektronix specialist show you today how you can better perform your measurements with spectrum analysis.

50 or 75 ohm Input

1 to 500 MHz

Ac, Dc, or Battery

Portable, Lightweight

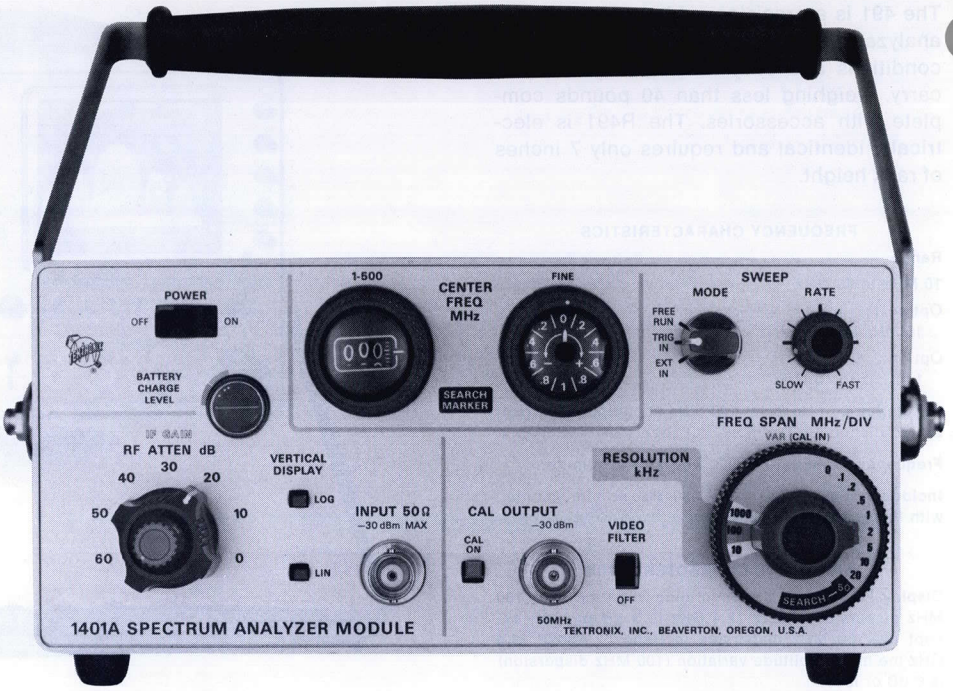
Built-in Calibrator

60 db Dynamic Range

Gated Mode

The 1401A and 1401A-1 Spectrum Analyzer Modules are used with the SONY/TEKTRONIX battery-operated scope for measurements in the 1 to 500 MHz frequency range.

Because of its battery operation, the 1401A is popular with persons engaged in remote site studies, field maintenance, and applications where power is not convenient. The unit may be used for surveillance measurements by law enforcement officials and for displays and measurements important to radio, TV, and CATV operators, medical personnel, aircraft equipment personnel, shop owners, and others. In addition, the 1401A Module may be connected to any inexpensive scope to form an economical 500 MHz analyzer.



1401A Spectrum Analyzer Module

FREQUENCY CHARACTERISTICS

Range — Continuously selectable with 10-turn digital frequency readout control, 1 to 500 MHz. Absolute accuracy within ±5 MHz (+5% of dial reading). Fine control provides a calibrated variation of up to ±1 MHz, within 10%.

Resolution — 10, 100, 1000 kHz Gaussian-shaped Filter.

Frequency Stability — Within 100 kHz over any 5 minute interval after 25 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Incidental FM — 20 kHz or less.

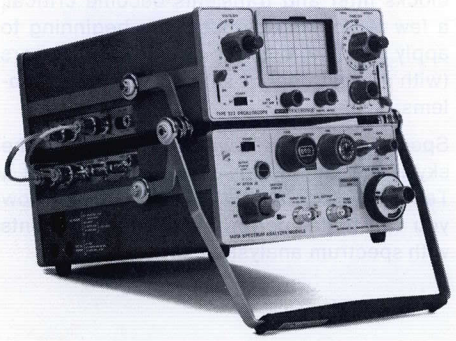
AMPLITUDE CHARACTERISTICS

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.

CW Sensitivity	1401A	1401A-1
3 kHz Resolution	≥ −100 dBm	≥ −45 dBmV
100 kHz Resolution	≥ − 85 dBm	≥ −30 dBmV
1000 kHz Resolution	≥ − 78 dBm	≥ −23 dBmV



1401A-1/323 Spectrum Analyzer System

Display Flatness — Amplitude variations are within 1.5 dB to 200 MHz and 3 dB to 500 MHz.

Intermodulation Distortion — 1401A at least 55 dB down with two signals at −30 dBm (+25 dBmV 1401A-1), 1 MHz apart; 60 dB down with signals at −40 dBm (+15 dBmV 1401A-1).

Dynamic Range — At least 60 dB in log mode at 10 dB/div.

INPUT CHARACTERISTICS

Impedance — 1401A 50 Ω nominally. 1401A-1 75 Ω nominally.

SWEEP CHARACTERISTICS

Sweep Rate — Continuously variable from one sweep per second or less to at least 100 sweeps per second.

Frequency Span (Dispersion) — 50 MHz/div to 100 kHz/div in 9 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.

OTHER CHARACTERISTICS

Calibrator — −30 dBm 1401A accuracy.
+25 dBmV 1401A-1 0.3 dB at 25°C

Power Source — 6 size C NICAD cells for 3½ hours of operation. 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 max 115 V ac.

Weight — 1401A or A1 and 323 Oscilloscope
15 lb 6.8 kg

ORDERING INFORMATION

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 (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00); operator's handbook (1401A).

1401A **$3025**

1401A-1 Included Accessories — Same as for 1401A except: 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).

1401A-1 . . . . . **$3125**

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 . . . . . **$4225**

1401A-1/323P7, Order 1401A-1-3 . . . . **$4325**

OPTIONAL ACCESSORIES

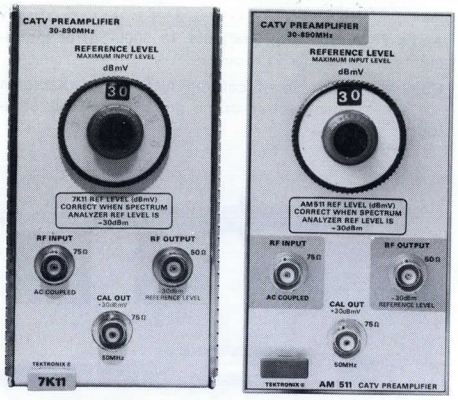
Protective Cover — Waterproof blue vinyl,
016-0112-00 . . . . . **$15**

Handle Conversion Kit (for Two Instruments) — For combining an existing 323 Oscilloscope with 1401A or 1401A-1, for a system as shown, **040-0563-00** . . . **$43**

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.
016-0119-02 . . . . . **$145**

Adapter — BNC 75 Ω to 50 Ω impedance matching network.
011-0112-00 . . . . . **$35**

146-0012-01 Battery Set — Set of 6 NiCd cells **$28**



These plug-in preamplifiers are designed for spectrum analyzer applications where extra sensitivity is required. The 7K11 is a 7000-Series Plug-in while the AM 511 fits into the TM 500 Modular Series power supplies.

The amplifiers are tailored to the CATV and field intensity measurement markets providing a 75 Ω input impedance and calibration in dBmV. The low noise figure makes the preamplifiers well suited for signal-to-noise and low level radiation measurements.

CHARACTERISTICS

(with 7L12 and 7L13)

Frequency Range — 30 MHz to 890 MHz.

Display Flatness — ±1.0 dB, with respect to the level at 50 MHz over the frequency range of 50 MHz to 300 MHz; increasing to +2.0 dB, −2.5 dB over the full frequency range.

Sensitivity — Signal + noise = 2X noise, in LIN mode at 50 MHz. −90 dBmV at 30 Hz, −80 dBmV at 300 Hz, −73 dBmV at 3 kHz, −65 dBmV at 30 kHz, −55 dBmV at 300 kHz, −45 dBmV at 3 MHz. Noise figure is no greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13) — Imd products and harmonics from two signals within the frequency range are 70 dB or more down from the reference level for: 1) third order intermodulation with two signals at the reference level (full screen), 2) second order intermodulation and harmonics with two signals 10 dB below the reference level.

Reference Level — Calibrated level in 1 dB steps from +79 dBmV to 0 dBmV. Accuracy is referenced to the +30 dBmV calibrator at 50 MHz.

Input Impedance — 75 Ω.

Calibrator — 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB, from 75 Ω.

Accessories — BNC to BNC 50 Ω Cable, 5½ inch: 012-0057-01 with 7K11 only; BNC to F Adapter: 013-0126-00; BNC to BNC 75 Ω Cable, 42 inch: 012-0074-00.

7K11 CATV Preamplifier $575

AM 511 CATV Preamplifier $575

TM 501 Power Module for AM 511 . . . . . $100

The 2701 and 2703 Step Attenuators are laboratory quality, bench top instruments for attenuation of large value radio frequency signals. The 2701 50 Ω Attenuator is particularly useful in making receiver sensitivity and distortion measurements. The range of attenuation is 0 to 79 dB, selected in 1 dB steps with tens and units cam swtiches.

The 2703 75 Ω Step Attenuator is tailored for television, CATV, telephone, and radio applications. A front-panel switch extends the range to 109 dB, making the attenuator an ideal accessory for wide-range measurements such as cross modulation, signal-to-noise and receiver sensitivity. A dc block has been incorporated on both rear-panel ports to protect the attenuator against accidental burnout from high dc offsets or ac power on center conductors.

The board assemblies and thick-film hybrid attenuation chips used in both instruments are mounted in a heavy, die-cast metal housing; solid top and bottom plates provide excellent mechanical and electrical stability. The two cam switches which select individual chips operate through gold-plated switch contacts. Held on a four-layer circuit board with spring clips, the chip substrates can be replaced easily in the field.

The attenuators may be used for frequencies up to 2 GHz, with slight degradation of the attenuation accuracy and vswr characteristics specified at 1 GHz.

CHARACTERISTICS	2701	2703
Attenuation	0 to 79 dB in 1 dB steps	0 to 109 dB in dB steps (Including extra 30 dB range)
Impedance	50 ohms	75 ohms
Frequency	Dc to 1000 MHz	3 kHz to 1000 MHz
Accuracy	Units Error +0.1 dB to −0.5 dB Max Error +1.0 dB to −0.7 dB	Units Error 500 MHz: +0.1 −0.5 dB; 1000 MHz: +0.1 −8 dB 79dB: +0.9 −0.8 dB; 79 dB: +1.4 −1.1 dB 109 dB: +1.3 −1.0 dB; 109 dB: +1.9 −1.3 dB
Insertion Loss	−(0.5 dB + 0.14 dB/100 MHz) or better	−(0.2 dB + 0.08 dB/100 MHz) or better
Return Loss	20 dB 10 −300 MHz (1.22 vswr) 17 dB >300 −600 MHz (1.32 vswr) 17 dB @ 1000 MHz (1.32 vswr)	20.5 dB 10 −300 MHz (1.22 vswr) 15.5 dB >300 −600 MHz (1.48 vswr) 11.5 dB @ 1000 MHz (1.78 vswr)
Max Average Input Power	1.5 W to 65°C	1.5 W to 65°C
Signal Coupling	Dc, ac, and dc terminated at one port only	Ac only both PORTS*
Size	7½ in lg x 4½ in w x 2½ in h	7½ in lg x 4½ in w x 2½ in h
Connector	Type BNC Female 50 ohm	Type BNC Female 75 ohm

**Blocking capacitors may be removed for specialized applications.*

ORDERING INFORMATION

2701 50 Ω Step Attenuator $245

2703 75 Ω Step Attenuator $295

NTSC Television Sideband Adapter | 1405

Response of Transmitter under Test within ±0.2 dB

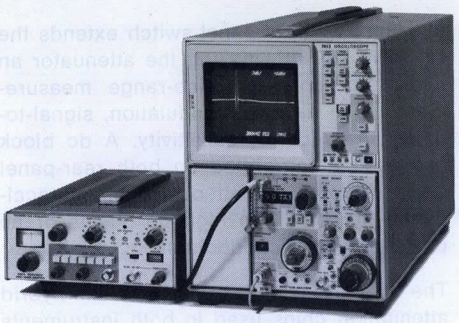
Frequency Response of RF and IF Circuits for Transmitters with Frequency to 1 GHz

Video Circuits Can Be Swept.

For In-service Testing, Use of External Blanking Allows Either Full-field or Single-line Operation

Check Aural FM Deviation with Built-in Bessel NULL Technique

Flexible Marker System Will Accept Standard Crystals



1405 NTSC TELEVISION SIDEBAND ADAPTER

The 1405 is used with a spectrum analyzer, such as the 7L12 or 7L13, to analyze the video output of television transmitters. The 1405 generates a composite video signal, the "picture" portion of which is a constant-amplitude sineusoidal signal that sweeps 15-0-15 MHz. This signal is applied as modulation to a television transmitter; the output is then displayed on the spectrum analyzer, and appears as the response curve of the transmitter under test. The 1405/spectrum analyzer combination will display the frequency response characteristics of rf and if circuits for transmitters with frequencies to 1 GHz. Video circuits (zero frequency offset) can also be analyzed.

Complete specifications and prices are available in the Television Products Catalog.

Numerous application notes and magazine article reprints on spectrum analyzer measurements are available. Notes on am, fm, and television measurements, cable television proof of performance, audio amplifier testing, noise and pulse testing, and others have been written to help you with your measurements.

In addition, our staff of specialists stands ready to help you solve any special measurement problems. Contact your local TEKTRONIX Field Office.

Pads and Adapters

75 Ω to 50 Ω Minimum Loss Attenuator with dc block
011-0112-00 ..... **$35**

75 Ω to 50 Ω Minimum Loss Attenuator with 11.25 dB conversion factor from dBm to dBmV
011-0024-00 ..... **$43**

Dc Block BNC to BNC-max dc potential 50 volts
015-0221-00 ..... **$59**

"F" Female to BNC Male Adapter 013-0126-00 ..... **$8**

BNC Female to "F" Male 103-0158-00 ..... **$7.50**

Calibrator Jumper 50 Ω BNC to BNC 5½ in
012-0214-00 ..... **$24**

Jumper Cable BNC to BNC 50 Ω, 42 in
012-0057-01 ..... **$9**

Jumper Cable BNC to BNC 75 Ω, 42 in
012-0074-00 ..... **$9**

"N" Female to BNC Male 103-0058-00 ..... **$6.50**

Protective Vinyl Covers

For extra protection in field environments, soft vinyl covers are available to fit over the entire cabinet model mainframe or instruments.

7000-Series 3 Hole Mainframe Cover
016-0192-01 ..... **$12**

7000-Series 4 Hole Mainframe Cover
016-0531-00 ..... **$12**

5000-Series Mainframe Cover 016-0544-00 ..... **$12**

491 Analyzer Cover 016-0074-01 ..... **$14**

1401A-323 Protective Cover 016-0112-00 ..... **$15**

Rigid Front Covers

Solid snap on or friction fit covers are available to protect the instruments in transit or field use.

7000-Series 3 Hole Mainframe ..... **Request Quote**

5000-Series Cabinet Mainframes ..... **Order Option 2**

491 Spectrum Analyzer — cover supplied, no charge with instrument.

1401A and 323 Analyzer Combination (2 required)
200-0812-00 ..... **$5.75**

Graticules, Filters

Plastic Implosion Shield and S A Graticule 7613 and 7623 Mainframes **378-0625-07** **$4**

Plastic Implosion Shield and S A Graticule 7403 and 7603 Mainframes **337-1439-01** **$2.20**

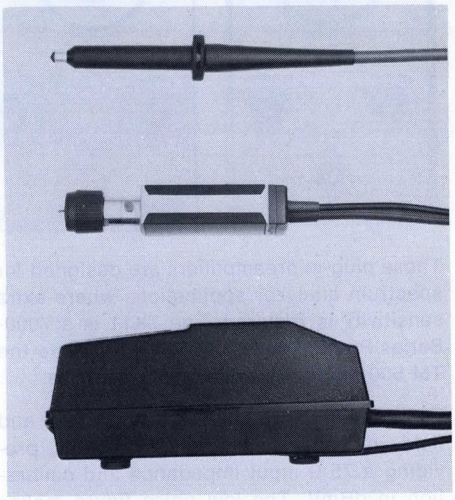
Plastic Implosion Shield and S A Graticule
All other 7000-Series Mainframes **337-1159-02** ... **$3.50**
(Internal graticules are available with most 7000-Series Mainframes)

EMI Metal Screen Mesh Filter for 7500-, 7700-Series instruments **378-0603-00** **$23**

EMI Metal Screen Mesh Filter for 7400-Series instruments **378-0696-00** **$23**

Audio 20-20 KHz Log Graticule for 5000-Series instruments — available on request.

Complete selection of colored filters is available in the accessories section of the general products catalog.



Probes

A variety of probes are available in varying frequency and impedance ranges that can be used with the 7L12, 7L13, and 1401A Spectrum Analyzers:

FET Probe P6201 to 900 MHz 010-6201-01 ..... **$550**

FET Probe P6202 to 500 MHz 010-6202-01 ..... **$325**

Conventional Probe P6057 250 Ω to 1.4 GHz with Adapter **010-6057-03** **$75**

Current Probe P6022 to 150 MHz 015-0135-00 ..... **$195**

Complete specifications are available in the probes and accessories section of the general products catalog.

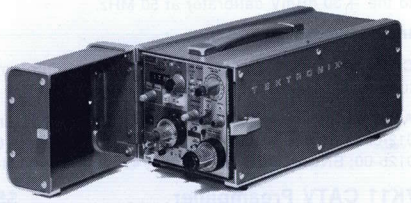
Cameras

A camera can greatly enhance the versatility of a spectrum analyzer. Many different units are available however, the most popular units for the 5000- and 7000-Series instruments are:

Polaroid Film Back C-59-P **$615**

Polaroid Film Back C-5 ..... **$235**

Complete specifications on all cameras are available in the general products catalog.



Carrying Cases and Mounts

Specialized carrying cases are available in 2 forms to protect your spectrum analyzer.

Metal carrying cases are available for the 7L12, 7L13, or 5L4N Plug-in units.

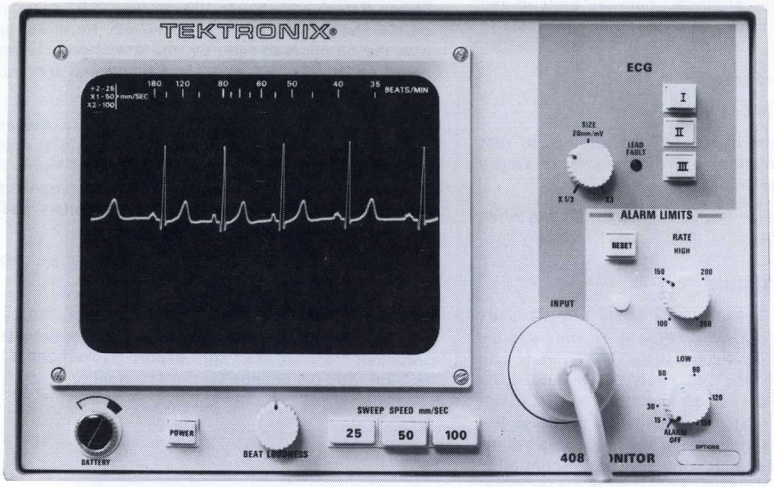
Military style fiberglass and foam type transit cases can be custom fitted to many of the instruments.

A special mounting bracket assembly can be fitted to bolt the analyzer securely into the mainframe if desired.

Your local field office can quote prices and availability on any of these accessories.

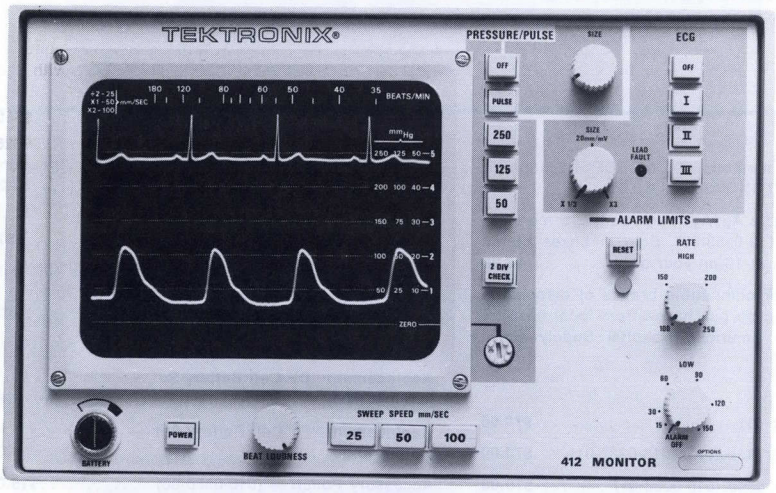
Portable Patient Monitors

Tektronix medical monitors are designed to provide the anesthesiologist and related professionals with a full range of vital signs monitoring features in extremely compact, easy to operate instruments. From simple ECG to pulse, temperature, and blood pressure variables, the 408, 412, and 414 monitors offer new capabilities in portable medical instrumentation. All Tektronix monitors permit cordless (internal battery) operation, all are self-contained in a single instrument package, and each weighs approximately 12 pounds.



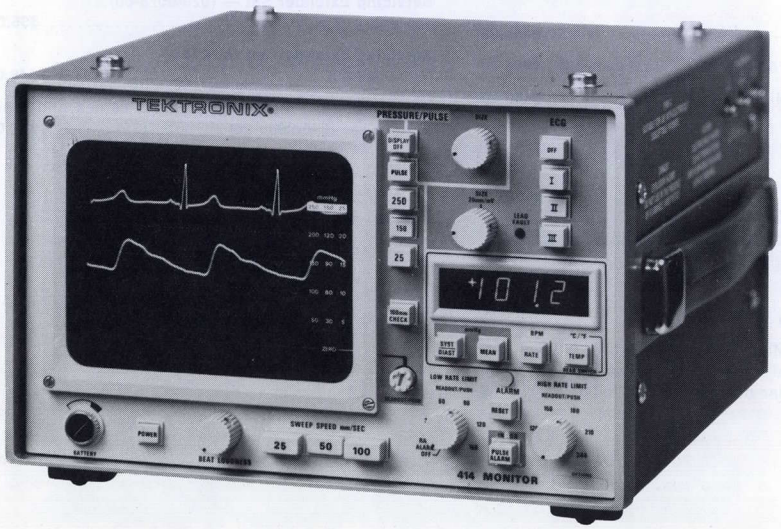
408 ECG Monitor

The 408 monitor is a low cost, single trace instrument designed for applications requiring direct ECG measurements. It features three lead selection, variable heart rate alarm limits, three selectable sweep speeds, and AC or internal battery operation. Full lead selection is optional. Price: $1500.



412 Portable Monitor

Standard model offers dual trace, three lead selectable ECG and blood pressure or peripheral pulse display; also variable heart rate alarm limits, three sweep speeds, and AC or internal battery operation. The 412 may be ordered with full lead selection, mean pressure display, high/low pressure alarm limits, or any combination of these features. Price: $2000.



414 Portable Monitor

414 is a dual trace (ECG and blood pressure or peripheral pulse) with digital display of heart rate, systolic/diastolic pressures, mean blood pressure, temperature, or rate alarm limits. The 414 is standard with three lead selection, pulse pressure and heart rate alarm limits, selectable sweep speeds, and ac or internal battery power. Full lead selection is optional. Dual pressure display will be available in early 1976. Price: $2400.

408/412/414 CHARACTERISTICS

ECG

ECG patient circuits are fully isolated for max patient safety.

Monitoring Bandwidth — 0.2 Hz to 50 Hz. Recovery after defibrillation—within 1 second.

Outputs — Two calibrated output levels, times 1000 gain and times 1 gain. Times one gain permits direct recording on a standard ECG machine.

Patient Circuit Leakage Current — Less than 5 μA RMS at 120 V 60 Hz AC.

414 Lead Check — Lead I: 1.0 mV. Lead II: 1.5 mV. Lead III: 0.5 mV.

408 and 412 Lead Check — 0.5 mV for Lead I and III, 1.0 mV for Lead II.

Lead Fault — Front panel lamp lights with loss of connection to patient.

Pressure (412 and 414)

Requires transducer standardized to 50 μV/V/cmHg.

Ranges — 250 (−50 to +300 mmHg), 150 (−30 to +180 mmHg), and 25 (−5 to +30 mmHg.)

Output — −0.5 V to +2.5 V full scale on each range and −0.5 mV to +2.5 mV full scale on each range.

414 Calibration Check — 100 mmHg on each range. Produces over-range indication on 25 mmHg range. Confirms system function.

412 Calibration Check — 2 div on display. Confirms system function.

Drift — Chopper stabilized for drift-free operation and minimum operating adjustment.

Pulse — (412 and 414) Uses light sensing peripheral blood pulse sensors. Output +2.5 V and ±2.5 mV full scale.

Digital Display (414 only)

Syst/Diast — Display alternates between systolic and diastolic values in mmHg with brief blank intervals to aid recognition.

Mean — Mean blood pressure in mmHg.

Rate — Heart rate in beats/minute.

Temp — Temperature in °C or °F, as selected by rear panel switch. Resolution to 0.1 degree. Uses Yellow Springs 7000-Series probes.

Over-Range — Display flashes on each function when range is exceeded.

Other Characteristics

Rate Alarm Limits — Rate limits apply to ECG when that function is in use. When ECG is off, rate applies to either Pressure or Pulse. HIGH RATE limits can be set between 90 and 240 beats per minute. LOW RATE can be set between 30 and 150 b/m. Rate limit violations must persist for about ten seconds to trip the alarm. Alarm is indicated in three ways: a yellow lamp, a continuous audible tone of operator-controlled loudness, and an electrical output from a rear panel connector. Alarm reset is by a front panel push button or by a remote switch via a rear connector.

Audio — Alarm is a continuous tone. Alarm and beat loudness are independently controlled.

Cathode-Ray Tube — Rectangular 8 x 10 cm viewing area. The P-7 phosphor has long decay time for convenient viewing. Anti-reflection graticule has a graduated heart-rate scale at the top and a vertical scale marked in centimeters, plus vertical graduations in mmHg on the 412.

Sweep Rates — 25, 50, or 100 mm/sec. CRT graticule on 408 and 412 is marked in beats/min. for direct use with the 50 mm/sec rate. On the 414, sweep is triggered on 50 and 100 mm/sec speeds and free running on 25 mm/sec.

Power — Ac:115 V ac or 230 V ac, 48 to 440 Hz. Battery pack ("D" cell) provides at least 3⅓ hours for the 408, 2 hours for the 412, and 1½ hours for the 414 of cordless operation. Battery recharge time is approx 16 hours. Option 3 ("F" cell battery pack) approx doubles battery operation time.

Dimensions — Height: 6.0 in (15.3 cm); width: 10.0 in (25.5 cm); depth: 11.7 in (29.8 cm).

Weights (approx) — Without battery pack: 10.0 lb (4.5 kg); with battery pack: 11.5 lb (5.2 kg); domestic shipping: 16.0 lb (7.3 kg); export packed: 18.0 lb (8.2 kg). Add 0.5 pounds for the 414 monitor.

408, 412, 414 ACCESSORIES

Patient Cables

Torso Cable (3 electrodes) — (012-0445-00).....**$30**

Limb Cable (3 electrodes) — With #4-40 tapped fittings (012-0459-00) **$50.00**

Electrode Wire for Patient Cables

18 in wires with snap fittings for disposable electrodes, set of three (012-0502-00) **$5**
18 in wires with #4-40 tapped fittings —
White (RA) (012-0449-00).....**$5**
Black (LA) (012-0450-00) **$5**
Red (LL) (012-0451-00) **$5**

Electrode Adapters

All equipped with #4-40 thread to mate with limb cable or related electrode wires.

Snap Adapter — (103-0110-00) **$2**

Needle Adapter — (103-0108-00) **$2**

Plate Adapter — (103-0079-00) **$1**

Electrodes

Electrode — Re-usable, Ag/Ag/Cl, with #4-40 thread (119-0197-00) **$5**

Attachment Rings — (006-1099-00) **$7.50**

Electrode Plate — (006-1098-00) **$1.50**

Other attachment methods — MICROPORE tape or pads cut from RESTON #1360 or #1561.

Pre-gelled disposable Ag/AgCl electrodes, three electrodes per pack (119-0353-00). Sold in boxes of ten packs. Specify box of 10 on your order.....**$3.00**

(GELPAD and other compatible brands of disposable electrodes can also be purchased from local hospital supply outlets — American Hospital Supply Corp. number 65375-030).

Pulse Sensors

Finger — (015-0236-01) **$70.00**

Radial — For finger, toe, etc. (015-0237-01)....**$70.00**

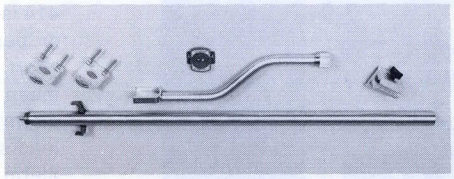
Lobe — For ear or nose (015-0238-01) **$70.00**

Transducers

Statham P23 Ia — (015-0233-00) **$450.00**

Trantec 800 — (015-0234-00) **$465.00**

Bell & Howell — 4-327 1-0109 (015-0235-00)...**$450.00**



Mounting Fixtures

Mounting Kit — Mounts monitor at five ft level. Attached to vertical pipes or surfaces of anesthesia machines or similar devices. (016-0110-00).....**$135**

Support — The upper-most portion of the mounting stand is available separately. (407-1767-00).....**$4.25**

Mounting Adapter — Attaches to instrument. (014-0054-00) **$10**

Pole Clamp, used to mount monitor models 408, 412, 414 on Poles ½ in to 1¼ in in diameter. (014-0053-00) **$36**

Miscellaneous

Replacement "D" Cell Battery Set — (119-0441-00) **$80**

Replacement "F" Cell Battery Set — (119-0443-00) **$130**

Accessory Pouch — (016-0560-00) **$15.00**

Servicing Extender Set — (020-0078-00) 408 and 412 only **$35.00**

Servicing Extender Set for 414 — (020-0188-00) **$45.00**

Repair Kit for #4-40 ends on limb cables and electrode wires (040-0696-00) **$12.00**

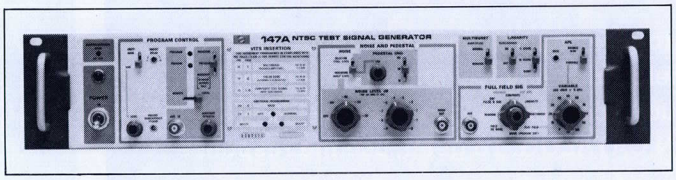
Television Products

TEKTRONIX Television Products time, test, measure, correct, and display the composite video signal.

This section is intended to give you an overview of the Tektronix products available to help you achieve and maintain picture quality. Complete product specifications are available in the TEKTRONIX TELEVISION CATALOG. To get it, use the response card in this catalog.

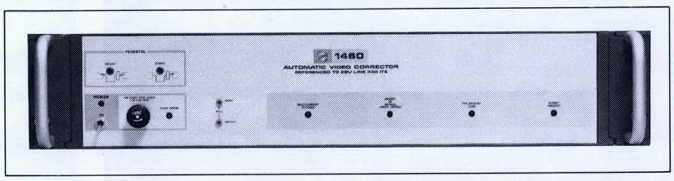
The Television Signal — a very complex analog signal — requires precise timing of its components and exacting analysis of its parameters in order to produce high picture quality. Since the early days of television, Tektronix has served the industry with many forward-looking instruments designed to help you improve picture quality. Our people and their products are industry leaders in the fields of Timing, Testing, Measuring, Correcting, and Displaying the television signal.

TEKTRONIX Television Products time, test, measure, correct, and display the composite video signal.



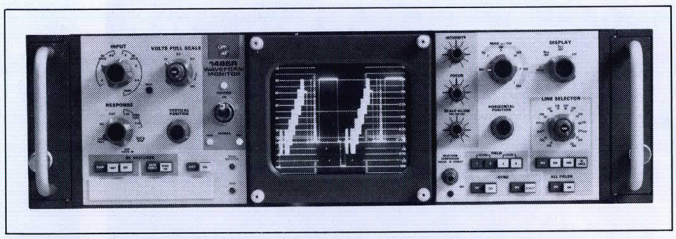
Generators

All of the many signals needed to time and accurately test broadcast and closed-circuit color video equipment are provided by TEKTRONIX Television Signal Generators. There are generators for NTSC, PAL, and PAL-M. Most TEKTRONIX Generators provide many signals rather than just one or two. Through an arrangement of fully or partially independent controls, and a variety of inputs and outputs, the TEKTRONIX Generators provide you with signal flexibility. This flexibility serves to meet your changing timing and testing needs.



Correctors

TEKTRONIX Automatic Video Correctors use a reference signal located in the vertical blanking interval to correct the video signal. The Corrector samples the parameters of the reference signal in the vertical interval and automatically changes its operating characteristics until correct values for the reference signal are achieved. The full field signal is simultaneously corrected by the same automatic changes that correct the reference signal. Automatic correctors and auxilliary products are available for NTSC and PAL Systems.

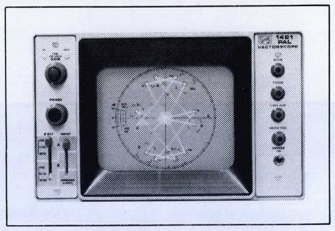


Waveform Monitors

The waveform monitor is a specialized oscilloscope with triggering and vertical characteristics designed for accurate measurement of the composite video signal.

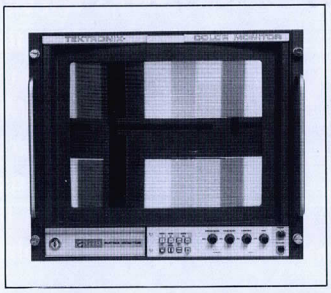
TEKTRONIX waveform monitor vertical amplifiers have very carefully controlled responses necessary for video system signal fidelity. There are waveform monitors for 525/60 and 625/50 systems.

Vectorscopes



Vectorscopes are used to display and examine the chrominance signal.

Think of a vectorscope as an oscilloscope with a circular time base. It displays a polar plot with the radius a function of chrominance amplitude and the angle a function of chrominance phase. The chrominance phase is measured with respect to burst or a reference subcarrier. Some TEKTRONIX Vectorscopes offer linear time base displays in addition to vector displays. Luminance amplitude, chrominance phase, chrominance amplitude, differential phase, and differential gain are included in the wide variety of specialized measurements for which vectorscopes are used.

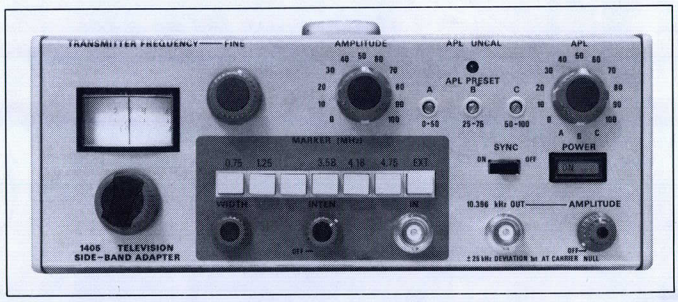


Picture Monitors

Picture monitors used in television production and transmission facilities are required to present program material and test patterns for critical evaluation by both engineering and production people. Therefore, consistent high-quality color reproduction is an important requirement. TEKTRONIX Color Picture Monitors meet this requirement.

In addition to having stable, consistent color characteristics, TEKTRONIX Color Picture Monitors provide underscan and vertical and horizontal delay functions for detailed examination of the entire picture.

TEKTRONIX monitors are sized to fit the critical space requirements of your installations. The trinitron kinescope makes both the 650 Series and the 670 Series simple to converge and contributes to the color stability of both series.

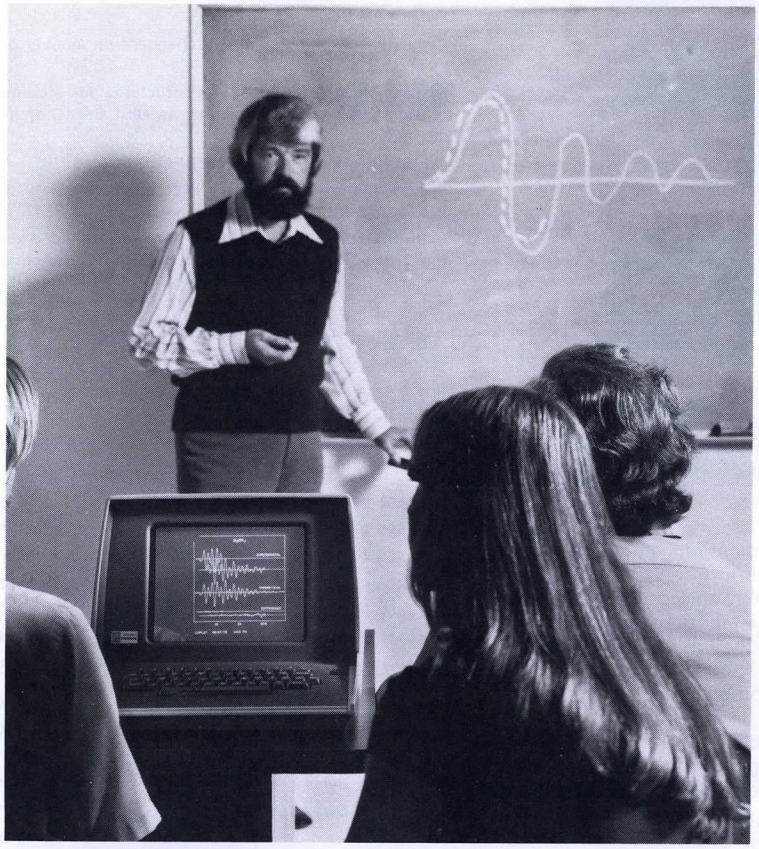


Other Products for Television

The catalog you are reading now lists many products you may find valuable for use in servicing television systems and in general engineering and design — particularly when you are working in impedances other than 75 ohms, or with radio frequencies, or with non-composite video. Among these products are spectrum analyzers, scopes with sync separation features, and the TM 500 Modular Instruments.

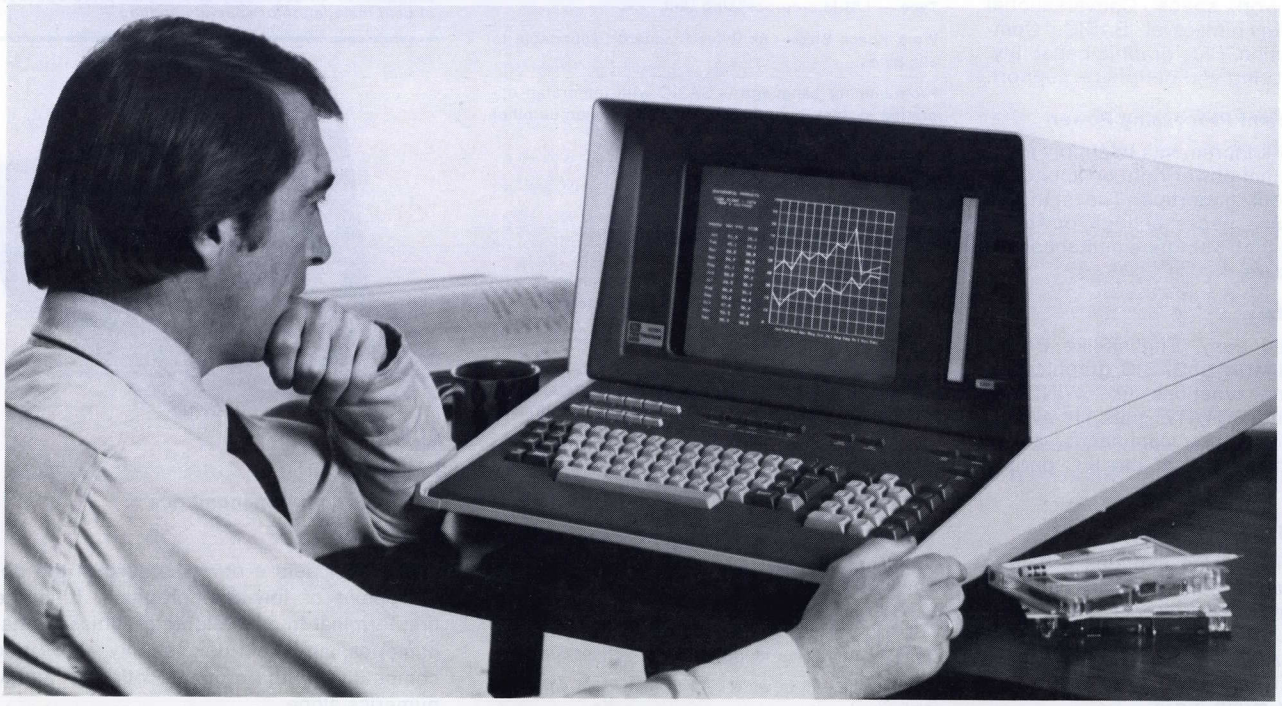
The complete reference for data on Tektronix Television Products is the TEKTRONIX Television Catalog. To get it, see the response card in this catalog.

Information Display Group Products



Information Display Group's new computer peripheral and calculator products provide a broad line of graphic and computational solutions to meet your professional needs. Included in the following pages are a few of the Group's most recent developments as well as our successful, time-proven products presently at work in a variety of applications. Whether the 4051's computational, desktop capability or the 4006-1's low-cost, graphics capability fit your particular application, you can rely upon Tektronix to provide a full line of low-cost peripherals for present and future needs.

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



Information Display Group Products

Graphic System and Computer Display Terminal

4051

Desktop Computational Power

Alphanumerics and Graphics

High-level BASIC

Up to 32k Work Space

Off-line Intelligence in a Graphics Terminal

A compact, comprehensive package with built-in computational power and high-density desktop graphics.

Up to 32k of work space. Conversational interactivity with high-level BASIC. Complete on-line option. Plus graphic capability. Standard interfacing and peripheral support.

8k of Self-sufficient Processing Power

Expandable in 8k increments to supply plenty of computational power right on your desk and right at your fingertips. The standard 8k of work space packs enough power to plot over 300 1-inch vectors simultaneously, with room to spare.

BASIC Vocabulary

We've enhanced easy, English-like BASIC with some ordinarily unBASIC graphics extras . . . including functions like WINDOW, VIEWPOINT, and ROTATE, plus file system data access, formatting commands, and a unique interrupt control of the IEC peripherals.

More for The Money

The basic package also includes a built-in 300k-byte capacity cartridge tape unit for plenty of extra storage; 20 user-definable functions; ten liner editor functions; full 128-character ASCII with upper-lower case keyboard; IEEE standard (488-1975) rear connector, and much more.

Our Data Communications Interface Option makes the 4051 perform all the functions of our famous 4012 Graphic Display Terminal: edit offline in any language; send and receive in batch, via the internal mag tape unit, at asynchronous speeds up to 2400 baud. Add on plug-to-plug peripherals like our 4631 Hard Copy Unit; the 4924 Auxiliary Magnetic Tape Unit for fast data I/O and tape copying. Plug in a digital plotter, a versatile joystick, and more.

CENTRAL PROCESSING UNIT

Type — LSI Microprocessing Unit.

Work Space Size — 8k Bytes Standard Expandable to 32k Bytes.

Programming Language — BASIC with integrated operating system, built-in graphics, and numerous other extensions.

Numeric Accuracy — 14 decimal digits.

Numeric Range — 1 x 10 $\pm^{308}$

INTERNAL PERIPHERALS

Keyboard —

Complete upper and lower case alphanumerics with auto-repeating keys. Full ASCII. 128 characters.

10 Function Keys with SHIFT for up to 20 separate function calls.

Five editing keys with SHIFT, control 10 different editing functions used to modify BASIC source programs.

Calculator key pad including 10 key numeric pad, 5 math operator keys, decimal point, and parenthesis.

Control keys — AUTO NUMBER—generates program line numbers automatically; STEP—executes program steps one at a time; AUTO LOAD—automatically loads and runs File 1 on tape; REWIND—rewinds tape; MAKE COPY—activates optional 4631 Hard Copy Unit.

DISPLAY CHARACTERISTICS

Type — Direct view storage crt.

Dimensions — 8 in wide by 6 in high (20.3 cm x 15.2 cm).

Alphanumeric Format — 72 characters per line, 35 lines; 2520 total.

Character Set — Full ASCII character set, including upper/lower case. Also includes Scandinavian, German, General European, and Spanish fonts.

Graphic Resolution — 1024 x 780 points.

Hard Copy — Compatible with our 4631 Hard Copy Unit.

TAPE DRIVE

Type — 3M DC300A cartridge.

Capacity — 300k bytes max (dependent on number of files).

System Characteristics — File structures for storage of programs or data. Access is via 4051 BASIC operating system.

GENERAL PURPOSE INTERFACE BUS (GPIB)

Specifications — Conforms to IEEE standard 488-1975. Byte serial, bit parallel transfer mode.

Control Mode — External devices can be serviced via interrupt procedures available in the BASIC operating system. Enable/disable, polling, and data transfer commands are available under program control.

PHYSICAL CHARACTERISTICS

Height — 13.6 in (34.5 cm).

Width — 18.3 in (46.5 cm).

Depth — 32.5 in (82.6 cm).

Weight — 65 lb (29.5 kg).

SOFTWARE

4050A01 PLOT 50: Statistics, Vol 1	**$175**
4050A02 PLOT 50: Statistics, Vol 2	**$175**
4050A03 PLOT 50: Statistics, Vol 3	**$400**
4050A04 PLOT 50: Mathematics, Vol 1	**$175**
4050A05 PLOT 50: Mathematics, Vol 2	**$225**
4050A06 PLOT 50: Electrical Eng, Vol 1	**$400**
4051 Graphic System	**$6995**
Opt 1 Data Comm I/F	**1500**
Opt 10 RS 232 Printer I/F	**+550**
Opt 20 16k Bytes Total Memory	**+2150***
Opt 21 24k Bytes Total Memory	**+3350***
Opt 22 32k Bytes Total Memory	**+4550***

**The same item ordered after the 4051 is delivered is available as an accessory at a higher price because of field installation or special handling.*

4006-1

High Resolution

Graphics and Alphanumerics

Under $3000

The 4006-1 sets a new standard in the development of low-cost graphics. It is the first terminal to consolidate graphics, alphanumerics, and Tektronix quality at a price competitive with terminals offering alphanumerics alone.

The 4006-1 supports high resolution, complex graphics, with 1024 X and 780 Y viewable points. The 4006-1's screen capacity of 2590 A/N characters exceeds most alphanumeric crts.

New Software

A software package that makes graphics easy for nonprogrammers, and which multiplies the capabilities of the experienced programmer, the PLOT-10/Interactive Graphing Package (IGP), provides easy-to-learn, English language structured commands that enable you to construct, edit, save, and recall graphs in a conversational relationship with the computer.

The IGP software package provides you the power to read data and commands from file; edit graphic data points; and update and compare graphs from storage.

There are plug-in peripheral options like our 4631 Hard Copy Unit, or the 4923 Digital Cartridge Tape Recorder for 200k-bytes of data storage on each tape.

SPECIFICATIONS

Display Medium — Direct view Bistable Storage crt.

Display Area — 7.5 in wide x 5.6 in high (19.05 cm x 14.22 cm).

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

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

Character Generation — 5 x 7 dot matrix.

Cursor — 8 x 8 dot matrix.

Graphics Display Mode — Vectors only. Vector drawing time, 3.6 ± 0.2 ms.

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

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

Input Power — 110/240 V ac (Low, Medium, High) 50 to 440 Hz, 105W.

Operating Temperature — +10°C to +40°C.

Operating Altitude — To 15,000 ft.

PHYSICAL CHARACTERISTICS

Height — 12⅜ in (31.43 cm).

Width — 15¼ in (38.74 cm).

Length — 27½ in (69.85 cm).

Net Weight — 42 lb (19.05 kg).

Shipping Weight — 50 lb (22.68 kg).

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

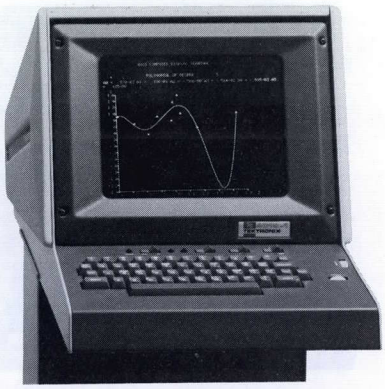
Peripherals — The 4006-1 is compatible with the 4631 Hard Copy Unit, for dry, high-quality, 8½ x 11 in copies of any information displayed on the 4006-1 screen.

The 4923 Digital Cartridge Tape Recorder, a low-cost off-line data storage device, is also compatible with the 4006-1.

ORDERING INFORMATION

4006-1 Computer Display Terminal . . . $2995

Option 1 Half Duplex Module . . . . . +$300



4010-1

Supports Alphanumeric Plus Low-Cost Computer Graphics

Convenient Pedestal Design for User Environments

Flicker-Free Storage Display

Complete Software Support

With its low price, the 4010 Computer Display Terminal is a data handling tool of great capacity and flexibility. The pedestal minibus design opens the way to a variety of system concepts.

With the 4010-1, permanent hard copies of displayed data can be obtained, using a 4610 Hard Copy Unit.

The Keyboard — The 4010 has a TTY style keyboard featuring 63 printing characters (including upper case alphanumerics), and standard ASCII control characters. Independently operated X and Y axis thumbwheels position the Graphic Cursor in the Graphic Input Mode.

Operating Modes — Three operating modes can be selected from the keyboard or the computer. In Alphanumeric mode, 35 lines of 74 characters each constitute a full display screen. In Graphic Display mode, the terminal produces clear, accurate vector display in response to computer commands. In Graphic Input Mode, operator/computer interactivity is permitted.

DESIGN CHARACTERISTICS

Screen Size — The screen is a direct-view storage crt 8¼ in wide x 6⅜ in high.

Format — The 4010 allows 74 characters per line, and 35 lines (2590 characters) per full screen.

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

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

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

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

ORDERING INFORMATION

4010 Computer Display Terminal with Standard Data Communications Interface $4195

4010-1 Computer Display Terminal with Standard Data Communications Interface $4695

4012

Low-Cost Full Range Performance

Upper and Lower Case Alphanumerics

Graphic Capability with High Resolution

Full ASCII Character Set

The 4012 Computer Display Terminal adds keyboard selection of the full ASCII set of 96 upper and lower case printing characters, or the 63 character TTY subset.

The Keyboard — Alphanumeric and control key entries are made directly from the keyboard. The TTY upper case subset is enabled by a special TTY lock key. Character repeat is accomplished by holding a key down. The graphic cross-hair cursor is controlled by keyboard thumb-wheels.

Operating Modes — Alphanumeric mode uses the full upper and lower case ASCII character set, or the TTY upper case subset. In Graphic Display mode, vector displays are drawn in response to computer commands. In Graphic Input mode, the thumbwheel controlled cross-hair cursor can be positioned on the display, for operator/computer interactivity.

DESIGN CHARACTERISTICS

Screen Size — The screen is a direct-view storage crt 8¼ in wide x 6⅜ in high.

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

Graphic Display Mode — Vector Drawing time, 2.6 ms.

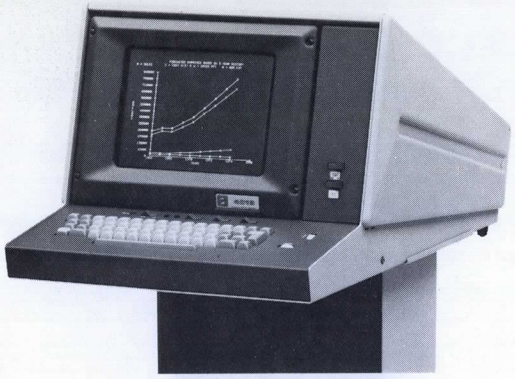
Graphic Matrix — There are 1024 X by 1024 Y addressable points, and 1024 X by 780 Y viewable points.

Graphics Input Mode — A thumb-wheel controlled cross-hair cursor.

ORDERING INFORMATION

4012 Computer Display Terminal with Standard Data Communications Interface $5995

R4012 Computer Display Terminal with Standard Data Communications Interface (Rackmount) $6395



4013

APL Character Capability with High Resolution

Full ASCII Character Set

APL (A Programming Language), is a highly interactive, problem-solving language which lends itself ideally to graphic display of computer data.

The 4013 Computer Display Terminal is especially designed to be used with APL, in addition to the complete ASCII upper and lower case character set and the TTY subset. The 88 symbol APL set includes the complete upper case italic alphabet, number set, special APL function symbols, and APL composites.

The Keyboard — The 4013 has APL symbols on the top surfaces of the keys, and the ASCII symbol differences on the forward surfaces. Graphic cross-hair cursor controls and character repeat are also featured on the 4013 keyboad.

Operating Modes — The 4013 offers Alphanumeric mode, Graphic Display mode for computer outputs, and the interactive Graphic Input mode.

DESIGN CHARACTERISTICS

Screen Size — The screen is a direct-view storage crt 8¼ in wide x 6⅜ in high.

Character Set — Includes 96 printing characters on a 7 x 9 dot matrix (full ASCII code), and 88 character APL set.

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

Graphics Input Mode — The 4013 has a thumb-wheel controlled cross-hair cursor.

ORDERING INFORMATION

4013 Computer Display Terminal with Standard Data Communications Interface $6195

R4013 Computer Display Terminal with Standard Data Communications Interface (Rackmount) $6595

4014-1

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

This TEKTRONIX 19 inch Computer Display Storage Terminal allows over three times more graphic and alphanumeric data display than ever before, with better resolution. The 4014 offers the complete ASCII upper and lower case character set, plus the TTY upper case subset.

Also available is the 4014-1, which is compatible with the 4631 Hard Copy Unit to provide permanent copies of display information.

The Display — A direct view 19 inch storage display tube allows up to 8512 alphanumeric characters, and four different character sizes. The 4014 has two display modes and the option of five vector types for graphic display.

DESIGN CHARACTERISTICS

Screen Size — A direct-view storage crt, 15 in wide x 11 in high.

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

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

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

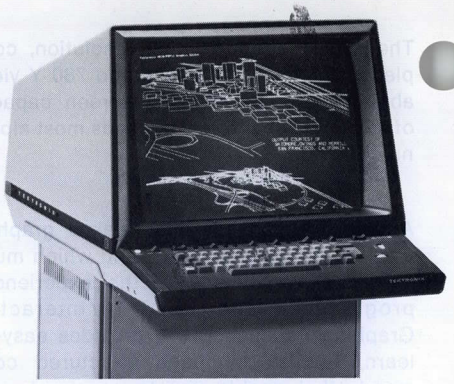
4014 Enhanced Graphics Module, Option 34 — With this extra-cost option, capacity is extended to 4096 X by 4096 Y addressable points, and 4096 X by 3120 Y displayable points. Dotted and dashed line vectors (five variables). Three point plotting codes allow program control of Writing Beam Brightness.

ORDERING INFORMATION

4014 Computer Terminal with Standard Data Communications Interface $10,595

4014-1 Computer Display Terminal with Standard Data Communications Interface $10,995

Option 34 Enhanced Graphics Module (Factory Installed Only) . . . . . Add $750



4015-1

Full APL and ASCII Character Sets

Large Direct-View Storage Crt

Interactive Graphics Capability

The 4015 Computer Display Terminal adds the powerful problem-solving APL Language to the increased display power of the 19 inch screen, along with the full ASCII upper and lower case set and TTY subset.

Also available is the 4015-1 model, compatible with the 4631 Hard Copy Unit to provide permanent copies of display information.

The Display — The 19 inch display is a direct view storage tube with a capacity of up to 8512 characters. The 4015 has four different sizes of character display, two display modes, and five vector types for graphic display.

Operation Modes — The 4015 functions in three modes: the Alphanumeric Mode, Graphic Display Mode for computer outputs, and the interactive Graphic Input Mode. Data received may be displayed alphanumerically or graphically.

DESIGN CHARACTERISTICS

Screen Size — The screen is a direct-view storage crt 15 in wide x 11 in high.

Character Set — Includes 96 characters (Full ASCII upper and lower case), a TTY subset, and an 88 character APL set.

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

Graphics Input Mode — A thumb-wheel controlled cross-hair cursor for 3 through 1024 addressable points horizontally, and 0 through 780 addressable points vertically.

4015 Enhanced Graphics Module, Option 34 — Expands capabilities to 4096 X by 4096 Y addressable points, and 4096 X by 3120 Y displayable points. Dotted and dashed line vectors (5 variables), three point plotting modes allow program control of Writing Beam Brightness.

ORDERING INFORMATION

4015 Computer Display Terminal with Standard Data Communications Interface $10,995

4015-1 Computer Display Terminal with Standard Data Communications Interface $11,395

Option 34, Enhanced Graphics Module (Factory Installed Only) . . . . . Add $750

4023

Low Cost Refreshed Versatility

Upper and Lower Case Capability

Operates at the Speeds You Require

The TEKTRONIX 4023 is a general-purpose alphanumeric, refreshed terminal with all the built-in features of a refreshed terminal — it is quiet, bright, and buffered, plus it has other features which are oriented toward rapid error-free data base entry and retrieval operations.

The 4023 keyboard provides selection of the full ASCII set of 96 printing characters, or the 63 character TTY upper case subset. Additional features of the keyboard include two-key roll-over and auto-repeat for any keys depressed over 0.3 second.

The memory (buffer) of the 4023 allows space for 24 lines with 80 characters each, providing a total of 1920 characters.

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.

Interfacing — Provided by two data communication interfaces for telephone line connection. One is the Standard Data Communications Interface supplied with the 4023 if no interface option is specified. Also available is an optional Data Communications Interface with added features for full- or half-duplex Data Communication system operations.

The Display — A refreshed crt, 9 inches wide by 5.5 inches high, P-4 type phosphor.

Video — Composite Video compatible with standard interlaced 525 line monitor.

ORDERING INFORMATION

4023 Computer Display Terminal, Includes Rulings Character Set $3495

Optional Data Communications Interface . . . . . Add $350

4631

Dry Process

8½ x 11 Inch Copies

Supports up to Four Terminals

The 4631 Hard Copy Unit is compatible with the 4006-1, 4010 family of display terminals and the 613 and 613-1 Storage Display Units; and at no additional cost to 4014-1 or 4015-1 owners. The 4631 provides permanent, dry copies of any information displayed on the terminal screen. For greater flexibility it can also be multiplexed to make copies from up to four display terminals and/or display monitors. When you need to keep records, or present information at that last-minute meeting, a touch of the button gives you copies of any displayed data quickly and easily.

The 4631 uses 3M Brand 777 Dry-Silver paper to give you the high image contrast you need for complex graphics and alphanumerics.

The 4631's copy time is 18 seconds for the first copy, and 10 seconds for subsequent copies.

CHARACTERISTICS

Paper Size — 8½ x 11 in.

Copy Size — Position I and III produces an 8.85 x 6.7 in copy, oriented horizontally on an 8½ x 11 in piece of paper. Position II produces a 7.1 in x 5.4 in copy, oriented vertically on an 8½ x 11 in piece of paper — not recommended for 19 in display tubes.

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

Dimension — (Height, width, length) 11.6 x 16 x 25.5 in (29.5 x 40.6 x 64.9 cm).

Weight — Approx 65 lb (29.48 kg).

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

ORDERING INFORMATION

4631 Hard Copy Unit $3995

Option 1 — Copy Counter—Automatically counts the copies made by the 4631 . . . . . **Add $55**

Option 2 — Four Channel Multiplexer . . . . . **Add $535**
One 4631 can copy up to 4 separate terminal displays and/or storage display units.

4923

RS-232-C Compatible

200,000 Characters of Storage

The 4923 Digital Cartridge Tape Recorder is the perfect step up in storage to team up with our 4010 family of terminals, or any system using an RS-232-C interface. Each tape cartridge can hold about 200,000 characters in high density storage. Each data file has a variable number of formatted records.

This is the perfect medium for local program storage, and a means to get better mileage out of your system — previewing and editing data before you go to the central processor.

Use the 4923 on audit trail to record all the data coming in from the central processor and terminal, or from our graphics terminal/tablet system. All transactions become a matter of record, so you can debug and alter later, if it's necessary.

The standard model hooks up directly to the 4010-Series terminals through the terminal bus; Option 1 uses an RS-232-C Data Communications Interface. Our standard version operates at approx 10k baud, while Option 1 lets you select the baud rate, from 110 to 9600.

SPECIFICATIONS

Cartridge Type — DC300A 3M data cartridge.

Tape Length — 300 usable ft.

Storage Capacity — 200,000 bytes (nominal).

Characters/Record — 128 eight-bit bytes.

Recording Density — 1600 bpi.

Data Transfer Rate —
Internal—48 kHz.
External—Standard, up to 10k baud. Option 1, 110 to 9600 baud selectable.

Data Format — 8-bit binary or 8-bit ASCII.

Data Integrity — Performs a read-after-read error check when an error is detected.

Number of Tracks — One effective data track.

Recording Format — NRZ two-track self-clocking.

Dimension — Width: 8.75 in; depth: 17.25 in; height: 6 in; weight: 17 lb.

Standard Accessories — One data cartridge.

ORDERING INFORMATION

4923 Digital Cartridge Tape Recorder $1895

Option 1, RS-232C Compatible . . . . . No Charge

4662

Microprocessor Based

4-Character Fonts

RS-232-C Compatible

The new TEKTRONIX 4662 Interactive Digital Plotter is micro-processor based, interactive, flexible in capabilities, and easy to use. It extends high industry standards which include:

10 in x 15 in drawing area
High resolution
1:1 reproduction of crt displays up to 19 in diagonal
Proven Tektronix technology
Convenient, accurate electrostatic positioning
16 to 22 ips

It is plug compatible with many Data Communications Systems (RS-232C, Full Duplex) and with the TEKTRONIX 4051 and IEEE 488-1975 interface standard. It offers systems flexibility and the following pacesetting characteristics:

The First Fully Resident Internal Character Generator
Excellent Quality Character Reproduction
Easy Labeling from Terminal Keyboard
Labeling of Curves without Loss of Spacing
Exact Sizing to 'Fit' Any Graph or Plot
Expandability

Its prime advantage as a digitizer (tablet) and plotter is in applications requiring reduced system cost and reduced space requirements. In many uses, the 4662 can actually function as a stand alone terminal.

Specific 4662 product capabilities include:
Accommodation of Formatted Media
Easy Ratio Selection
Multiple Images
Calibration to Scale
Allowance for Up-Dating or Changes on Back of Master Plot
Less Heat, Cost
Improved Reliability
Quietness and Lightness

ORDERING INFORMATION

4662 Interactive Digital Plotter $3995

Option 1 Interactive Digital Plotter (for 4051 Graphic System) . . . . . No Charge

4921/4922

The Flexible Disc Memory is for users who need a convenient, user-controlled storage system for off-line or auxiliary use. The Disc Memory consists of one or two disc drive units, plug-in circuit boards, and its own interfacing board, which slides into the 4010-Series terminal.

The Memory has its own power supply and interface electronics to make it a versatile, local memory and terminal driver. The user has full control.

The Memory can store data from any of the terminal keyboards, and send data up onto any terminal screen. It can also send data to (or receive it from) a computer.

The 4922 (the two-disc drive model) can duplicate discs and store or send lengthy, continuous data streams. Either Memory can replace a paper tape device with few, if any, software changes.

The Memory has a "read-after-write" feature and a Disc/Error light for an extraordinarily safe 10^{-8} error rate.

Number of data tracks: 64

Number of sectors/track: 32

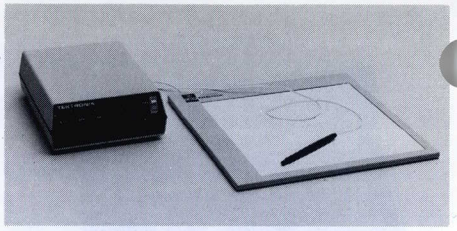
8 bit bytes per sector: 128

Total disc capacity: 262,144 bytes

ORDERING INFORMATION

4921 Flexible Disc Memory
(single drive with interface) **$3695**

4922 Flexible Disc Memory
(dual drive with interface) **$5995**



4953/4954

Single Point Entry

Multiple Point Entry

Tracking (Continuous) Entry

Local Display

The Graphic Tablet comes complete, with its own electronics, one of two input device options, and easy-to-follow set-up instructions.

Choice of a pen for the ultimate in convenience, or a pushbutton cursor where exacting accuracy is required. Keep pen to tablet to get instant vectors, or lift the pen between inputs for separated points. You can input points, or all of anything you put on the tablet, including maps, graphic hard copies, drawings, schematics, designs. Select options from a written "menu" placed on the Graphic Tablet. Use it for fast digitizing, freehand graphics, etc. Use it to get numbers out of any graphic display. You can store these inputs, recall them later, and make hard copies of them, just like any other graphics.

Two sizes of tablets are available: the 11 x 11 inch model 4953, or the drawing board size 40 x 30 inch model 4954.

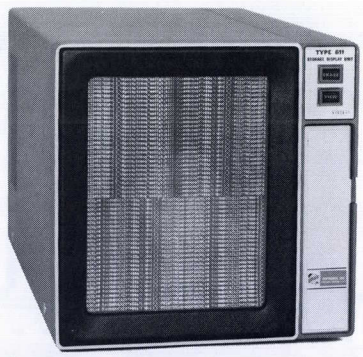
Either Graphic Tablet is compatible with the entire family of TEKTRONIX Graphic Display Terminals. TEKTRONIX PLOT-10 Software effectively supports operation of the Graphic Tablet in the vast majority of mini- and major-computer environments.

ORDERING INFORMATION

4953 Graphics Tablet
(with interface) 11 in x 11 in **$2995**

4954 Graphics Tablet
(with interface) 40 in x 30 in **$4995**

Cursor (119-0622-00) $220



611

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 digital computers having D/A converters and from analog signal sources. The stored display eliminates the need for costly memory devices to refresh the display, and provides high information density with excellent resolution without flicker or drift. All 611 control functions (Erase, Write-Thru, Non-store, and View) are remotely programmable.

DESIGN CHARACTERISTICS

The 611 uses an 11 in (diagonal measure) flat-faced storage tube. Resolution is 4000 characters, based on a 70 x 90 mil dot matrix; this is equivalent to 400 vertical by 300 horizontal (300 vertical by 400 horizontal for the 611-2) stored line pairs. Dot writing time is 5 μs or less; erase time is 500 ms or less. Viewing time is 15 minutes without loss of resolution but may be extended to one hour.

Vertical and Horizontal Amplifiers — The deflection factor is 1 V full scale, either axis. Any of 9 adjustable initial beam positions can be selected by internal switches. Input R and C is 100 kΩ shunted by approx 70 pF.

Z Axis Amplifier — Input turn-on level (unblanked) is + 1 V; turn-off level (blanked) is + 0.5 V or less. Input R and C is the same as the Vertical and Horizontal amplifier.

Other Features — A busy signal is provided at the rear connector to inhibit external equipment (computer, etc) during the erase cycle.

Requirements — The 611 operates on 110 or 220 V ac (LO, MED, HI) 48 to 66 Hz, and requires 250 watts at 115 V, 60 Hz.

Included Accessories — Program connector; connector cover, and maintenance manual.

ORDERING INFORMATION

611 Storage Display Unit (Vertical Format) $3950

611-2 Storage Display Unit (Horizontal Format) $3950

613

Bright Flicker-Free Viewing

Low Cost

Storage Economy

Hard-Copy Compatibility

Remote Programming of Display Functions

The 613 Storage Display Unit is a bright large screen data storage display unit which allows satisfactory viewing under high ambient light conditions. It is ideal for storing and presenting a substantial amount of data in a single display. The 613 provides greater stored display brightness of alphanumeric and graphic information from digital computers having D/A converters and from analog signal sources.

The TEKTRONIX 4631 Hard Copy Unit will copy the 613 Display Monitor.

DESIGN CHARACTERISTICS

The 613 uses an 11 in (diagonal measure) flat-faced crt, with resolution equivalent to 200 vertical by 266 horizontal line pairs. Viewing time is 15 minutes; longer viewing may require more than one erasure to clear previously stored data. Dot writing time is 5 μs or less; erase time is 900 ms or less.

Vertical and Horizontal Amplifiers — The deflection factor is 1 V full scale, either axis. Any one of nine initial beam positions may be internally selected. Input R and C is 20 kΩ minimum, shunted by less than 60 pF.

Z Axis Amplifier — Beam turn-off (unblanked) level is + 1 V; beam turn-off (blanked) is + 0.5 V or less. Input R and C is 10 kΩ shunted by approx 50 pF. A TTL LO input circuit may be selected to turn on the crt writing beam.

Other Features — All 613 operating modes (Erase, View, Nonstore, Cursor) can be remotely controlled by applying the appropriate ground closures to the remote program connector. All control signal inputs are TTL compatible.

Power Requirements — The 613 operates on 110 or 220 V ac, (LO, MED, HI), 48-66 Hz, and requires 180 watts (max) at 115 V ac, 60 Hz.

ORDERING INFORMATION

613 Storage Display (Horizontal Format) $3195

613-1 Storage Display (Vertical Format) $3195

4632

Permanent 8½ in x 11 in Gray Scale Copies from Standard Video Signals and 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. As an option, it can be multiplexed to provide copying capability from one to four video sources.

DESIGN CHARACTERISTICS

Standard Copy size adjustment is 8½ in by 11 in for horizontal raster display (4:3 aspect ratio). Copy time is approx 18 s for the first copy and about 8 s for additional copies of the same display. Machine warm-up time is 20 min. The recommended ambient temperature for operation is 0°C to +35°C.

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

Power Requirements — The 4632 operates on 110-115 V ac, or 200-230 V ac, 50-60 Hz; these are factory wired options.

Included Accessories — One 75 ohm termination.

ORDERING INFORMATION

4632 Video Hard Copy Unit $3995

Option 1, Copy Counter ..... Add $55

Option 2, 4-channel Multiplexer ..... Add $535

Option 3, Set up for 625 Line, 50 Hz Field Operation ..... No Charge

Option 4, Set up for 1029 Line, 60 Hz Field Operation ..... No Charge

Paper — One roll is included with the 4632. Refills are available from Tektronix, Inc.

For one roll, Order 006-1603-00 ..... $50

For one carton of four rolls, Order 006-1603-01 ... $180

Information Display Group Products

Programmable Calculators, Instrumentation System, and Digital Plotter

31

35 Built-in Math Function Keys

25 User-Definable Function Keys

Complete Alphanumeric Keyboard

Optional Silent Alphanumeric Printer

The 31 is the desk-top programmable calculator that serves as the controller for graphic calculator systems, instrumentation systems, and is powerful enough to stand alone.

Data Storage Memory — 74 data storage registers are standard. Each register will store any number shown in the display.

Program Memory — The calculator comes with a 512-step program memory. This memory is also the storage area for the user-definable feature, whereby a user can recall and execute complex sequences with a single keystroke.

Permanent Storage — Any program — all or part — up to 6000 steps or 600 registers may be transcribed on magnetic tape cartridges.

PROMs — The 31 PROMs (programmable-read-only-memory) add to — rather than subtract from — existing calculator memory. They are permanent, nonerasable copies of your important programs.

Easy Programming — With such features as: • data entry with floating, scientific, or mixed notation • conditional branching • unconditional branching • single key register arithmetic • indirect addressing • symbolic addressing of subroutines • subroutine nesting • programmable flag • comprehensive editing • overrange indication.

Display — A 10-digit mantissa with a 2 digit exponent.

Standard Accessories — 31 instruction manual • 31 Verification program • power cord • one 6000-step magnetic tape cartridge • two user overlays.

ORDERING INFORMATION

31 Programmable Calculator **$2850**

Option 1 — Alphanumeric Thermal Printer . . . **add $700**

Order 040-0685-02 if added later . . . . . **add $750**

Magnetic Tape Cartridge, Order 020-0082-00 . . . . . **$13**

User-Definable Overlay Package (10/package) Order 016-0578-00 . . . . . **$16**

Thermal Printer Paper (5/package) 006-1775-00 . . . . **$8**

31/53

Modularity

Versatility

Natural Programming Ease

Low Cost High Performance

Tektronix's instrumentation system, the 31/53, is the choice for many data acquisition and processing applications. Its capabilities include logging, documenting, program control, and all the mathematical operations the job requires.

With this versatility, the low-cost 31/53 offers an excellent alternative to many higher priced minicomputer systems. The system combines the 31 Programmable Calculator and the 153 Instrumentation Interface. For the instrumentation package, you get a mainframe/power supply unit which accepts two modular plug-ins; a digital translator/interface unit is already plugged in. You choose the other two instruments to complete your system. You can use a digital multimeter and a digital counter, or two of a kind.

153 INTERFACE FEATURES

The 153 is capable of transmitting to the 31 all data displayed on the module's digital displays.

Programmable interface pulse outlets.

Trigger out, front and back panels 12 μs width.

Logic levels are TTL compatible $\geq$2.4 V high, $\leq$0.8 V low.

Calculator display flashed by interface with a momentary short or pulldown to 0.8 V or less.

PATCH PLUG INFORMATION

A Type 1 patch plug is provided as standard for use with one counter and one multimeter in the 31/53 system mainframe. For a system with two multimeters, Option 30 should be ordered (no charge). It replaces the Type 1 as standard equipment. For a system with two counters, Option 31 should be ordered (no charge). It replaces the Type 1 as standard equipment. When ordering subsequent instrumentation, all additional patch plugs are available as optional accessories.

ORDERING INFORMATION

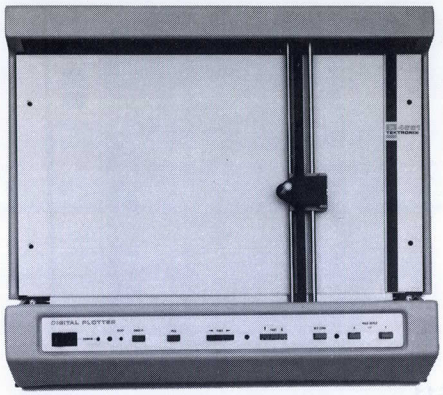
31/53 Calculator Instrumentation System **$3995**

153 Instrumentation Interface **$995**

31/53 Choice of Multimeter and Counter Modules.

Counters **pp 132-135**

Digital Multimeters **pp 136-137**



4661

Repeatability: Pen Will Return to Any Previously Plotted Point, ± 0.0025 in

Accuracy: ± 0.0025 in and ± 0.4% of Vector Length

The low cost 4661 can provide graphic displays of statistical data, histograms, sales curves, production rates.

Versatility — Scale controls and electrostatic hold-down allow either full or half size plots on paper size to 11 x 17 inch max.

Plotting Area — 10 x 15 inch, on Y and X axis respectively (approx 26 x 40 cm).

Scale Selection — Front panel selection of full or half scale can be made independently for each axis.

Data Zero — (a) A floating zero point can be established at any place on the plotting surface from the front panel of the plotter or the calculator. (b) Zero is automatically set for first-quadrant operation on power up.

Data Range — In full scale mode, the plotter accepts 10 inch of Y data and 15 inch of X data. In half scale mode, the plotter accepts 20 inch of Y data, and 30 inch of X data.

Motor Drive — ±0.005 inch (0.127 mm).

Resolution — Numerical — (a) At full scale, resolution is 0.010 in (0.254 mm). (b) At half scale, resolution is 0.005 in (0.127 mm).

ORDERING INFORMATION

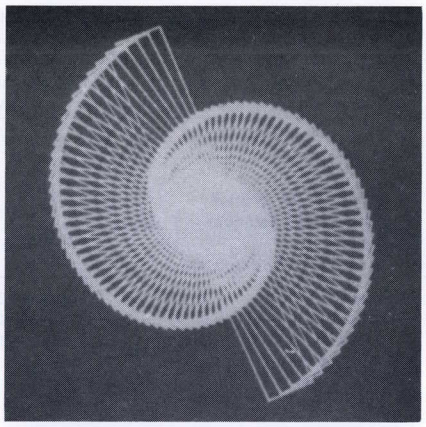
4661 Digital Plotter . . . . . ~~**$2645**~~

OPTIONAL ACCESSORIES

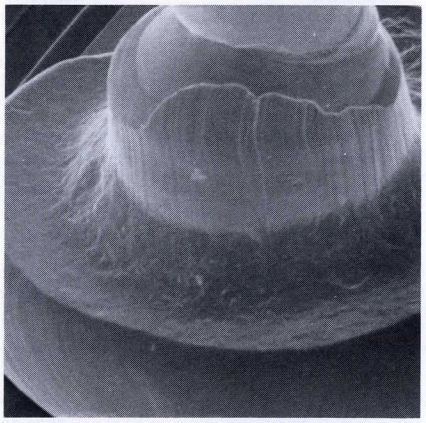
Paper: 100 sheets/package (11 x 16½ in),
10 x 15 in linear, 10 div/in (006-1698-00) $7
25 x 38 cm linear, 10 div/cm (006-1699-00) . . $7
15 in x 3 cycles (006-1700-00) $7
Semi-log: 15 in x 2 cycles (006-1701-00) $7
Log-log: 2 cycles x 3 cycles (006-1702-00) . . $7

Display Monitors

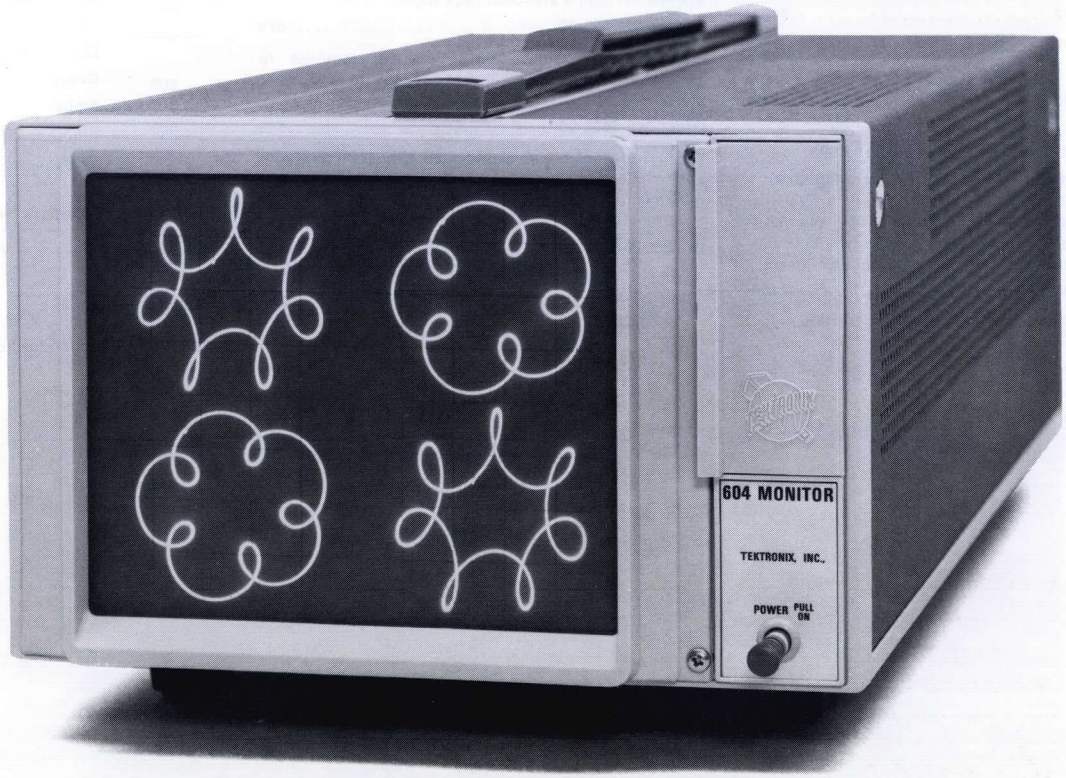
Tektronix' growing line of display monitors now includes the 602 High-Resolution Monitor, the 603 X-Y Monitor with bistable storage and variable stored brightness, the 604 Monitor featuring small screen size and easy operation at a low cost, and the 605 3-MHz Monitor with variable persistence storage.



There are a number of factors to be considered in selecting the appropriate display monitor for your particular application. Whether you plan to view or photograph the display, parameters like bandwidth, rise time, resolution, and so on must be evaluated, and the optimum combination of phosphor, filters, and film type must be determined.



The following pages will help you choose the monitor that's right for you. Our Display Monitors Booklet (it's yours for the asking) gives in-depth information on TEKTRONIX Monitors, detailed guidelines for performance and instrument specifications, and examples of monitor applications; it also includes an indispensable monitor selection chart. Consult your local Tektronix field engineer for expert up-to-date advice on which TEKTRONIX Monitor will meet your special requirements.



MONITORS SELECTION CHART

CHARACTERISTICS		602	603*	604*	605*
CRT — GENERAL	Standard Phosphor	P31	P1	P31	P31
	Graticule Size	8 x 10, 1 cm/div	8 x 10, 1.27 cm/div	8 x 10, 1.27 cm/div	8 x 10, 0.9 cm/div
	Standard Graticule	Int Illum	None	Int Non-Illum	Int, Non-Illum
	Spot Diameter	0.20 mm at 0.5 μA	0.50 mm at 0.5 μA	0.50 mm at 0.5 μA	0.50 mm at 0.5 μA
	Accelerating Voltage	4 kV	3.5 kV	3.5 kV	8.5 kV
CRT — STORAGE	Type of Storage	—	Bistable Storage	—	Variable Pers
	Writing Speed	—	≥ 25 cm/ms[5]	—	≥ 900 cm/ms[2]
	Dot Writing Speed	—	≤ 4 μs[5]	—	≤ 300 ns
	Short Axis Resolution	—	≥ 80 Line Pairs	—	≥ 80 Line Pairs
	Long Axis Resolution	—	≥ 100 Line Pairs	—	≥ 100 Line Pairs
	View Time	—	≥ 60 Min	—	≥ 5 Min[3]
	Luminance (Brightness)	—	≥ 50 Nits[5]	—	≥ 340 Nits
VERTICAL (Y-AXIS)	Input RC	100 kΩ 30 pF	1 MΩ < 47 pF	1 MΩ < 47 pF	1 MΩ < 47 pF
	Volts/Div	Adj 90-135 mV	Adj 50-1250 mV	Adj 50-1250 mV	Adj 50-1250 mV
	Common-Mode Rej Ratio	Single Input	100:1 at 100 kHz	100:1 at 100 kHz	100:1 at 100 kHz
	Max Common-Mode Signal	—	± 3 V[1]	±3 V [1]	± 3 V[1]
	Linearity (2 Div Signal)	≤ 2% Change	≤5% Change	≤ 5% Change	≤ 5% Change
	Bandwidth	Dc to 1 MHz	Dc to 2 MHz[4]	Dc to 2 MHz[4]	Dc to 3 MHz[4]
HORIZONTAL (X-AXIS)	Input RC	100 kΩ 30 pF	1 M < 47 pF	1 M < 47 pF	1 M < 47 pF
	Volts/Div	Adj 90-110 mV	Adj 50-1250 mV	Adj 50-1250 mV	Adj 50-1250 mV
	Common Mode Rej Ratio	Single Input	100:1 at 100 kHz	100:1 at 100 kHz	100:1 at 100 kHz
	Max Common-Mode Signal	—	± 3 V[1]	± 3 V[1]	± 3 V[1]
	Linearity (2 Div Signal)	≤ 6% Change	≤ 5% Change	≤ 5% Change	≤ 5% Change
	Bandwidth	Dc to 1 MHz	Dc to 2 MHz[4]	Dc to 2 MHz[4]	Dc to 3 MHz[4]
X & Y AXES	Phase Difference	≤ 1° to 1 MHz	≤ 1° to 500 kHz/	≤ 1° to 500 kHz	≤ 1° to 500 kHz
	Settling Time (Full Scale)	≤ 1 μs for ±0.20 mm	≤ 1 μs for ±0.50 mm	≤ 1 μs for ±0.50 mm	≤ 1 μs for ±0.50 mm
	O-V Beam Position Adj	Any point on screen	Any point on screen	Any point on screen	Any point on screen
INTENS (Z-AXIS)	Input RC	100 kΩ 70 pF	1 MΩ < 47 pF	1 MΩ < 47 pF	1 MΩ < 47 pF (Two)
	Bright-to-Blank-Range	0-1 V	Adj 0-1 to 0-5 V	Adj 0-1 to 0-5 V	Adj 0-1 to 0-5 V
	Bandwidth	Dc to 1 MHz	Dc to 5 MHz	Dc to 5 MHz	Dc to 5 MHz

** Optional built-in time base and trigger.*
1. Or ± 15 V for 50:1 cmrr.
2. For 1-min view time.
3. At reduced writing speed without save.
4. For 80% or less of full-scale deflection.
5. Faster option with less luminance.
6. TTL input available.

RACKMOUNTING FOR 602

5¼ in Rack Adapter — Two 602s may be mounted side by side.

Order 016-0115-02 ..... **$130**

Blank Panel — For covering half of 016-0115-02 Rack Adapter.

Order 016-0116-00 ..... **$20**

RACKMOUNTING FOR 603, 604, and 605

Cabinet-to-Rackmount Conversion Kit, equipped with slide-out assembly, required to rackmount a 603 Option 3, 604 Option 3, or 605 Option 3, in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is used.

Order 040-0601-00 ..... **$100**

Cabinet-to-Rackmount Conversion Kit, equipped with slide-out assembly, required to rackmount two 603 Option 3s, two 604 Option 3s, or two 605 Option 3s, side-by-side in a standard rack width.

Order 040-0600-00 ..... **$70**

Rackmount-to-Cabinet Conversion Kit, required to convert a rackmount 603, 604, or 605 to a cabinet style.

Order 040-0602-00 ..... **$65**

Cabinet-to-Rackmount Conversion Kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 603, 604, or 605 in a standard rack width.

Order 040-0624-00 ..... **$55**

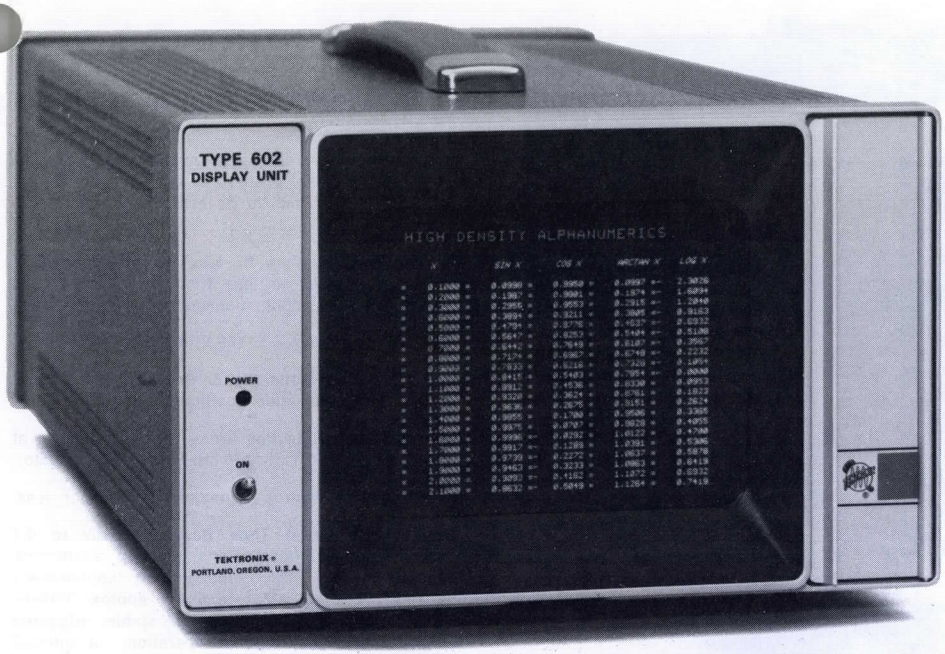
Crt Light Filters

Monitor	Filter	Part No	Price
602	Smoke-gray	378-0586-00	$2.20
	Amber	378-0595-00	$6.00
603 604 605	Clear	337-1440-00	$1.50
	Green	337-1440-01	$1.50
	Amber	337-1440-02	$1.50
	Blue	337-1440-03	$1.50
	Gray	337-1440-04	$1.50

Camera Selection Chart

Monitors	Recommended Cameras
602 and 605	C-5A, C-30A, or C-59G
603 and 604	C-5A, C-59P, or C-59R

See camera section for complete information.



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 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, Y-T plots of amplitude vs time displays, and gamma camera displays.

Permanent records of the 602 display can be made on Polaroid film with a TEKTRONIX Camera. Two 602s may be mounted side by side using an optional rack adapter.

CRT DISPLAY

Cathode Ray Tube— 5 in flat-faced rectangular crt with P31 phosphor.

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—Max trace width within the 8 x 10 cm display area is 14 mils at 0.5 μA beam current (typically less than 10 mils).

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/hr 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.

Max Input Voltage— ± 10 V (dc and peak ac).

Recommended Source Impedance— 1 kΩ or less.

Z-AXIS AMPLIFIER

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.

Max Input Voltage— ±10 V (dc and peak ac).

Recommended Source Impedance— 1 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 V ac, or 180 to 272 V ac, 48 to 440 Hz. 50 W at 115 V ac, 60 Hz. Rear-panel selector provides rapid accommodation for 6 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.

Dimension and Weights (Cabinet Included)—

	in	cm
Height	6	15.3
Width	8½	21.6
Depth	17⅜	44.1
	lb	**kg**
Net Weight	17½	7.9
Shipping Weight	≈22	≈9.9

Included Accessories—Smoke-gray filter; maintenance manual.

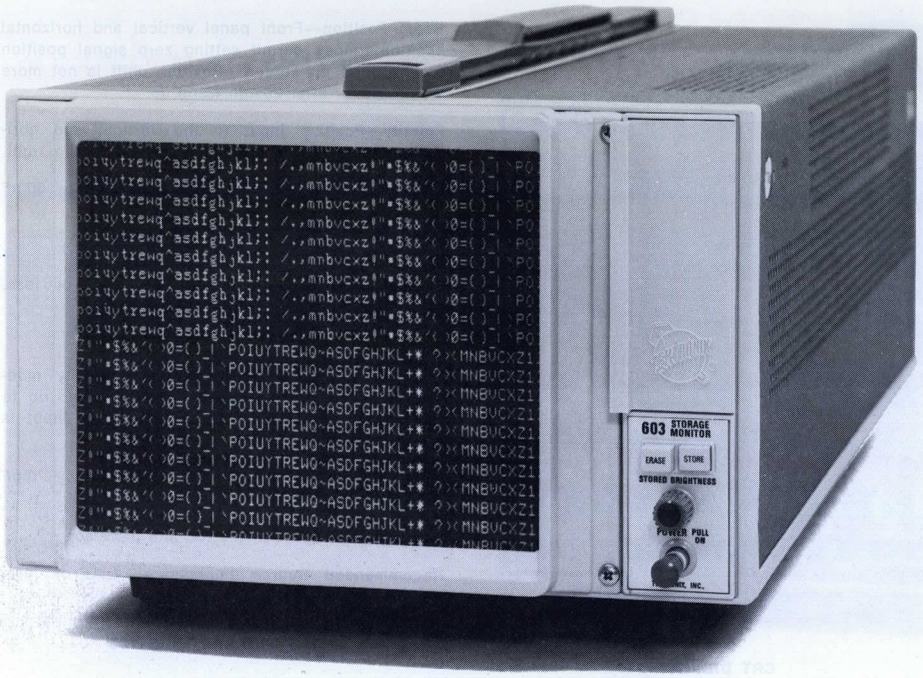
ORDERING INFORMATION

602 Display Unit $1075
Option 1 without Cabinet ..... Subtract $25
Option 2 Internal 8 x 10 cm Outline Graticule ..... No Charge
Option 5 Vector Display Graticule (P31 Phosphor Only) ..... Add $25
Option 7 without Handles, Feet, and All Dust Covers ..... Sub $20

See page 210 for information on cameras, crt light filters, and rackmounting.

603 Storage Display Monitor

X-Y Monitor with Variable Stored Brightness



Low-Cost X-Y Monitor
Time Base Option
6½ In Storage Crt
1 Million Dots/S 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 a refreshed or stored mode on a 6½ in 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 10 hr. Permanent records of the 603 display can be obtained on Polaroid prints using a TEKTRONIX 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. Also included is a remote program connector for positive signal inputs.

CRT DISPLAY AND STORAGE

Cathode Ray Tube— 6½ in flat faced bistable, storage tube. Phosphor is similar to P1. 3.5 kV accelerating potential. Two storage tubes are available (standard crt for brighter stored display or Option 2 for a faster writing speed at lower stored brightness). 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 200,000 dots/s; Option 2 crt, at least 1 million dots/s.

Display Size— 10.2 cm vertically, 12.7 cm horizontally. An internal nonilluminated graticule (8 x 10 div, 1.27 cm/div) 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 in deflection from point on the crt will not vary more than 5%.

Viewing Time—At least 1 hr at normal intensity without loss of resolution. Viewing time can be extended to 10 hr with the variable brightness control.

Erase Time—Approx 250 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—Dc to 2 MHz at 3 dB down from 80% of full scan.

Deflection Factor—Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. Internal 5X attenuator extends deflection factor range to 12.5 V full scale.

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 0 signal position to any point on screen. Position shift is 1 mm/hr or less after 20 min warm-up.

Settling Time— 0.2 μs or less for distances of 1 div or less. 1 μs or less from any point on the crt to within 1 spot diameter of final position.

Max 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 μs/div to 0.1 s/div in 6 calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approx 1 s/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For nontriggered operation, an internal switch selects bright baseline or no sweep.

Z-AXIS AMPLIFIER

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 the 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 V to +5 V for full intensity control; 0 V input cuts off intensity.

Differential Input—Cmrr at least 100:1 and common-mode range at least ±5 V.

Input R and C— 1MΩ ±1% paralleled by less than 47 pF.

Max 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 W max at nominal line voltage.

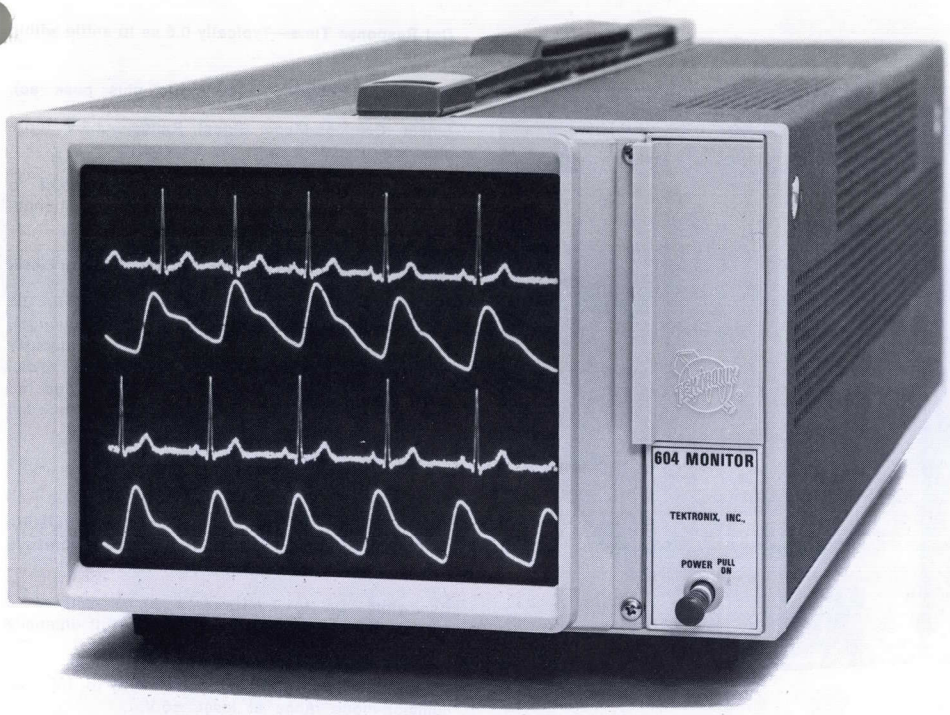
Dimensions and Weights—See next page.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00); external graticule (331-0303-00).

ORDERING INFORMATION

603 Storage Monitor **$1300**
Option 1 Internal Graticule ..... **No Charge**
Option 2 Fast Writing Speed Crt ..... **Add $35**
Option 3 without Handle and Feet ..... **Sub $10**
Option 4 Time Base ..... **Add $150**
Option 7 without Handles, Feet, and All Dust Covers ..... **Sub $2**

See page 210 for information on cameras, crt light filters, and rackmounting.



Low Cost Monitor

Time Base Option

6½ in 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

With its 6½ in crt, the 604, 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 apparently dynamic 3 dimensional illustrations. Optionally available calibrated horizontal sweep rates 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 a TEKTRONIX 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 in flat-faced rectangular crt with P31 phosphor.

Display Size—Internal parallax-free nonilluminated graticule marked in 8 vertical and 10 horizontal div (1.27 cm/div). Option 1 is without graticule.

Display Linearity—The voltage required to produce a 1 in 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 from 80% of full scan.

Deflection Factor—Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. Internal 5X attenuator extends deflection factor range to 12.5 V full scale.

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 0 signal position to any point on screen. Position shift is 1 mm/hr or less after 20 min warm up.

Max 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 μs/div to 0.1 s/div in 6 calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 1 s/div. TRIG SLOPE/LEVEL control for stable triggered displays. For nontriggered operation, an internal switch selects bright baseline or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth—Dc to 5 MHz over usable range. Sensitivity is adjustable from +1 V to +5 V for full intensity control; 0 V input cuts off intensity.

Differential Input—Cmrr at least 100:1 and common-mode range at least ±5 V.

Input R and C— 1MΩ ±1% paralleled by less than 47 pF.

Max 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 W max at nominal line voltage.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00).

603/604 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	6.65	16.9	5.25	13.5
Width	8.4	21.4	8.4	21.4
Length	19.25	48.9	19.0	48.25
Weight (approx)	lb	kg	lb	kg
Net	17.5	7.9	17.5	7.9
Shipping Weight	23.0	10.4	23.0	10.4

ORDERING INFORMATION

604 Monitor **$900**

Option 1 Without Graticule ..... **No Charge**

Option 3 without Handle and Feet ..... **Sub $10**

Option 4 Time Base ..... **Add $150**

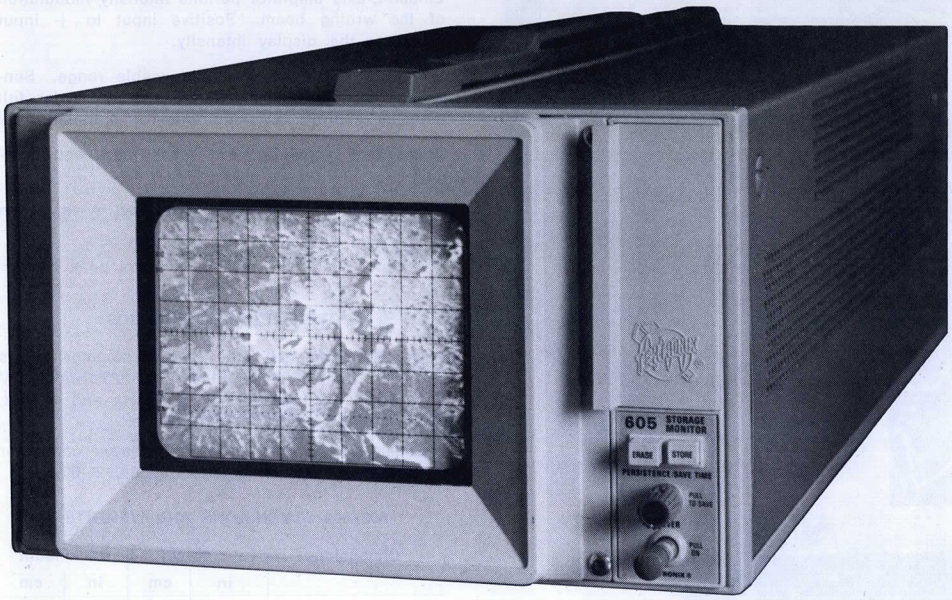
Option 5 Vector Display Graticule (P31 Phosphor Only) ..... **Add $30**

Option 7 without Handles, Feet, and All Dust Covers ..... **Sub $20**

See page 210 for information on cameras, crt light filters, and rackmounting.

605 Storage Display Monitor

3 MHz Variable Persistance Storage Monitor



Low Cost X-Y-Z Monitor

Variable Persistence Storage

1 Div/μs Writing Speed

3 MHz X and Y Bandwidth

5 MHz Dc-coupled Z-Axis Amplifier

Front Panel Controls

Remote Programmability

Time Base Option

The 605 displays low-repetition-rate signals, single-shot waveforms, and slowly scanned images at normal intensity without flicker. Low-repetition-rate applications include viewing biophysical signals and mechanical waveforms such as those in engine analysis. Bright, uncluttered single-shot displays of vibration waveforms are obtained with the fast (1 div/μs) writing speed. An example of a slow scanning application is the gray-scale image of a metal sample shown on the 605 pictured above. The image is from a scanning electron microscope at X2000 magnification.

Simply turning a dial varies the length of time a display is held on the crt from a fraction of a second to more than 5 min. The 605 combines variable peristence storage with an intensity input to produce slow scan, gray scale images. Ultrasound, thermographic, and nuclear scanning are biophysical applications for which the 605 is well suited. Fast dot response makes the instrument an excellent choice for random scanning use. An optional low cost time base adds the capability of monitoring real time biophysical signals.

Resolution of spectrum analyzers is improved since the desired frequency span can be viewed at low scan rate. The slowly fading trace of the 605 provides valuable trajectory information for radar and sonar displays.

CRT DISPLAY AND STORAGE

Variable Persistence Storage Crt— 5 in flat faced, rectangular tube with P31 phosphor. 8.5 kV accelerating potential.

Display Size— 8 div vertically, 10 div horizontally at 0.9 cm/div.

Graticule—Standard external, graticule. Internal 8 x 10 div graticule supplied as Option 1.

Max Writing Speed—At least 1 div/μs for 1 min viewing time.

Storage View Time—Greater than 5 min at reduced writing speed.

Save Time—Viewing time is extended up to 10 times in the save mode.

Halftone Resolution—At least 10 lines/div.

Halftone Luminance—At least 100 footlamberts.

Erase Time—Approx 500 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—Dc to 3 MHz at 3 dB down from 80% of full scan.

Polarity—Positive signal to both + inputs moves beam up and to the right.

Deflection Factor—Nominally 1 V full scale. Internally adjustable from 0.5 V to 2.5 V full scale. Internal 5X attenuator extends deflection factor range to 12.5 V full scale.

Input R and C— 1 MΩ paralleled by less than 47 pF.

X-Y Phase Difference—Not more than 1° to 500 kHz.

Beam Position—Front-panel position control allows setting 0 signal position to any point on screen. Position shift is 0.09 cm/hr or less after 20 min warm-up.

Dot Response Time—Typically 0.5 μs to settle within 1 dot diameter.

Max Input Voltage— ±100 V (dc plus peak ac).

Linear Common-Mode Signal Range— ±3 V (non-attenuated); ±15 V with 5X attenuation.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz, 50:1 to 100 kHz with 5X attenuation.

Recommended Source Impedance— 10 kΩ or less.

Optional Horizontal Time Base— 1 μs/div to 0.1 s/div in 6 calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approx 1 s/div. TRIG SLOPE/LEVEL control for stable triggered displays. For nontriggered display, an internal switch selects bright baseline or no sweep.

Z-AXIS AMPLIFIER

Linear Z-axis amplifier permits intensity modulation of the writing beam. Display intensity increases with positive inputs.

Bandwidth—Dc to 5 MHz (—3 dB). Sensitivity is adjustable from +1 V to +5 V for full intensity control; 0 V input cuts off intensity.

Differential Input—Cmrr at least 100:1 to 100 kHz; common-mode range at least ±5 V.

Input R and C— 1 MΩ paralleled by less than 47 pF.

Max Input Voltage— ±100 V (dc plus peak ac).

OTHER CHARACTERISTICS

Remote Inputs—TTL compatible. 0.52 V or less provides logic low. 2.5 V or more provides logic high.

Erase Interval Output—TTL compatible. Logic low is 0.4 V or less. Logic high is 2.5 V or more. Will drive 10 unit loads.

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220, and 240 V (±10% on each range), and 48 to 440 Hz. Power consumption is 40 W max at nominal line voltage.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00).

Ambient Temperature Limits— 0°C to +50°C operating; —40°C to +70°C nonoperating.

DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	6.65	16.9	5.25	13.5
Width	8.4	21.4	8.4	21.4
Length	19.25	48.9	19.0	48.25
Weight (approx)	lb	kg	lb	kg
Net	17.5	7.9	17.5	7.9
Shipping Weight	23.0	10.4	23.0	10.4

ORDERING INFORMATION

605 Variable Persistence Storage Monitor **$1695**

Option 1 Internal Graticule ..... **No Charge**

Option 3 Without Handle and Feet ..... **Sub $10**

Option 4 Time Base ..... **Add $150**

Option 7 without Handles, Feet and All Dust Covers ..... **Sub $20**

See page 210 for information on cameras, crt light filters, and rackmounting.

Accessories

Cameras, Probes, Oscilloscope Carts, and Other Oscilloscope Accessories to extend your measurement capabilities.

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CHOOSING A TEKTRONIX CAMERA

A camera can be a valuable part of your measurement system. It allows you to capture single events and document your results, and it helps you communicate your results with clarity and credibility.

The following pages give information to help you select a camera well suited to your needs.

Overview of TEKTRONIX Camera Families

C-5A: The C-5A is a low-cost, general-purpose camera. It is available with options molded to fit 7000, 5000, 455, 464, 465, 466, 475, and T900 Oscilloscopes and 600 (except the 611 and 613) Monitors.

C-12/C-27: The C-12 and C-27 are very flexible cameras with interchangeable lens/shutter assemblies and film backs. They fit many 7000, 5000, 600, 1400, and 500 Series instruments. The C-12 allows the use of changeable projected graticules.

C-30 Series: The C-30 Series is primarily designed for 400-Series Oscilloscopes. The fast lens of the C-31 makes it especially useful for high-speed recording. The variable magnification of the C-30A allows it to be used on a variety of instruments, including the 400 Series and many 7000, 5000, 300, and 600 Series instruments.

C-50 Series: The C-50 Series is recommended for most 7000, 600, and 5000 Series Oscilloscopes and Monitors. C-50 Series Cameras range from moderately priced general-purpose cameras such as the C-59, to high-speed, electronically controlled instruments like the C-51.

CAMERA SELECTION CHECK LIST

Camera Mounting, page 219, lists all the available Tektronix Oscilloscope/Camera adapters. C-50 Series Cameras include the appropriate adapter for mounting to 7000, 5000, and 600 Series (except the 611 and 613) Oscilloscopes and Monitors. C-30 Series Cameras include an adapter for mounting to 400 Series Oscilloscopes. The C-5A mounting device is part of the camera.

Lens: Relative light-gathering power (or lens speed) and magnification are the important lens factors to consider.

Oscilloscopes designed for single-event photography have a specified maximum photographic writing rate based on a specific combination of camera and film. If you are considering a camera other than the one approximate maximum photographic writing used for specification, you can determine its speed by comparing it with the specified camera in the camera summary chart.

The field of view, or maximum area the camera can "see," should be as large as the largest screen area you wish to record. Fields of view for Tektronix Cameras are listed with each camera type. Both field of view *and* magnification ratio must be considered when determining whether a given camera can record all of a given crt.

Magnification or magnification ratio is the ratio of the diameter of the image on the film to the actual screen diameter. This chart gives the recommended approximate magnification for various combinations of films and screen sizes.

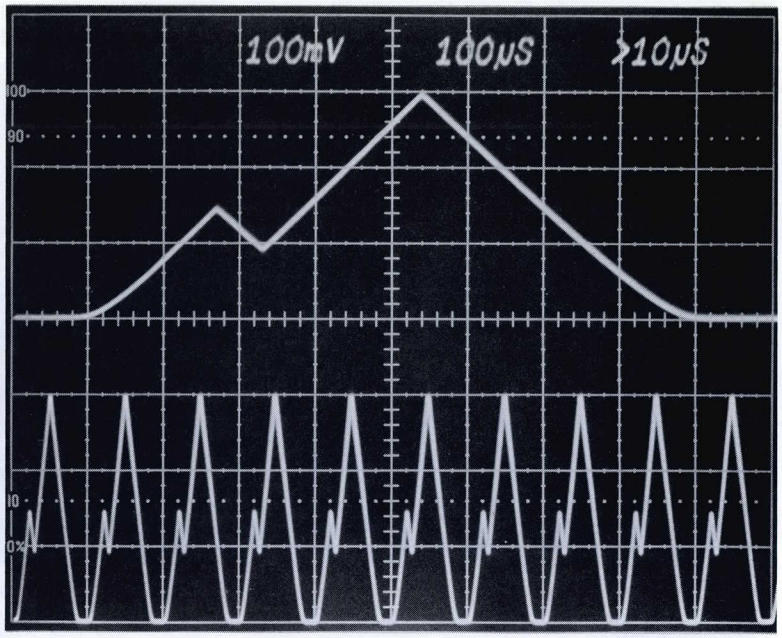
Screen Size	5 x 6.3 cm	7.2 x 9 cm	8 x 10 cm	9.76 x 12.2 cm
Film Type				
90 mm roll film and 47, 410, 107, 105 POLAROID (7.3 x 9.5 cm active area)	UNITY	UNITY	0.85	0.67
55 P/N, 57, 52 POLAROID (8.9 x 11.4 cm active area)	UNITY	UNITY	UNITY	0.85 or less
6 x 7 cm format roll film (70 mm, 120, 220, etc)	UNITY	0.67	0.67	not recommended

0.5 magnification is used for high speed recording, since reducing the size of the image increases its brightness.

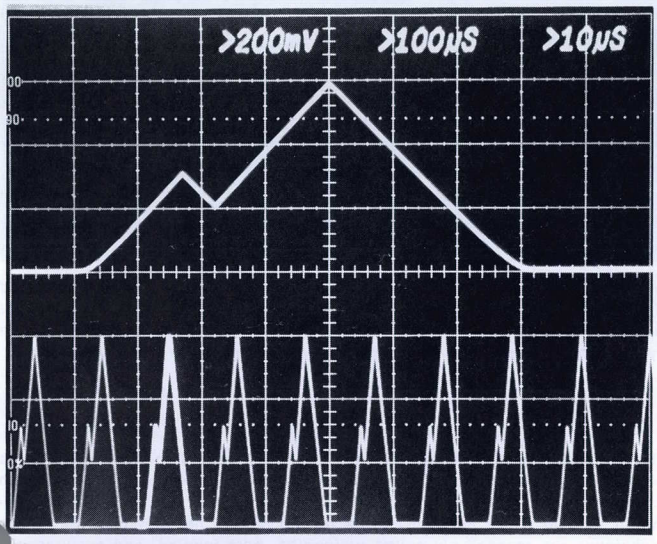
Magnification

Actual Size Photos of 8 x 10 cm Displays

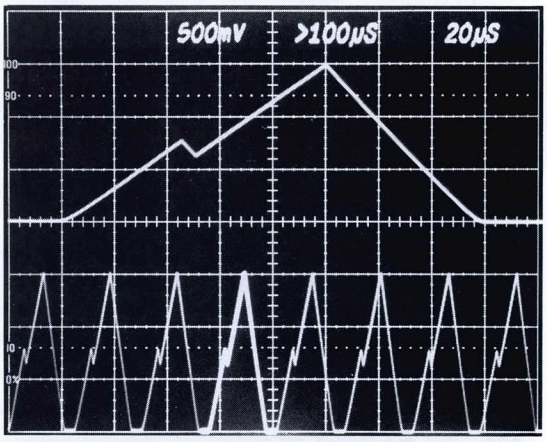
Recorded with unity magnification lens on 4 x 5 Polaroid film.

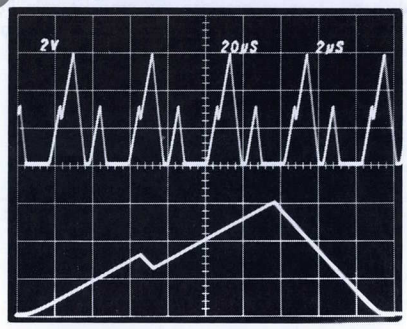


Recorded with 0.85 magnification lens on 3¼ x 4¼ 107, 47, or 410 film. Similar results are obtained when photographing 9.76 x 12.2 cm display at 0.67 magnification.



Recorded with 0.7 magnification lens. Also suitable for 6 x 7 cm format roll film.





Recorded with 0.5 magnification lens. Suitable for high speed recording or for use with roll film.

SHUTTERS:

There are two types of shutters, mechanical and electric.

Mechanical shutters are simple to operate and economical. They are actuated by pressure on a release mechanism.

Electric shutters permit remote, automatic, or manual release. The Speedcomputer control box for the C-12, C-27, and C-30 Series electric shutters requires 117 or 120 V ac. They may be actuated by an insulated switch closure.

The C-50, 51, 52, and 53 electric shutters require +15 V, normally supplied by a 7000-Series Oscilloscope. An external battery pack is available for situations where one of these cameras is used on a non-7000 Series instrument. These shutters can be actuated by a switch closure to ground.

FILM:

Many different types of Polaroid film are available in rolls, packs, and 4 x 5 single-sheet packets. The types most commonly used in oscilloscope and monitor photography are types 107, 47, and 410. For assistance from the Polaroid Company, call (617) 547-5176 collect.

Type 107 (ASA equivalent 3000) is a medium-contrast, high-sensitivity film packaged in 8 exposure packets. It is suitable for use in Tektronix cameras with pack film backs.

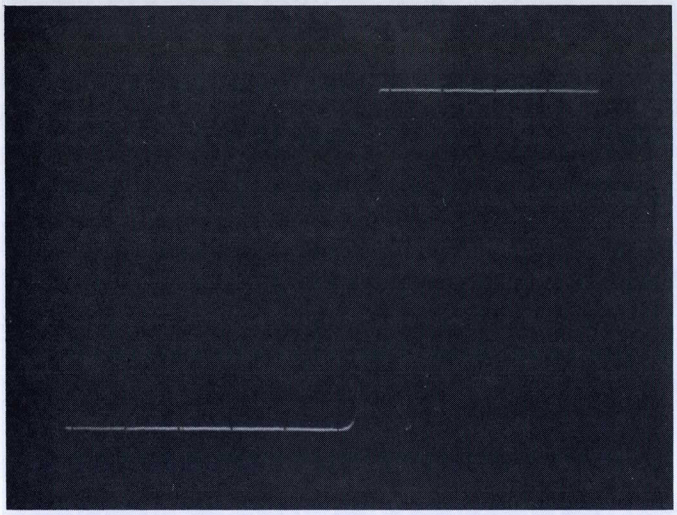
Type 47 and 410 are roll format films suitable for use in Tektronix cameras with roll film backs. Type 47 is a medium-contrast, high-sensitivity film with an equivalent ASA of 3000. Type 410 is a high-contrast, very high sensitivity film with an equivalent ASA of 10,000. 4 x 5 single-sheet packets are used where a larger format is important. They require a 4 x 5 Polaroid Land film holder mounted in a Graflok* back camera.

Conventional roll or sheet film is used where economy or very long grey scale is important. Their use requires an appropriate film holder mounted on a Graflok* back camera. Holders for 120, 220, 70mm, 90mm, 105mm, and 4 x 5 conventional film are available from several manufacturers.

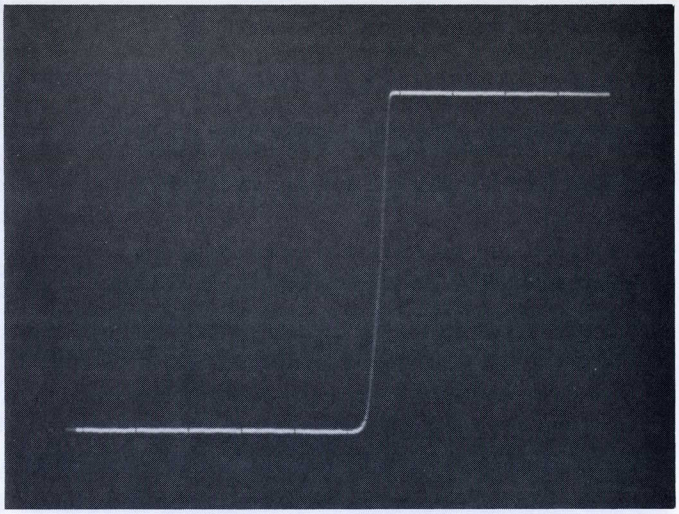
All Tektronix cameras except the C-5A have interchangeable backs.

*Singer Education System Trademark

Film fogging is a technique for increasing the maximum sensitivity of photographic film by giving it a short exposure to dim, diffuse light. The TEKTRONIX Writing Speed Enhancer is designed to fill this need.



This Polaroid Type 107 3000-speed Pack Film was exposed to the single-trace display of a pulse waveform with a fast-rising leading edge too dim to produce a developable image.



Film from the same pack was exposed to the same single-trace waveform and simultaneously to light from a Writing Speed Enhancer. The Enhancer light supplied the additional photons needed at the weak development centers formed by the dim leading edge, to produce a visible image of the entire waveform.

Polaroid Film		Actual Relative Film Writing Speed		
Type	ASA EQUIVALENT SPEED	Unfogged		Fogged
		Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination*
107	3000	1 (Reference)	Print base is opaque	3
47	3000	1	1.2	3
410	10,000	2	2.2-2.4	4

*Viewing a fogged print with back illumination does not increase the apparent writing speed.

The Enhancer installs in minutes, and can be triggered in three ways: by a pushbutton on the control box, remotely with a switch closure to ground (such as provided by the camera-shutter X-sync switch), or by the oscilloscope-sweep + gate. Thus, the film can be fogged before 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.

CAMERA SUMMARY CHART

Camera	Page	Suggested For	Performance Highlights	Maximum Relative Aperture	Magnification	Largest Standard TEK Crt Photographable (cm)	Relative Light Gathering Power	Shutter Type
C-5A	228	5000, 600 Series, TLD83, 7313	Low Cost, Simple Operation, Changeable Mag, Graticule Flash	f/16	0.67/0.85	9.76 x 12.2	0.02	Mechanical
OPT 1		7000 Series (except 7313)	(No Graticule Flash)					
OPT 2		455, 464, 465, 466, 475	(No Graticule Flash)					
OPT 3		T900 Series	(Has Graticule Flash)					
C-12	224	540, 560 Series	Projected Graticule Interchangeable Lenses	f/1.9 (Std Lens)	0.85 (Std Lens)	8 x 10	0.65 (Std Lens)	Mechanical and Electric Versions Available
C-27		540, 560, Series 7000, 5000, 600 8 x 10 cm or smaller	Interchangeable Lenses, Including High Speed Type			10 x 10 (8 x 10 w 3¼ x 4¼ Polaroid)	1 (Std Lens)	
C-30A	226	400, 7000, 5000, 600 Series 8 x 10 cm or smaller	Variable Magnification	f/1.9	0.7 to 1.5	8 x 10 (slight corner vignetting, also see Opt 1)	1 @ 0.7 mag	
C-31	227	400 Series	High Speed at Low Cost	f/1.2	0.5	7.2 x 9 (8 x 10 with Opt 1)	2.9	
C-50	220	7603	General Purpose, Electronic Shutter	f/1.9	0.7	9.76 x 12.2 (slight corner vignetting)	1.2	Electronically Controlled
C-51	220	7000 Series except 7403N, 7603	High Writing Speed, Electronic Shutter	f/1.2	0.5	8 x 10	3	
C-52	220	7613, 7623A, 7633	Electronic Shutter, Unity Magnification	f/1.4	1	8 x 10 (w/4 x 5 film)	1.4	
C-53	220	7000 Series except 7403N, 7603	General Purpose, Electronic Shutter	f/1.9	0.85	8 x 10	1	
C-58	222	7613, 7623A, 7633, 5441	Low Cost Unity Magnification	f/2.8	1	8 x 10	0.4	Mechanical
C-59	223	5440, 5444, 7603, 7403N, 5111, 5113, 5115, 603, 604	Low Cost General Purpose	f/2.8	0.67	9.76 x 12.2	0.65	

OSCILLOSCOPE/CAMERA ADAPTER GUIDE

Type Oscilloscope	Recommended Cameras	C-50 Series and C-27 Adapter Part Number	C-30 Series Adapter Part Number	C-12 Adapter Part Number
422	C-30A	———	016-0306-00	———
432, 434,[1] 464, 466	C-30A Opt 1 C-5A Opt 2	———	016-0301-00	———
453A, 454A	C-30A C-31	———	016-0306-00	———
455, 465, 475	C-30A Opt 1 C-31 Opt 1 C-5A Opt 2	———	016-0301-00 (C-30A Opt 1) 016-0269-02 (C-31 Opt 1)	———
485	C-30A C-31	———	016-0306-00	———
491	C-30A	———	016-0306-00	———
502A	C-59	016-0225-03	016-0243-00	016-0226-01
503, 504	C-27	016-0225-03	016-0243-00	016-0226-01
519	C-27 Opt 4	Integral with 519	———	———
544, 545B, 546, 547, 549, 556, 568	C-27	016-0225-03	016-0243-00	016-0226-01
561B, 564B	C-27	016-0224-00	016-0244-00	016-0217-00
565	C-59	016-0225-03	016-0243-00	016-0226-01
575	C-12	016-0225-03	016-0243-00	016-0226-01
576, 5030, 5031	C-59 (Requires 016-0288-00 Adapter Frame Corrector Lens)	016-0288-00 (C-59) 016-0264-01 (C-12, C-27)	———	———
577[1]	C-5A, C-59	016-0249-03	016-0248-00	016-0263-00
601, 602, 603,[1] 604, 605	C-5A, C-5A Opt 1 C-59, C-30A	016-0249-03	016-0248-00	016-0263-00
647A	C-27	016-0223-00	———	———
5100 Series[1]	C-5A, C-59	016-0249-03	016-0248-00	016-0263-00
5440, 5444	C-59, C-27 Opt 4, C-5A Opt 1	016-0249-03	016-0248-00	016-0263-00
5441	C-59, C-58, C-5A Opt 1	016-0249-03	016-0248-00	016-0263-00
7313, 7503, 7504,[1] 7514, 7704A, 7904, R7903, 7603 11S	C-53, C-59, C-5A Opt 1, C-51 C-27, C-27 Opt 4	016-0249-03	016-0248-00	016-0263-00
7844	C-53, C-59, C-5A Opt 1, C-51	016-0249-03	016-0248-00	———
7613, 7623A, 7633	C-58, C-52 C-59, C-27 Opt 3	016-0249-03	016-0248-00	016-0263-00
7403N, 7603	C-59, C-5A Opt 1	016-0249-03	016-0248-00	016-0299-00
T900 Series	C-5A Opt 3	———	———	———
Some HP Scopes Round crt only	———	016-0228-00	———	———
1502, 314, 326,[1] 335	C-30A	———	016-0327-00 Plus 016-0306-00	———
601, 602, 603, 604, 605, 5100, 5400, 7000	014-0045-00 will mechanically mount any of the following cameras: HP Models 195A, 197A; Beattie Coleman Models K-5, K-5R, KD-5, Mark 11A, Mark 11-911, 565A, Polexa.			

[1]Only the C-5A and C-5A Opt 3 can illuminate a non-illuminated graticule. The background glow of bistable storage may be used to backlight a graticule if necessary.

Viewing: All standard Tektronix cameras (except the C-30 Series) have a viewing port for viewing the trace with the camera in place.

Accessories: Carrying case, adapter lenses, extra film backs, and Writing Speed Enhancers are among the accessories available for Tektronix cameras. See individual camera listings for details.

CAMERA ADAPTER PART NUMBERS & PRICES

016-0217-00	$30	016-0248-00	$40
016-0223-00	$34	016-0249-03*	$40
016-0224-00	$40	016-0263-00	$30
016-0225-03	$34	016-0269-02**	$55
016-0226-01	$34	016-0295-00	$34
016-0228-00	$40	016-0299-00	$35
016-0242-00	$30	016-0301-00***	$50
016-0243-00	$36	016-0306-00†	$50
016-0244-00	$40		

*(Included with C-50 Series Cameras)
**(Included with C-31 Opt 1 Cameras)
***(Included with C-30A Opt 1 Cameras)
†(Included with C-30A, C-31 Cameras)

ACCESSORIES FOR GRAFLOK TYPE BACKS

(For C-12, C-27, and C-50 Series)

Here are a few of the film holders available for use with the Graflok Backs to allow use of roll film, and Polaroid 4 x 5 in Film. Order these accessories from the manufacturer or from your local camera store.

RH/10 120 Roll-Film Holder—10 exposures 2¼ x 2¾ in Graflex Catalog #1295 for 4 x 5 in Graflok Backs. (122-0736-01)

RH/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ in Graflex Catalog #1297 for 4 x 5 in Graflok Backs. (122-0971-00)

RH/50 70 mm Holder—50 exposures, 2¼ x 2¾ in Graflex Catalog #1240 for 4 x 5 in Graflok Backs only. (122-0967-00)

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 in Single Exposure Film Packets. (016-0201-01)

Roll film holders are also manufactured by several other companies.

ADAPTER FRAME/CORRECTOR LENS FOR C-12 or C-27 CAMERA

Expands the field of view of the C-12 and C-27 to fully cover the 6½ in crt and adjacent scale readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of a standard camera's 0.85-mag lens to 0.45 so it can record the entire display on Polaroid 3¼ x 4¼ in film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. The C-12 provides a view of the crt screen only. The C-27's view is restricted to the lower two thirds of the crt and scale readout. Both cameras can of course be swung aside to allow a full view of the entire display. 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 .....$55

ADAPTER FRAME/CORRECTOR LENS C-59 CAMERA

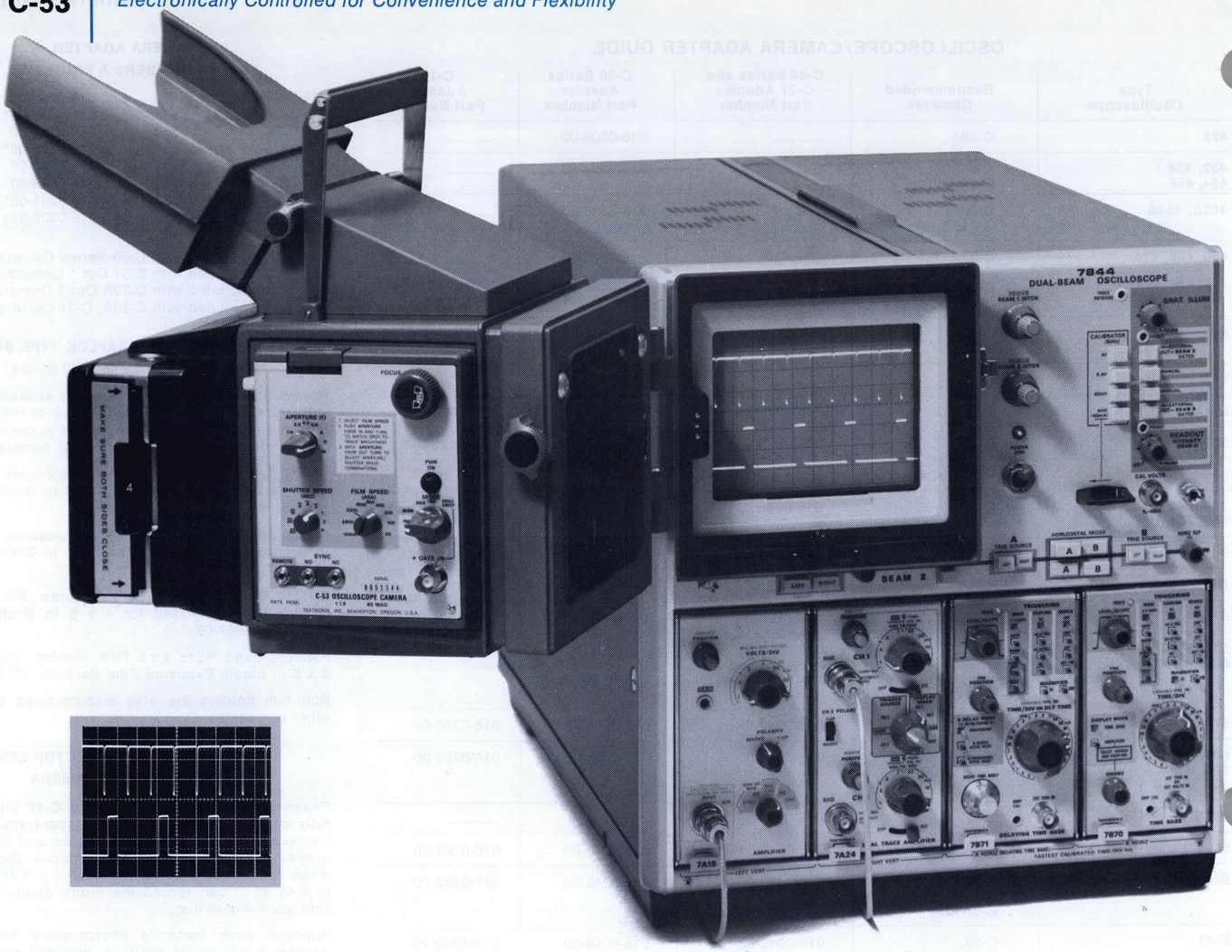
Expands the field of view of the C-59 to fully cover the 6½ in crt and adjacent scale-readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of the C-59 to 0.5 so it can record the entire display on Polaroid 3¼ x 4¼ in film.

Although the camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. However, all but the upper one-fourth of the display can be viewed via the viewing tunnel and the camera can be swung aside to allow a full view of the entire display.

For C-59 Camera, Order 016-0288-00 .....$65

Cameras

Electronically Controlled for Convenience and Flexibility



Electronically Controlled Shutter Allows Remote, Automatic, or Manual Shutter Actuation

Automatic Single-Sweep Control Simplifies Single-Event Photography

Photometer Exposure Aid Provides an Easy Way to Estimate Exposure for Repetitive or Stored Traces

Range Finder Focusing Permits Refocusing without Removing the Film

These electrically powered cameras offer more convenient and flexible operation than any other trace-recording camera. With short focal length lenses, these compact cameras are less than 11 in long.

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 in focus.

Photometer Exposure Aid—Mechanical analogs of film speed, shutter speed, and crt trace brightness are set by panel controls into a gear train which properly relates these factors. The operator can set the shutter controls quickly and easily for the exposure value that will provide properly exposed photos over a wide range of trace brightness.

Four selectable filters allow the user to match the color of the photometer spot to P1, P2, P11, and P31 phosphors. The filters are mounted on a thumbwheel that is interlocked with the exposure-photometer gear train.

Shutter—The electronically controlled shutter can be triggered locally with a pushbutton 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 5 s after the sweep ends. Shutter speeds range from 4 to 1/60 s plus bulb and time. Provides X sync.

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 these cameras to be used with other oscilloscopes.

Interchangeable Backs—Roll, pack, and Graflok type 4 x 5 backs can be interchanged without fogging the film.

C-50 for Large Crts

An f/1.9, 0.7 mag lens with relative speed of 1.2 covers up to 10.2 x 12.7 cm screen area. Recommended for 7603 (slight corner vignetting). May also be used with other 7000, 5000, and 600 Series instruments. (Use battery pack 016-0270-00 for non-7000-Series instruments).

C-51 for High Writing Speed

An f/1.2, 0.5 mag lens with relative writing speed of 3 covers up to 8 x 10 cm screen area. Recommended for 7904, R7903, 7844, 7704A, and R7704. May also be used on other 7000-Series instruments (except 7603, 7403N) and with 602, 605, and 5441 (use battery pack 016-0270-00).

C-52 for Smaller Crts

An f/1.4 unity mag lens with relative speed of 1.4 covers up to 8 x 10 cm screen area. Recommended for 7633, 7623A, 7613 (with 107, 47, or 410 film), for 7904, R7903, 7844, 7704A, 7313 (with 4 x 5 film). May also be used with 5441 (107, 47, 410 film) and 8 x 10 cm display units. Use battery pack 016-0270-00 for non-7000-Series instruments.

C-53 for General-Purpose Use

An f/1.9, 0.85 mag lens with relative speed of 1 covers up to 8 x 10 cm screen area. Recommended for 7904, R7903, 7844, 7704A, R7704, 7313. May also be used with 602, 605, 5441. (Use battery pack 016-0270-00).

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-50 P		C-51 R		C-52 G		C-53P	
	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
Width	7.5	19.1	9.8	24.8	7.5	19.1	7.5	19.1
Length	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**
Net	7.5	3.4	9.5	4.3	8.0	3.6	7.5	3.4
Shipping	12.0	5.4	15.0	6.8	12.0	5.4	12.0	5.4

ORDERING INFORMATION

"P" models accept Polaroid pack film.
"R" models accept Polaroid roll film.
"G" models accept 4 x 5 sheet or roll-film holders.

C-50

C-50-P CAMERA ..... $ 990
C-50-R CAMERA $1030
C-50-G CAMERA ..... $ 965

C-51

C-51-P CAMERA $1260
C-51-R CAMERA $1300
C-51-G CAMERA $1235

C-52

C-52-P CAMERA $1290
C-52-R CAMERA $1330
C-52-G CAMERA $1265

C-53

C-53-P CAMERA $1000
C-53-R CAMERA $1040
C-53-G CAMERA ..... $ 975

Included Accessories—Focus plate for Polaroid pack film (387-0893-02), or focus plate for Polaroid roll back (387-0893-01), or focusing screen integral with Graflok type back (016-0249-03) mounting adapter for all 7000, 5000, and small 600 Series.

OPTIONAL ACCESSORIES

Battery Pack — Provides an auxiliary +15 V power source for the C-50, C-51, C-52, and C-53 with oscilloscopes that don't provide camera power. A three-position mode switch on the battery pack also allows the camera to be powered from a 7000-Series Oscilloscope or an external +15 V source. Net weight of pack, including batteries, is 1.2 lb.
Order 016-0270-00 ..... $110

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed by about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

Writing Speed Enhancer for C-50 Camera,
Order 016-0278-00 ..... $190

Writing Speed Enhancer for C-51 Camera,
Order 016-0279-00 ..... $190

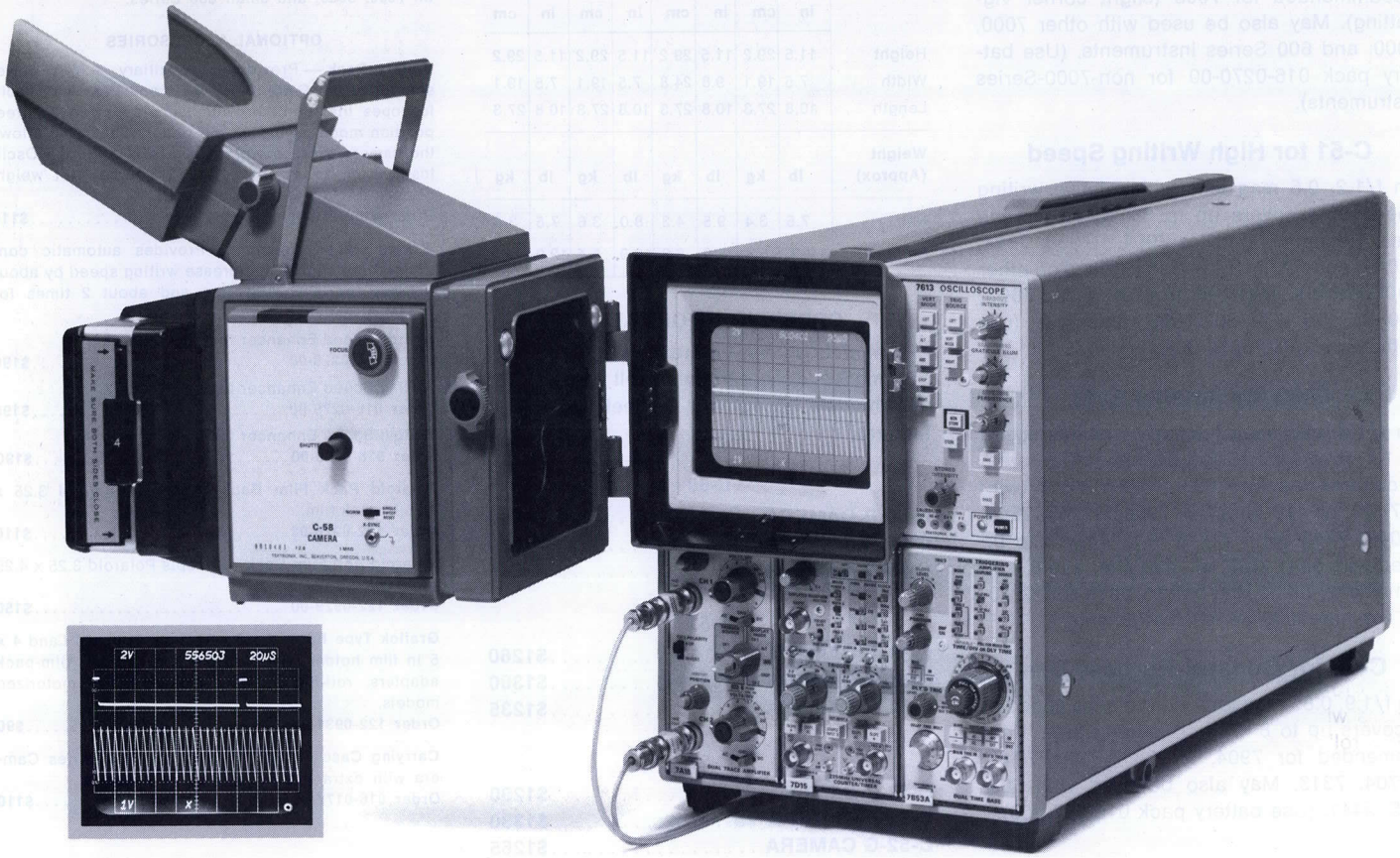
Writing Speed Enhancer for C-53 Camera
Order 016-0300-00 ..... $190

Polaroid Pack Film Back—Accepts Polaroid 3.25 x 4.25 in pack film.
Order 122-0926-00 ..... $110

Polaroid Roll Film Back—Accepts Polaroid 3.25 x 4.25 in roll film.
Order 122-0929-00 ..... $150

Graflok Type Back, 4 x 5—Accepts Polaroid Land 4 x 5 in film holder, standard cut-film holders, film-pack adapters, roll-film holders except heavy motorized models.
Order 122-0931-01 ..... $90

Carrying Case—Holds a complete C-50 Series Camera with extra film-backs and accessories.
Order 016-0177-00 ..... $110



The C-58 is an ideal camera for general-purpose oscilloscope photography where full-size photos are desired but fast writing speed is not necessary. 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 infra red thermogram instruments.

Lens—f/2.8, unity magnification lens with relative writing speed of 0.4, covers up to 8.9 x 11.4 cm screen area.

Shutter—The mechanical shutter is actuated by a plunger on the control panel. It has six selectable speeds, from 1 to 1/50 s with time and bulb modes.

Focus Control—The spring-loaded knob is pushed in and turned to focus the camera while observing the crt display on the focusing screen. When the knob is released, the camera is in focus.

X Sync Switch—A normally open switch in the shutter closes when the shutter opens. 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 camera shutter operation.

Recommended for 7633, 7623A, 7613, 5441 (with 107, 47, 410 film), for 7904, R7903, 7844, 7704A, 7313, 8 x 10 cm display units (with 4 x 5 film).

	C-58-G	
Dimensions	**in**	**cm**
Height	11.5	29.2
Width	7.7	19.3
Length	10.8	27.3
Weight (approx)	**lb**	**kg**
Net	6.0	2.7
Shipping	10.0	4.5

ORDERING INFORMATION

C-58-P CAMERA
for Polaroid pack film **$755**

C-58-R CAMERA
for Polaroid roll film **$785**

C-58-G CAMERA
for 4 x 5 sheet or roll-film holders **$730**

Included Accessories—Focus plate for Polaroid's pack film (387-0893-02) or focus plate for Polaroid roll back (387-0893-01) or focusing screen integral with Graflok type back; 016-0249-03 mounting adapter for all 7000, 5000, and small 600 Series display units.

OPTIONAL ACCESSORIES

Polaroid Pack Film Back—Accepts Polaroid 3.25 x 4.25 in pack film.
Order 122-0926-00 ..... **$110**

Polaroid Roll Film Back—Accepts Polaroid's 3.25 x 4.25 in roll film.
Order 122-0929-00 ..... **$150**

Graflok Type 4x5 Back—Accepts Polaroid Land 4x5 in film holders, standard cut-film holders, film pack adapters, roll film holders (except heavy motorized models).
Order 122-0931-01 ..... **$90**

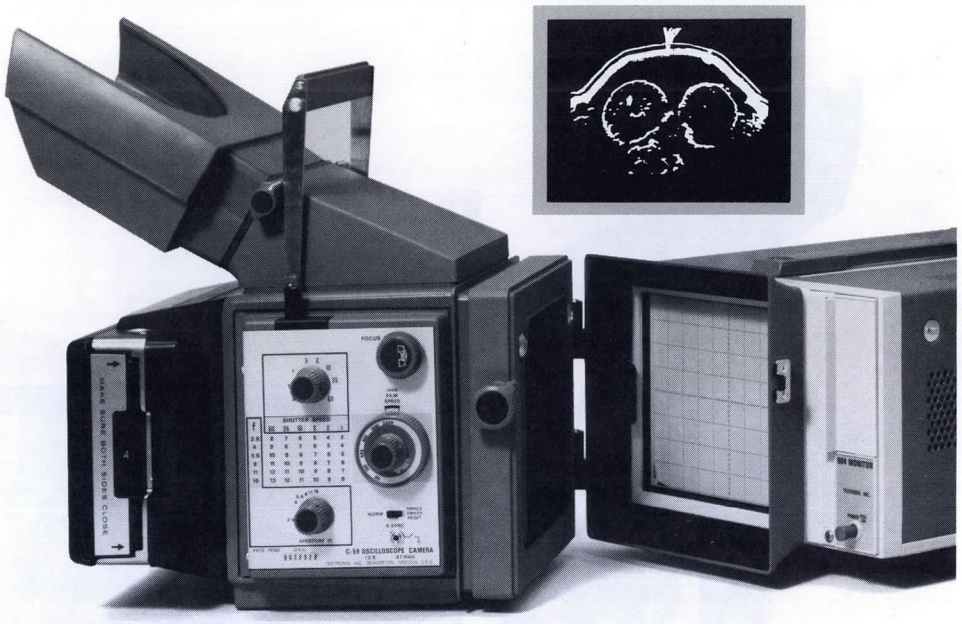
Carrying Case—Holds a complete C-50 Series Camera with extra film backs and accessories.
Order 016-0177-00 ..... **$110**

Photometer Exposure Aid
Provides an Easy Way to Estimate Exposure for Repetitive or Stored Traces

Rangefinder Focusing
Permits Refocusing without Removing the Film

Interchangeable Backs for Versatility

Widely Accepted for General Oscilloscope, Ultrasound, and Thermographic Recording, and Other Medical Documentation



Lens—f/2.8, 0.67 magnification with relative light-gathering power of 0.65 covers up to 10.2 x 12.7 cm screens with 4 x 5 film; covers 9.76 x 12.2 cm or smaller screens with 107, 47, or 410 film; covers 8 x 10 cm or smaller screens when 6 x 7 cm format 120, 220, or 70 mm roll film is used.

Shutter—The shutter is mechanical, with speeds from 1 to 1/50 s plus bulb and time. Electric shutter versions are also available as modified products. Consult your Tektronix representative for details.

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 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 on the left side of the camera 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 produce a correctly exposed photo.

An absorption filter over the photometer lamp provides an approximate color match of the photometer light spot to P31 phosphor.

X Sync Switch—A normally open switch in the shutter closes when the shutter fully opens. 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.

Recommended for 603, 604, 5100 Series storage instruments, 7603, 5444, 5440, D-83, 520A, 521A, 522A, 528, 1480, 1481, 1482, 1485 with P or R back (1400 Series requires factory mod for graticule illumination); for 602, 605, 7904, R7903, 7844, 7704A, 7313 with G back and 6 x 7 cm film. May also be used with all other 7000 and the 5441.

C-59-P

Dimensions	in	cm
Height	11.5	29.2
Width	7.7	19.3
Length	10.8	27.3
Weight (approx)	**lb**	**kg**
Net	7.0	3.2
Shipping	11.0	5.0

ORDERING INFORMATION

"P" models accept Polaroid pack film.
"R" models accept Polaroid roll film.
"G" models accept 4 x 5 sheet or roll-film holders.

C-59-P CAMERA **$615**
C-59-R CAMERA **$655**
C-59-G CAMERA **$590**

Included Accessories—Focus Plate for Polaroid pack film (387-0893-02) or focus plate for Polaroid roll back or focusing screen integral with Graflok back; 016-0249-03 mounting adapter for all 7000-, 5000-, and small 600-Series display units; 8 alkaline cells.

OPTIONAL ACCESSORIES

Writing Speed Enhancer—increases effective film speed 2 or 3 times,
Order 016-0290-00 ..... **$190**

Polaroid Pack Film Back—Accepts Polaroid 3.25 x 4.25 in pack film,
Order 122-0926-00 ..... **$110**

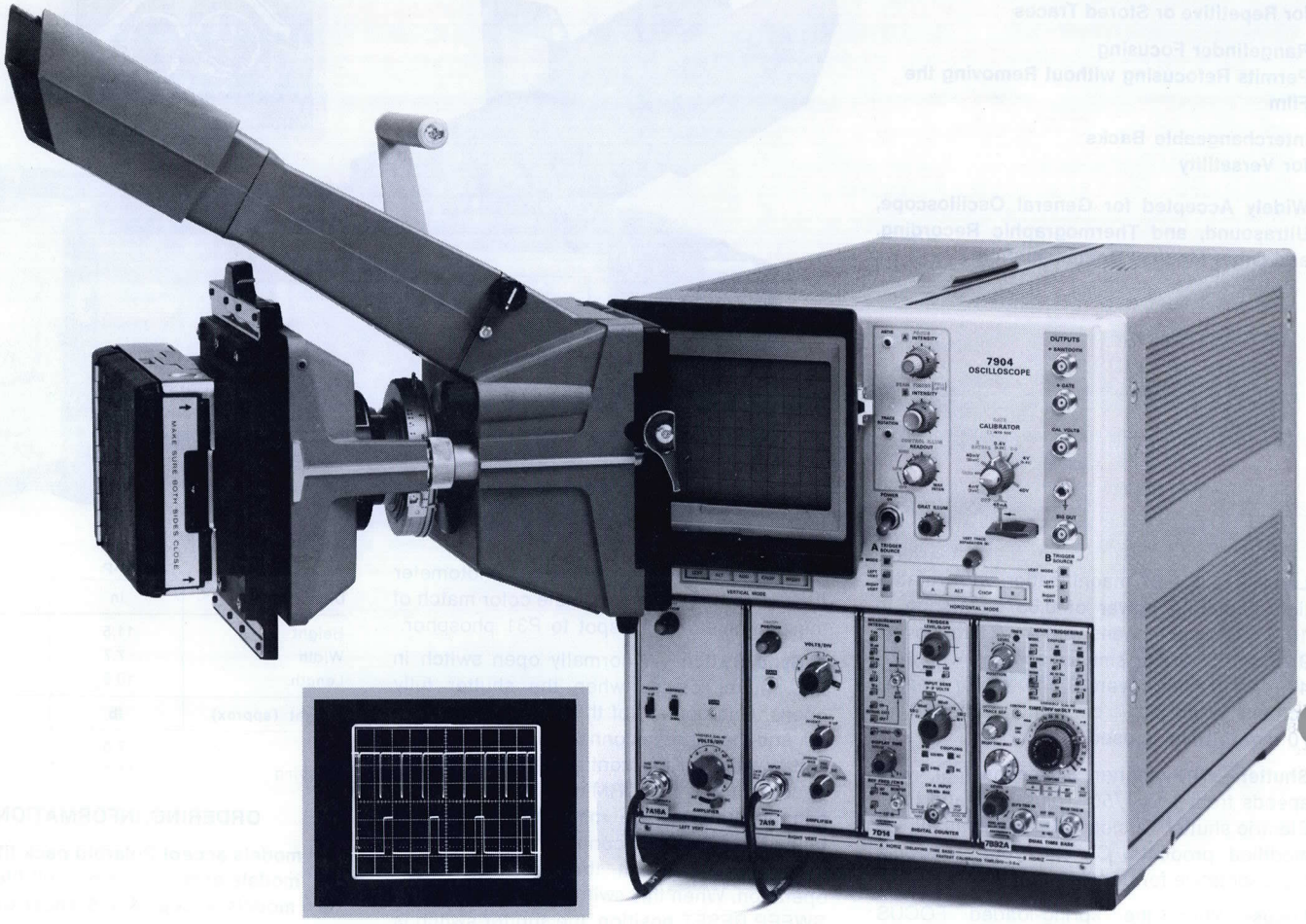
Polaroid Roll Film Back—Accepts Polaroid 3.25 x 4.25 in film,
Order 122-0929-00 ..... **$150**

Graflok Type 4 x 5 Back—Accepts Polaroid Land 4 x 5 in film holders, standard cut film holders, film pack adapters, roll film holders (except heavy motorized roll film holders),
Order 122-0931-01 ..... **$90**

Carrying Case—Holds a complete C-50 Series Camera with extra film backs and accessories,
Order 016-0177-00 ..... **$110**

Cameras

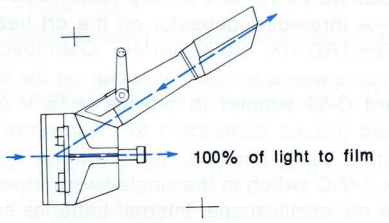
Multiple Options to Fill Many Needs



General Recording, High-Speed Recording, or Unity Magnification Depending on Option Selected

Manual or Electric Shutters Provide Economy or Remote Operation

Interchangeable Backs for Polaroid Roll or Pack Film; Conventional Roll or Sheet Film Holders



C-27 MAIN FRAME

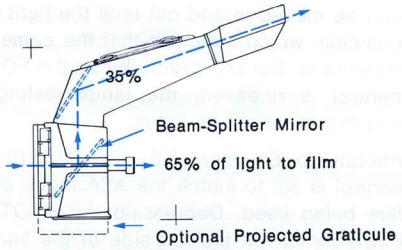
C-27

Lens—f/1.9, 0.85 magnification lens with relative light-gathering power of 1 covers up to 10 x 10 cm displays.

Shutter—Mechanical shutter for simplicity of operation and economy. Provides speeds of 1 to 1/100 s plus bulb and time. Provides X-Sync.

Recommended for 7000 Series except 7603, 7403N. May also be used with 602 and 605.

REQUIRES MOUNTING ADAPTER, SEE p. 219.



C-12 MAIN FRAME

C-12

The C-12 is very similar to the C-27 except that it uses a beam-splitting periscope viewing tunnel for reducing viewing parallax. The C-12 also has an optional graticule projection to provide changeable graticules. Relative writing speed for all C-12 models is 0.65 times the writing speed for the equivalent C-27 model. All C-27 options are available for the C-12 (order by same option number). The C-12 covers up to 8 x 10 cm display.

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
Weight	**lb**	**kg**	**lb**	**kg**
Net	12.3	5.5	10.5	4.7
Shipping	16.0	7.2	14.0	6.3

ORDERING INFORMATION

"P" Models accept Polaroid pack film.
"R" Models accept Polaroid roll film.
"G" Models accept 4 x 5 sheet or roll film holders.

C-27P **$690**
C-27R **$720**
C-27G **$670**

C-12P **$750**
C-12R **$780**
C-12G **$730**

For electric shutter less SPEEDCOMPUTER (requires control voltage),
Order Opt 9 ..... **add $20**

Included Accessories: Cable release (122-0586-02); split-image focus plate for Polaroid pack film back (387-0893-02) or split-image focus plate for Polaroid roll back (387-0893-01) or focusing screen integral with Graflok type back.

Electric Shutter Versions—Includes SPEEDCOMPUTER control box with shutter speeds from 1 to 1/60 s plus bulb and time. Remote triggering with insulated switch closure. Requires 115 V ac, 50-60 Hz.

C-27PE **$1030**
C-27RE **$1060**
C-27GE **$1010**

C-12PE **$1090**
C-12RE **$1120**
C-12GE **$1070**

OPTIONS

Option 1

FOR RECORDING 8 X 10 CM DISPLAYS ON CONVENTIONAL ROLL FILM

A f/1.9, 0.7 mag lens with relative light-gathering power of 1.2, records 8 x 10 cm display on 6 x 7 cm format roll film such as 120, 220, or 70 mm.
Specify Opt 1 ..... **Add $20**

Option 3

UNITY MAGNIFICATION

A f/1.4 unity mag lens with relative light-gathering power of 1.4 records full-sized image of 8 x 10 cm display on 4 x 5 in film.
Specify Opt 3 ..... **Add $190**

Option 4

HIGH WRITING SPEED

A f/1.3, 0.5 mag lens with relative light-gathering power of 2.6 records 8 x 10 cm display on Polaroid roll or pack film or on conventional roll or sheet film.
Specify Opt 4 ..... **Add $190**

OPTIONAL ACCESSORIES

Writing Speed Enhancer—Provides automatic controlled film fogging to increase writing speed about 3 times for 3000 ASA film and about 2 times for 10,000 ASA film. Installs in minutes.

Also Fits C-12.
Order 016-0280-01 ..... **$135**

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 or SPEEDCOMPUTER. Other end of cable has miniature phone plug.
Order 012-0364-01 ..... **$15**

Carrying Case—Protects your C-12 or C-27 Camera during transport.
Order 016-0208-01 ..... **$135**

Graticule Projector (C-12 only)—Projects film work graticule. Includes 8 x 10 cm film work, 6 x 10 cm film work, write-in area film work mask, graticule film holder, power cord (161-0015-01), for 115 V,
Order 016-0204-00 ..... **$235**

for 230 V, **Order 016-0234-00** **$235**

Polaroid Pack Film Back — Accepts Polaroid 3¼ x 4¼ in pack film. Split-image focusing plate included.
Order 122-0671-00 ..... **$105**

Polaroid Roll Film Back—Accepts Polaroid 3¼ x 4¼ in roll film. Split-image focusing plate included.
Order 122-0603-00 ..... **$135**

4 x 5 in Graflok Type Back with Focusing Screen — Accepts standard cut-film holders, film-pack adapters, roll-film holders, Polaroid 4 x 5 in film holder.
Order 122-0604-00 ..... **$90**

Extra Lenses with Mechanical Shutters—f/1.9, 0.7 magnification.
Order 122-0547-00 ..... **$285**

f/1.4, unity magnification.
Order 122-0608-00 ..... **$455**

f/1.3, 0.5 magnification.
Order 122-0662-00 ..... **$455**

f/1.9, 0.85 magnification.
Order 122-0692-00 ..... **$265**

Extra Lenses with Electric Shutters—SPEEDCOMPUTER or external control voltage required for operation. SPEEDCOMPUTER and electric shutter are included with all C-27E and C-12E Cameras.

f/1.9, 0.7 magnification.
Order 122-0772-00 ..... **$305**

f/1.4, unity magnification.
Order 122-0840-00 ..... **$475**

f/1.3, 0.5 magnification.
Order 122-0769-00 ..... **$425**

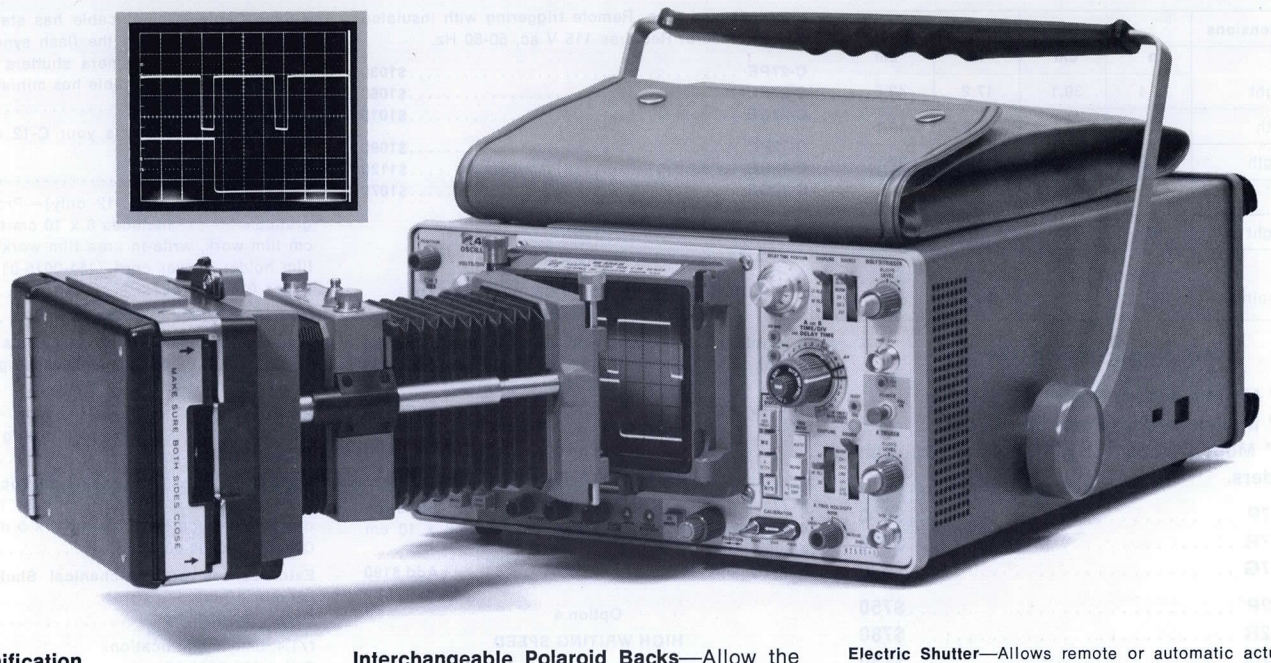
f/1.9, 0.85 magnification.
Order 122-0771-00 ..... **$285**

SPEEDCOMPUTER requires 115 V ac, 50-60 Hz.
Order 122-0767-02 ..... **$310**

Mounting bracket for SPEEDCOMPUTER.
Order 122-0713-00 ..... **$15**

C-30A
C-30A Opt 1

Cameras
Variable Magnification



Variable Magnification for Recording Various Crt Sizes

Optional Electric Shutter for Remote Actuation

Adaptable to Many Instrument Types

The C-30A/C-30A Opt 1 is primarily designed for use with 400 Series Portable Oscilloscopes, but is also adaptable to 8 x 10 cm or smaller 7000, 5000, 600, and 300 Series instruments and to some others (see p 219 for details). If a moderately fast, adjustable camera is required, or if one camera is to be used on several instruments, the C-30A, or C-30A Opt 1 is highly recommended.

Lens—f/1.9, 0.7 to 1.5 magnification lens with relative light-gathering power of 1 (at 0.7 magnification) covers crt screens up to 8 x 10 cm (at 0.85 magnification; slight corner vignetting).

Shutter—Mechanically actuated, with speeds from 1 to 1/60 s plus bulb and time. Provides X sync switch closure for arming oscilloscope single sweep or initiating the event of interest. (Also see electric shutter option.)

Interchangeable Polaroid Backs—Allow the user to change between Polaroid roll and pack film. The C-30AP comes with a Polaroid pack film back, the C-30AR with a Polaroid roll film back.

Recommended for—485, 491. For 335, 326, 314, 1502 use 016-0327-00 adapter. May also be used with 7633, 7623A, 7613, 5441, 7904, R7903, 7844, 7704A, 7313, 602, 605 (except nonilluminated graticule options) with 016-0248-00 adapter. Also see Opt 1.

C-30AP

Dimensions	in	cm
Height	5.1	13.0
Width	7.5	19.1
Length	10.4	25.4
Weight (approx)	**lb**	**kg**
Net	4.8	2.2
Shipping	9.0	4.1

ORDERING INFORMATION

C-30AP **$650**
C-30AR **$680**

Included Accessories: Split-image focusing plate for Polaroid pack back (387-0893-02); or for Polaroid roll back (387-0893-01); mounting adapter for 485 and 491 size bezel (016-0306-00).

OPTIONS

Opt 1 Expanded Field of View—f/1.9, 0.8 magnification lens covers 8 x 10 cm crt screen without vignetting. Relative light-gathering power is 0.9. Includes adapter for 465 size bezel (016-0301-00).
Recommended for—455, 464, 465, 466, 475.
Specify Opt 1 ..... **Add $15**

Standard Model/Opt 1 Conversion—016-0306-00 converts Opt 1 to the full standard model. 016-0301-00 converts the standard model to Opt 1. 016-0306-00 is the 453/454 Series mounting adapter. It is not required for use with 7000, 5000, or 600 Series instruments.
Order 016-0301-00 ..... **$50**
Order 016-0306-00 ..... **$50**

Electric Shutter—Allows remote or automatic actuation of the shutter with an insulated switch closure. Includes SPEEDCOMPUTER control box. Provides speeds of 1 to 1/60 s plus bulb and time. Requires 115 V ac, 50-60 Hz.
Order C-30APE ..... **$ 970**
Order C-30ARE **$1000**

OPTIONAL ACCESSORIES

Mounting Adapters—The C-30A/C-30A Opt 1 may be mounted on several oscilloscopes other than 400 Series instruments. 016-0248-00 fits 7000, 5000, and small 600 Series, (see page 219 for others).
Order 016-0248-00 ..... **$40**

Writing Speed Enhancer—Increases effective film speed about 3 times for 3000 speed film or about 2 times for 10,000 speed film. Fits C-30A, C-30A Opt 1, and C-31. Installs in minutes.
Order 016-0284-00 ..... **$190**

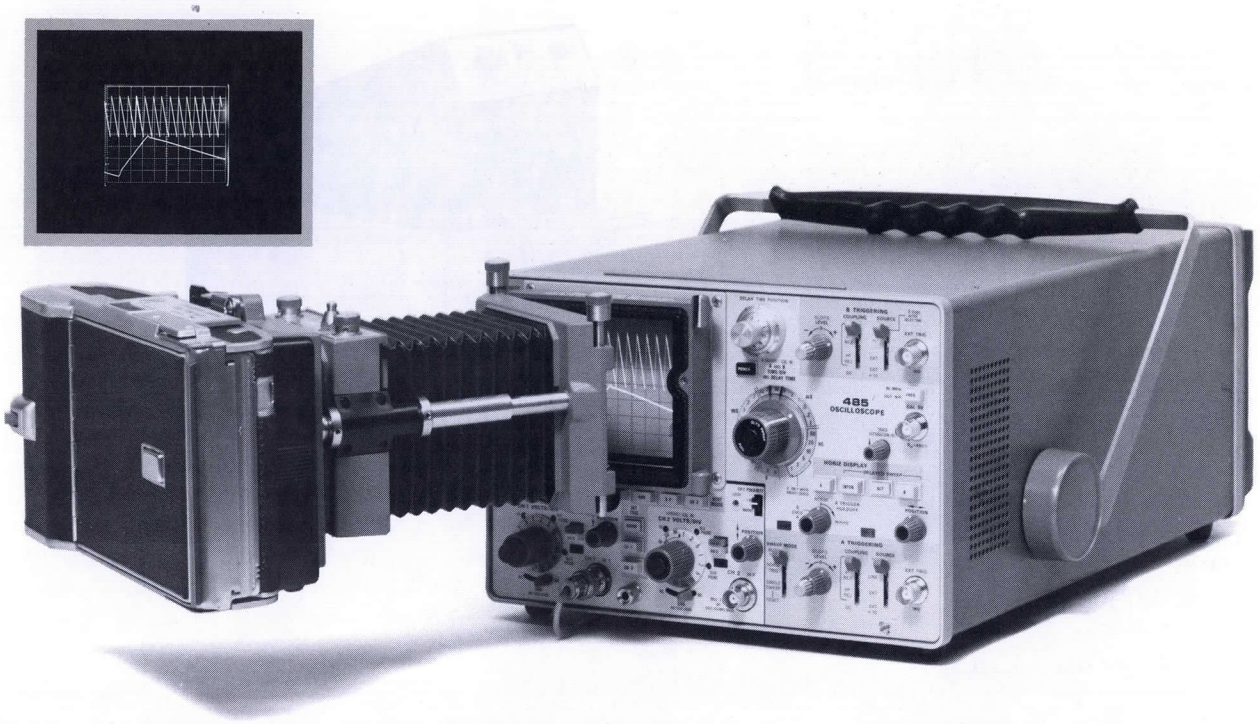
Polaroid Pack Film Back—Accepts Polaroid 3000 speed pack film.
Order 122-0752-00 ..... **$105**

Polaroid Roll Film Back—Accepts Polaroid 3000 or 10,000 speed film.
Order 122-0754-00 ..... **$135**

Carrying Case—Molded high-impact plastic case with polyurethane foam liners to protect your camera in transit. 18.5 x 14.5 x 8 in.
Order 016-0587-00 ..... **$40**

X Sync Cable—Connects to C-30A/C-30A Opt 1 X sync contacts; provides phone plug on opposite end.
Order 012-0364-01 ..... **$15**

C-30A Portra Lens—A slip-on auxiliary lens which extends the focus distance of the camera so it can be used for off-scope photography of scenes such as test set-ups. At a distance of 21 in, the camera covers 19 x 21 in. Useable with either the C-30A or C-30A Opt 1.
Order 016-0246-02 ..... **$22**



High Writing Speed for Fast Events
Optional Electric Shutter
Adaptable to Many Instrument Types

The C-31/C-31 Opt 1 is primarily designed for use with 400-Series Portable Oscilloscopes, but is also adaptable to 8 x 10 cm or smaller 7000, 5000, and 600 Series instruments, and to some others. If a very fast adjustable camera is required, or if one camera is to be used on several instruments, the C-31 is highly recommended.

Lens—f/1.2, 0.5 magnification lens with relative light-gathering power of 2.9 covers crt screens up to 8 x 9 cm. (See Opt 1 for larger screens.)

Shutter—Mechanically actuated, with speeds from 1 to 1/60 s plus bulb and time. Provides X sync switch closure for arming oscilloscope single sweep or initiating event of interest. (Also see electric shutter option.)

Interchangeable Polaroid Backs—Allow user to change between Polaroid roll and Polaroid pack film. The C-31P comes with a Polaroid pack film back, the C-31R with a Polaroid roll film back.

Recommended For—485. May also be used with 491, 7633, 7623A, 7613, 5441 with adapter 016-0248-00. Also see Opt 1.

C-31R

Dimensions	in	cm
Height	5.5	14.0
Width	9.1	23.1
Length	10.6	26.9
Weight (approx)	**lb**	**kg**
Net	6.8	3.1
Shipping	11.0	5.4

ORDERING INFORMATION

C-31P **$770**
C-31R **$800**

Included Accesories—Split-image focusing plate for Polaroid pack film back (387-0893-02) or for Polaroid roll film back (387-0893-01); mounting adapter (016-0306-00).

OPTIONS

Opt 1, Expanded Field of View—f/1.2, 0.44 magnification lens with relative light-gathering power of 2.9 covers crt screens up to 8 x 10 cm.
Recommended for—455, 464, 465, 466, 475.
Specify Opt 1 ..... **Add $15**

Standard Model/Opt 1 Conversions — 016-0269-02 converts standard model to Opt 1. 016-0306-00 converts Opt 1 to full standard model. 016-0306-00 is not required for use with non-400 Series instruments.

Order 016-0269-02 ..... **$55**
Order 016-0306-00 ..... **$50**

Electric Shutter—Allows remote or automatic actuation of the shutter with an insulated switch closure. Includes SPEEDCOMPUTER control box. Provides speeds of 1 to 1/60 s plus bulb and time. Requires 115 V ac, 50-60 Hz.

Order C-31PE **$1090**
Order C-31RE **$1120**

OPTIONAL ACCESSORIES

The C-31 accessories listed below are identical to those for the C-30A. See descriptions under C-30A OPTIONAL ACCESSORIES.

Writing Speed Enhancer
Order 016-0284-00 ..... **$190**

Extra Film Backs
Order 122-0752-00 Polaroid Pack Film Back **$105**
Order 122-0754-00 Polaroid Roll Film Back **$135**

Carrying Case
Order 016-0587-00 ..... **$ 40**

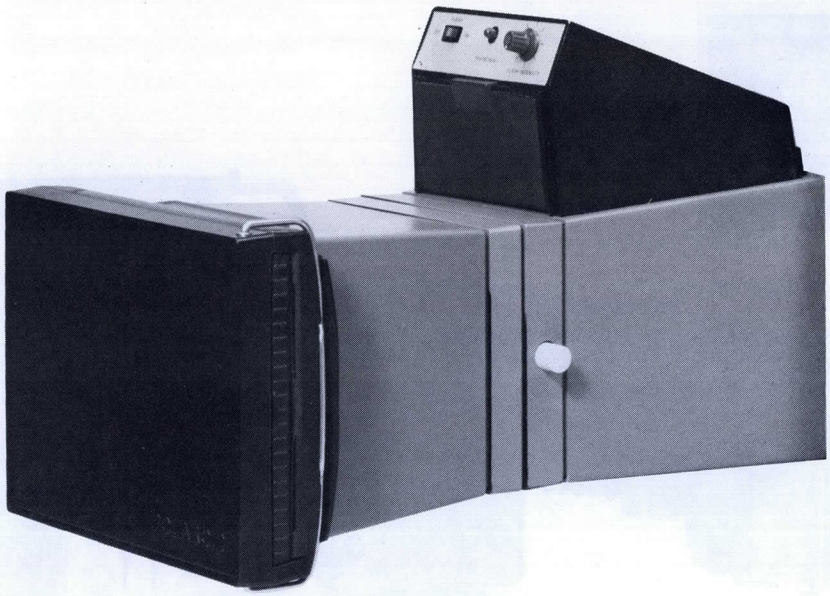
X-Sync Cable
Order 012-0364-01 ..... **$ 15**

C-32

The C-32 is designed to provide unity magnification image for recording traces with the 422, 453A, 454A, 485, or 491. It has an f/1.4 lens, and magnification ratios of 0.85, 0.9, 1, 1.1, and 1.2. It covers a screen size of up to 7 x 9 cm.

ORDERING INFORMATION

C-32P ..... **$ 835**
C-32R ..... **$ 865**
C-32PE **$1155**
C-32RE **$1185**



Easy to Use

Low Cost

Graticule Illumination

Versatile

Lens—Fixed focus, fixed aperture f/16, 0.67 or 0.85 magnification (user adjustable) lens with relative light-gathering power of 0.02 fills 107 film with 9.76 x 12.2 cm or 8 x 10 cm screen depending on magnification selected. 7.2 X 9 cm displays record 6.12 X 7.65 cm image at 0.85 magnification.

Shutter—Mechanical shutter with speeds of 1/5 to 1/25 s, plus bulb and time.

Graticule Illumination—Variable intensity, reliable Xenon flash lamp evenly illuminates crt screen to backlight nonilluminated graticules so they can be recorded.

Power Required—Two AA penlight batteries.

Dimensions	in	cm
Height	5.5	14
Width	6.6	16.8
Length	10.1	25.7
Weights (approx)	**lb**	**kg**
Weight	3	1.4
Net Shipping	4.1	1.9

Recommended for—all 7000-Series, 5000-Series, and small 600-Series display units, 1420, 1421, 1422, 577, 528, where external graticule illumination is required.

Order C-5A **$235**

OPTIONS

Opt 1 is the same as the basic camera except that it does not have graticule illumination. Recommended for all 7000-Series, 5000-Series, and small 600 Series display units, 1420, 1421, 1422, 577, 528 where external graticule illumination is not required.
Opt 1 ..... **Subtract $35**

Opt 2 does not have graticule illumination. It is molded to fit 400-Series Oscilloscopes. Recommended for the 455, 464, 465, 466, and 475 models.
Opt 2 ..... **Subtract $35**

Opt 3 has graticule illumination and is molded to fit T900-Series Oscilloscopes. Recommended for All T900-Series Oscilloscopes.
Opt 3 ..... **No Charge**

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 at least two orders of magnitude greater than the circuit source impedance. For higher frequencies (greater than about 30 MHz), the importance of the capacitance increases drastically and will become the prime consideration.

2. For rise time measurements, the interaction of the probe capacitance with the source impedance is of importance (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25 Ω source environment.

3. For general purpose use, passive voltage probes offer a wide probe selection for a variety of applications (see chart on page 230 for voltage probes for 1 MΩ inputs).

4. Where higher frequencies (above 250 MHz) are encountered, active FET probes which have high input resistance and low input capacitance through their dynamic range, should be used. For 50 Ω systems, see adjacent selection chart of 50 Ω divider probes.

5. For measuring currents from dc to 1000 A, see the adjacent selection chart for current probes.

Current probes can be used where low loading of the circuit is necessary. Loading is typically in the milliohm to low ohm range. Current probes can be used for differential measurements, where the probe measures the result of two opposing currents in two conductors in the jaw of the probe.

A current waveform may be very different from a voltage waveform in a current-dependent circuit. Measuring only the voltage will not show this difference. To obtain the total picture, a measurement of the current waveform is necessary.

FET PROBES

Type	Atten	Length*	Package Number	Loading		Rise time in ns	INPUT LIMITS: Max dc + Pk ac	INPUT LIMITS: Linear Dynamic Range	INPUT LIMITS: Dc Offset Range	Read-out	Page
P6046	1X	6.0	010-0213-00 Std	1 MΩ	10 pF	3.5	±25 V	±5 V		NO	234
Diff/Amp	10X			10 MΩ	3 pF		±250 V	±5 V			
P6201	1X	6.0	010-6201-01 Std	100 kΩ	3 pF	0.4	±100 V	±0.6 V	±5.6 V	YES	232
FET	10X			1 MΩ	1.5 pF		±200 V	±6 V	±56 V		
	100X			1 MΩ	1.5 pF		±200 V	±60 V	±200 V		
P6202	10X	2m	010-6202-01 Std	10 MΩ	2 pF	0.7	±200 V	±6 V	±60 V	YES	233
FET	100X		010-0384-00 Opt	10 MΩ	2 pF	0.7	±200 V	±60 V	±200 V	NO	

50-Ω DIVIDER PROBES

Type	Atten	Length*	Package Number	Loading		Rise time in ns	INPUT LIMITS: Max dc + Pk ac	INPUT LIMITS: Linear Dynamic Range	Read-out	Page
P6056	10X	6.0	010-6056-03 Std	500 Ω	1 pF	0.1	±16 V	±16 V	YES	234
		9.0	010-6056-05 Opt 2							
P6057	100X	6.0	010-6057-03 Std	5 kΩ	1 pF	0.25	±50 V	±50 V	YES	234
		9.0	010-6057-05 Opt 2							

**Length in feet except where specified.*

CURRENT PROBES

Type	Bandwidth Hz to MHz	Current/Div Scope at: 50mV/Div mA to A	Current/Div Scope at: Any Sensitivity mA/mV	SATURATION: Dc Amps	SATURATION: Pulse Amp-Sec Product	MAXIMUM CURRENT: dc + Pk ac Amp	MAXIMUM CURRENT: ac p-p Amp	MAXIMUM CURRENT: Derate Below	MAXIMUM CURRENT: Derate Above	MAXIMUM CURRENT: Peak Pulse Amp	Page
P6042	dc 50	1 1		10		10	20		1 MHz	10	236
P6042 with CT-5	0.5 20	20 1 k		20	8		20 k	20 Hz	1.2 kHz	10 k	
P6021 Passive Term	120 50		2 or 10	0.5	0.5×10^{-3}		15	300 Hz	5 MHz	250	237
134	12 35	1 to 1		0.5	0.5×10^{-3}		15	230 Hz	5 MHz	15	
CT-5/ Passive Term	120 20		40 or 10 k	20	0.5		2000	300 Hz	1.2 kHz	50 k	
CT-5/134	12 20	20 to 1 k		20	0.5		2000	230 Hz	1.2 kHz	15 k	
P6022 Passive Term	8.5 k 100		1 or 10	0.2	9×10^{-6}		6	3 kHz	10MHz	100	237
134	100 60	1 to 1		0.2	9×10^{-6}		6	1.3 kHz	10MHz	15	
CT-1	30 k 1000		5mV/mA	0.2	1×10^{-6}		1.4			100	238
CT-2	1.2 k 100		1mV/mA	0.2	50×10^{-6}		7			100	239

OTHER PROBES

Probe	Package Number	Function	Use	Page
P6058	010-0260-00	Temperature and Voltage Probe	DM 501 7D13	136 60
P6430	010-6430-00	Temperature Probe	DM 40 DM 43	96 97
	010-0277-00	High Voltage Probe	DM 501 DM 502	136 137
P6450	010-6450-01	Data Acquisition Probe	LA 501	122
P6401	010-6401-01	Logic Probe	TTL Logic	231

1 m = 3 1/2 ft
2 " = 6 "
3 " = 9 "

VOLTAGE PROBES for 1 MΩ Inputs

Type	Atten	Length*	Package Number	Loading		Useful[5] BW MHz	Dc Max	Scope C in pF	Readout	Page
P6006[1]	10X	3.5 6 9 12	010-0127-00 Opt 1 010-0160-00 Std 010-0146-00 Opt 2 010-0148-00 Opt 3	10 MΩ	7.5 pF[2] 8.5 11 13	35 25 25 12	600 V	15 to 55	NO	240
P6007	100X	3.5 6 9 12	010-0150-00 Opt 1 010-0165-00 Std 010-0152-00 Opt 2 010-0154-00 Opt 3	10 MΩ	2 pF[2] 2.2 2.4 2.6	25 20 15 13	1.5 kV	15 to 55	NO	240
P6008	10X	6	010-0129-01 Std	10 MΩ Environmentalized —50°C to +150°C	7.5 pF	100	600 V	12 to 47	NO	240
P6009	100X	9 9	010-0170-00 Opt 4 010-0264-01 Std	10 MΩ	2.5 pF[2] 2.5 pF	120 100	1.5 kV	12 to 47	NO YES	240
P6010	10X	3.5	Furnished with S-5 (Page 66) For other uses see P6054A or P6105							
P6011	1X		OBSOLETE—REPLACED BY P6101							
P6012	10X		OBSOLETE—REPLACED BY P6108							
P6013A	1000X	10 25	010-0177-01 Std 010-0175-01 Opt 3	100 MΩ	3 pF 3.5	80 13	12 kV	15 to 55	NO	241
P6015	1000X	10	010-0172-00 Std	100 MΩ	3 pF	75	20 kV	12 to 47	NO	241
P6027	1X		OBSOLETE—USE P6028 & 103-0032-00 ADAPTER							
P6028	1X	3.5 6 9 12	010-0074-00 Opt 1 010-0075-00 Std 010-0076-00 Opt 2 010-0077-00 Opt 3	1 MΩ	50 pF[2] 67 90 112	17 10 7 4	600 V	ANY	YES	241
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	—
P6049B	10X	3.5	010-6049-11	10 MΩ	13.5 pF	20	500 V	43 to 66	NO	—
P6053B	10X	3.5 6 9	010-6053-11 Opt 1 010-6053-13 Std 010-6053-15 Opt 2	10 MΩ	9.5 pF 12.5 13.5	250 250 88	500 V	15 to 24	YES	242
P6054A	10X	3.5 6 9	010-6054-11 Opt 1 010-6054-13 Std 010-6054-15 Opt 2	10 MΩ	9.5 pF 12.5 13.5	250 250 88	500 V	15 to 24	NO	242
P6055[3]	10X	3.5	010-6055-01 Std	1 MΩ	10 pF[2]	60	500 V	20 to 47	YES	242
P6060[3]	10X	3.5 6	010-6060-01 Opt 1 010-6060-03 Std	10 MΩ	7.5 pF[2] 8.5	35 25	600 V	15 to 55	YES[4]	243
P6062A	10X or 1X 10X or 1X 10X or 1X	3.5 6 9	010-6062-01 Opt 1 010-6062-03 Std 010-6062-05 Opt 2	10 MΩ 1 MΩ 10 MΩ 1 MΩ 10 MΩ 1 MΩ	13.5 pF 100 pF 14 pF 105 pF 17 pF 135 pF	100 8 100 6.7 95 4.5	500 V	15 to 47	YES	243
P6063A	10X or 1X 10X or 1X	3.5 6	010-6063-01 Opt 1 010-6063-03 Std	10 MΩ 1 MΩ 10 MΩ 1 MΩ	11 pF 80 pF 14 pF 105 pF	200 12 200 6	500 V	15 to 24	YES	243
P6065A	10X	6	OBSOLETE—REPLACED BY P6105							
P6075A	10X	6	010-6075-13 Std	10 MΩ	12.5	200	500 V	Designed for 475 only	YES	—
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 MΩ	32 pF 54 78	34 15.5 8	500 V	ANY	YES	244
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V	15 to 47	YES	245
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 MΩ	10.5 pF 13 pF 15.5 pF	100 100 95	500 V	15 to 47	NO	246

**Length in feet except where specified.*

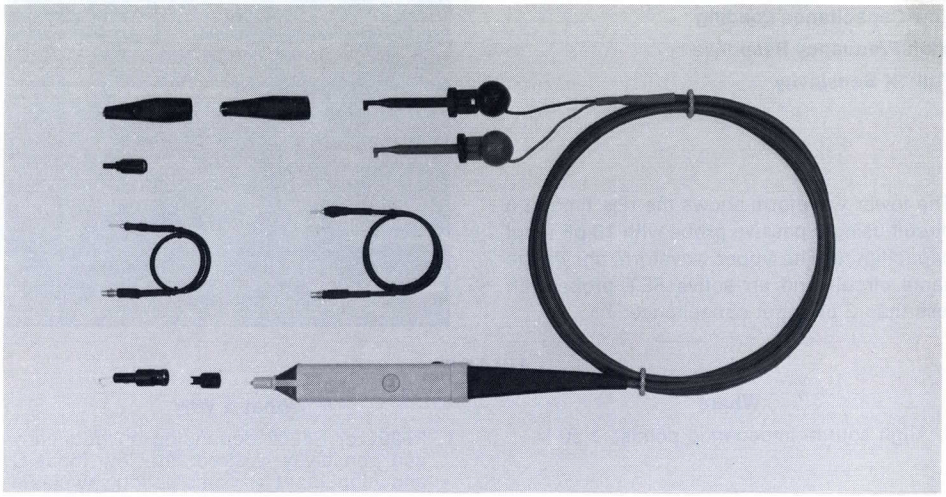
1. *To convert to UHF connectors, use adaptor 103-0032-00.*
2. *Rating varies with scopes having other than 20 pF inputs.*
3. *Designed for use with scopes having differential inputs.*
4. *Not compatible with crt readout.*
5. *25 Ω source.*

P6302
010-6302-01
current Probe

P6420
010-6420-03- $85.—

P6430
010-6430-00 -
$110.—

TTL/DTL Compatible
Detects Steady Logic Levels
Detects Trains of Logic Pulse
Detects Abnormal Conditions
Strobed Detection of Logic Pulses
Store Mode
Protected against Overvoltage



The TEKTRONIX P6401 Logic Probe is a device to extend and improve your capability to analyze and troubleshoot even the most advanced TTL and DTL circuitry. The P6401 Logic Probe detects and positively identifies logic states or conditions at the point checked. Just touch and see, no level setting or other operational adjustment is required. LSI circuitry developed and manufactured by Tektronix, Inc. enables the P6401 to operate as indicated in the state or condition table. The P6401 is light, small, and uses the same wide group of probe accessories that extend the usefulness of TEKTRONIX oscilloscope probes.

To put the P6401 to work, simply connect the convenient power clips to your 5 volt Vcc supply and touch the circuit element to be tested. Two lamps (green for indicating low state and red for indicating high state) are located near the probe tip for ease of viewing while probing. If a single logic pulse is to be detected, a switch on the probe body activates a "store" mode. The "store" mode holds the indication that a logic pulse has (or has not) occurred. This indication is held until the probe is reset. When coincidence of logic levels at two points is to be detected, simple connections are made with strobe leads furnished with the probe.

State or Condition	Indication
Steady high state	Steady red light
Steady low state	Steady green light
Pulse trains (normal logic switching)	Blinking red and green light at full intensity
Abnormal state (Between high and low)	No lights
Open circuit	No lights
Excessive input voltage greater than 6 V	Both red and green lights lit
Alternating between high state and abnormal state	Blinking red light
Alternating between low state and abnormal state	Blinking green light
Single or very low duty cycle logic pulse	Using STORE mode, one light will be on initially. Event has occurred when second light is lit.

SPECIFICATIONS

Low State—0 V to +0.7 V ±0.125 V.

High State—+2.175 V ±0.125 V to Vcc.

Minimum Recognizable Pulse Width—10 ns.

Impedance—≃7.5 kΩ paralleled by≃ 6 pF.

Minimum Circuit Resistance for Open Circuit Indication—10 kΩ.

Max Safe Input—± 150 V (dc or rms).

Minimum Recognizable Strobe Pulse Width—20 ns.

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

Strobe Input Impedance—approx 5.6 kΩ.

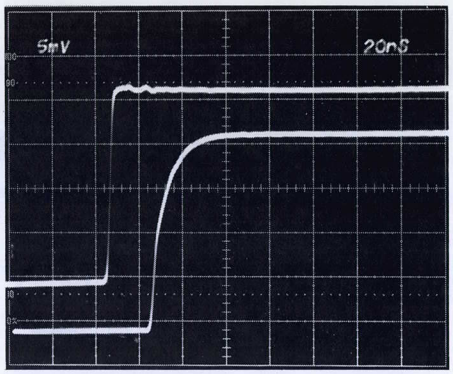
ORDERING INFORMATION

Included Accessories:

206-0114-00	1 **TIP,** hook
175-0958-00	1 **LEAD,** strobe
175-0958-01	1 **LEAD,** strobe
206-0137-01	1 **TIP,** probe to 0.025 in square pin adapter
348-0023-00	1 **PLUG,** white
344-0046-00	2 **CLIPS,** alligator
016-0537-00	1 **POUCH,** accessory (not shown)

P6401 5-ft Probe, 010-6401-01 . . . . . $90

Low Capacitance Loading
High Frequency Response
Full 1X Sensitivity

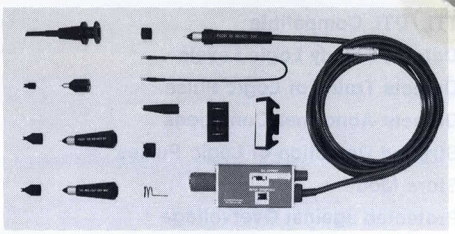


The lower waveform shows the rise time of a circuit using a passive probe with 10 pF input capacitance. The upper waveform shows the same circuit and an active FET probe with less than 2 pF input capacitance.

USAGE

Where	What & Why
1. High source impedance points; >50 Ω	1. P6201 or P6202 depending on frequency and sensitivity desired: the low input C and high input R combination, available only in an active probe provides fastest rise time (C influenced) and accurate amplitude.
2. Low power circuits	2. P6201 or P6202 depending on frequency and sensitivity desired: the high input impedance of an active probe at all frequencies will provide a minimum signal power drain.
3. Small signal circuits	3. P6201: 1X or full sensitivity without bandwidth loss allows maximum amplitude of small signals.
4. > 200 MHz frequency responses desired	4. P6201, P6202, P6056, P6057: the specific choice will depend upon the frequency and other circuit characteristics.
5. Tuned circuits	5. P6201, P6202: These probes offer minimum disturbance due to low C.
6. No instrument probe power availability	6. P6202: the only active probe available today designed to work from a 110/220 outlet.
7. Generally any circuit where a voltage measurement is needed and minimal circuit disturbance desired	7. The general benefit of an active probe is its combination of low C and high R.
8. High cmrr needed—differential measurement	8. P6046: to obtain maximum cmrr, the active circuitry needs to be at the measurement point.

P6201 Dc to 900 MHz, 1X



Dc to 900 MHz Bandwidth
Unity Gain
Two Plug-on Attenuator Heads that Maintain Scope Readout Factor
Low Input Capacitance
Dc Offset
Ac-dc Coupling Switch

The P6201 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 rise time 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, 7800, 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.

e 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. **Rise Time** 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 approx 3.0 pF. Attenuator heads are 1 MΩ (within 1%) shunted 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 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. **Max 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.

ORDERING INFORMATION

Included Accesories:

013-0135-00	1 **TIP,** retractable hook
010-0376-00	1 **ATTENUATOR** head 10X
010-0377-00	1 **ATTENUATOR** head 100X
206-0200-00	3 **PROBE TIPS**
131-1302-00	1 **CONTACT,** ground
175-0848-02	1 **LEAD,** ground, 3 in
103-0164-00	1 **PROBE TIP** to test point jack
344-0046-00	1 **CLIP,** alligator
166-0557-00	1 **SLEEVE,** insulating
342-0180-00	1 **INSULATOR,** ground contact
016-0156-02	1 **CARRYING CASE**

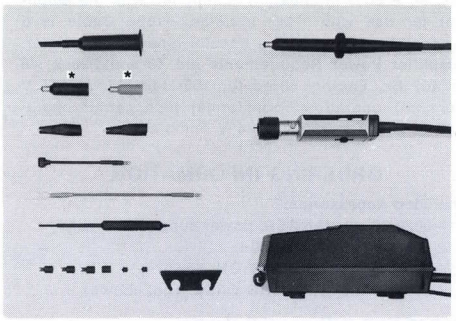
P6201 FET Probe, Order 010-6201-01 . . $550

1101 Power Supply

Accessory Power Supply, for powering up to four P6201 Probes.

1101 Probe Power Supply, Order 1101 . . $350

P6202



Dc to 500 MHz Bandwidth
Self-Contained Power Supply
Dc Offset
High Input Impedance through Freq Range
Small Probe Size
Rugged
Low Cost

The P6202 is an active (FET) probe providing dc to 500 MHz bandwidth. Because of its self-contained power supply, it can be used on any instrument without concern for probe power. The very low input capacitance of the probe permits acquisition of high frequency signals with a minimum loading of circuits under test while the high input resistance minimizes low frequency and dc loading.

The probe has a dc offset feature to offset any dc component within the range of the control to bring the signal into the dynamic range of the probe.

The probe was designed to be used with any oscilloscope (real time, sampling, spectrum analyzer, etc) where high frequency signals are acquired and/or low circuit loading is necessary. A switch in the output of the probe amplifier allows the probe to be used on 50 Ω or 1 MΩ inputs.

The probe body is small for getting into tight areas, and is very rugged to withstand the rigors of production, testing, and yet sophisticated enough for R & D work.

Optional accessories are a plug-on 10X attenuator head, for 100X attenuation and a plug-on ac coupling head to block out unwanted dc components.

The probe includes a BNC connector which provide scale readout on the 10X mode to instruments having readout capability, while maintaining compatibility with the instruments without readout.

SPECIFICATIONS

Characteristic	Probe	Opt 10X Attenuator Head	Opt Ac Coupling Cap
Bandwidth (−3 dB)	dc to ≥ 500 MHz	dc to ≥ 500 MHz	16 Hz to ≥ 500 MHz
Rise Time	≤0.7 ns	≤0.7 ns	≤0.7 ns
Attenuation	10X within 4%	100X within 2%	——
Input Impedance	10 MΩ within 2% shunted by approx 2 pF	10 MΩ within 2% shunted by approx 2 pF	approx 4 pF
Dynamic Range	0 to ±6 V	0 to ±60 V	——
Dc Offset Range	−60 V to +60 V	−200 V to +200 V	——
Noise (Tangential)	150 μV or less	150 μV or less	——
Max Input Voltage	200 V dc + peak ac	200 V dc + peak ac	200 V dc + peak ac

ORDERING INFORMATION

Included Accessories:

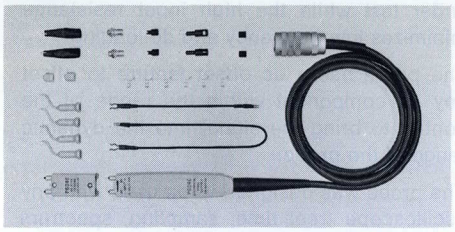
013-0097-01	1 **TIP,** retractable hook
352-0351-00	1 **PROBE HOLDER**
344-0046-00	2 **CLIPS,** alligator
175-0849-00	1 **LEAD,** 8 cm ground
016-0378-00	1 **CARRYING CASE** (not shown)
003-0675-01	1 **TOOL,** adjustment
175-1017-00	1 **LEAD,** 13 cm ground
206-0230-00	2 **TIPS,** probe
166-0404-01	1 **SLEEVE,** insulating

P6202 FET Probe 2 Meter Cable, Order 010-6202-01 . . . . . $325

***Optional Accessories:**

P6202 10X Attenuator, Order 010-0384-00 . . . . . $36
P6202 ac Coupling Cap, Order 010-0360-00 . . . . . $15

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. 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. **Rise Time** is 3.5 ns or less. **Common-Mode Rejection Ratios** with deflection factors of 1 mV/div to 20 mV/div to at least 10,000:1 at 50 kHz, 5000:1 at 1 MHz, 1000:1 from 10 MHz to 20 MHz, and 1000:1 at 50 MHz. **Common-Mode Linear Dynamic Range** is ±5 V, ±50 V with 10X attenuator. **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). **Max 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 ft long terminated with a special nine-pin connector. **Amplifier Power Requirements** are 10 watts max, 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).

ORDERING INFORMATION

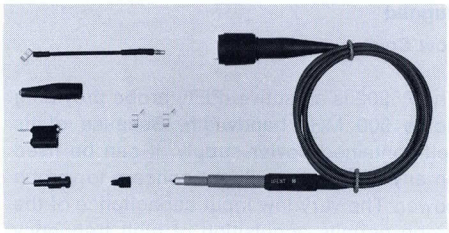
Included Accessories:

014-0029-00	1 **HANGER,** power supply assembly
012-0076-00	1 **CABLE,** 50-Ω
011-0049-01	1 **TERMINATION,** 50-Ω
016-0111-01	1 **CARRYING CASE,** (not shown)

P6046 FET Differential Probe, Amplifier, and Power Supply, Order 010-0232-00 ..... $975

Opt 5 w/o Amplifier, and Power Supply, Order 010-0213-00 ..... $540

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. **Rise Time** is less than 100 ps, probe only. **Typical Rise Time** 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. **Max Input Voltage RF (CW)** 22 V, dc 16 V. **Max Power Dissipation** is 0.5 W. **Transit Time Variation** from probe to probe is less than 70 ps.

ORDERING INFORMATION

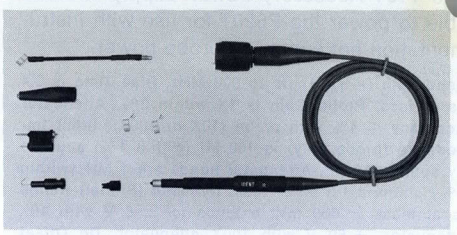
Included Accessories:

344-0046-00	1 **CLIP,** alligator
206-0114-00	1 **TIP,** hook
013-0085-00	1 **ADAPTER,** bayonet ground
214-0283-00	1 **CONTACT,** electrical
175-0249-00	1 **CABLE,** ground

P6056 10X 50 Ω Probe, 6 ft Order 010-6056-03 ..... $75

Opt 2, 9 ft Order 010-6056-05 ..... $75

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 female 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. **Rise Time** is less than 250 ps, probe only. **Typical Rise Time** 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. **Max Input Voltage** 50 V dc or rms to 500 MHz decreasing to 21 V at 1 GHz. **Transit Time Variation** from probe to probe is less than 70 ps.

ORDERING INFORMATION

Included Accessories:

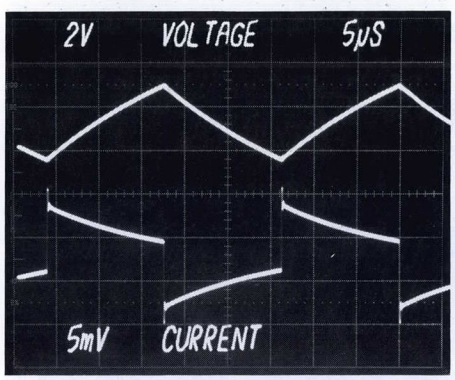
344-0046-00	1 **CLIP,** alligator
206-0114-00	1 **TIP,** hook
013-0085-00	1 **TIP,** bayonet ground
214-0283-00	1 **CONTACT,** electrical
175-0249-00	1 **CABLE,** ground

P6057 100X 50 Ω Probe, 6 ft, Order 010-6057-03 ..... $75

Opt 2, 9 ft, Order 010-6057-05 ..... $75

Lowest Loading
Clip-on; No Need to Break Circuit Under Test
Observe Current Waveform
Differential Measurements
Measure Bare Conductors

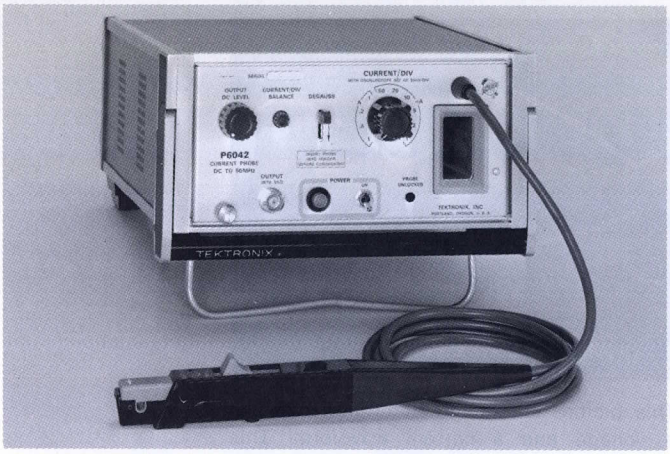
USING A CURRENT PROBE



This picture shows the difference between a voltage and a current waveform. This application is looking at the charging voltage and current of a capacitor.

When	Why
1. Looking at reactive sources (capacitive, inductive).	1. Voltage measurements tell only a portion of the systems characteristics.
2. Evaluating current dependent devices (transistors, SCRs, commutators, etc)	2. A voltage measurement alone can't characterize the operation of the device.
3. Probing high source impedance points (drains, collectors, plates, and other passive or active high impedance points).	3. Lower loading providing more accurate rise time and amplitude measurements.
4. Evaluating source points sensitive to loading.	4. Voltage techniques may alter the operating characteristics of circuits sensitive to loading. Current probes exhibit significantly less source loading, providing more accurate signal representations (minimize alteration of actual circuit operation).
5. Any time information on current characteristics is needed.	5. A current measurement directly defines current characteristics without calculations and assumptions about the circuit.

P6042 Dc to 50 MHz Current Probe



Dc to 50 MHz
10 Amps Dc
Clip-on 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 0.15 in 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.

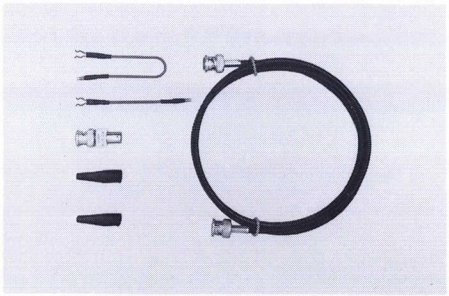
CHARACTERISTICS

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 (−3 dB). **Rise Time** 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. **Max Input Current** is 10 A (dc plus peak ac).* **Max 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.

**P-p current derating is necessary for cw frequencies higher than 1 MHz. At 50 MHz, the max allowable current is 2 A.*

Amplifier Power Requirement is approx 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 in (11.4 cm) high by 7½ in (19.2 cm) wide by 9¾ in (24.8 cm) deep; 6½ lb (3.1 kg). **Probe Cable** is 6 ft long, permanently connected between the probe head and amplifier.



ORDERING INFORMATION

Included Accessories:

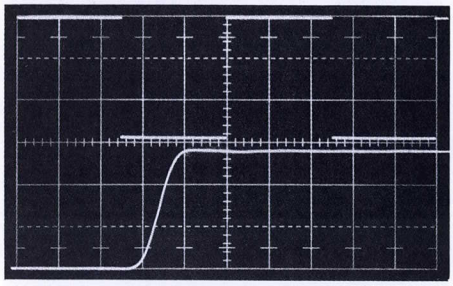
012-0057-01	1 **CABLE** assembly
175-0124-01	1 **LEAD,** ground, 5 in
175-0263-01	1 **LEAD,** ground, 3 in
344-0046-00	2 **CLIPS,** miniature alligator
011-0049-01	1 **TERMINATION,** 50 Ω

P6042 Dc to 50 MHz Current Probe
Order 010-0207-00 . . . . . $925

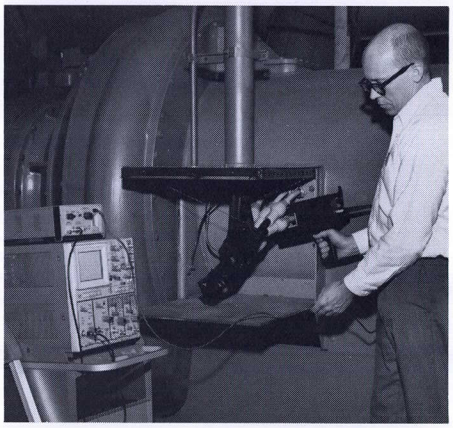
OPTIONAL ACCESSORIES

The CT-5 High-Current Transformer extends the max measurement capability of the P6042 at frequencies from 0.5 Hz to 20 MHz.

CT5 Current Probe (Includes dc Bucking Coil)
Order 015-0189-01 . . . . . $650
Opt 5 w/o dc Bucking Coil, Order 015-0189-00 . . $495

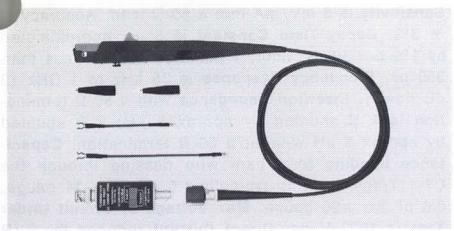


Upper display is a 60-Hz squarewave demonstrating the dc response of the P6042. The lower display is the same waveform at 10 ns/div. Double exposure photograph.



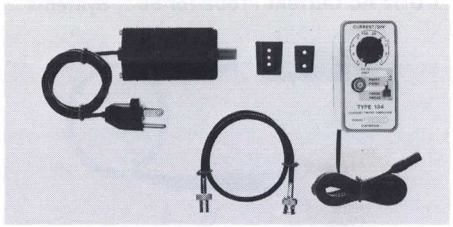
Typical application of the CT-5 clip-on high-current transformer, P6042 dc current probe and 7000-Series Oscilloscope measuring the running current of a 1500 hp delta-connected induction motor.

AC Current Probes—12 Hz to 200 MHz:



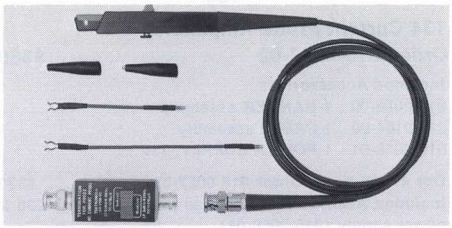
P6021 w/Term

For General Purpose Applications
120 Hz to 60 MHz
Clip-on Probe



134 Current Probe Amplifier

Use to Expand the Low Frequency Capability and Sensitivity of Either Probe



P6022 w/Term

Small Size Suitable for Compact Circuitry
935 Hz to 200 MHz
Clip-on Probe

The individual units; P6021, 134, and P6022 provide versatility in a user assembled ac current measurement system. These various components can be assembled into a variety of performance packages.

1. P6021 w/134
2. P6021 w/term
3. P6022 w/134
4. P6022 w/term

The P6021 and P6022 are ac current probes designed for use with real time oscilloscopes. Either probe, with passive termination or with the amplifier, can be used with oscilloscopes having input resistance of 1 MΩ or greater. (Neither the termination nor the amplifier is required to use the P6021 probe with the TEKTRONIX 5A21N Amplifier.) 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 0.15 in with P6021 and 0.1 in with P6022) in the probe slot, and release the slide. No electrical connection is required.

The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under the 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.

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). A passive termination is not required when using a 134 and a P6021 or P6022.

The 134 can also be used as an auxiliary voltage amplifier by placing the CURRENT/DIV switch in the VOLTS position.

PERFORMANCE CHARACTERISTICS

		Probe with Passive Termination	Probe with 134 Amplifier
Sensitivity	**P6021**	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ± 3%.	134 Amplifier switchable in steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ± 3%.
	P6022	1 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.	
Bandwidth†	**P6021**	2 mA/mV ≤ 450 Hz to 60 MHz 10 mA/mV ≤ 120 Hz to 60 MHz	12 Hz to 38 MHz
Probe Only*	**P6022**	1 mA/mV—≤ 8.5 kHz to 130 MHz 10 mA/mV—≤ 935 Hz to 200 MHz	100 Hz to 65 MHz
Max Current (CW)	**P6021**	15 A p-p sine wave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV.	15 A p-p sine wave between 230 Hz and 5 MHz
	P6022	6 A p-p sine wave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV.	6 A p-p sine wave between 1.3 kHz and 10 MHz
Max Current (Pulse)	**P6021**	250 A peak, not to exceed 500 A-μs or 5 A rms	15 A peak, not to exceed 500 A-μs or 5 A rms
	P6022	100 A peak, not to exceed 9 A-μs or 2 A rms	15 A peak, not to exceed 9 A-μs or 2 A rms
Noise			≤ 150 μA
Max Voltage		600 V (dc + peak ac)	600 V (dc + peak ac)
Net Weight		≃ 1 lb	≃ 5 lb

†All bandwidths stated are −3dB

**To estimate the scope/probe system bandwidth from the probe only bandwidth, use the relationship*

$$(t_r \text{ system})^2 = (t_r \text{ probe})^2 + (t_r \text{ scope})^2$$

$$t_r = .35 \text{ BW}$$

ORDERING INFORMATION
134

134 Current Probe Amplifier, Order 015-0057-02 ..... $330

Included Accessories:
014-0029-00 1 **HANGER** assembly
012-0104-00 1 **CABLE** assembly
015-0058-01 1 **POWER SUPPLY,** 110 V

Opt 4, 230 V ac, Order 015-0057-03 ..... $330
Included Accessories: Same as above, but with 230 V power supply (015-0058-01).

P6021

P6021 Current Probe and Term, 5 ft, Order 015-0140-02 ..... $170

Opt 2, 9 ft and Term, Order 015-0140-03 ..... $170
Opt 6 5 ft w/o Term, Order 010-0237-02 ..... $115
Opt 2 and 6, 9 ft w/o Term, Order 010-0244-02 ..... $115

P6022

P6022 Current Probe and Term, 5 ft, Order 015-0135-00 ..... $195

Opt 2, 9 ft and Term, Order 015-0135-01 ..... $195
Opt 6, 5 ft w/o Term, Order 010-0238-00 ..... $140
Opt 2 and 6, 9 ft w/o Term, Order 010-0238-02 ..... $140

OPTIONAL ACCESSORIES for P6021, P6022 and 134

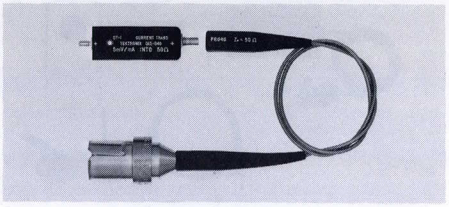
Calibrator Adapter, BNC, Order 013-0092-00 ..... $20
Carrying Case for P6021 and P6022, and a 134 Amplifier, Order 016-0087-01 ..... $12

Passive Termination

For P6021, Order 011-0105-00 ..... $60
For P6022, Order 011-0106-00 ..... $65

CT-1

1 GHz Ac Current Probe for 50 Ω Systems



Can Be Used with 50 Ω Systems, or Wide Band Non-sampling Oscilloscopes Using a 50 Ω Term

CT-1 Permanently Inserted in 50 Ω Circuit has Minimum Effect in the 50 Ω Environment

Several CT-1s Can Be Used with Only One Probe Cable

1 GHz Bandwidth

Probe Cable

The 010-0133-00 probe cable 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 probe cable can be used to monitor any one of them.

The probe cable 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 in. 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 ± 3%. **Decay Time Constant** is 5 μs, approximated by 1% per 50 ns; limit, 1 μs. **Rise Time** 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 approx 5 μH; 2 Ω shunted by approx 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. **Max 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 max. **Temperature Rating** is −25°C to +65°C. **Physical Dimensions** are ⅜ x 9/16 x 1-13/16 in plus #6-32 x ¼ in mounting stud.

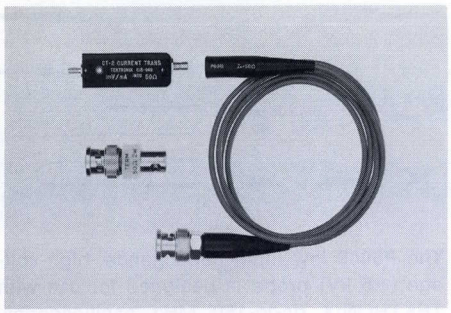
ORDERING INFORMATION

CT-1 Current Transformer and Probe, Order 015-0041-00 ..... $75

Opt 5 CT-1 Current Transformer (without Probe), Order 015-0040-00 ..... $40
Probe Cable, Order 010-0133-00 ..... $37

CT-2

100 MHz Ac Current Probe



For Use with Oscilloscopes Up to 100 MHz Bandwidth

CT-2 Current Transformer has Insulated Case for Applications Where Limited Space Exists

Several CT-2's Transformers Can Be Used in the Circuit and Monitored by One or More Probe Cables

Probe Cable

The 010-0164-00 probe cable serves as an interconnecting cable between the CT-2 Transformer and the oscilloscope input. A 50 Ω termination is used in conjunction with the probe cable for terminating the probe cable at the high impedance input of the oscilloscope used.

Impedance is 50 Ω. **Attenuation** is 1X. **Output Connector** is BNC type. **Cable Length** is 42 in. 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 AC CURRENT PROBE

Sensitivity is 1 mV/mA into a 50 Ω load. Accuracy is ±3%. **Decay Time Constant** is 125 μs, approx by 1% per 1.25 μs; limit, 25 μs. **Rise Time** 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. **Max 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 μs. **Rms Current Rating** is 2.5 A max. **Temperature Rating** is −25°C to +65°C.

ORDERING INFORMATION

Included Accessories:
010-0164-00 1 **CABLE,** probe
011-0049-01 1 **TERMINATION,** 50 Ω

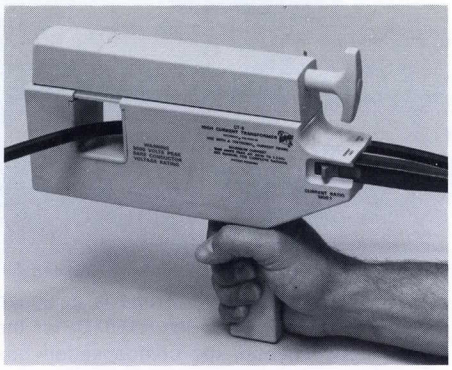
CT-2 plus Cable and Term, Order 015-0047-00 ..... $80

Opt 5 w/o Cable or Term, Order 015-0046-00 ....$40

Probe Cable, Order (010-0164-00) $26

CT-5

Pulsed Currents to 50,000 A



50,000 A Pulse Currents

20 mA per Division Sensitivity

1.5 Inch Diameter Conductors

Clip-on Probe

Measurements on Bare Conductors to 3000 V

Nullifies Dc Effects to 300 A

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 using the P6021 and passive termination, provided the 0.5 A-sec rating is not exceeded. The P6021 and 134 current probe amplifier may also be used for measurements at normal power line frequency and above. (The P6022 and CT-5 are not compatible with each other.) The CT-5 has receptacles for insertion of a current probe in either 20:1 or 1000:1 step-down ratios. The 1.5 in 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 V, and to 10 kV rms when using high voltage bushing.

Use of an optional dc bucking coil assembly, which slips over the front of the CT-5, allows up to 300 A 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, because the unbucked dc signal will degrade the accuracy of the measurement.

CT-5 Current Measurement Combinations

Product	Current/Div Scope at 50 mV/Div	Bandwidth	Amp Milli-Sec Product	Max Current	
				RMS	Peak Pulse
CT5/P6021/134	20 mA to 1 kA	12 Hz to 20 MHz	500	700 A	15 kA
CT5/P6042	20 mA to 1 kA	0.5 Hz to 20 MHz	8000	700 A	10 kA
CT5/P6021/Term	40 mA to 10 A	120 Hz to 20 MHz	500	700 A	15 kA

CT-5 CHARACTERISTICS

The following are characteristics of the CT-5 using either the P6042 or P6021/134 combination.

Rise Time 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); 1A/div to 1000 A/div (1000:1 step-down ratio). Accuracy is within 4%. **Max Current** is 1000 A peak cw.* **Amp-Sec** product is 8 A-s. **Max Voltage** of circuit under test is 3000 V (bare conductor). **Max Dc Bucking Current** is 300 mA to buck out 300 A dc (using dc bucking coil). **Dimensions and Weight** —the length is 10.5 in, width is 2.25 in, height is 9.5 in, net weight is approx 4 lb.

**Max current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.*

ORDERING INFORMATION

Included Accessories:
016-0191-03 1 **CARRYING CASE**
015-0194-00 1 **BUSHING,** high voltage, 12 in

CT-5 Current Probe (Includes dc Bucking Coil) Order 015-0189-01 ..... $650

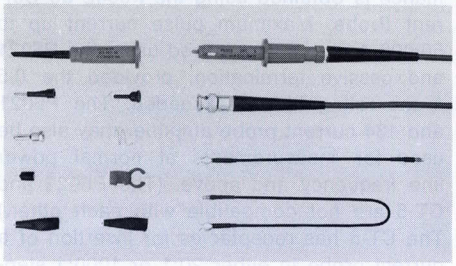
Opt 5 w/o dc Bucking Coil, Order 015-0189-00 ..... $495

OPTIONAL ACCESSORIES

Dc Bucking Coil, Order 015-0190-00 ..... $170

High-Voltage Bushing, 4 ft long, inside diameter is 1 in, Order 015-0194-01 ..... $25

P6006 Dc to 35 MHz 10X



The P6006 is a general-purpose probe. It 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 approx 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 Rise Time** is approx 5 ns; **Voltage Rating** is 600 V dc, ac peak, or dc and ac peak combined.*

ORDERING INFORMATION

P6006 10X Probe, Order 010-0160-00 . . . $38

Opt 1, 3.5 ft BNC, Order 010-0127-00 . . . . . $38

Opt 2, 9 ft BNC, Order 010-0146-00 . . . . . $38

Opt 3, 12 ft BNC, Order 010-0148-00 . . . . . $38

**P-p 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 is a low input-capacitance, high-voltage (1.5 kV) probe. It 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 approx 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 Rise Time** is approx 14 ns for the 3.5 ft version; **Voltage Rating** is 1.5 kV dc or ac rms, 4.2 kV ac p-p.*

ORDERING INFORMATION

P6007 100X Probe, 6 ft,
Order 010-0165-00 . . . . . $50

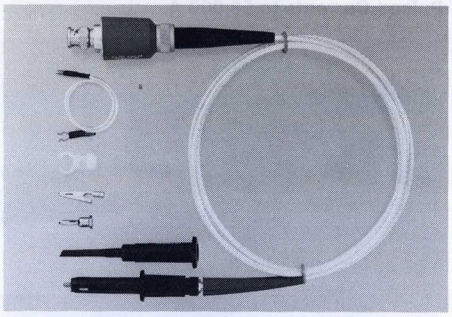
Opt 1, 3.5 ft, Order 010-0150-00 . . . . . $50

Opt 2, 9 ft, Order 010-0152-00 . . . . . $50

Opt 3, 12 ft, Order 010-0154-00 . . . . . $50

**P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 10 MHz, the max allowable p-p voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.*

P6008 Environmental 10X



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° to +55°C. It is designed for use with TEKTRONIX dc-to-100 MHz oscilloscopes. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitance of 12 pF to 47 pF and input resistance of 1 MΩ.

Attenuation is 10X; **Input Resistance** is 10 MΩ; **Input Capacitance** is approx 7.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Rise Time** is less than 3.5 ns; **Bandpass** is 100 MHz; **Voltage Rating** is 600 V dc, ac peak, or dc and ac peak combined.*

ORDERING INFORMATION

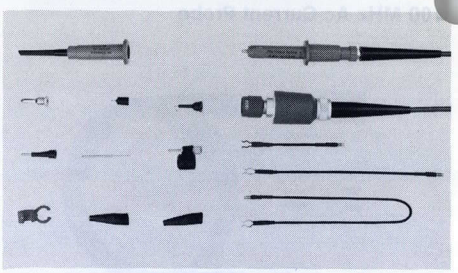
Included Accessories:

134-0013-00	1 **PLUG,** banana
344-0045-00	1 **CLIP,** miniature alligator
175-0925-00	1 **LEAD,** ground, 12.5 in
352-0090-00	1 **PROBE HOLDER**
013-0071-01	1 **TIP,** retractable hook

P6008 10X Probe, 6 ft, Envir,
Order 010-0129-01 . . . . . $110

**P-p voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the max allowable p-p 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 approx 2.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Rise Time** is approx 2 ns; **Voltage Rating** is 1.5 kV dc or ac rms, 4 kV ac p-p.* **Cable** is 9 ft long, terminated with a BNC connector; **Net Weight** is approx 16 oz.

ORDERING INFORMATION

Included Accessories:

175-0125-01	1 **CABLE,** ground lead, 12 in
175-0124-01	1 **CABLE,** ground lead, 5 in
175-0263-01	1 **CABLE,** ground lead, 3 in
013-0071-00	1 **PINCHER TIP**
352-0090-00	1 **HOLDER,** probe
013-0052-00	1 **ASSEMBLY,** bayonet ground assembly includes: 214-0325-00 1 **PIN,** center
344-0046-00	2 **CLIPS,** miniature alligator
206-0060-00	1 **TIP,** probe, male, w/6-32 threads
206-0105-00	1 **TIP,** probe, w/6-32 threads
134-0013-00	1 **PLUG,** banana, female, w/6-32 threads
206-0015-00	1 **TIP,** w/straight shank

P6009 100X Probe, 9 ft, w/Readout,
Order 010-0264-01 . . . . . $95

Opt 4 w/o Readout, Order 010-0170-00 . . . . . $95

**P-p voltage derating is necessary for cw frequencies higher than 200 kHz. At 40 MHz, the max allowable p-p voltage is 425 V.*

†Readout coding inoperative with 7A15A and 7A22.

P6013A 12kV 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 Rise Time** is 7 ns or less with 10 ft cable, 13.5 ns or less with 25 ft cable. **Voltage Rating** is 12 kV, peak pulse, or peak ac.* **Net Weight** is approx 5½ lb.

ORDERING INFORMATION

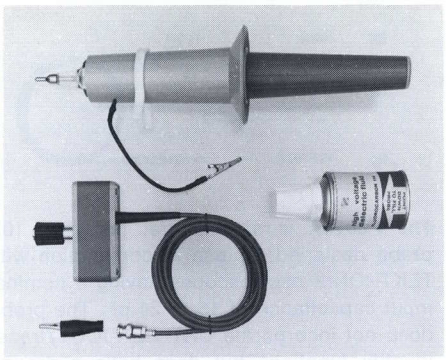
Included Accessories:

015-0083-00	1 **COMPENSATING BOX,** BNC
344-0005-00	1 **CLIP,** alligator
352-0056-00	1 **PROBE HOLDER**
016-0129-01	1 **CARRYING CASE**

P6013A 1000X probe, 10 ft,
Order 010-0177-01 ..... $300
Opt 3, 25 ft, Order 010-0175-01 ..... $300

**P-p voltage derating is necessary for cw frequencies higher than 100 kHz. At 1 MHz, the max allowable p-p 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 approx 3 pF. **Probe Rise Time** is approx 4 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.*

ORDERING INFORMATION

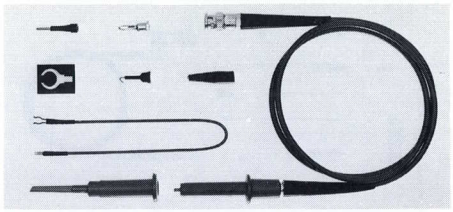
Included Accessories:

015-0049-00	1 **COMPENSATING BOX,** BNC
344-0005-00	1 **CLIP,** alligator
352-0056-00	1 **PROBE HOLDER**
252-0120-00	1 **CAN** of high-voltage dielectric fluid
016-0128-01	1 **CARRYING CASE**

P6015 1000X Probe, 10 ft,
Order 010-0172-00 ..... $350

**P-p voltage derating is necessary for cw frequencies higher than 100 kHz. At 10 MHz, the max allowable p-p voltage is 13 kV.*

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.

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 Rise Time** is approx 10 ns. **Voltage Rating** is 600 V dc or ac p-p.*

ORDERING INFORMATION

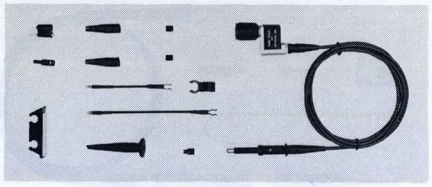
Included Accessories:

175-0125-01	1 **CABLE** ground lead, 12 in
352-0068-00	1 **HOLDER,** probe, molded
344-0046-00	1 **CLIP,** miniature alligator
013-0071-00	1 **PINCHER TIP**
134-0013-00	1 **PLUG,** banana
206-0105-00	1 **TIP,** probe, hook
206-0060-00	1 **TIP,** probe, spring

P6028 1X Probe, 6 ft,
Order 010-0075-00 ..... $28
Opt 1, 3.5 ft, Order 010-0074-00 ..... $28
Opt 2, 9 ft, Order 010-0076-00 ..... $28
Opt 3, 12 ft, Order 010-0077-00 ..... $28

**P-p voltage derating is necessary for cw frequencies higher than 1 MHz. At 10 MHz, the max allowable p-p voltage is 60 V.*

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 pushbutton for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

Attenuation is 10X. **Input Resistance** is 10 MΩ. **Input Capacitance** for the 3.5 ft probe is 9.5 pF; 12.5 pF for the 6 ft version. **Bandwidth,** when used with an oscilloscope with a bandwidth of at least 225 MHz: 3.5 and 6 ft probes is approx 200 MHz and the 9 ft probe is approx 115 MHz. **Voltage Rating** is 500 V (dc + peak ac).*

ORDERING INFORMATION

Included Accessories:

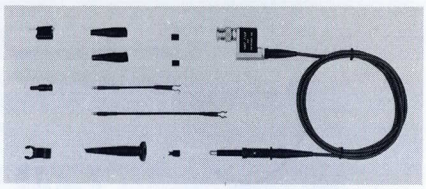
013-0107-03	1 **TIP,** probe, retractable, hook assy w/flange
352-0351-00	1 **HOLDER,** probe, plastic adhesive back
206-0114-00	1 **TIP,** probe, hook
013-0085-00	1 **TIP,** probe, ground
175-0124-01	1 **LEAD,** electrical, ground 5 in
175-0263-01	1 **LEAD,** electrical ground, 3 in
344-0046-00	2 **CLIPS,** miniature alligator
166-0404-01	2 **SLEEVES,** ins, plastic

P6053B 10 X Probe, 6 ft,
Order 010-6053-13 ..... $75

Opt 1, 3.5 ft, Order 010-6053-11 ..... $75
Opt 2, 9 ft, Order 010-6053-15 ..... $75

**Peak voltage derating is necessary for cw frequencies higher than 5 MHz. At 10 MHz, the max allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.*

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.

Attenuation is 10X. **Input Resistance** is 10 MΩ. **Input Capacitance** for the 3.5 ft probe is 9.5 pF; for the 6 ft version 12.5 pF; for the 9 ft version 13.5 pF. **Bandwidth with 454A Oscilloscope**—3.5 ft probe is at least 115 MHz. **Voltage Rating** is 500 V (dc + peak ac).†

ORDERING INFORMATION

Included Accessories:

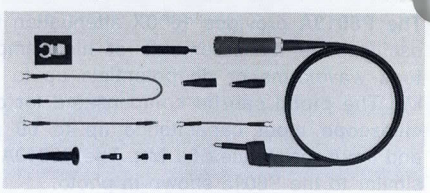
352-0234-00	1 **HOLDER,** probe, plastic
206-0114-00	1 **TIP,** probe, hook
013-0085-00	1 **TIP,** probe, ground
013-0107-03	1 **TIP,** probe, retractable hook assy w/flange
175-0124-01	1 **LEAD,** electrical, ground, 5 in
175-0263-01	1 **LEAD,** electrical, ground, 3 in
344-0046-00	2 **CLIPS,** miniature alligator
166-0404-01	2 **SLEEVES,** ins, plastic

P6054A 10X Probe, 6 ft,
Order 010-6054-13 ..... $68

Opt 1, 3.5 ft, Order 010-6054-11 ..... $68
Opt 2, 9 ft, Order 010-6054-15 ..... $68

†Peak voltage derating is necessary for cw frequencies higher than 6 MHz. At 10 MHz the max 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 10X



The P6055 is a miniature, low-capacitance, 10X probe designed for use with TEKTRONIX differential amplifiers having nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 MΩ ± 2%). A special locking type readout connector allows the probe to be used with instruments with or without readout capability.

When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the cmrr of the system.

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. **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. **Typic Rise Time** of the probe with 7A13 and 7704 Oscill scope is 5.4 ns. **Voltage Rating** is 500 V (dc + peak ac).*

ORDERING INFORMATION

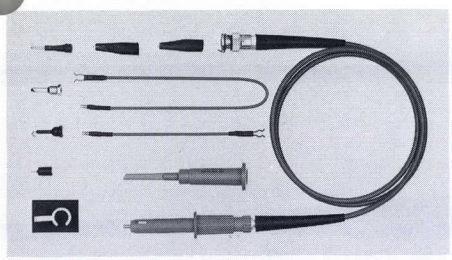
Included Accessories:

013-0107-03	1 **TIP,** probe, retractable, hook
003-0675-00	1 **SCREWDRIVER,** probe adjust
175-0124-01	1 **LEAD,** electrical, 5 in
175-1256-00	1 **LEAD,** electrical, 6 in
175-0125-01	1 **LEAD,** electrical, 12 in
206-0114-00	1 **TIP,** probe
344-0046-00	2 **CLIPS,** miniature alligator
166-0404-01	2 **TUBES,** insulating
352-0090-00	1 **HOLDER,** probe

P6055 10X Differential Probe, 3.5 ft,
Order 010-6055-01 ..... $120

**P-p voltage derating is necessary for cw frequencies higher than 12 MHz. At 70 MHz, the max allowable p-p voltage is 100 V.*

6060 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; with 55 pF instruments it is ≃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 ft probe at least 40 MHz (with scope bandwidth of at least 60 MHz); 6 ft probe at least 30 MHz (with scope bandwidth of at least 60 MHz). **Max Input Voltage**—600 V (dc + peak ac).*

ORDERING INFORMATION

Included Accessories:

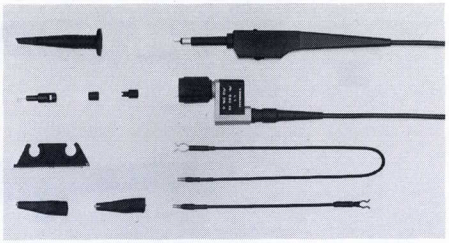
206-0060-00	1 **TIP,** probe, spring
344-0046-00	2 **CLIPS,** miniature alligator
134-0013-00	1 **PLUG,** banana, threaded
175-0125-00	1 **CABLE,** ground lead, 12 in
175-0124-00	1 **CABLE,** ground lead, 5 in
206-0105-00	1 **TIP,** probe, hook
206-0015-00	1 **TIP,** probe, BNC
352-0090-00	1 **HOLDER,** probe, plastic
013-0071-00	1 **TIP,** probe, retractable hook, screw-on

P6060 10X Probe, 6 ft,
Order 010-6060-03 ..... $45
Opt 1, 3.5 ft, Order 010-6060-01 ..... $45

**P-p voltage derating is necessary for cw frequencies higher than 3 MHz. Max input voltage at 50 MHz is 50 V.*

P6062A Dc to 100 MHz

1X, 10X Selectable Attenuation



The P6062A is a passive dual attenuation probe designed for TEKTRONIX oscilloscopes with bandwidths to 100 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multi-trace display. The P6062A can be compensated with instruments having a nominal input capacitance of 15 to 47 pF. The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

Attenuation, 10X and 1X. **Input Resistance** 1X position, 1 MΩ; 10X position, 10 MΩ 0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** for the 3.5 ft probe is 100 pF in the 1X position, and 13.5 pF in the 10X position; for the 6 ft version, 105 pF in the 1X position, and 14 pF in the 10X position. For the 9 ft probe 135 pF in the 1X position and 17 pF in the 10X position. **Bandwidth** of the 10X probe is at least 100 MHz for the 3.5 ft and 6 ft, and 95 MHz for the 9 ft when used with a 465 or 464 oscilloscope. **Bandwidth** of the 1X probe 3.5 ft is at least 8 MHz, 6 ft is at least 6.7 MHz and 9 ft is at least 4.5 MHz. **Voltage Rating** is 500 V (dc + peak ac).

ORDERING INFORMATION

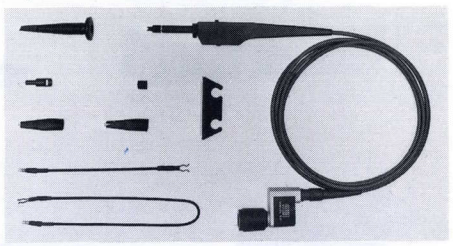
Included Accessories:

352-0341-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** probe
013-0107-03	1 **TIP,** probe; ret hook assy
175-0124-01	1 **LEAD,** elec, probe ground, 5 in
175-0125-01	1 **LEAD,** elec, probe ground, 12 in
344-0046-00	2 **CLIPS,** miniature alligator with cover
166-0404-01	1 **SLEEVE,** insul for 0.188 dia probe bushing

P6062A Switchable Attenuation Probe, 6 ft,
Order 010-6062-03 ..... $80
Opt 1, 3.5 ft, Order 010-6062-01 ..... $80
Opt 2, 9 ft, Order 010-6062-05 ..... $80

P6063A Dc to 200 MHz

1X, 10X Selectable Attenuation



The P6063A is a fast-rise dual attenuation, passive probe designed for TEKTRONIX oscilloscopes with bandwidths greater than 100 MHz. A sliding switch on the probe body selects 1X to 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multi-trace display. The P6063A can be compensated with instruments having a nominal input capacitance of 15 to 24 pF.

The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X-10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

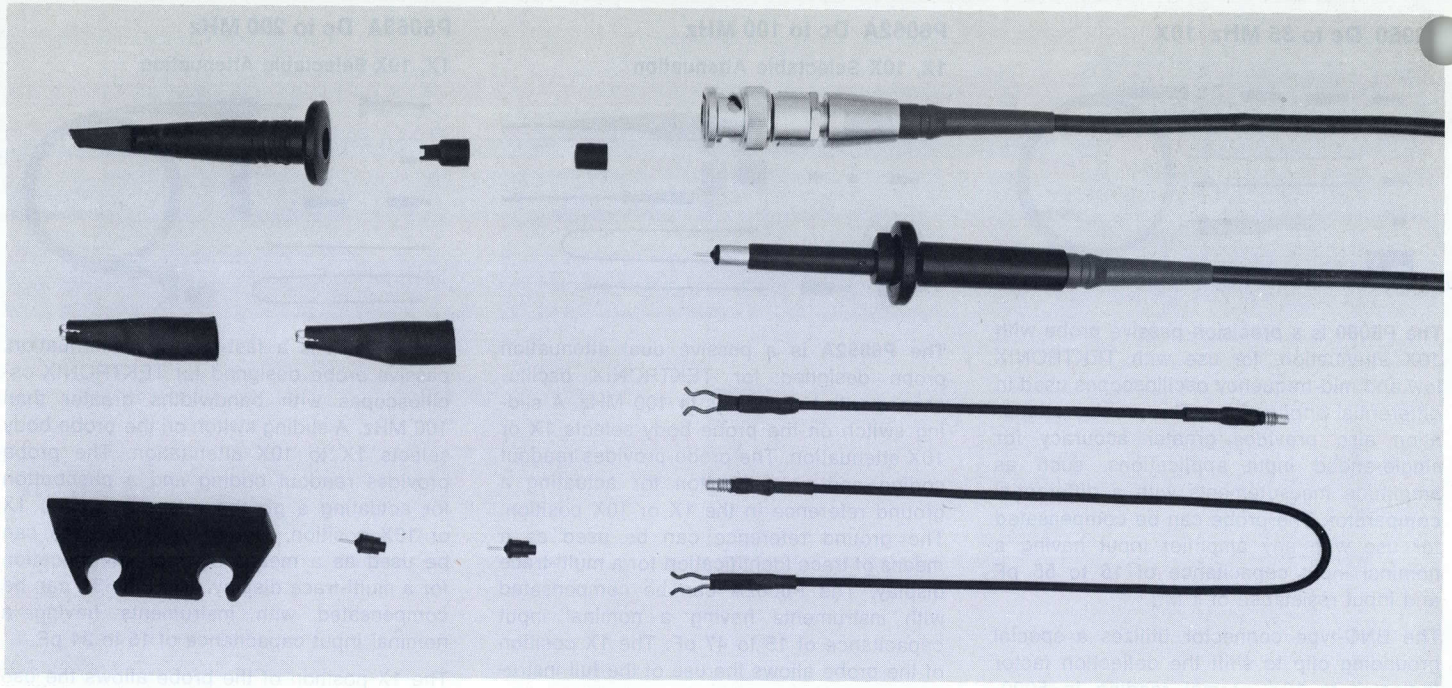
Attenuation is 10X and 1X. **Input Resistance** 1X position, 1 MΩ; 10X position, 10 MΩ within 0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input Capacitance** for the 3.5 ft probe is 80 pF in the 1X position and 11 pF in the 10X position; for the 6 ft version 105 pF in the 1X position and 14 pF in the 10X position. **Bandwidth** of the 10X position (3.5 ft and 6 ft versions) is at least 200 MHz when used with an oscilloscope with a bandwidth greater than 225 MHz. **Bandwidth** of the 1X position for the 3.5 ft probe at least 12 MHz and for the 6 ft probe at least 6 MHz. **Voltage Rating** is 500 V, (dc + peak ac).

ORDERING INFORMATION

Included Accessories:

352-0351-00	1 **HOLDER,** probe
206-0114-00	1 **TIP,** probe
013-0107-03	1 **TIP,** probe, ret hook assy
175-0124-01	1 **LEAD,** elec, probe ground, 5 in
175-0125-01	1 **LEAD,** elec, probe ground, 12 in
344-0046-00	2 **CLIPS,** miniature alligator
166-0404-01	1 **SLEEVE,** insul for 0.188 dia probe bushing
016-0521-00	1 **POUCH,** accessory (not shown)

P6063A Switchable Attenuation Probe, 6 ft,
Order 010-6063-03 ..... $95
Opt 1, 3.5 ft, Order 010-6063-01 ..... $95



P6101 1X , 34 MHz

The P6101 probe is a miniature 1X passive probe for use with all general purpose oscilloscopes. Modular construction of the probe simplifies repair, as both the probe head and BNC connector are easy to remove from the cable assembly, no tools are required. The P6101 is available in three lengths and identified by the colored strain relief at each end of the cable. Blue for 1 meter, yellow for 2 meters, and red for 3 meters.

Attenuation 1X. **Input Resistance** is 1 MΩ, with 1 MΩ input oscilloscopes. The accuracy is that of the oscilloscope. **Input Capacitance** (approx) for the 1 meter probe is 32 pF, 2 meter probe is 54 pF, and 3 meter probe is 78 pF. For total input capacitance, add the input capacitance of the oscilloscope. **Bandwidth** with oscilloscope input C of 20 pF, 1 meter at least 34 MHz, 2 meter at least 15.5 MHz, and 3 meter at least 8 MHz. **Max Input Voltage** is 500 V dc + peak ac to 200 kHz derated to 20 V at 30 MHz.

ORDERING INFORMATION

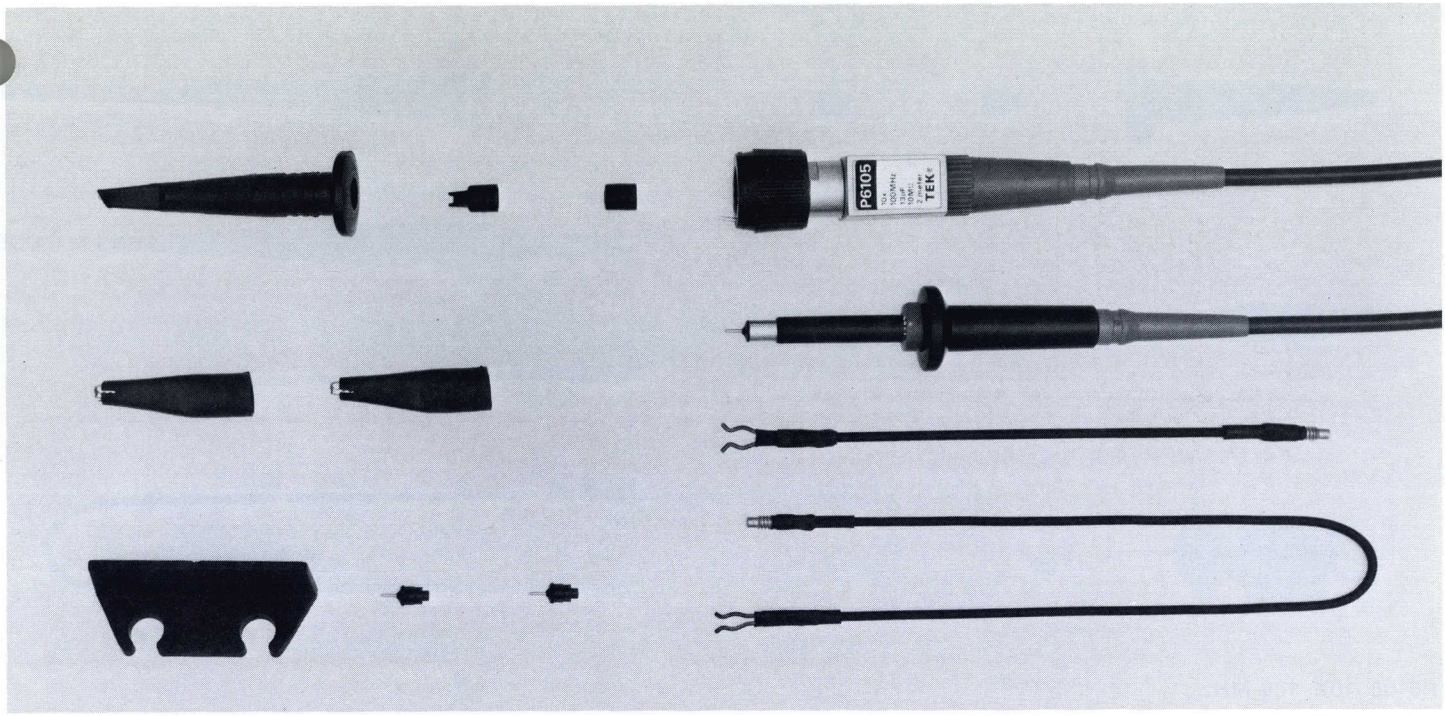
Included Accessories:

013-0107-03	1 **TIP,** retractable hook
344-0046-00	2 **CLIPS,** miniature alligator
175-0124-01	1 **LEAD,** ground, 13 cm
175-0125-01	1 **LEAD,** ground, 30 cm
166-0404-01	1 **SLEEVE,** insulating
352-0351-00	1 **PROBE HOLDER**
206-0191-00	2 **TIPS,** probe

P6101, 1X Probe, 2 m,
Order 010-6101-03 ..... **$30**

Opt 1, 1 m, Order 010-6101-01 ..... **$**

Opt 2, 3 m, Order 010-6101-05 ..... **$30**



P6105 10X 100 MHz

The P6105 is a miniature 10X modular probe for use with dc to 100 MHz oscilloscopes with an input capacitance range of 15-47 pF and an input resistance of 1 MΩ. A ground reference pushbutton on the probe body permits a ground reference or determination of a trace in a multi-trace display. A coding pin on the BNC output connector actuates the volts/div readout encoding of the oscilloscope to include the 10X attenuation of the probe. The connector is compatible with all BNC input connectors.

Modular construction of the probe simplifies repairs, as both the probe body and compensating box can be unplugged from the cable assembly. The P6105 comes in three lengths identified by the colored strain relief at each end of the cable. Blue for 1 meter, yellow for 2 meters, and red for 3 meters.

Attenuation 1X. **Input Resistance** is 1 MΩ, with 1 MΩ input oscilloscopes. The accuracy is that of the oscilloscope. **Input Capacitance** (approx) for the 1 meter probe is 32 pF, 2 meter probe is 54 pF, and 3 meter probe is 78 pF. For total input capacitance, add the input capacitance of the oscilloscope. **Bandwidth** with oscilloscope input C of 20 pF, 1 meter at least 34 MHz, 2 meter at least 15.5 MHz, and 3 meter at least 8 MHz. **Max Input Voltage** is 500 V dc + peak ac to 200 kHz derated to 20 V at 30 MHz.

ORDERING INFORMATION

Included Accessories:

013-0107-03	1 **TIP,** retracta
344-0046-00	2 **CLIPS,** mini
175-0124-01	1 **LEAD,** grour
175-0125-01	1 **LEAD,** grour
166-0404-01	1 **SLEEVE,** ins
352-0351-00	1 **PROBE HOL**
206-0191-00	2 **TIPS,** probe

P6105, 10X Probe, 2 m,
Order 010-6105-03 ..... **$60**

Opt 1, 1 m, Order 010-6105-01 ..... **$60**

Opt 2, 3 m, Order 010-6105-05 ..... **$60**

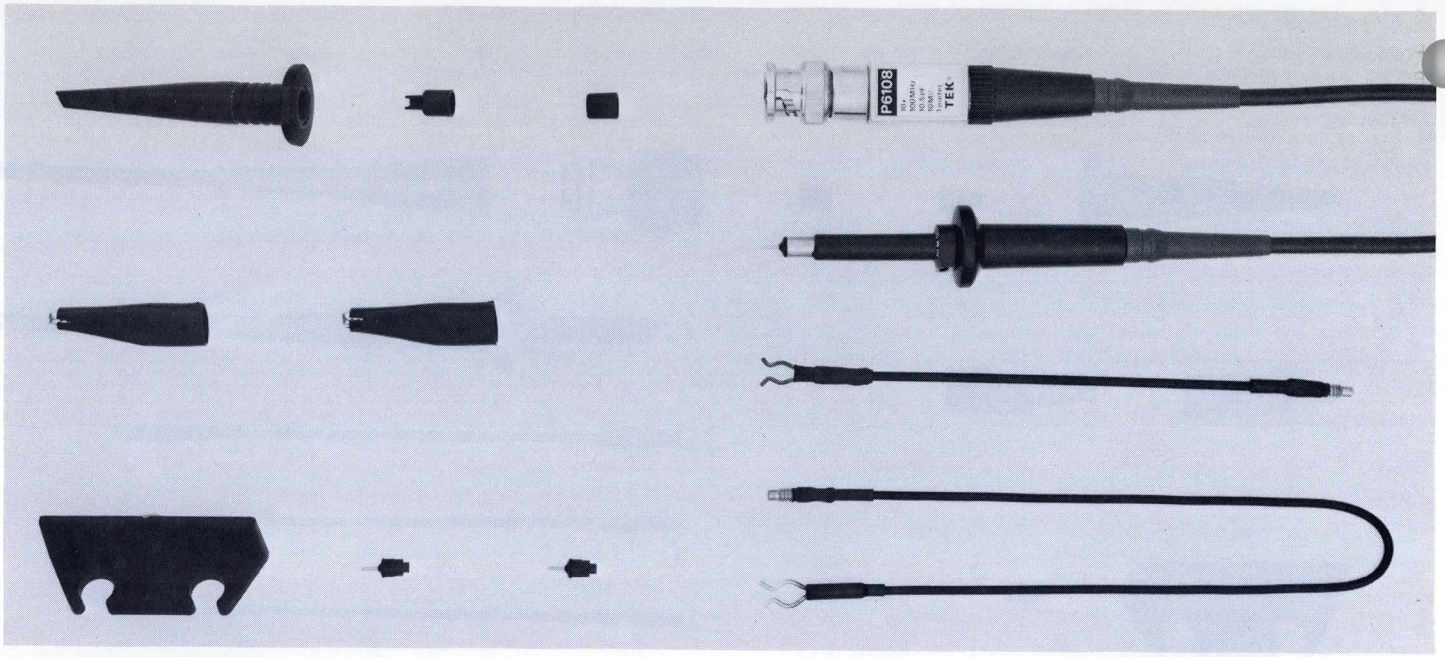
P6101 CATALOG SPEC ERROR

The 1976 long form catalog soon to be distributed has the wrong specification information listed for the P6105 on page 245. The specifications listed are actually those of the P6101. The specifications for the P6105 are the same as those listed for the P6108 on page 246, except the attenuation accuracy is 0.5% instead of 1.5%.

There is at least one more error in the probe and accessory section of this catalog; if anyone can find it, or any other errors in this section, you will learn a lot about probes by reading the new information.

Jen 3/5/76

Ron Lang
Accessories Marketing
Service Instrument Division
58/129, Ext. 5133



P6108 10X 100 MHz

The P6108 is a miniature 10X modular probe for use with dc to 100 MHz oscilloscopes with an input capacitance range of 15 pF to 47 pF and an input resistance of 1 MΩ. Modular construction of the probe simplifies repairs, as both the probe body and compensating box can be unplugged from the cable assembly. The P6108 comes in three lengths identified by the colored strain relief at each end of the cable. Blue for 1 meter, yellow for 2 meters, and red for 3 meters.

Attenuation within 3%, oscilloscope input 1 MΩ within 2%. **Input Resistance** 10 MΩ within 1.5%, oscilloscope input 1 MΩ within 2%. **Input Capacitance,** 1 meter approx 10.5 pF, 2 meters approx 13 pF, 3 meters approx 15.5 pF. **Compensation Range** 15 pF to 47 pF. **Bandwidth** at least 100 MHz for 1 and 2 m, at least 95 MHz for 3 m with an oscilloscope bandwidth of at least 105 MHz. **Max Input Voltage** 500 V dc + peak ac to 1.7 MHz derated to 27 V at 100 MHz.

ORDERING INFORMATION

Included Accessories:

013-0107-03	1 **TIP,** retractable hook
344-0046-00	2 **CLIPS,** miniature alligator
175-0124-01	1 **LEAD,** ground, 13 cm
175-0125-01	1 **LEAD,** ground, 30 cm
166-0404-01	1 **SLEEVE,** insulating
352-0351-00	1 **PROBE HOLDER**
206-0191-01	2 **TIPS,** probe

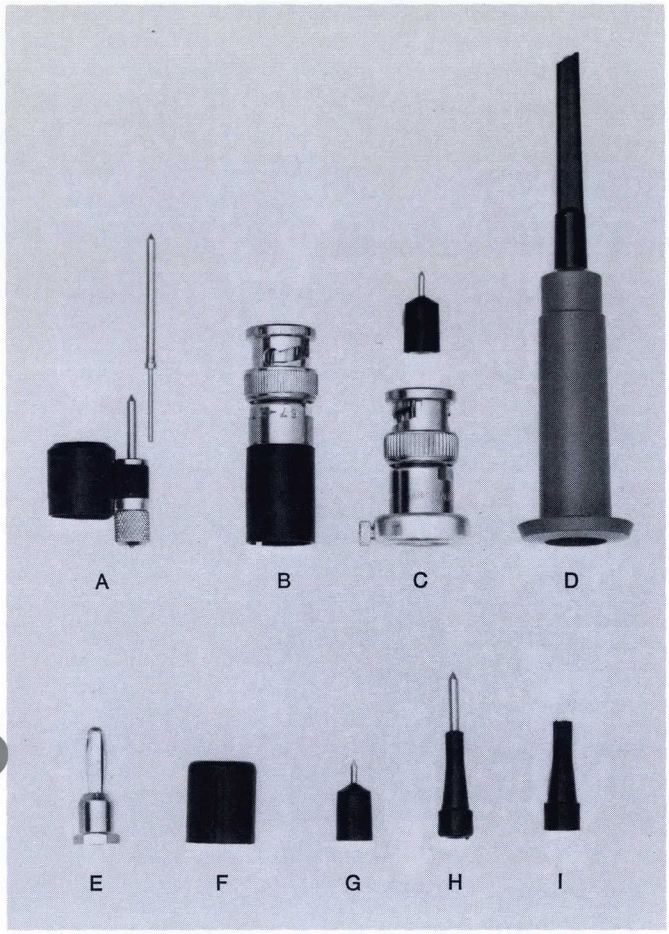
P6108, 10X Probe, 2 m, Order 010-6108-03 ..... $45

Opt 1, 1 m, Order 010-6108-01 ..... $45

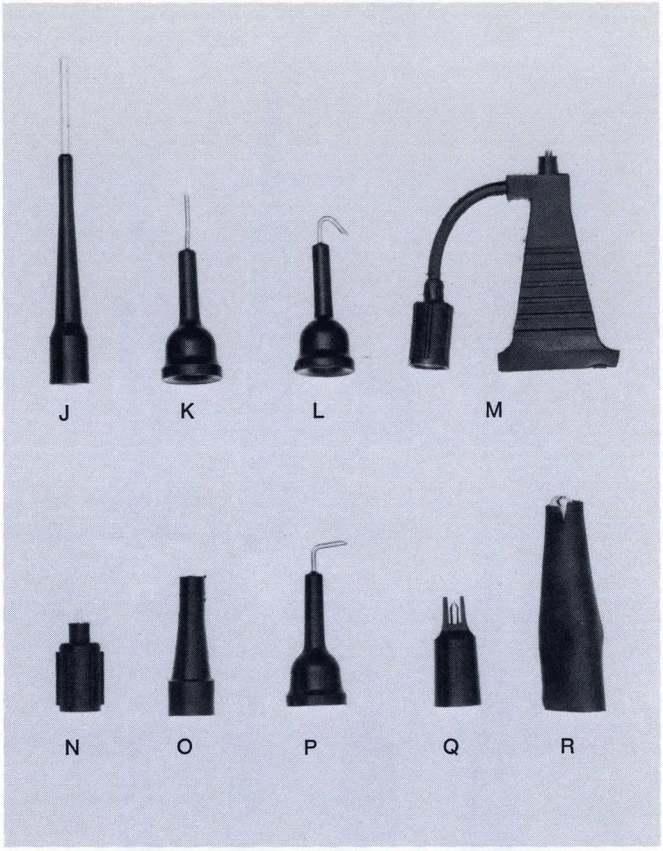
Opt 2, 3 m, Order 010-6108-05 ..... $45

#6-32 Probe Tips and Accessories

The following tips and adapters can be used on all TEKTRONIX Probes that accept a #6-32 screw-on tip, including the P6006, P6007, P6008, P6009, P6028, and P6060 Probes.



CODE	DESCRIPTION	PART NUMBER	PRICE
A	Bayonet ground assembly for (P6006, P6007, P6008, P6009, P6060)	013-0052-00	$ 3.00
B	Probe tip to BNC adapter (for P6006 P6007, P6008, P6009, P6060)	013-0054-00	8.00
C	Probe tip to BNC adapter (for P6028)	013-0056-00	8.00
D	Probe retractable hook tip (for P6006, P6007, P6008, P6009, P6028)	013-0071-00	2.40
E	Probe banana tip	134-0013-00	0.50
F	Probe ground cover (for P6009)	166-0428-00	1.00
G	Probe straight tip (0.055 in dia)	206-0015-00	0.40
H	Probe spring tip (0.080 in dia)	206-0060-00	0.80
I	Probe spring tip (accepts 0.065 in dia pin)	206-0061-00	0.60



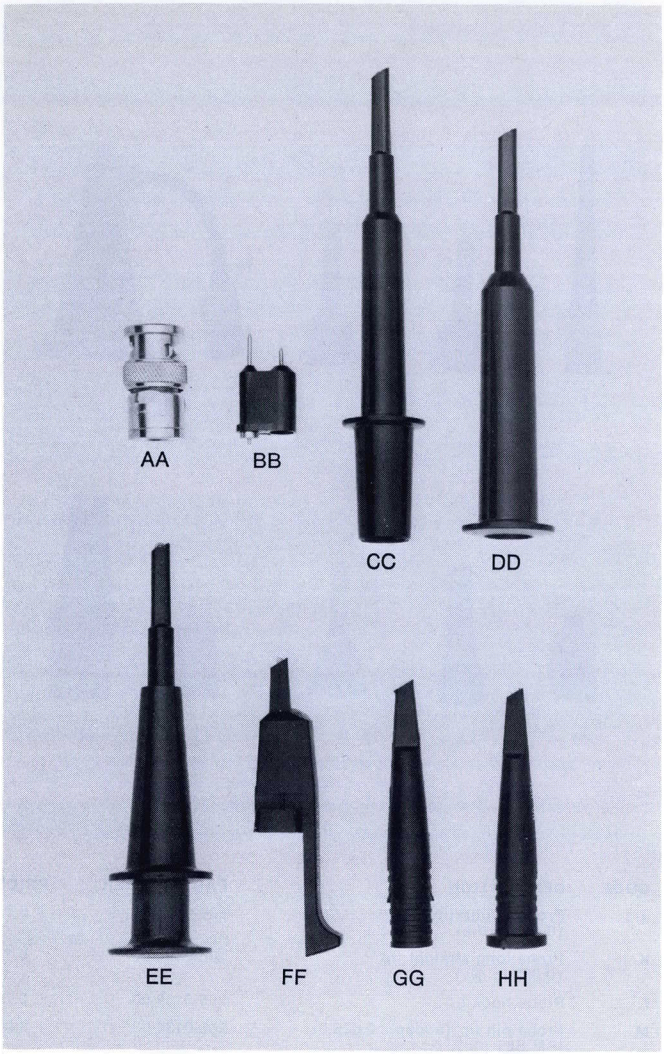
CODE	DESCRIPTION	PART NUMBER	PRICE
J	Probe calibration tip (0.063 in dia)	206-0100-00	$ 8.00
K	Probe long straight tip (0.032 in dia)	206-0104-00	0.75
L	Probe hook tip	206-0105-00	0.75
M	Probe pin tip (accepts 0.025 in IBM SLT pin)	206-0134-03	3.00
N	Probe ground lead adapter (#6-32 to 0.025 in x 0.025 in square pin)	206-0137-01	1.30
O	Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	1.50
P	Probe right angle hook tip	206-0185-00	1.00
Q	IC test tip (for P6009, P6022, P6028)	206-0203-00	1.00
R	Miniature alligator clip	344-0046-00	1.00

IDENTIFICATION TAGS

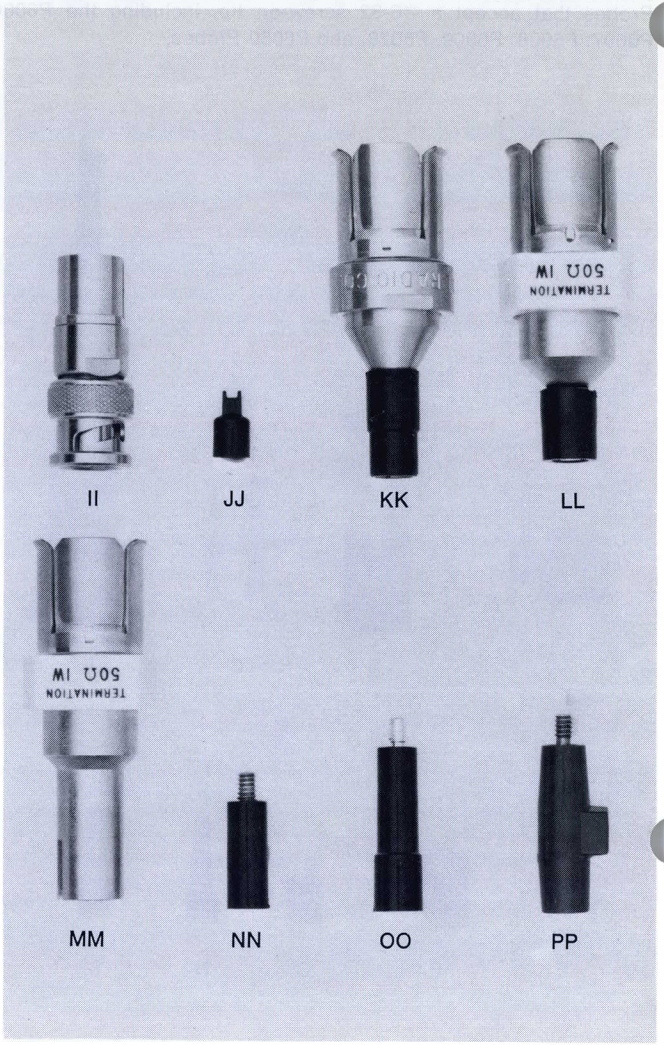
DESCRIPTION		
For 1/8 in dia cable	016-0130-00	3.00
For 3/16 in dia cable	016-0127-00	2.40

Slip-on Probe Tips and Adapters

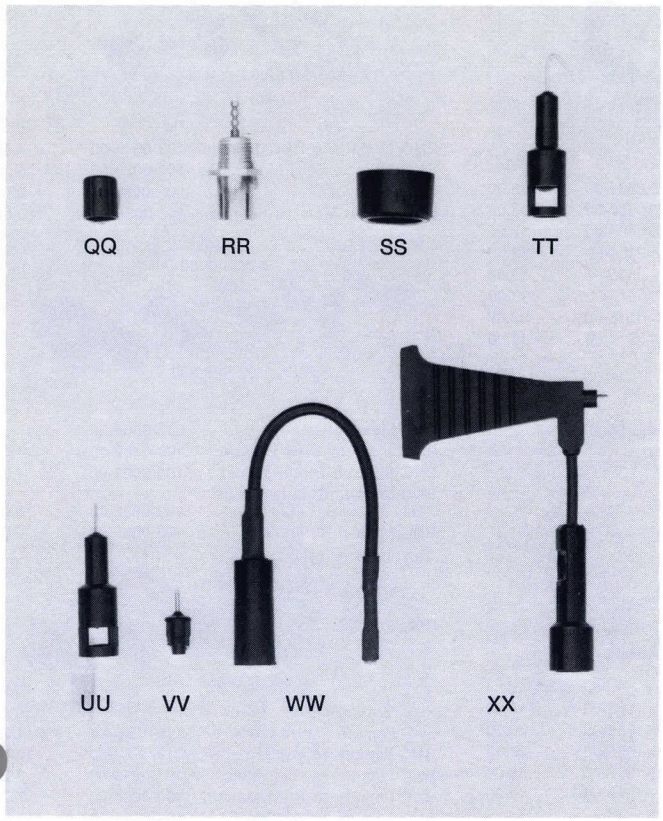
The following tips and adapters are designed for use with TEKTRONIX Miniature Probes that accept a slip-on tip.



CODE	DESCRIPTION	PART NUMBER	PRICE
AA	Probe tip to BNC adapter	013-0084-01	$ 8.00
BB	Bayonet ground assembly	013-0085-00	3.25
CC	Retractable hook tip (for P6010, P6011, P6048)	013-0090-00	2.60
DD	Retractable hook tip (for S-3A, P6202)	013-0097-01	5.00
EE	Retractable hook tip (for P6052)	013-0105-00	4.25
FF	Retractable hook tip (for 7A11, P6401)	013-0106-00	4.95
GG	Retractable hook tip (for 211, 212, 213, 214, 221)	013-0107-02	2.40
HH	Retractable hook tip (for P6053B, P6054A, P6055, P6101, P6105, P6108, P6075A, P6049B)	013-0107-03	2.40

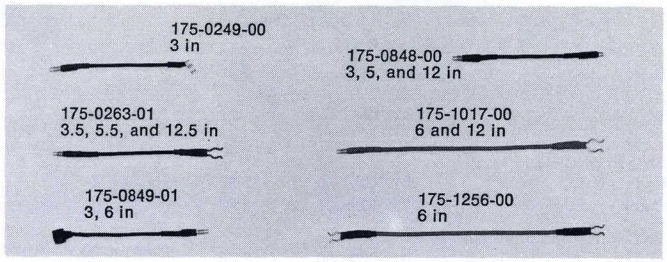


CODE	DESCRIPTION	PART NUMBER	PRICE
II	P6201 Probe tip to BNC adapter	013-0145-00	$ 7.25
JJ	Miniature probe tip cover, IC tester, Package of 10 Package of 100	 015-0201-01 015-0201-02	 5.00 10.00
KK	Miniature Probe tip to GR adapter	017-0076-00	20.00
LL	Miniature Probe tip to GR 50-Ω termination adapter	017-0088-00	31.00
MM	P6201 probe tip to GR 50-Ω termination adapter	017-0094-00	28.00
NN	Miniature Probe to #6-32 adapter (for P6045, P6046, 7A11, S-3A)	103-0051-00	2.80
OO	Miniature Probe to #6-32 adapter (for all miniature probes except P6045)	103-0051-01	2.80
PP	Miniature Probe to #6-32 adapter with ground connection	103-0131-00	4.00



CODE	DESCRIPTION	PART NUMBER	PRICE
QQ	Miniature probe tip ground cover, insulating sleeve	166-0404-01	$ 0.15
RR	Chassis mount test jack—miniature probe	131-0258-00	2.80
SS	Ground lead, insulating sleeve	166-0433-00	0.60
TT	Probe tip hook	206-0114-00	2.00
UU	Probe tip straight	206-0114-01	2.00
VV	Replaceable probe tip, pkg of 10	206-0191-01	12.00
WW	Probe tip flexible for 0.25 sq pin	206-0193-00	5.00
XX	Probe pin tip (accepts 0.025 in, IBM SLT pin)	206-0209-00	2.50

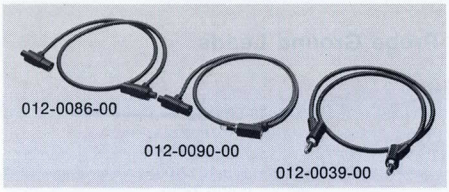
Probe Ground Leads



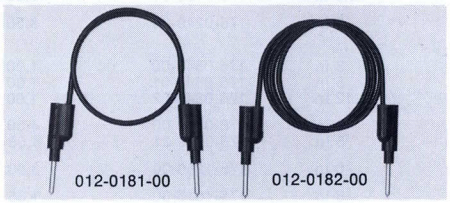
DESCRIPTION		PART NUMBER	PRICE
Ground lead†	3.5 in	175-0263-01	$ 1.50
Ground lead†	5.5 in	175-0124-01	1.00
Ground lead†	12.5 in	175-0125-01	1.00
Ground lead for S-3A, P6056, P6057	3 in	175-0249-00	3.50
Ground leads for P6053 P6054, P6075, 7A11, P6201	3 in 5 in 12 in	175-0848-00 175-0848-01 175-0848-02	1.00 1.00 1.00
Ground leads for P6202	3 in 5 in	175-0849-00 175-0849-01	4.50 4.50
Ground lead for P6055	6 in	175-1256-00	3.50
Ground lead for S-3A	6 in 12 in	175-1017-00 175-1018-00	1.35 1.35

†For the P6053B, P6054A, P6075A, P6101, P6105, P6108 and other probes requiring clip on ground leads.

PATCH CORDS

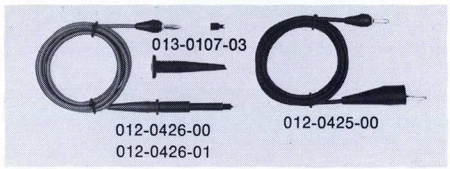


BNC to BNC, 18 in		
Red	012-0087-00	$2.20
Black	012-0086-00	2.20
BNC to banana plug-jack, 18 in		
Red	012-0091-00	2.20
Black	012-0090-00	2.20
Banana plug-jack to banana plug-jack, 18 in		
Red	012-0031-00	2.20
Black	012-0039-00	2.20



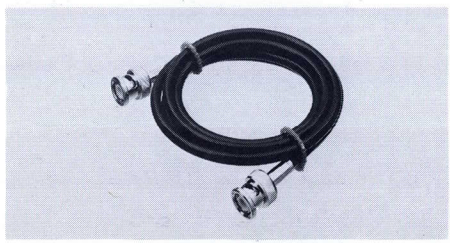
Pin-jack to pin-jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	$2.85
Red, 18 in	012-0180-00	2.85
Black, 8 in	012-0181-00	2.85
Black, 18 in	012-0182-00	2.85

TEST LEADS



Test Lead, Black, 4 ft	012-0425-00	$ 4.20
Test Lead, Red, 4 ft	012-0426-00	6.50
Test Lead, Black, 4 ft	012-0426-01	6.50
Test Lead set of 012-0425-00, 012-0426-00, and 013-0107-03	012-0427-00	$12.00

COAXIAL CABLES
BNC Connectors

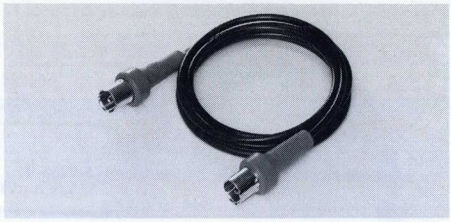


Coaxial, 50 Ω, 42 in	012-0057-01	$ 9.00
Coaxial, 75 Ω, 42 in	012-0074-00	9.00
Coaxial, 93 Ω, 42 in	012-0075-00	9.00
Coaxial, 50 Ω, 18 in	012-0076-00	9.00
Coaxial, 50 Ω Precision, 36 in	012-0482-00	16.00

N Connectors 50 Ω

Coaxial N connectors, 6 ft	012-0114-00	$15.00

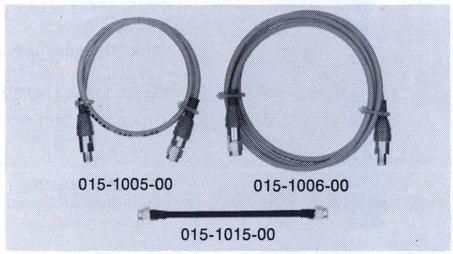
GR Connectors 50 Ω



Coaxial 10 ns RG58A/U	017-0501-00	$33.00
Coaxial 5 ns RG213/U	017-0502-00	33.00
Coaxial 1 ns RG58A/U*	017-0503-00	17.00
Coaxial 20 ns RG213/U	017-0504-00	33.00
Coaxial 2 ns RG58A/U	017-0505-00	33.00
Coaxial 5 ns RG58A/U	017-0512-00	33.00
Coaxial 10 in RG213/U	017-0513-00	33.00
Coaxial 20 in RG213/U	017-0515-00	33.00

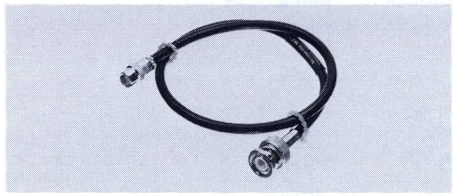
*Connector on one end only.

50 Ω CABLES
SMA (3 MM) Connectors 50 Ω



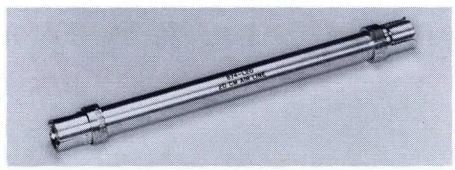
Coaxial 2 ns	015-1005-00	$44.00
Coaxial 5 ns	015-1006-00	60.00
Coaxial semirigid 500 ps	015-1015-00	28.00
Coaxial semirigid 750 ps	015-1017-00	28.00
Coaxial 1 ns	015-1019-00	40.00

BNC to BSM Connectors 50 Ω



Coaxial, 10 in, RG58 BSM Female to BNC Male	012-0128-00	$11.00
Coaxial, 18 in, RG58 BSM Female to BNC Male	012-0127-00	11.00

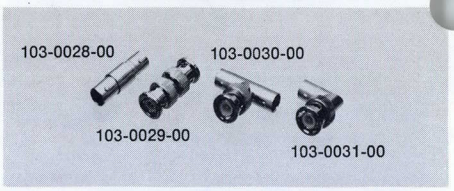
50 Ω AIR LINE



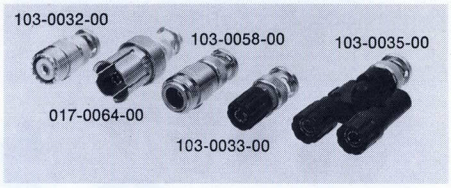
The 20 cm 50 Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50 Ω Air Line	017-0084-00	$30.00

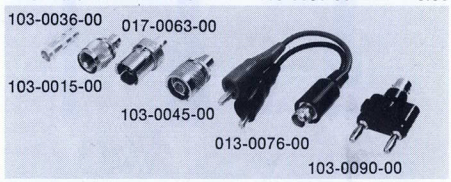
ADAPTERS



BNC Female to BNC Female	103-0028-00	$ 4.65
BNC Male to BNC Male	103-0029-00	5.25
BNC T	103-0030-00	6.00
BNC Elbow Male to Female	103-0031-00	3.00

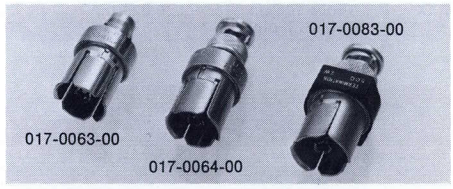


BNC Male to GR	017-0064-00	$17.50
BNC Male to UHF Female	103-0032-00	4.50
BNC Male to Binding Post	103-0033-00	4.00
BNC Male to Dual Binding Post	103-0035-00	11.00
BNC Male to N Female	103-0058-00	6.50



BNC Female to clip leads	013-0076-00	$ 4.75
BNC Female to GR	017-0063-00	16.5
BNC Female to UHF Male	103-0015-00	3.2
BNC Female to BSM Male	103-0036-00	7.75
BNC Female to N Male	103-0045-00	11.00
BNC Female to Dual Banana	103-0090-00	6.50

GR to N Male	017-0021-00	$19.00
GR to C Male	017-0027-00	28.00
GR to N Female	017-0062-00	22.00
GR to C Female	017-0065-00	28.00

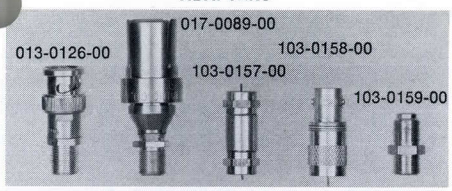


GR to BNC Female	017-0063-00	$16.50
GR to BNC Male	017-0064-00	17.50
50 Ω termination, thru-line	017-0083-00	50.00

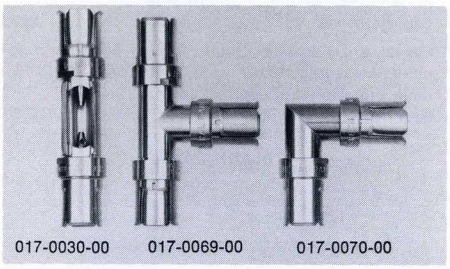
*(GR to BNC Male)
*Upper frequency limit vswr not specified

N Male to GR	017-0021-00	$19.00
N Female to GR	017-0062-00	22.00
N Male to BNC Female	103-0045-00	11.00
N Female to BNC Male	103-0058-00	6.50

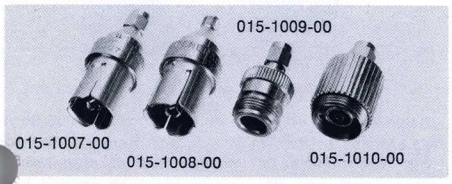
ADAPTERS



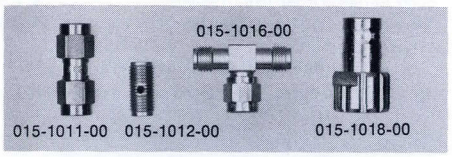
"F" Female to BNC Male	013-0126-00	$ 8.00
"F" Female to GR874	017-0089-00	22.00
"F" Male to "F" Male	103-0157-00	7.50
"F" Male to BNC Female	103-0158-00	7.50
"F" Female to "F" Female	103-0159-00	7.50



GR Insertion Unit	017-0030-00	$44.00
GR T	017-0069-00	55.00
GR Elbow	017-0070-00	50.00

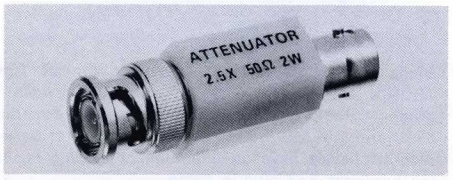


SMA Male to GR	015-1007-00	$38.00
SMA Female to GR	015-1008-00	50.00
SMA Male to N Female	015-1009-00	47.00
SMA Male to 7 mm APC	015-1010-00	150.00



SMA Male to Male	015-1011-00	$15.00
SMA Female to Female	015-1012-00	15.00
SMA T	015-1016-00	25.00
SMA Male to BNC Female	015-1018-00	5.00

ATTENUATORS—TERMINATIONS



50 Ω feedthrough termination[1]	011-0049-01	$20.00
50 Ω 10X (20 dB) attenuator[2]	011-0059-02	23.00
50 Ω 5X (14 dB) attenuator[2]	011-0060-02	23.00
50 Ω 2X (6 dB) attenuator[2]	011-0069-02	23.00
50 Ω 2.5X (8 dB) attenuator[2]	011-0076-02	23.00
50 Ω feedthrough termination (5 W)[3]	011-0099-00	30.00

Characteristics—dc resistance is 50 Ω ± 1 Ω. Attenuation accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 W average.

vswr

[1]Less than 1.1 dc—250 MHz and less than 1.2 dc—500 MHz.

[2]Less than 1.1 dc—1.0 GHz and less than 1.2 dc—2.0 GHz.

[3]1.1 dc—100 MHz.

75 Ω feedthrough termination	011-0055-00	$17.00
93 Ω feedthrough termination	011-0056-00	20.00
50 Ω to 75Ω min loss attenuator	011-0057-00	22.00
50 Ω to 93 Ω min loss attenuator	011-0058-00	22.00
75 Ω 10X attenuator	011-0061-00	20.00
93 Ω 10X attenuator	011-0062-00	20.00
600 Ω feedthrough termination (1 watt, dc to 1 MHz)	011-0092-00	27.00
75 Ω to 50 Ω min loss attenuator (ac coupled)	011-0112-00	35.00

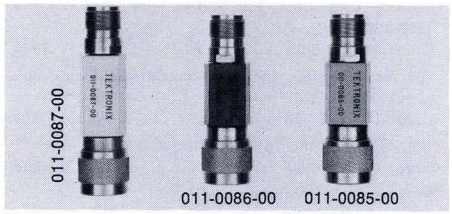
CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is ±2% at dc.

Power Rating of attenuators is ½ watt and terminations 1 watt.

Voltage Standing Wave Ratio (vswr) not specified.

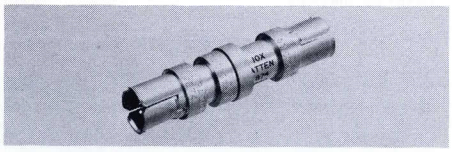
ATTENUATORS and TERMINATORS N 50 Ω



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

10 dB attenuator	011-0085-00	$65.00
20 dB attenuator	011-0086-00	65.00
40 dB attenuator	011-0087-00	90.00

GR

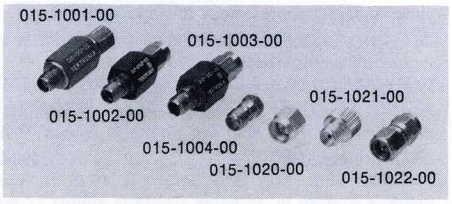


125 Ω min loss	017-0052-00	$65.00
50 Ω 10X attenuator	017-0078-00	65.00
50 Ω 5X attenuator	017-0079-00	65.00
50 Ω 2X attenuator	017-0080-00	65.00
50 Ω termination, end-line	017-0081-00	55.00

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.

3 mm 50 Ω

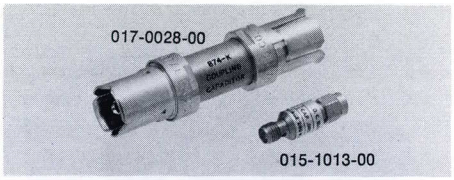


50 Ω 2X attenuator	015-1001-00	$120.00
50 Ω 5X attenuator	015-1002-00	120.00
50 Ω 10X attenuator	015-1003-00	120.00
50 Ω termination Female	015-1004-00	50.00
Short-Circuit termination Male	015-1020-00	15.00
Short-Circuit termination Female	015-1021-00	15.00
50 Ω termination Male	015-1022-00	32.00

CHARACTERISTICS

	Dc — 12.40 GHz		12.41 — 18.00 GHz		Power
	Atten Accuracy	Vswr	Atten Accuracy	Vswr	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	±0.75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	±0.75 dB	1.40	±1.00 dB	1.60	1.0 W

50 Ω COUPLING CAPACITOR



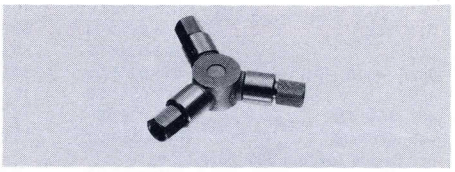
The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150 ps TDR system), max is 0.03. Voltage rating is 200 V.

Coupling Capacitor SMA (3 mm)	015-1013-00	$120.00

The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

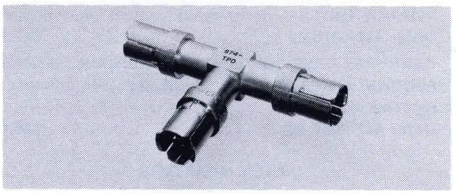
Coupling Capacitor GR	017-0028-00	$33.00

50 Ω POWER DIVIDERS



This coaxial tee is designed for use in broad-band, 50 Ω, systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. Load isolation is nominally 6 dB while the voltage attenuation ratio is nominally 2X (input to either load arm, other load arm terminated in a standard 50 Ω termination). Max vswr is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

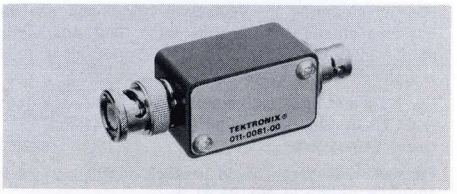
Power Divider SMA (3 mm)	015-1014-00	$200.00



This coaxial tee has a 16.67 Ω resistor in each leg, connected so that the tee looks like 50 Ω if two legs are terminated in 50 Ω. It is designed for use in broad-band 50 Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Power Divider GR	017-0082-00	$145.00

ACCESSORY HOUSING



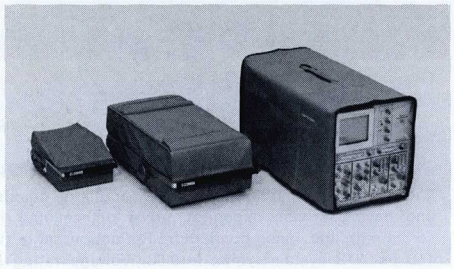
Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing	011-0081-00	$15.00

TM503 – 016-0620-00 $25.– } MSR
TM504 – 016-0621-00 30.– } 10/15/76
Rain covers

Accessories

OSCILLOSCOPE PROTECTIVE COVERS



The cover provides protection for the oscilloscope during transport or storage. Made of waterproof blue vinyl, the covers are available for both laboratory and portable instruments. The covers for 500, 5000, and 7000-Series Laboratory Oscilloscopes have clear vinyl frontal areas.

PROTECTIVE COVERS

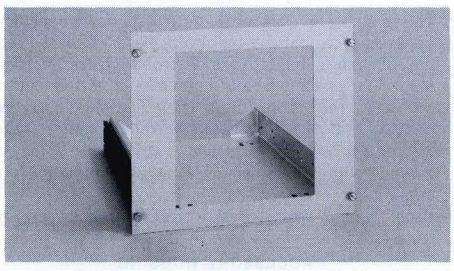
INSTRUMENT	PART NUMBER	PRICE
299 Series	016-0512-00	$12.00
323, 324, 1401A, 1401A-1, 1501	016-0112-00	15.00
314, 335	016-0612-00	39.00
326	016-0532-00	30.00
453A, 454A, 491	016-0074-01	14.00
455	016-0344-00	14.50
434, 464, 466	016-0365-00	15.75
465, 475, 485	016-0554-00	15.00
560 Series (except 565, 567, 568)	016-0067-00	14.50
565, 567, 568	016-0069-00	14.50
540 Series	016-0068-00	14.50
1480C, 1481C, 1482C, 1485C	016-0085-00	14.50
5000 Series	016-0544-00	15.00
7300, 7400, 7600 Series	016-0192-01	12.00
7704A, 7900	016-0531-00	12.00

PLUG-IN UNIT CARRYING CASES

CARRYING CASE FOR 2, 3, 10, AND 11 SERIES PLUG-IN UNITS — accommodates two plug-in units.
Order 437-0070-00 .....**$42.00**

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 .....**$36.00**

RACK ADAPTERS

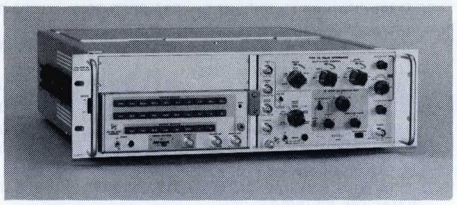


For rackmounting the 7000-Series Oscilloscopes and 611 in a standard 19 in wide rack. Rack adapter includes slide-out assemblies. 7000-Series mask finish is light gray, 611 mask finish is black.

For 7704 and 7904, rack height is 15.75 in; rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0554-00 .....**$220.00**

For 611, rack height is 14 in, rack depth is 21.75 in, shipping weight is approx 41 lb.
Order 040-0551-00 .....**$140.00**

RACK ADAPTERS



For rackmounting most TEKTRONIX generators in a standard 19 in wide rack. The rack height is 5.25 in, rack depth is 19.75 in. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and 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 .....**$325.00**

284 Mounting Kit includes quarter-rack width blank panel (016-0109-00).
Order 016-0187-00 .....**$48.00**

106, 114, 115, and 191 Mounting Kits.
Order 016-0186-00 .....**$24.00**

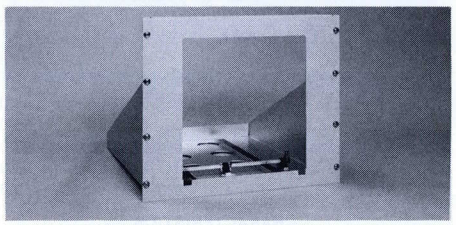
2101 and 2901 Mounting Kits.
Order 016-0188-00 .....**$14.50**

286 Mounting Kit.
Order 016-0190-00 .....**$22.00**

For rackmounting two TM 503s.
Order 040-0616-01 .....**$60.00**

For rackmounting one TM 503
Order 040-0617-01 .....**$95.00**

CRADLE MOUNTS



For rackmounting 500 and 7000-Series cabinet-type oscilloscopes in a standard 19 in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, and 7700-Series mask finish is light gray.

For 7704A, rack height is 15.75 in, rack depth is 22 in, shipping weight is approx 16 lb.
Order 040-0560-00 .....**$62.00**

For 540 Series and 575, rack height is 17.5 in, rack depth is 21-9/16 in, shipping weight is approx 16 lb.
Order 040-0281-00 .....**$60.00**

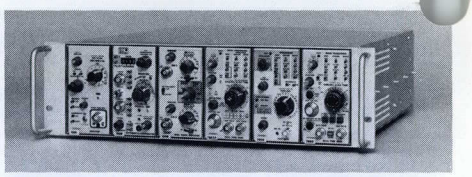
For 561B and 564B, rack height is 15.75 in, rack depth is 21-9/16 in, shipping weight is approx 17 lbs.
Order 040-0321-01 .....**$60.00**

REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19 in backless rack. Shipping weight is approx 3 lb.
For R561B, R564B, and R647A.
Order 040-0344-00 .....**$14.50**

For RM565 and R567.
Order 040-0346-00 .....**$15.75**

STORAGE CABINETS

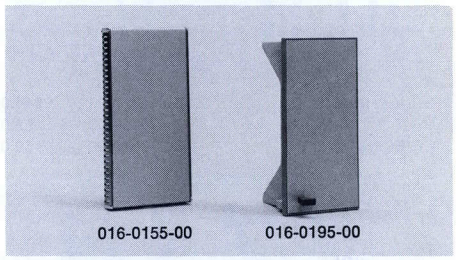


For 7000-Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19 in rack, 5.25 in high.
Order 437-0126-01 .....**$165.00**

For 1-Series and Letter-Series Plug-in Units—Holds 3 plug-in units. Measures 19 in wide, 8¾ in high, 9⅜ in deep. Net weight is approx 9 lb.
Order 437-0031-00 .....**$60.00**

For 2 and 3-Series Plug-in Units—holds 4 plug-in units. Measures 19 in wide, 7 in high, 13-5/16 in deep. Net weight is approx 10 lb.
Order 437-0071-00 .....**$65.00**

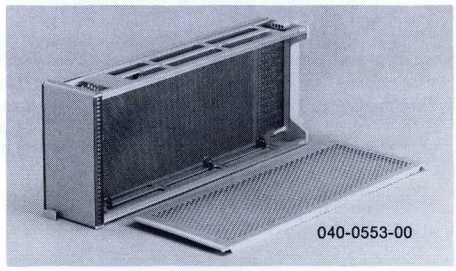
BLANK PANEL



Blank Panel — When operating the 5000/7000-Series Mainframes or the TM 500 or 2600 Series Generators with less than a full complement of plug-ins, a blank panel may be used to cover an unused compartment. The panel for the 7000 Series is also good for EMI shielding.

7000 Series, 2600 Series, Order 016-0155-00...$15.00
5000 Series, Order 016-0195-00 .....$ 7.50
TM 500 Series, Order 016-0195-01 .....$ 7.50

BLANK PLUG-IN CHASSIS



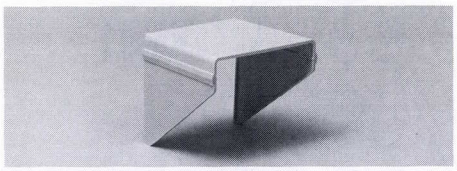
Blank Plug-in Chassis—are available for all TEKTRONIX Mainframes. The 7000 Series provides a printed circuit board, plug-in frame, and securing hardware. The 560 Series, 1-Series, and Letter Series plug-in chassis have an interconnecting plug securing hardware and plug-in frame.

7000 Series, Order 040-0553-00 .....$60.00
TM 500 Series, Order 040-0652-01 .....$28.00
560 Series, Order 040-0245-00.....$38.00
1 and Letter Series, Order 040-0065-00 .....$38.00

For 5000 Series Use TM 500 must make minor adjustment in Waveform

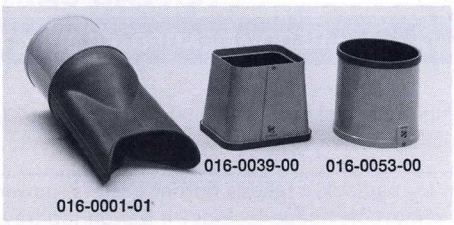
VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.



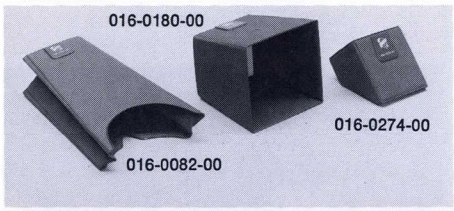
View Hood (folding)—for 200 Series, 314, 323, 324, 326, 335, 400 Series, 576, 577, 5000, and 7000-Series Oscilloscopes.

For 576, order 016-0259-00 .....$10.00
For 577, 5000, and 7000 Series order 016-0260-00 .....$10.00
For 200 Series (not pictured), order 016-0199-01 .....$ 3.00
For 323 and 324 (not pictured), order 016-0247-01 .....$ 3.55
For 326, 314, and 335 (not pictured), order 016-0297-00 .....$ 3.25
For 464, 466, 455 (not pictured), order 016-0592-00 .....$11.50



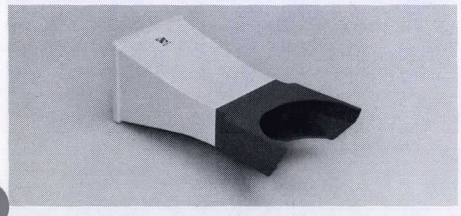
Polarized Viewers—For TEKTRONIX 5 in oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.
Rectangular Viewer, order 016-0039-00 .....$16.25
Plastic Round Viewer, order 016-0053-00 ....$22.00

Viewing Hood—For TEKTRONIX 5 in oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield.
Order 016-0001-01 .....$16.25



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 .....$12.00
For 422, 453A, 454A, 485, 491, order 016-0274-00 .....$ 8.75

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 455, 465, 475, 464, 466, order 016-0180-00 .....$16.25



Viewing Hood—for 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.
For 576, order 016-0153-00 .....$12.50
For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577, order 016-0154-00 .....$12.50

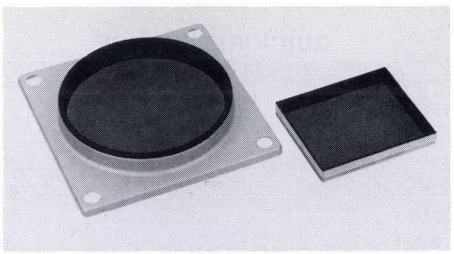
Viewing Hood (folding binoculars)—for some 400 Series.
For 434, 455, 464, 466,
Order 016-0566-00 .....**$13.00**

CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
314, 335	Blue	378-2016-00	$1.00
	Amber	378-0843-00	1.60
200 Series	Blue	378-0691-00	.95
455	Clear	337-2122-01	1.40
	Blue	337-2122-00	1.40
323, 324	Smoke-gray	426-0403-00	2.50
	Blue†	426-0811-00	2.50
	Amber	426-0513-00	2.50
326	Blue†	426-0871-00	2.70
422,491, 453A, 454A, 485	Smoke-gray	378-0549-00	1.50
	Green	378-0557-00	1.50
	Blue†	378-0664-00	1.50
	Amber	378-0559-00	1.50
465, 475, 464, 466	Blue	337-1674-00	2.15
	Clear	337-1674-01	2.15
540-, 550-Series, 565, 575	Smoke-gray†	378-0567-00	2.20
	Green	378-0568-00	2.20
	Blue	378-0569-00	2.20
	Amber	378-0570-00	2.20
529, 561B, 567, 568	Smoke-gray†	378-0560-00	2.20
	Green	378-0561-00	2.20
	Blue	378-0562-00	2.20
	Amber	378-0563-00	2.20
520A, 521A, 522A	Smoke-gray†	378-0581-00	2.20
576	Blue†	378-0616-00	2.20
	Amber	378-0616-01	2.20
602	Smoke-gray†	378-0586-00	2.20
	Amber	378-0595-00	6.00
7904, 7844, 7313, 7700-Series, 7613 7623	Blue†	378-0625-00	2.20
	Amber	378-0625-01	2.20
	Gray	378-0625-02	2.20
	Green	378-0625-03	2.20
	Gray TV Graticule CCIR	378-0625-05	4.00
	Gray TV Graticule NTSC	378-0625-06	4.00
	Clear Shield With Spectrum Analyzer Graticule	337-1159-02	3.50
7613, 7623, 7623A, 7633	Spectrum Analyzer	378-0625-07	4.00
	Green (UV)	378-0625-08	2.20
	TV Graticule CCIR	378-0625-09	4.00
	TV Graticule NTSC	378-0625-10	4.00
7403N, 7603	Blue	378-0684-00	2.70
	Amber	378-0684-01	2.70
	Gray	378-0684-02	2.70
	Green	378-0684-03	2.70
	Gray TV Graticule CCIR	378-0684-04	4.50
	Gray TV Graticule NTSC	378-0684-05	4.50
	Clear Shield With Spectrum Analyzer Graticule	337-1439-01	2.20
	Blue Implosion Shield†	337-1700-01	2.20
	Clear Implosion Shield	337-1700-04	2.20
5100 and 5400 Series, 603, 604, 605	Clear	337-1440-00	1.50
	Green	337-1440-01	1.50
	Amber	337-1440-02	1.50
	Blue	337-1440-03	1.50
	Gray	337-1440-04	1.50
434	Clear	378-0677-00	1.90
	Blue	378-0678-00	2.70

**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
314, 326,335	378-0063-00	$10.00
323, 324	378-0596-00	23.00
432, 434	378-0682-00	22.00
422, 491, 453A, 454A, 485	378-0648-00	20.00
465, 475, 464, 466, 434	378-0726-01	24.00
540-Series, 565	378-0572-00	23.00
529, 561B, 564B, 568	378-0575-00	23.00
7400	378-0696-00	23.00
7500, 7700-Series	378-0603-00	23.00

**For both cabinet and rackmount instruments.*

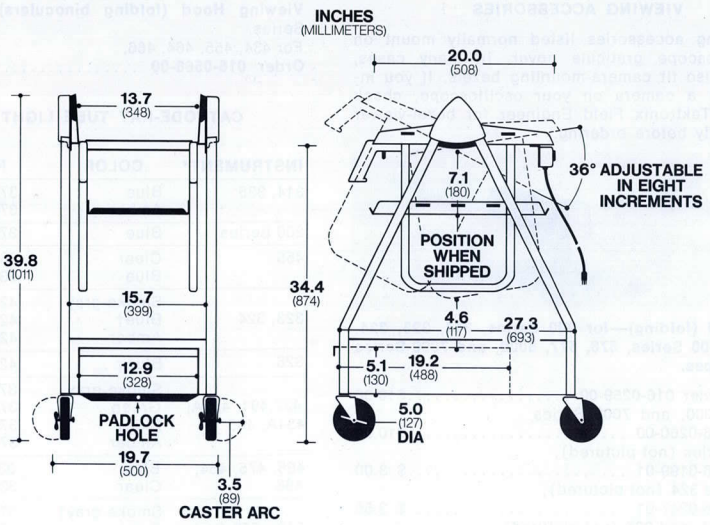
SCOPE-MOBILE® Carts

Give Mobility—Save Bench Space—Provide Storage

QUICK REFERENCE

Product	Cart Model
TM 503	3
TM 504	3
21	206
31	206
31/53	206
230	205
241	205
432	200C
434	200C
455	200C
464	200C
465	200C
466	200C
475	200C
485	200C
491	200C
520	205
528	*
529	*
564B	3
568	205
576	3
577	3
602	*
603	*
604	*
605	*
611	205
613	205
632	205
650	205
670	205
1105	*
1140A	205
1340	205
1420	*
2601	205
4601	206
4610	206
4623	206
4632	206
4661	206
4921	206
4922	206
5100-Series	3
5400-Series	3
7313	3
7403	3
7603	3
7613	3
7623A	3
7633	3
7704A	3
7844	3
7904	3
All rackmounts (R Series)	205

*These products are applicable to several carts—see dimensions and features for your specific needs.



TEK LAB CART

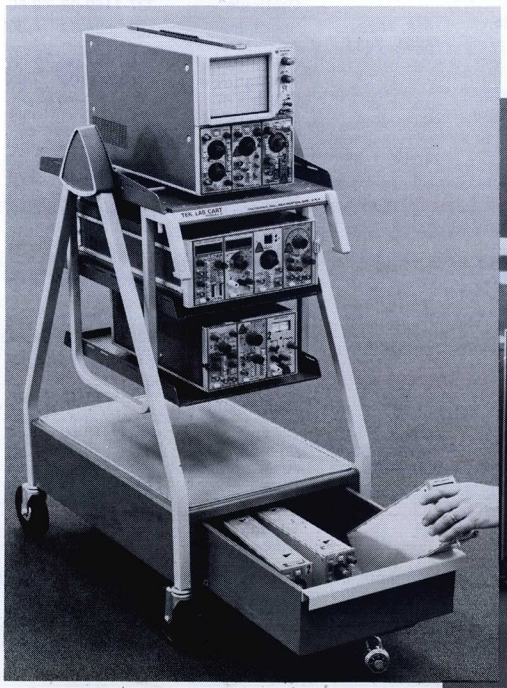
RECOMMENDED PRODUCT

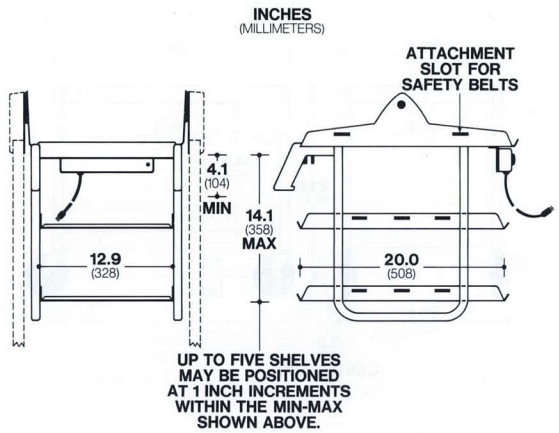
TOP TRAY

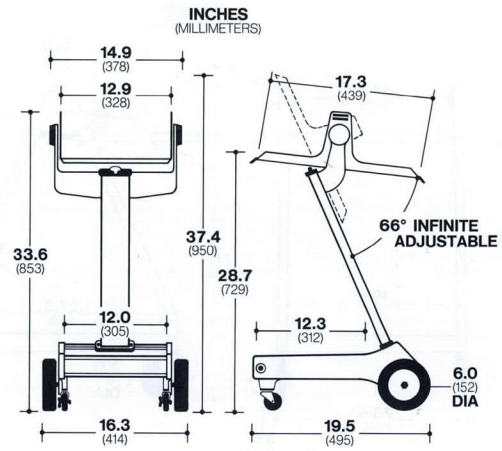
5100, 5400, and all 7000-Series three and four plug-in oscilloscopes. All 400 Series. 576, 577, TM 503, and TM 504.

MODEL 3 includes drawer in base with provision for padlock, brakes on front casters, power distribution module (four outlets and 15 ft cord), removable scope lock-down bar on top tray, one shelf, one safety belt. Net weight 57 lb, 25.8 kg. Shipping weight 75 lb, 34 kg. Blue vinyl finish. **Order Model 3** **$285**

INTERNATIONAL VERSION deletes power module for shipment outside U.S.A.
Order Option 1 . . . . . **No Charge**







MODEL 3

COMPATIBILITY

SHELVES

TM 503, TM 504. All 5100 and 5400 Series. All 400 Series (except 455).

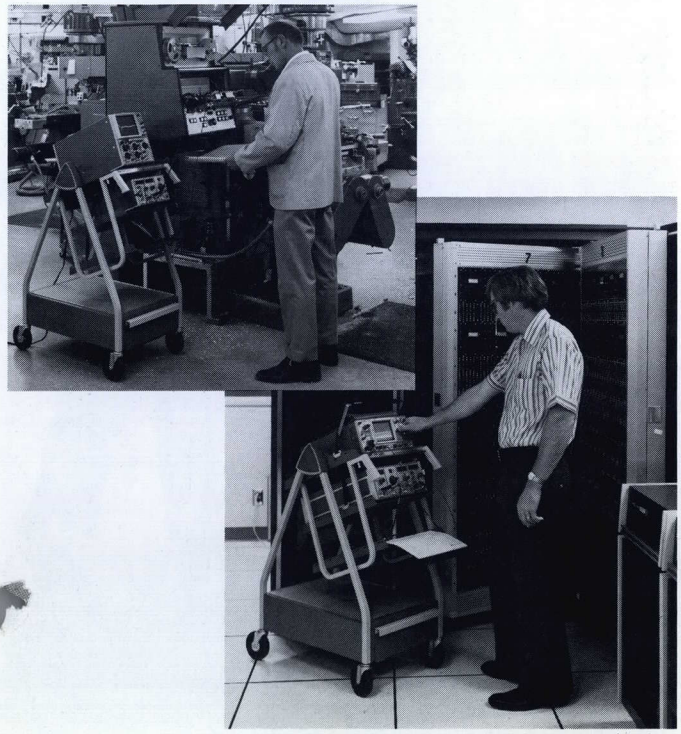
Optional Accessories

Shelf with four mounting screws. Net weight 0.9 lb, 0.4 kg. Shipping weight 3 lb, 1.4 kg.

Order 436-0132-01 ..... **$25**

Safety belt to secure instruments on top tray, shelves, or base. (Not needed for 5000- or 7000-Series Scopes on top tray.) Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

Order 346-0136-01 ..... **$15**



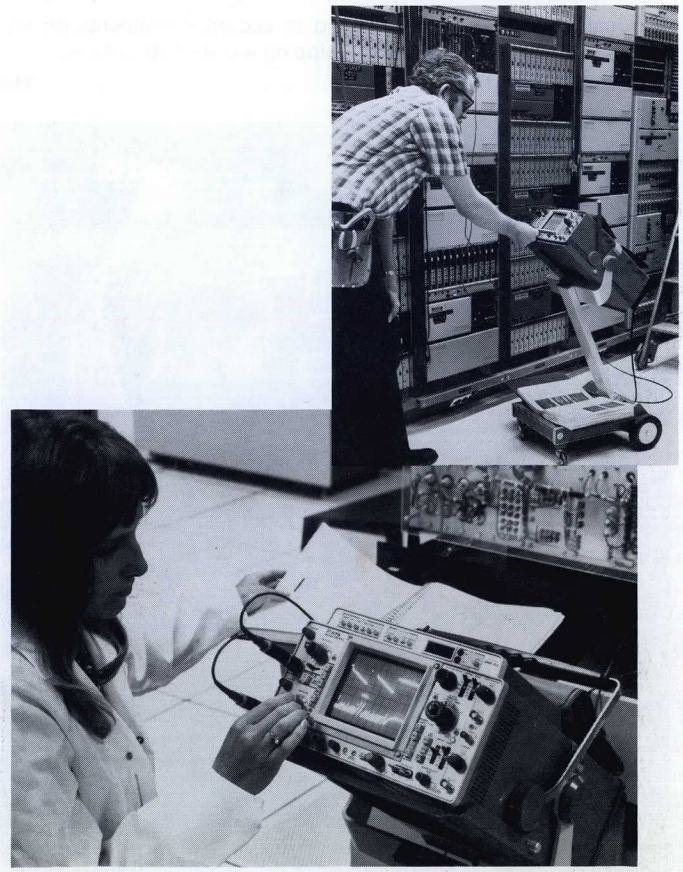
SCOPE-MOBILE® CART MODEL 200C

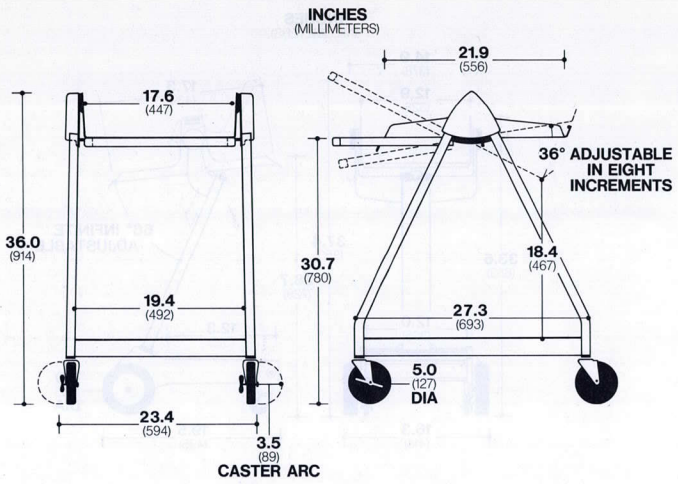
RECOMMENDED PRODUCT COMPATIBILITY

All 400-Series Portable Scopes, TM 503, and TM 504.

MODEL 200C includes brakes on front casters, safety belt to secure instrument on top tray. Blue vinyl finish. Net weight 16 lb, 7.2 kg. Shipping weight 27 lb, 12.2 kg.

Order Model 200C **$145**





SCOPE-MOBILE® CART MODEL 205

RECOMMENDED PRODUCT COMPATIBILITY

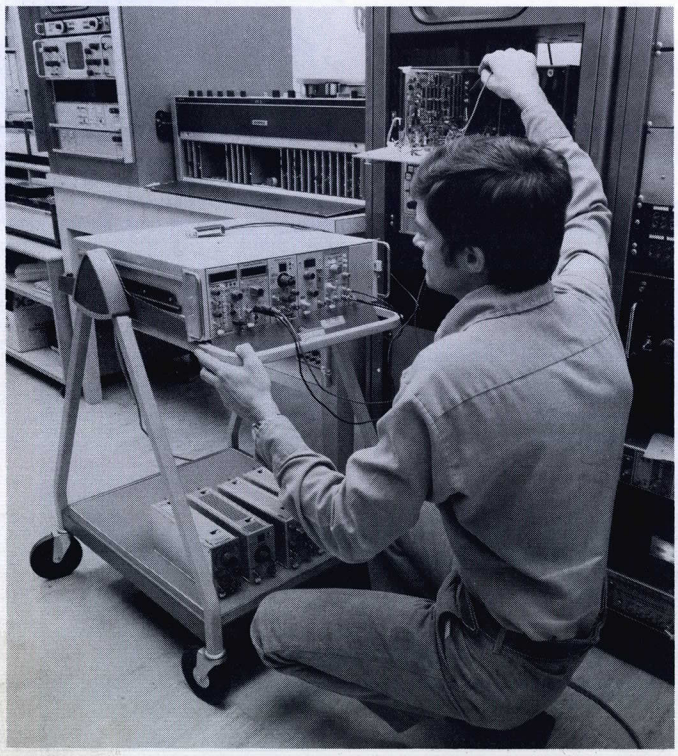
All rackmount width instruments. Note width dimension of top tray in diagram above. Rackmounting ears overhang sides of tray.

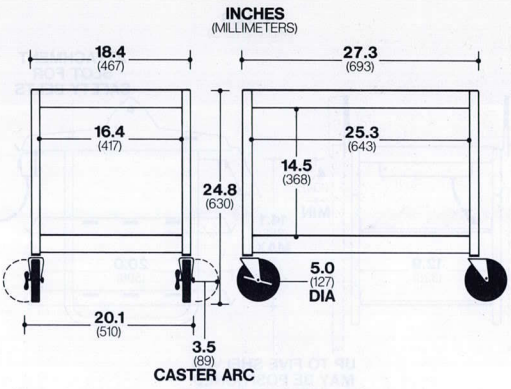
MODEL 205 includes brakes on front casters, storage drawer, power distribution module (three outlets, 15 ft cord). Blue vinyl finish. Net weight 43 lb, 19.5 kg. Shipping weight 57 lb, 25.8 kg.

Order Model 205 ..... **$235**

Optional safety belt recommended to secure instruments on top tray. Net weight 0.5 lb, 0.23 kg. Shipping weight 1 lb, 0.45 kg.

Order 346-0070-01 ..... **$15**





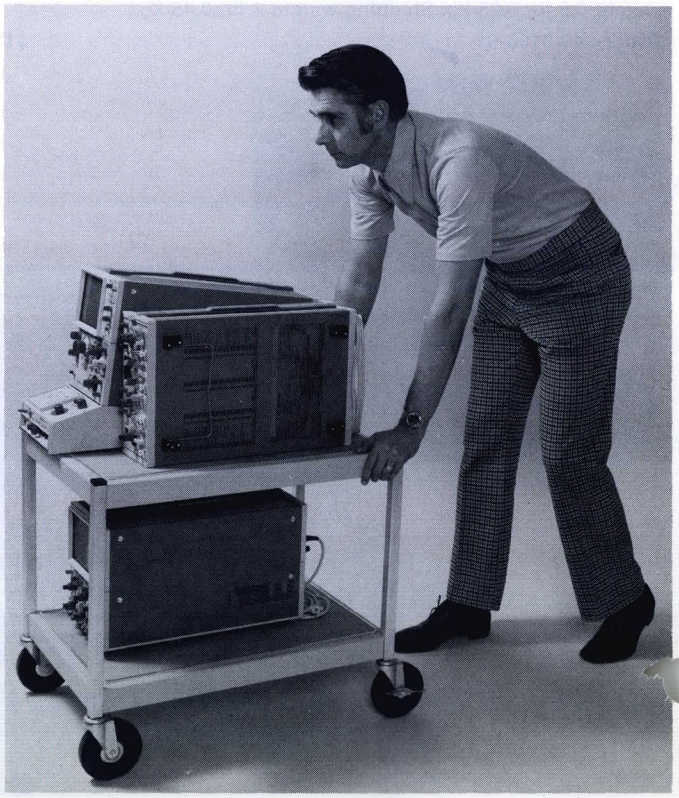
SCOPE-MOBILE® CART MODEL 206

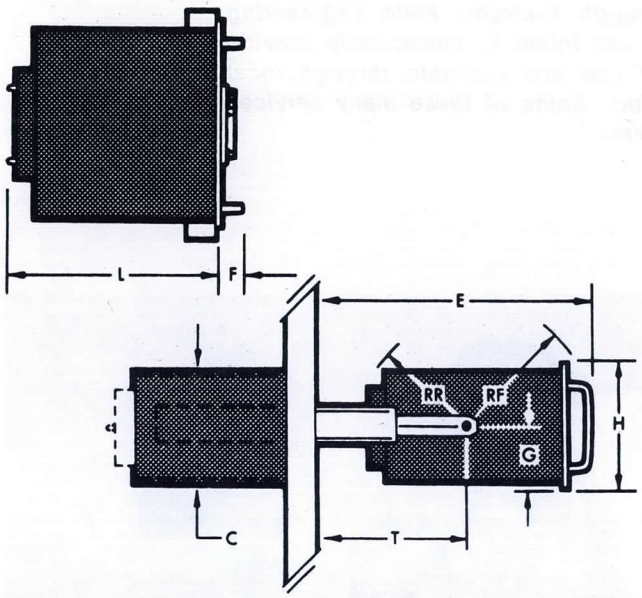
RECOMMENDED PRODUCT COMPATIBILITY

Computer terminals, calculators, and peripherals. General instruments, laboratory and office equipment.

MODEL 206 includes brakes on casters at one end of cart. Plastic laminate on top tray and base. Light grey vinyl finish. Net weight 30 lb, 13.6 kg. Shipping weight 38 lb, 17.2 kg.

Order Model 206 ..... **$105**





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.

MOUNTING DIMENSIONS

PRODUCT	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
R434	5.3	13.3	18.0	45.7	1.6	4.1	—	—	—	—	—	—	—	—	—	—	5.3	13.2
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
R5100N, R5400	5.3	13.3	19.0	48.3	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	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
R7844	7.0	17.8	24.8	62.9	2.3	5.8	1.75	4.4	—	—	—	—	—	—	—	—	7.0	17.8
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
RTM506	5.25	13.5	18.9	48.0	1.82	4.6	—	—	—	—	—	—	—	—	—	—	5.25	13.5
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
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	—	—	—	—	—	—	—	—
040-0600-00	5.25	13.5	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.5
040-0601-00	5.25	13.5	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.5
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
040-0624-00	5.25	13.5	18.3	46.5	0.7	1.8	—	—	—	—	—	—	—	—	—	—	5.25	13.5
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

Tektronix Service and Support

There are many field services available through Tektronix Field Engineering Offices and Overseas Representatives. It is our intent to consistently provide unequaled 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 Engineers are fully prepared to respond to your technical and business requirements. They have a strong technical background and extensive product and business training. Periodic refresher courses fully acquaint them with new products and services. Be sure to take advantage of their services.

COMMUNICATIONS

Your Field Engineers are a valuable communication link between you and the factory. They know the exact person to contact in each circumstance, and can reach that person fast and easily. Let them help your communications on any problem related to your TEKTRONIX 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 will be happy to arrange a demonstration of the instrument . . . in your application if you so desire.

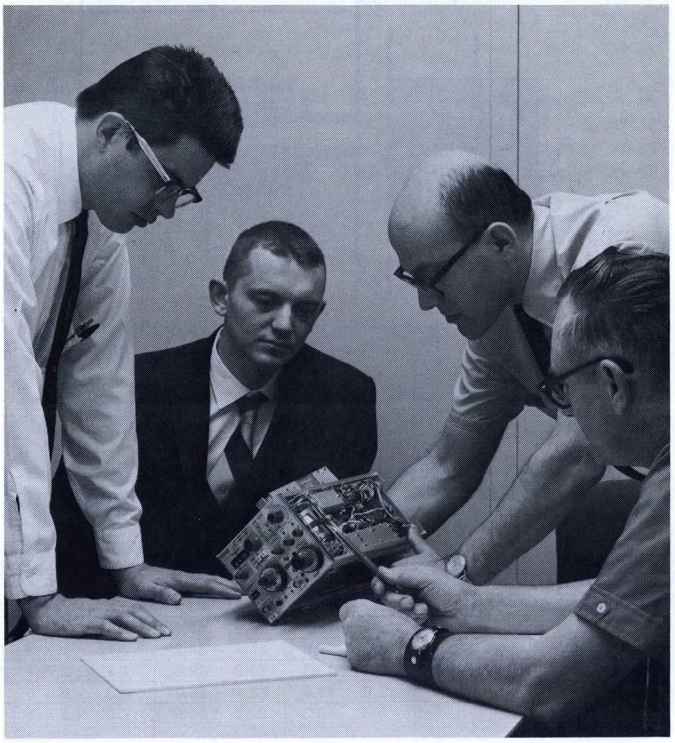
If you are a Purchasing Agent or Buyer, your Field Engineer *or field secretary* can provide information on prices, terms, shipping estimates, and best method of transportation on instruments, accessories, and replacement parts.

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. Your Field Engineer has full details, and 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).

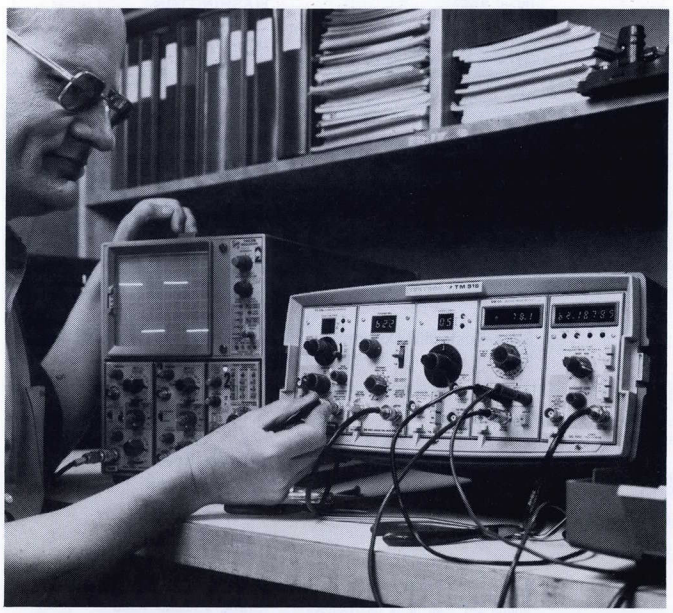
CERTIFICATES AVAILABLE

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.



CUSTOMER ASSISTANCE

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

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 or Service Center for details concerning • Warranty • Calibration • 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.

Tektronix, Inc.

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†**Service Center**

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General Terms Of Sale And Warranty

Orders should be placed with your Tektronix Field Engineering Office listed on page 260.

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 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.

The standard Tektronix, Inc., warranty and quantity discount apply to products leased under this installment term.

SECURITY AGREEMENT

This program provides monthly installment payment terms while TEKTRONIX products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

An advance payment equal to approximately 10% of the purchase price of the equipment desired is required for a Security Agreement. Installment terms covering the balance of the contract price are available for 6, 12, 18, 24, 30, or 36 months. Minimum balance amounts may be financed, ranging from $200 for six months to $2000 for thirty-six months. Longer terms of 48 to 60 months are available by quotation for financed balances of more 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.

Information Display Products

Most information display products are available under an operating lease program. The minmum fixed terms of this program are 12, 24, 36 months or longer. Automatic extension on a month to month basis with a declining rate is also available after the fixed minimum term. Equipment leased on this program is maintained by Tektronix, Inc., during the terms of the agreement. Rental of information display products for customer evaluation is available for periods of 90 or more days.

During the term of the operating leases or rentals described, the customer may exercise an option to purchase the equipment provided 30 days notice is given. A portion of the installments already paid will be credited toward the purchase price.

Questions regarding warranty should be discussed with your Tektronix 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.

Specification and price change privileges reserved.

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MICROFICHE CATALOG

This 1976 Tektronix General Catalog is also available on 24X, NMA standard microfiche. You may request your personal set of 3 fiche on the adjacent reply card. Ask for A-3277 for use within the U.S. Outside the U.S. ask for X-3277.

TEKSCOPE

A bimonthly publication whose objective is to provide informative, timely articles presented in a readable manner across the whole of Tektronix technology. Each issue of TEKSCOPE contains articles describing instruments, measurements, and techniques. Servicescope, a regular feature of TEKSCOPE, provides information for those responsible for the servicing of TEKTRONIX products. The New Products section provides information on products recently introduced, including photos, brief descriptions of unique features, and major specifications for each product. A New Literature section gives a brief description of new brochures, application notes, and catalogs available from Tektronix.

PRODUCT FAMILY CATALOGS

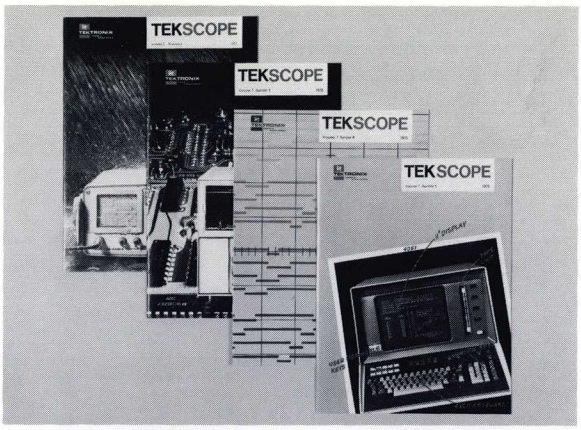
To provide a more convenient and complete source of information for a specific product family, Tektronix has available individual catalogs for product groups such as the 7000-Series, Television Products, TM 500 Test and Measurement System, TELEQUIPMENT and others.

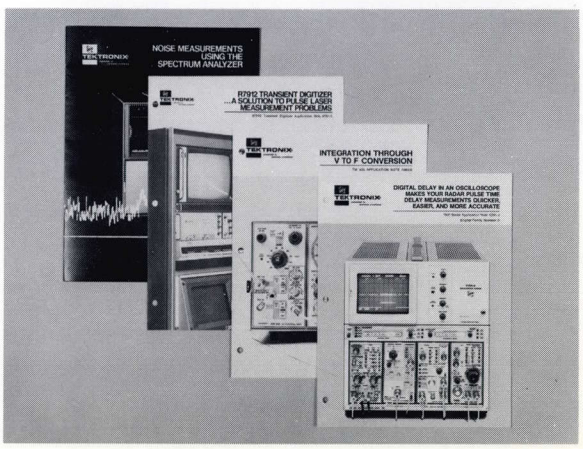
APPLICATION NOTES

Some unique measurement capabilities of TEKTRONIX products in the field of television broadcasting, radar, communications, etc., are described in a series of application notes available at no charge.

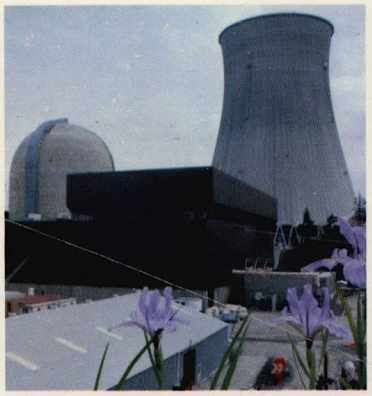
INSTRUCTION MANUALS

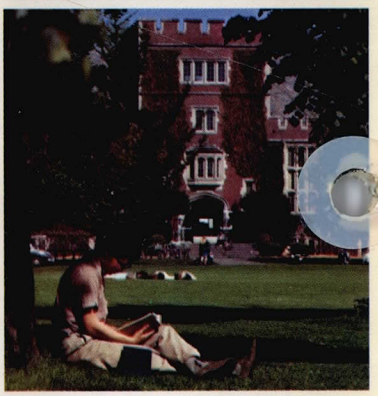
TEKTRONIX instruction manuals are written for both the user and maintenance personnel. Shipped with each instrument, instruction manuals contain instrument specifications, operating instructions, circuit descriptions, maintenance information and calibration instructions as well as complete schematics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

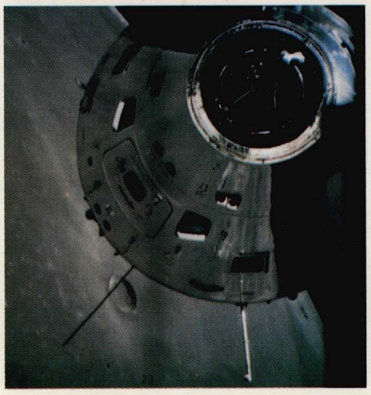




TEKTRONIX IS COMMITTED TO EXCELLENCE IN THE DESIGN, MANUFACTURE, AND SUPPORT OF PRODUCTS FOR USE IN FIELDS SUCH AS COMMUNICATIONS, TRANSPORTATION, COMPUTERS, MILITARY, GOVERNMENT, EDUCATION, NATURAL RESOURCES DEVELOPMENT, AND RESEARCH.







TEKTRONIX®

MARKETING SALES RELEASE

#561

FILE

DATE August 12, 1976

016-0489-00 Rack Adaptor for
1405 Sideband Adaptor

Description

The 016-0489-00 Rack Adaptor is an optional accessory for rackmounting the 1405 or 1405 Option 1 Sideband Adaptor. It is a standard 3 1/2 inch rackmount cabinet.

Price

016-0489-00 Rack Adaptor (for the 1405) $120.00

Customer Availability

Availability will be October of 1976. The Rack Adaptor can be ordered with the 1405 or it can be ordered as an accessory from Customer Service.

Literature

The Rack Adaptor will be added as an optional accessory to a revised 1405 data sheet (A-3329-1).

Gary Mott
FDI Marketing
58/741 X5660

GM/kp

COMPANY CONFIDENTIAL

Mary Lewis

Inter-Office Communication

RECEIVED
AUG 13 1976
CLEVELAND OFFICE
TEKTRONIX, INC

To: District Manager,
Field Operation Services

Date: August 3, 1976

From: Jack McQuain

Subject: Shipment of Hard Copy Paper

Handling of the 3M Type 777 Dry Silver Paper is very critical. More attention needs to be paid to assure delivery of good paper.

The attached I.O.C. is a request to the order processing personnel to help us assure faster delivery of the paper.

Would you please see that the attached I.O.C. is distributed to the Customer Service Representatives.

Regards,

Jack

Jack McQuain
JM/seg/mh
Attachment
CC: Merlin Miller, Don Zenger

Distribution:
Vern Champeaux
Roseann Richards
Dick Sylvester
Ron Stempel
Art Goodell
Warren Dixon
Cliff Briesenick
Sandy Yesberg
Ernie Maynard

c/ Supervisors
Bonnie + Gail

Inter-Office Communication

To: Customer Service Representatives Date: August 3, 1976

From: Jack McQuain

Subject: Air Shipment of 3M Type 777 Dry Silver Paper
006-1603-00 and 006-1603-01

The paper used in our 46XX Series Hard Copy Units is a heat sensitive paper.

Handling of this Hard Copy Paper is very critical. To assure delivery of good paper, it is imperative that delivery be as expedient as possible. Paper shipped in unrefrigerated surface transportation into warmer areas of the United States is almost certain to arrive at the customer partially developed and will exhibit poor copy quality.

To help eliminate excessive delay in delivery of Hard Copy Paper, it is in our best interest to have all 3M Dry Silver Paper shipped via Air.

If your customer, when placing an order, has the paper characteristics explained to him, I believe you will have little trouble gaining his O.K. for the extra charge to ship via Air.

A study of 128 orders produced the following data:

Average Transportation	Cost/Roll
Original Routing	2.12
Air Routing	4.32
Cost Difference	2.20

Note, this is just an average. The difference in transportation method will vary depending on your particular location.

Regards,

Jack McQuain

JM/seg/mh

CC: Merlin Miller, Don Zenger

NEW TTY PORT RFQ'S

DEAN HILL

Recently we have had a rash of requests for new "TTY Port" interfaces for new minicomputers or later versions of existing minicomputers - namely Varian 73, Interdata 72, Computer Automation Alpha 16, General Automation SPC16 or Modular Computers 2CP etc. To help you in dealing with your customers with these requirements, I offer the following information.

First of all, remember that our TTY Port interfaces are designed to work and be installed on specific minicomputer models with specific TTY controllers. The manual for the appropriate TTY Port interface reflects this by listing specified strap settings, clocking rates and specific wiring changes on the TTY controller (lift pin 1 of U74 located....etc.). Even though your customer or the computer salesman will tell you the new controller is the same as the old version or it's similar to such and such (It controls a teletype machine - right?), we have found that this is not the case in terms of actually connecting our device to it. Operationally the controller is very likely the same, but electrically and physically it's different. Therefore when you request a quotation on a TTY Port interface to a new or updated minicomputer, to us, it's the same as if you requested a new product. And, in fact, it is a new product. You will get new strap settings, different connectors, new rear panel, new cabling, new installation kit and a new manual.

An approximate price for one each new TTY Port interface would be in the ballpark of $10-12K. For 20 each the price would drop to approximately $1400 each.

When requesting interfaces to new or different computers, your customer has three alternatives in getting our terminals connected to his machine:

1. Pay Tektronix to develop the new TTY Port interface.
2. Buy any of the standard optional interfaces and figure out how to make the connection himself.
3. Go RS232 and use the interface supplied with the terminal. It should be noted that most mini manufacturers are going with the UART (Universal Asynchronous Receiver Transmitter) chip for their TTY controllers which is only good to about 20K baud in most applications. Therefore the speed benefits of our TTY Port interfaces have, to a large degree, evaporated anyway.

We hope this helps to answer some of your (and possibly your customer's) questions.

MAINTENANCE SUPPORT OF MODIFIED PRODUCTS *DEAN HILL*

The level of support for modified products has been and will continue to be below that of standard items i.e. no software is available for these products, the manual is the minimum necessary and replacement parts are not necessarily "off-the'shelf", and because they are low volume items every Service Center in the country may not have encountered these mods before.

When you, the A.E. or S.E., sell a modified product, remember that you know more about it than the Service Center probably does. If you expect the Service Center to support your customer, you had better see to it that they are aware of the installation first of all and secondly that they get some documentation at the time of the sale.

Maintenance problems with modified products should not be input through normal Service Center channels but rather to the IDD Modified Products group itself. John Schmid, Bob Thacker and I will assist you in getting your problem solved either by working with the CST (we'll bring him in on the problem), working with the customer or even getting someone there from Beaverton (if needed) but you, the A.E. or S.E., will be the focal point for all activity.

For the reasons above and also the 48 hour response time requirement, standard IDD lease and maintenance contract terms and conditions do not apply. In fact, modified products are not leasable and maintenance contract terms must be negotiated with the applicable Service Center.

HARD COPY PAPER SHIPMENT & STORAGE 500 ft/Roll *Jack Scribner*

Handling of the 3M Type 777 Dry Silver Paper is very critical. More attention should be paid to assuring delivery of good paper to your customer. Also a better demo can be assured if the paper is fresh and has not been exposed for long periods of time to excessive heat.

The paper used in our Hard Copy Units has an effective life of approximately two years when stored at 40°F and six months when stored at 72°F, 50% relative humidity. The life of the paper is extremely short at temperatures above 90°F. To minimize chances of the paper being exposed for long periods to excessive temperatures, it is suggested that all hard copy paper be shipped by air, particularly during the hotter months.

Field offices should not keep a substantial stock of hard copy paper unless it is kept refrigerated. Salesmen are especially discouraged from leaving paper in an automobile, where internal temperatures can be well over 100°F.

If you must keep paper inside a car for long periods of time, a cooler chest would be worth considering as a method of holding the temperature of the paper to a safer level.

It is recommended that all salesmen discuss this with the secretaries and encourage them to ask the customer to authorize air shipment at the time the order is placed, particularly in non Tek-air areas.

Refer to Hard Copy Users & Service manual for additional information on paper storage and possible problems caused by high temperature storage.

MARKETING SALES RELEASE

FILE #523

DATE April 26, 1976

602 Display Unit

Delete Option 7 (without Handle, Feet and Dust Covers). Option 1 (without Cabinet) will accomplish the same purpose since the feet and handle are fastened to the cabinet.

603, 604, and 605 Display Units

The 1976 catalog lists an Option 3 (without Handle and Feet) and Option 7 (without Handle, Feet and All Dust Covers. Either one of these options, but not both, can be ordered for the same instrument.

Stan Foss
T & M Display Components Mktg.
Ext. 6317

COMPANY CONFIDENTIAL

Type Oscilloscope	Recommended Cameras	Use*	C-50 Series and C-27 Adapter Part Number	C-30 Series Adapter Part Number	C-12 Adapter Part Number
422	C-30A	GP	----------	016-0306-00	----------
432, 434,** 464, 466	C-30A Opt 1 C-5A Opt 2	GP LC	----------	016-0301-00	----------
453A, 454A	C-30A C-31	GP HS	----------	016-0306-00	----------
455, 465, 475	C-30A Opt 1 C-31 Opt 1 C-5A Opt 2	GP HS LC	----------	016-0301-00 (C-30A Opt 1) 016-0269-02 (C-31 Opt 1)	----------
485	C-30A C-31	GP LC	----------	016-0306-00	----------
491	C-30A	GP	----------	016-0306-00	----------
502A	C-59	GP	016-0225-03	016-0243-00	016-0226-01
503, 504	C-27	GP	016-0225-03	016-0243-00	016-0226-01
519	C-27 Opt 4	HS	Integral with 519	----------	----------
544, 545B, 546, 547, 549, 556, 568	C-27	GP	016-0225-03	016-0243-00	016-0226-01
561B, 564B	C-27	GP	016-0224-00	016-0244-00	016-0217-00
565	C-59	GP	016-0225-03	016-0243-00	016-0226-01
575	C-12	GP	016-0225-03	016-0243-00	016-0226-01
576, 5030, 5031	C-59 (Requires 016-0288-00 Adapter Frame Corrector Lens)	GP	016-0288-00 (C-59) 016-0264-01 (C-12, C-27)	----------	----------
577**	C-5A C-59	LC GP	016-0249-03	016-0248-00	016-0263-00
601, 602, 605	C-5A, C-5A Opt. 1 C-59 C-30A	LC 67 GP	016-0249-03	016-0248-00	016-0263-00
603, 604	C-5A, C-5A Opt. 1 C-59	LC GP	016-0249-03	016-0248-00	016-0263-00
647A	C-27	GP	016-0223-00	----------	----------
5100 Series**	C-5A C-59	LC GP	016-0249-03	016-0248-00	016-0263-00
5440, 5444	C-59 C-27 Opt 4 C-5A Opt 1	GP HS LC	016-0249-03	016-0248-00	016-0263-00
5441	C-59 C-58 C-5A Opt 1	67 GP LC	016-0249-03	016-0248-00	016-0263-00
7313, 7503, 7504,** 7514, 7704A, 7904, R7903, 7603N11S	C-53, C-27 C-59 C-5A Opt 1 C-51, C-27 Opt 4	GP 67 LC HS	016-0249-03	016-0248-00	016-0263-00
7844	C-53 C-59 C-5A Opt 1 C-51	GP 67 LC HS	016-0249-03	016-0248-00	----------
7613, 7623A, 7633	C-58, C-52 C-27 Opt 3 C-59	GP 67	016-0249-03	016-0248-00	016-0263-00
7403N, 7603	C-59 C-5A Opt 1	GP LC	016-0249-03	016-0248-00	016-0299-00
T900 Series	C-5A Opt 3	LC	----------	----------	----------
Some HP Scopes Round CRT only	----------	--	016-0228-00	----------	----------
1502, 314, 326,** 135	C-30A	GP	----------	016-0327-00 Plus 016-0306-00	----------
601, 602, 603, 604, 605, 5100, 5400, 7000	014-0045-00 will mechanically mount any of the following cameras: HP Models 195A, 197A; Beattie Coleman Models K-5, K-5R, KD-5, Mark 11A, Mark 11-911, 565A, Polexa.				

* Use:
- GP = General Purpose, typically with 107 or 47 Polaroid film or 90mm roll film
- LC = Low Cost
- HS = High Speed
- 67 = 6 X 7 cm roll film (70mm, 120, 220, etc.)

** Only the C-5A and C-5A Opt. 3 can illuminate a non-illuminated graticule. The background glow of bistable storage may be used to backlight a graticule if necessary.

C5A ADAPTER HOODS

The C5A camera may be readily changed to fit scopes other than those for which it was ordered. The three adapter hoods along with extra viewing doors and flash units are available separately, although they are not listed in the 1976 Catalog. The following table shows what is needed to fit various instruments:

Instrument	Camera	Includes Adapter Hood	Also Includes
432, 434, 455, 464, 465, 466, 475, 475A	C5A opt. 2	016-0359-00	Viewing door 200-1933-00
528	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
577	C5A	016-0357-00	Flash unit 016-0363-00
600 Series w/o graticule	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
600 Series w/unilluminated graticule	C5A	016-0357-00	Flash unit 016-0363-00
600 Series w/illuminated graticule	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
1420 Series	C5A	016-0357-00	Flash unit 016-0363-00
5100 Series	C5A	016-0357-00	Flash unit 016-0363-00
5400 Series	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
7000 Series	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
T900 Series except T922R	C5A opt. 3	016-0358-00	Flash unit 016-0363-00
T922R	C5A opt. 1	016-0357-00	Viewing door 200-1933-00
Telequipment D83	C5A opt. 1	016-0357-00	Viewing door 200-1933-00

To convert to a different option, just order the parts listed above as necessary. Combinations other than listed options are also possible for special cases. The flash unit, viewing door and adapter hoods will be listed in the 1977 Catalog.

Pete Keller
58/129, Ext. 7769

Oscilloscope Camera/Adapter

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	USE*	C-5A ADAPTER HOOD PART NUMBER	C-50 SERIES AND C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-12 ADAPTER PART NUMBER
314 326 335	C-30A	GP	—	—	016-0327-00	—
422	C-30A	GP	—	—	016-0306-00	—
432[1], 434[2], 464, 466	C-30A Opt 01 C-5A Opt 02	GP LC	016-0359-00	—	016-0301-00	—
453, 453A, 454, 454A	C-30A C-31	GP HS	—	—	016-0306-00	—
455, 465, 475, 475A	C-30A Opt 01 C-31 Opt 01 C-5A Opt 02	GP HS LC	016-0359-00	—	016-0301-00 (C-30A Opt 01) 016-0269-02 (C-31 Opt 01)	—
485	C-30A C-31	GP HS	—	—	016-0306-00	—
491	C-30A	GP	—	—	016-0306-00	—
502, 502A	C-59	GP	—	016-0225-03	016-0243-00	016-0226-01
503, 504	C-27	GP	—	016-0225-03	016-0243-00	016-0226-01
519	C-27 Opt 4 C-51[4]	HS HS	—	016-0240-00 (Integral w/519)	—	016-0239-00
520A, 521A, 522A	C-59	GP	—	016-0295-00	—	—
528	C-59 C-5A Opt 01	GP LC	016-0357-00	016-0249-03	016-0248-00	—
529	C-59	GP	—	016-0224-00	016-0244-00	016-0217-00
530, 540, 550 Series	C-27	GP	—	016-0225-03	016-0243-00	016-0226-01
561A, 561B, 564A, 564B	C-27	GP	—	016-0224-00	016-0244-00	016-0217-00
565	C-59	GP	—	016-0225-03	016-0243-00	016-0226-01
568	C-27	GP	—	016-0224-00	016-0244-00	016-0217-00
575	C-27	GP	—	016-0225-03	016-0243-00	016-0226-01
576	C-27 C-59	GP GP	—	See Adapter Frame/Corrector Lens Systems at right		
577[2]	C-5A C-59	LC GP	016-0357-00	016-0249-03	016-0248-00	016-0263-00
601, 602	C-30A C-5A Opt 01	GP LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
603[6 7]	C-5A Opt 01 C-59	LC GP	016-0357-00	016-0249-03	016-0248-00	016-0263-00
604 [6 8]	C-5A	LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
605, 606, 607	C-30A C-5A Opt 01	GP LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
647, 647A	C-27	GP	—	016-0223-00	—	—
1420 Series	C-5A	LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
1480 Series	C-59	GP	—	016-0342-00	—	—
1502, 1503	C-30A	GP	—	—	016-0327-00[1]	—
5030, 5031	C-27 C-59	GP GP	—	See Adapter Frame/Corrector Lens Systems at right		
5100 Series	C-5A	LC	016-0357-00	016-0249-03[1 6]	016-0248-00[1 6]	016-0263-00[1 6]
5403/D40 5440, 5444	C-59 C-5A Opt 01	GP LC	016-0357-00	016-0249-03[6]	016-0248-00[6]	016-0263-00[6]
5403/D41, 5441	C-58 C-59 C-5A Opt 01	GP 67 LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
7313[2], 7503, 7504, 7514, 7613 7623A, 7633 7704A, 7904, R7903, 7834, 7844	C-53, C-27 C-59 C-51 C-5A Opt 01 C-58	GP 67 HS LC 45	016-0357-00	016-0249-03	016-0248-00	016-0263-00

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	USE*	C-5A ADAPTER HOOD PART NUMBER	C-50 SERIES AND C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-12 ADAPTER PART NUMBER
7403N, 7603 7603-N11S	C-59 C-5A Opt 01	GP LC	016-0357-00	016-0249-03[6]	016-0248-00[6]	016-0299-00[6]
SC502	C-30A	GP	—	—	016-0327-00[1]	—
T900 Series Except T922R	C-5A Opt 03	LC	016-0358-00	—	—	—
T922R	C-5A Opt 01	LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
TELEQUIPMENT Except D83	None	—	—	—	—	—
TELEQUIPMENT D83	C-59 C-5A Opt 01	GP LC	016-0357-00	016-0249-03[6]	016-0248-00[6]	016-0263-00[6]
HP 5" Round CRT	C-27	GP	—	016-0228-00	—	—
HP 5" Rect. CRT (8 x 10 cm)	C-27	GP	—	HP 10362-A[5]	HP 10363-A[5]	HP 10361-A[5]
HP 1332A, 1335A	C-27 C-5A	GP LC	016-0357-00	016-0249-03	016-0248-00	016-0263-00
HP 1700 Series (6 x 10 cm)	C-30A	GP	—	—	HP 10106-A[5]	—
HP 182	—	—	—	—	—	—
600, 5100, 5400, 7000-Series	—	—	014-0045-00	Will mount HP Models 195A, 197A Cameras.		

[1]Graticule is nonilluminated and will not photograph.

[2]Graticule is nonilluminated and will not photograph except when crt is in the stored mode.

[3]Increases camera's field-of-view so that the full 8 x 10-cm crt display area can be recorded.

[4]C-50, C-51, C-52, and C-53 Cameras require Battery Pack 010-0270-00 for power when not used with 7000-Series Oscilloscopes.

[5]Available from Hewlett-Packard. See HP catalog for additional compatability information and prices.

[6]Only the C-5A and C-59 Cameras can entirely record the 6½-inch crt display without cropping.

[7]The C-59 is suitable for the standard-model Type 603 but it cannot photograph the nonilluminated graticule of the Option 01 Model.

[8]The C-59 also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

*GP = General Purpose
LC = Low Cost
HS = High Speed
45 = 4 x 5" Sheet film
67 = 6 x 7 cm Roll film (70 mm, 120, 220, etc.)

CAMERA ADAPTER PART NUMBERS & PRICES

014-0045-00	$65	016-0263-00	$40
016-0217-00	$40	016-0269-02**	$65
016-0223-00	$40	016-0295-00	$40
016-0224-00	$40	016-0299-00	$40
016-0225-03	$40	016-0301-00***	$60
016-0226-01	$40	016-0306-00†	$60
016-0228-00	$40	016-0327-00	$42
016-0243-00	$45	016-0342-00	$42
016-0244-00	$45	016-0357-00††	$12
016-0248-00	$45	016-0358-00†††	$12
016-0249-03*	$48	016-0359-00††††	$12

*(Included with C-50 Series Cameras)

**(Adapter with lens included with C-31 Opt 01 Cameras)

***(Adapter with lens included with C-30A Opt 01 Cameras)

†(Included with C-30A, C-31 Cameras)

††(Included with C-5A and C-5A Opt 01 Cameras)

†††(Included with C-5A Opt 03 Cameras)

††††(Included with C-5A Opt 02 Cameras)

see page 234 for extra viewing doors and flash units

ADAPTER FRAME/CORRECTOR LENS FOR C-12 or C-27 CAMERA

Expands the field of view of the C-12 and C-27 to fully cover the 6½ in crt and adjacent scale readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of a standard camera's 0.85-mag lens to 0.45 so it can record the entire display on Polaroid 3¼ x 4¼ in film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. The C-12 provides a view of the crt screen only. The C-27's view is restricted to the lower two thirds of the crt and scale readout. Both cameras can of course be swung aside to allow a full view of the entire display. 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 ..... $60

ADAPTER FRAME/CORRECTOR LENS C-50 and C-59 CAMERAS

Expands the field of view of the C-50 and C-59 to fully cover the 6½-inch crt and adjacent scale-readout characters of the 576 Curve Tracer and 5030-Series scopes. The Corrector Lens reduces the effective magnification of the C-50 to 0.55 and the C-59 to 0.5 so they can record the entire display on Polaroid 3¼ x 4¼-inch film.

Although each camera's photographic field is expanded to include the entire display, the view through the viewing tunnel is not. However, all but the upper one-fourth of the display can be viewed via the viewing tunnel and both cameras can be swung aside to allow a full view of the entire display.

For C-50 Camera, Order 016-0271-00 ..... $80
For C-59 Camera, Order 016-0288-00 ..... $75

ACCESSORIES FOR GRAFLOK TYPE BACKS (For C-12, C-27, and C-50-Series)

Here are a few of the film holders available for use with the Graflok Backs to allow use of roll film, and Polaroid 4 x 5 in Film. Order these accessories from the manufacturer or from your local camera store.

RH/10 120 Roll-Film Holder—10 exposures 2¼ x 2¾ in Graflex Catalog #1295 for 4 x 5 in Graflok Backs. **(122-0736-01)**

RH/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ in Graflex Catalog #1297 for a 4 x 5 in Graflok Backs. **(122-0971-00)**

RH/50 70 mm Holder—50 exposures, 2¼ x 2¾ in Graflex Catalog #1240 for 4 x 5 in Graflok Backs only. **(122-0967-00)**

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 in Single Exposure Film Packets. **(016-0201-01)**

Roll film holders are also manufactured by several other companies.

#554

MARKETING SALES RELEASE

FILE

DATE July 23, 1976

P6450 & P6451 REPLACEMENT PROBES

P6450 and P6451 replacement probes will be sold in probe packages only. Package P/N and prices are:

P6450 (010-6450-01). $250

P6451 (010-6451-01). $375

Any orders for either of these probes (without lead sets) should be converted to the probe package numbers listed above.

Rick Watkins/Bernie Floersch
SID Marketing
50-442

COMPANY CONFIDENTIAL

Probe	Description	Part Number	Price
P6101	1 meter probe only	010-6101-00	$29.00
	1 meter probe package	010-6101-01	$32.00
	2 meter probe only	010-6101-02	$29.00
	2 meter probe package	010-6101-03	$32.00
	3 meter probe only	010-6101-04	$29.00
	3 meter probe package	010-6101-05	$32.00
	P6101 head (all lengths)	206-0223-00	$10.00
	P6101 BNC (all lengths)	103-0189-00	$12.00
P6105	1 meter probe only	010-6105-00	$59.00
	1 meter probe package	010-6105-01	$62.00
	1 meter head	206-0216-00	$30.00
	1 meter comp box	206-0219-00	$30.00
	2 meter probe only	010-6105-02	$59.00
	2 meter probe package	010-6105-03	$62.00
	2 meter head	206-0217-00	$30.00
	2 meter comp box	206-0220-00	$30.00
	3 meter probe only	010-6105-04	$59.00
	3 meter probe package	010-6105-05	$62.00
	3 meter head	206-0218-00	$30.00
	3 meter comp box	206-0221-00	$30.00
P6108	1 meter probe only	010-6108-00	$44.00
	1 meter probe package	010-6108-01	$47.00
	1 meter head	206-0224-00	$20.00
	1 meter comp box	206-0227-00	$25.00
	2 meter probe only	010-6108-02	$44.00
	2 meter probe package	010-6108-03	$47.00
	2 meter head	206-0225-00	$20.00
	2 meter comp box	206-0228-00	$25.00
	3 meter probe only	010-6108-04	$44.00
	3 meter probe package	010-6108-05	$47.00
	3 meter head	206-0226-00	$20.00
	3 meter comp box	206-0229-00	$25.00
	1 meter cable assembly	175-1661-00	$18.00
	2 meter cable assembly	175-1661-01	$18.00
	3 meter cable assembly	175-1661-02	$18.00

#556

MARKETING SALES RELEASE

FILE

DATE July 23, 19

MODULAR "PROBE ONLY's"

Due to customer demand, the probe only's in the modular probe line will now be available for sale. On the next page is a complete listing of all the modular probes now available, including the probe only's and the replacement modular components. This listing along with the modular probe data sheet will give you all the available information on the modular probes.

Ron Lang
TEK-Peripherals
SID Marketing
58/129 Ext. 5133
July 19, 1976

COMPANY CONFIDENTIAL

MARKETING SALES RELEASE

FILE #631

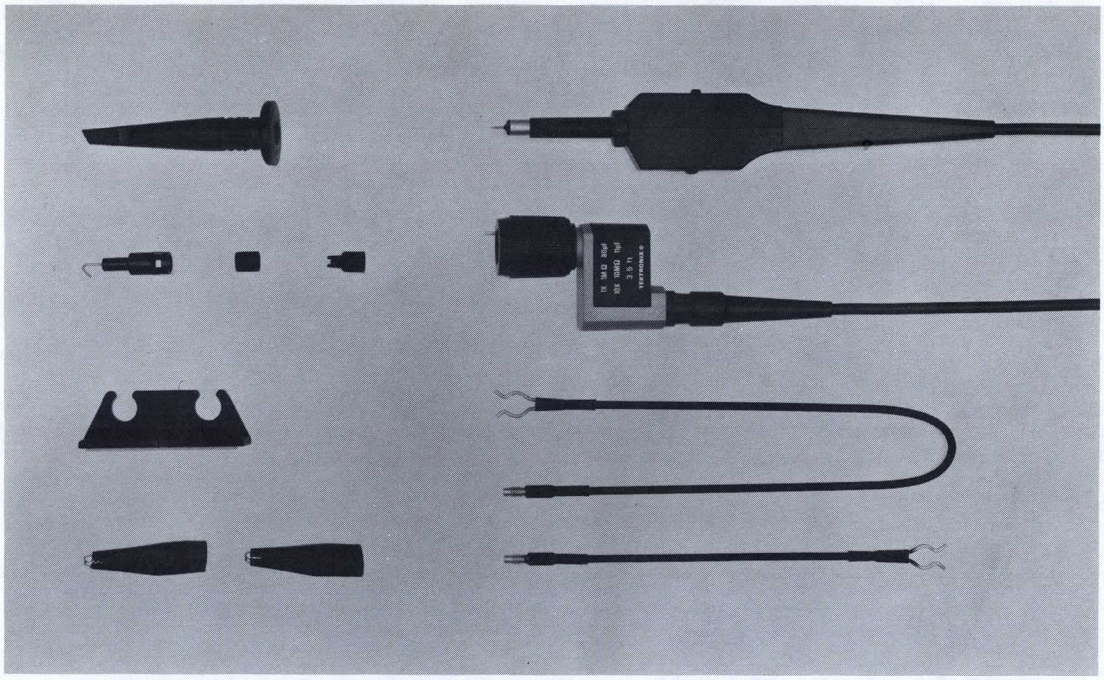
DATE February 18, 1977

TWO NEW

1X-10X PASSIVE PROBES

P6062B Dc to 100 MHz

P6063B Dc to 200 MHz



The P6062B and P6063B probe heads and compensation box with connector are physically the same. They also use the same standard accessories except for the ground leads.

The P6062B and P6063B replace the P6062A and P6063A; they provide the same good features and performance but are more rugged and more reliable.

Both types have a ground-reference button and 1X-10X attenuation slide switch on the probe body. A coding pin on the BNC output connector encodes the probe's attenuation setting on those scope types that have CRT or knobskirt readout. The output connector is compatible with all BNC scope-input connectors.

FEATURES AND BENEFITS

* The 1X-10X switch allows the user to conveniently switch a decade of sensitivity without returning to the oscilloscope.
* The 1X mode allows maximum scope sensitivity for observing small signals of 10MHz or less.
* Switching between 1X and 10X allows convenient evaluation of the effects of different capacitive and resistive loading on the signal source.
* The ground reference button can be used for trace identification.

COMPANY CONFIDENTIAL

PERFORMANCE CHARACTERISTICS

BANDWIDTH*

P6062B

Length	Attenuation	
	1X	10X
3.5 Ft.	8.0 MHz	100 MHz
6 Ft.	6.7 MHz	100 MHz
9 Ft.	4.5 MHz	95 MHz

*With oscilloscope bandwidth of at least 105 MHz.

P6063B

Length	Attenuation	
	1X	10X
3.5 Ft.	12 MHz	200 MHz
6 Ft.	6 MHz	200 MHz

*With oscilloscope bandwidth of at least 225 MHz.

INPUT CAPACITANCE

P6062B

Length	Attenuation	
	1X	10X
3.5 Ft.	100 pF	13.5 pF
6 Ft.	105 pF	14 pF
9 Ft.	135 pF	17 pF

P6063B

Length	Attenuation	
	1X	10X
3.5 Ft.	80 pF	11 pF
6 Ft.	105 pF	14 pF

INPUT RESISTANCE

P6062B *and* P6063B

Attenuation	Input Resistance
1X	Same as oscilloscope input resistance.
10X	10 MΩ within 0.5%, with oscilloscope input resistance of 1 MΩ within 2%.

PERFORMANCE CHARACTERISTICS

BANDWIDTH*

P6062B

Length	Attenuation	
	1X	10X
3.5 Ft.	8.0 MHz	100 MHz
6 Ft.	6.7 MHz	100 MHz
9 Ft.	4.5 MHz	95 MHz

*With oscilloscope bandwidth of at least 105 MHz.

P6063B

Length	Attenuation	
	1X	10X
3.5 Ft.	12 MHz	200 MHz
6 Ft.	6 MHz	200 MHz

*With oscilloscope bandwidth of at least 225 MHz.

INPUT CAPACITANCE

P6062B

Length	Attenuation	
	1X	10X
3.5 Ft.	100 pF	13.5 pF
6 Ft.	105 pF	14 pF
9 Ft.	135 pF	17 pF

P6063B

Length	Attenuation	
	1X	10X
3.5 Ft.	80 pF	11 pF
6 Ft.	105 pF	14 pF

INPUT RESISTANCE

P6062B and P6063B

Attenuation	Input Resistance
1X	Same as oscilloscope input resistance.
10X	10 MΩ within 0.5%, with oscilloscope input resistance of 1 MΩ within 2%.

ATTENUATION

P6062B *and* P6063B

1X position: Same as oscilloscope specification.

10X position: 10X within 3%, with oscilloscope input R of 1 MΩ within 2%.

MAXIMUM INPUT VOLTAGE

Attenuation	P6062B	P6063B
1X	500 V (DC + peak AC) to 450 kHz, derated to 35 V at 10 MHz	500 V (DC + peak AC) to 850 kHz, derated to 70 V at 10 MHz
10X	500 V (DC + peak AC) to 3.5 MHz, derated to 25 V at 100 MHz	500 V (DC + peak AC) to 4.5 MHz, derated to 30 V at 200 MHz

COMPENSATION RANGE

P6062B	P6063B
15pF to 47pF	15pF to 24pF

TEMPERATURE RANGE

P6062B *and* P6063B

Storage: -55°C to +75°C

Operating: -15°C to +75°C

ALTITUDE

P6062B *and* P6063B

Storage: To 50,000 feet

Operating: To 15,000 Feet

Performance Characteristics - continued -

ATTENUATION

P6062B and P6063B

1X position: Same as oscilloscope specification.

10X position: 10X within 3%, with oscilloscope input R of 1 MΩ within 2%.

MAXIMUM INPUT VOLTAGE

Attenuation	P6062B	P6063B
1X	500 V (DC + peak AC) derated to 450 kHz, derated to 35 V at 10 MHz	500 V (DC + peak AC) derated to 850 kHz, derated to 70 V at 10 MHz
10X	500 V (DC + peak AC) derated to 3.5 MHz, derated to 25 V at 100 MHz	500 V (DC + peak AC) derated to 4.5 MHz, derated to 30 V at 200 MHz

COMPENSATION RANGE

P6062B: 15pF to 47pF

P6063B: 15pF to 24pF

TEMPERATURE RANGE

P6062B and P6063B

Storage: -55°C to +75°C

Operating: -15°C to +75°C

ALTITUDE

P6062B and P6063B

Storage: To 50,000 Feet

Operating: To 15,000 Feet

STANDARD ACCESSORIES INCLUDED

FOR P6062B

1	Hook Tip	206-0114-00
1	Retractable Hook Tip	013-0107-03
2	Minigator Clips	344-0046-00
1	5-inch (13 cm) Ground Lead	175-0124-01*
1	12-inch (30 cm) Ground Lead	175-0125-01*
1	Insulating Sleeve	166-0404-01
1	Integrated Circuit Test Tip (installed on probe)	--- ---- --[1]
1	Probe Holder	352-0351-00
1	Vinyl Pouch	016-0521-00
1	Data Sheet	062-2927-00*
1	Data Card	062-1675-00

[1] Available only in packs of 10 by Tek part number 015-0201-01, or in packs of 100 by part number 015-0201-02.

FOR P6063B

* The above list applies to the P6063B except for the ground leads and data sheet as listed below:

1	3-inch (7.5 cm) Ground Lead	175-0263-01
1	5-inch (13 cm) Ground Lead	175-0124-01
1	Data Sheet	062-2928-00

STANDARD ACCESSORIES INCLUDED

FOR P6062B

1	Hook Tip	206-0114-00
1	Retractable Hook Tip	013-0107-03
2	Minigator Clips	344-0096-00
1	5-inch (13 cm) Ground Lead	175-0124-01*
1	12-inch (30 cm) Ground Lead	175-0125-01*
1	Insulating Sleeve	166-0404-01
1	Integrated Circuit Test Tip (installed on probe)	--- ---- --
1	Probe Holder	352-0351-00
1	Vinyl Pouch	016-0521-00
1	Data Sheet	062-2927-00*
1	Data Card	062-1675-00

1 Available only in packs of 10 by Tek part number 015-0201-01, or in packs of 100 by part number 015-0201-02.

FOR P6063B

* The above list applies to the P6063B except for the ground leads and data sheet as listed below:

1	3-inch (7.5 cm) Ground Lead	175-0263-01
1	5-inch (13 cm) Ground Lead	175-0124-01
1	Data Sheet	062-2928-00

PROBE ORDERING INFORMATION

P6062B (With accessories)

3.5 feet (1.1 meter):	Order 010-6062-11	$ 95
6.0 feet (1.8 meter):	Order 010-6062-13	$ 95
9.0 feet (2.7 meter):	Order 010-6062-15	$ 95

P6062B (Probe only, without accessories)

3.5 feet (1.1 meter):	Order 010-6062-10	$ 92
6.0 feet (1.8 meter):	Order 010-6062-12	$ 92
9.0 feet (2.7 meter):	Order 010-6062-14	$ 92

P6063B (With accessories)

3.5 feet (1.1 meter):	Order 010-6063-11	$120
6.0 feet (1.8 meter):	Order 010-6063-13	$120

P6063B (Probe only, without accessories)

3.5 feet (1.1 meter):	Order 010-6063-10	$117
6.0 feet (1.8 meter):	Order 010-6063-12	$117

PROBE ORDERING INFORMATION

P60628 (With accessories)

3.5 feet (1.1 meter): Order 010-6062-11 . . . . . $ 95

6.0 feet (1.8 meter): Order 010-6062-13 . . . . . $ 95

9.0 feet (2.7 meter): Order 010-6062-15 . . . . . $ 95

P60628 (Probe only, without accessories)

3.5 feet (1.1 meter): Order 010-6062-10 . . . . . $ 92

6.0 feet (1.8 meter): Order 010-6062-12 . . . . . $ 92

9.0 feet (2.7 meter): Order 010-6062-14 . . . . . $ 92

P60638 (With accessories)

3.5 feet (1.1 meter): Order 010-6063-11 . . . . . $120

6.0 feet (1.8 meter): Order 010-6063-13 . . . . . $120

P60638 (Probe only, without accessories)

3.5 feet (1.1 meter): Order 010-6063-10 . . . . . $117

6.0 feet (1.8 meter): Order 010-6063-12 . . . . . $117

SCHEDULE OF EVENTS

Announcement:	By This MSR Week 6, AP 710 (2-11-77)
Start Shipments To Customers:	Week 9, AP 710 (3-1-77)
Demo Availability:	Week 9, AP 710 (3-1-77)
P.A.L. Initial Quote:	3 Weeks
Probe Spec. Sheet:	Week 12 (3-20-77)

Beaverton Personnel

Engineering:	Bob Johnson
Manufacturing:	Tom Thayer
Marketing:	Earl Williams
Advertising:	Maury Floathe
Service Support:	Max Brown

Earl Williams
Accessories Marketing
Service Instrument Division
58/129 Ext. 7465
February 8, 1977

SCHEDULE OF EVENTS

Announcement:	By THIS MSR Week 6, AP 710 (2-11-77)
Start Shipments To Customers:	Week 9, AP 710 (3-1-77)
Demo Availability:	Week 9, AP 710 (3-1-77)
P.A.L. Initial Quote:	3 Weeks
Probe Spec. Sheet:	Week 12 (3-20-77)

Beaverton Personnel

Engineering:	Bob Johnson
Manufacturing:	Tom Thayer
Marketing:	Earl Williams
Advertising:	Maury Floathe
Service Support:	Max Brown

Earl Williams
Accessories Marketing
Service Instrument Division
58/129 Ext. 7465
February 8, 1977

Tektronix®
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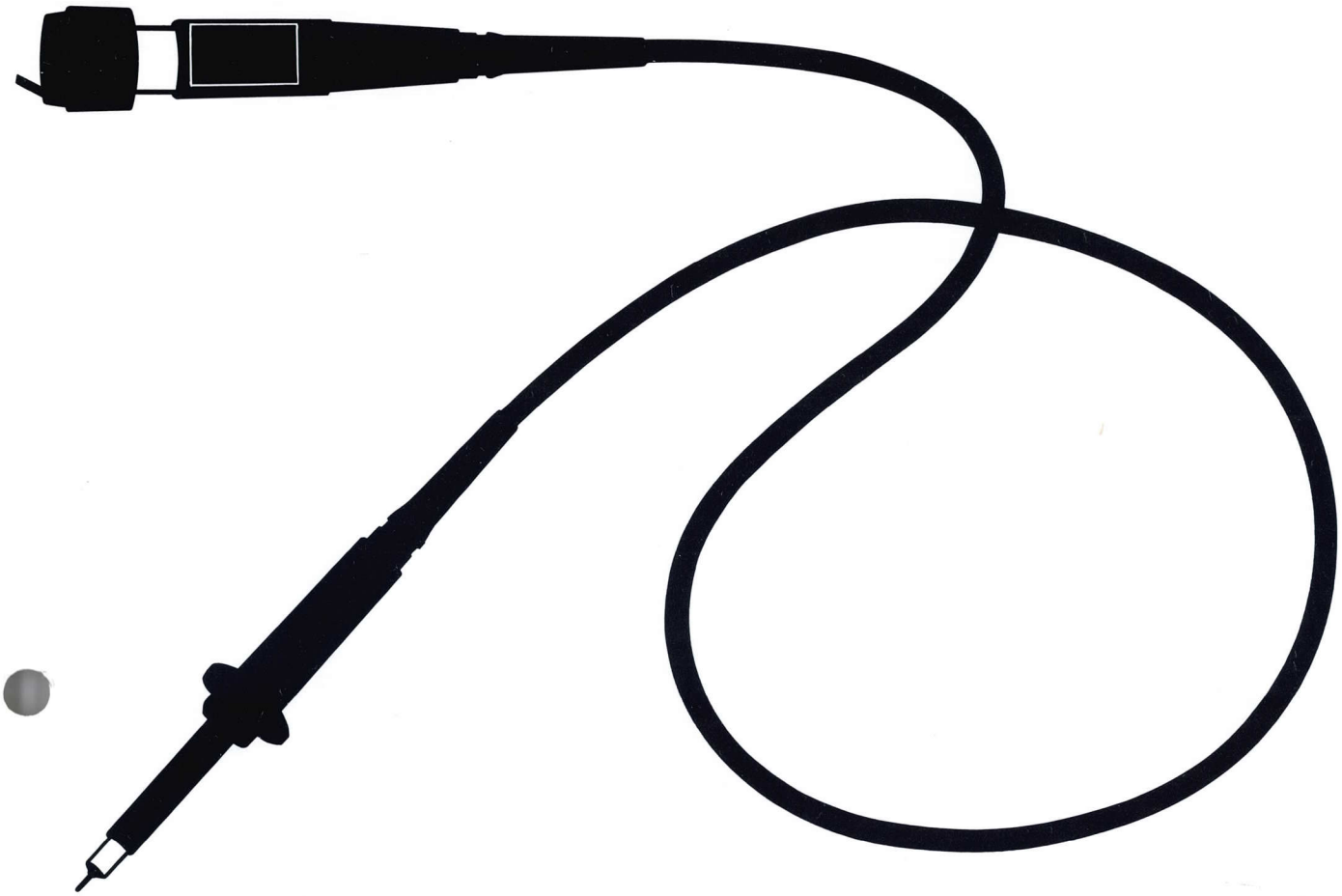
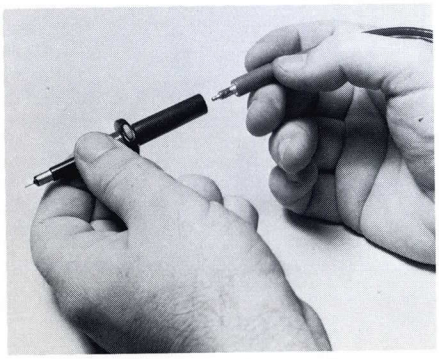
Modular Probes P6101, P6105, P6106, P6108 and P6149



Simplified, Faster Maintenance and Repairs
High Fidelity Signal Acquisition at Low Cost
Rugged for Greater Reliability
Available in Three Lengths



Modular parts snap together

The wide variety of TEKTRONIX Modular Probes gives you a choice of the price/performance combination suited to your needs. Your selection ranges from low-cost, low frequency 60 MHz probes to high performance, high frequency 300 MHz probes with readout and ground reference.

These five modular, miniature, general-purpose probes represent an exciting new concept in probe design. Each divides into three modules (probe head, cable, and connector/compensation box) which snap together, eliminating soldering irons and tools. Because spare modules can be ordered and stocked, modular probes do not have to be sent in to be repaired. This makes maintenance and repair less expensive, faster, and much easier. And strain relief and modular component design make these probes rugged for greater reliability.

The P6101 is a 1X, 1 MΩ probe. The P6105, P6106, P6108 and P6149 are 10X, 10 MΩ probes. When used with oscilloscopes equipped with vertical scale or crt readout, the P6105 and P6106 will automatically scale the readout by a factor of 10. Also ground level can be determined on the display simply by pushing a button on the probe head. And all five probes may be used to acquire high fidelity signals from low source impedance circuits.

The P6101, P6105, P6106 and P6108 are available in three lengths identified by the colored strain relief at the end of the cable—blue for one meter, yellow for two meters, and red for three meters. (The P6149 is two meters long.)

TEKTRONIX Modular Probes are designed for specific TEKTRONIX Instruments but may be purchased as options for all TEKTRONIX Oscilloscopes with 1 MΩ and appropriate pF inputs as indicated on the reverse side. The P6105 is standard with both portable and rackmount TEKTRONIX 434, 455, 465, and 465 DM 44 Oscilloscopes. The P6106 is standard with the TEKTRONIX 475 and 475A Oscilloscopes. The P6108 is standard with the TEKTRONIX T932 and T935 Oscilloscope and the P6149 is standard with TEKTRONIX 300-Series Oscilloscopes.

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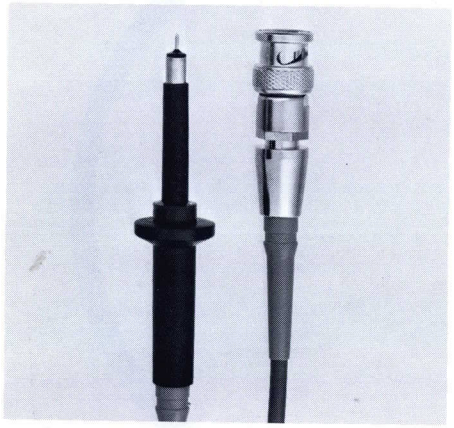
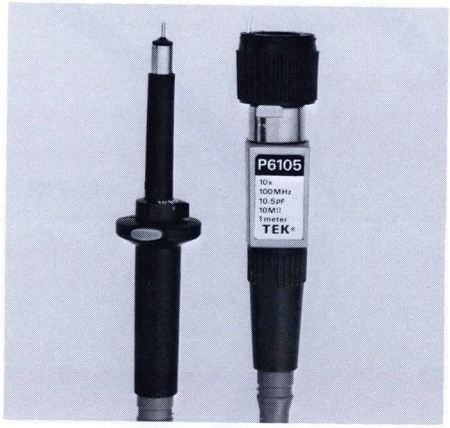
Modular Probes P6101, P6105, P6106, P6108 and P6149

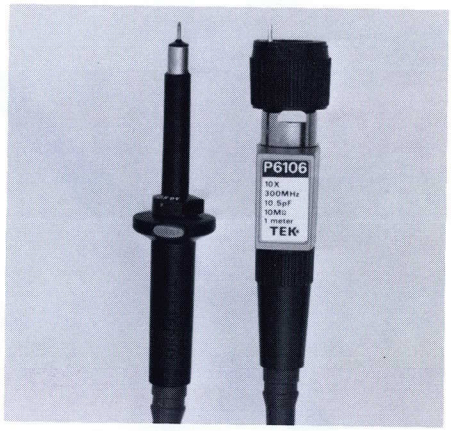
Type	Attenuation	Length	Package Number	Loading		Useful BW MHz	Dc Max	Scope C in pF	Readout
P6101	1X	1 m 2 m 3 m	010-6101-01 010-6101-03 010-6101-05	1 MΩ	32 pF 54 pF 78 pF	34 15.5 8	500 V	ANY	——
P6105	10X	1 m 2 m 3 m	010-6105-01 010-6105-03 010-6105-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V	15 to 47	YES
P6106	10X	1 m 2 m 3 m	010-6106-01 010-6106-03 010-6106-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	300 250 150	500 V	15 to 24	YES
P6108	10X	1 m 2 m 3 m	010-6108-01 010-6108-03 010-6108-05	10 MΩ	10.5 pF 13.0 pF 15.5 pF	100 100 95	500 V	15 to 47	NO
P6149	10X	2 m	010-6149-03	10 MΩ	15.5 pF	60	500 V	20 to 62	NO



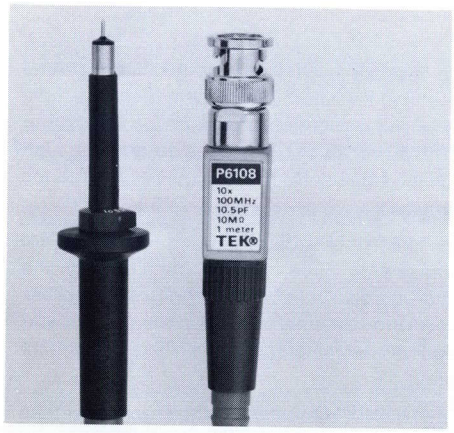
P6101, 1X Probe, 2 m
Order 016-6101-03 ..... **$34**
Opt 01, 1 m, Order 016-6101-01 ..... $34
Opt 02, 3 m, Order 016-6101-05 ..... $34



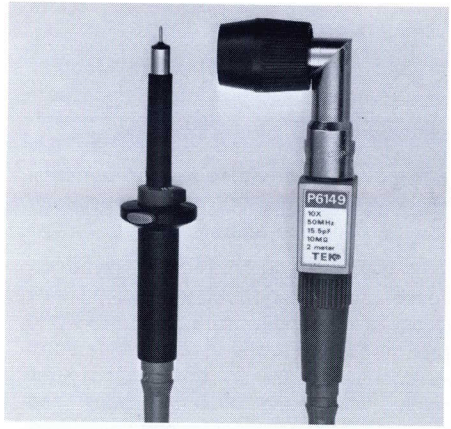
P6105, 10X Probe, 2 m
Order 010-6105-03 ..... **$64**
Opt 01, 1 m, Order 010-6105-01 ..... $64
Opt 02, 3 m, Order 010-6105-05 ..... $64



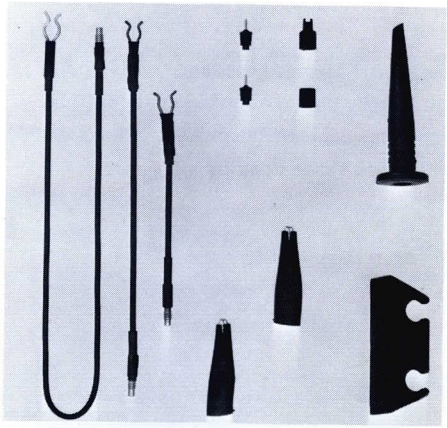
P6106, 10X Probe, 2 m
Order 010-6106-03 ..... **$82**
Opt 01, 1 m, Order 010-6106-01 ..... $82
Opt 02, 3 m, Order 010-6106-05 ..... $82



P6108, 10X Probe, 2 m
Order 010-6108-03 ..... **$49**
Opt 01, 1 m, Order 010-6108-01 ..... $49
Opt 02, 3 m, Order 010-6108-05 ..... $49



P6149, 10X Probe, 2 m
Order 010-6149-03 ..... **$61**



Included Accessories:

175-0125-01	1 LEAD, ground, 30 cm (not included with P6106)
175-0124-01	1 LEAD, ground, 13 cm
175-0263-01	1 LEAD, ground, 7.6 cm (P6106 only)
————*—	2 TIPS, probe
————**—	1 TEST TIP, integrated circuit
166-0404-00	1 SLEEVE, insulating
344-0046-00	2 CLIPS, miniature alligator
013-0107-03	1 TIP, retractable hook
052-0351-00	1 PROBE HOLDER

*Available in packs of 10 (206-0191-01) or packs of 100 (206-0191-02) only.
**Available in packs of 10 (015-0201-01) or packs of 100 (015-0201-02) only.

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2/77

A-3502

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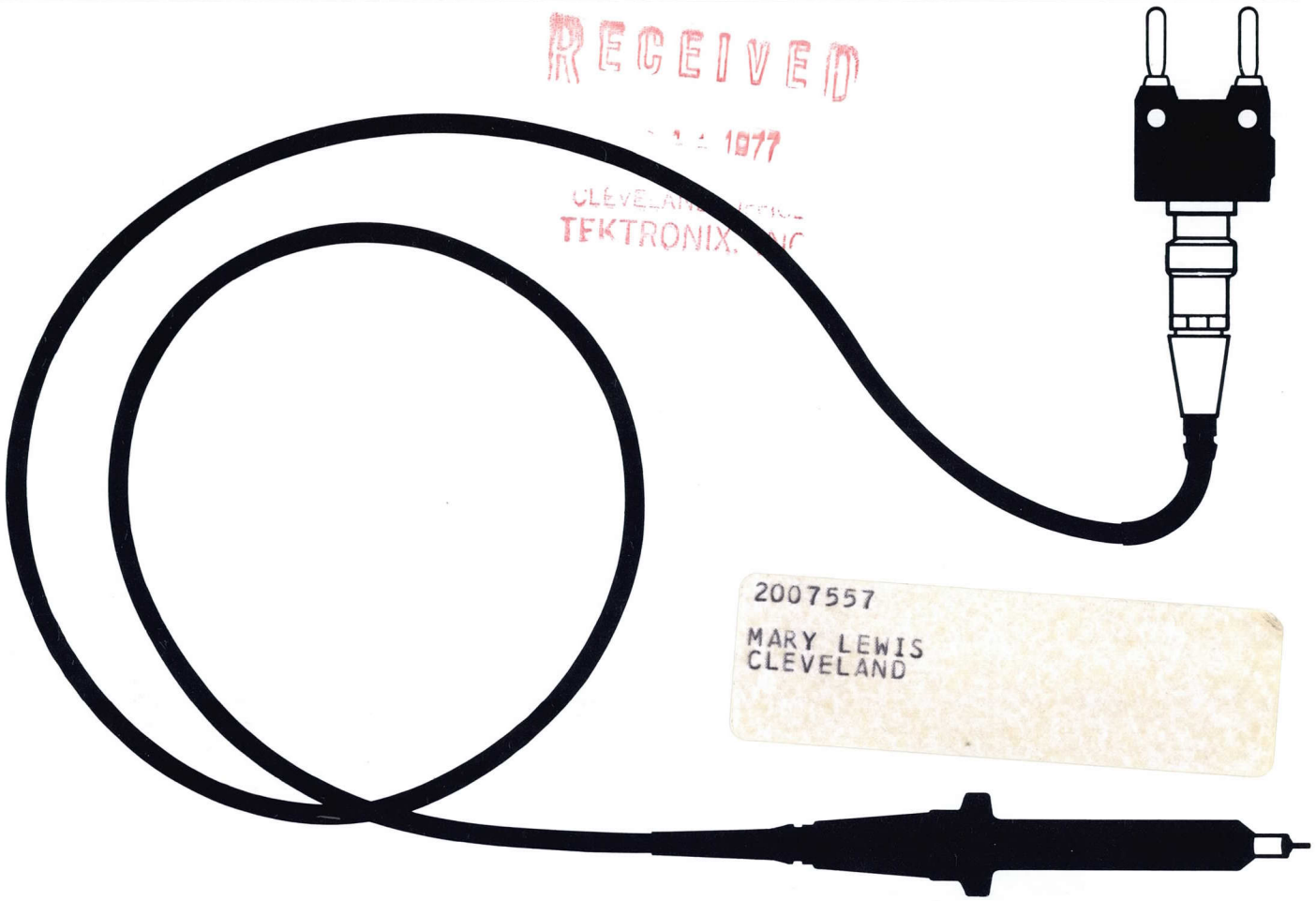
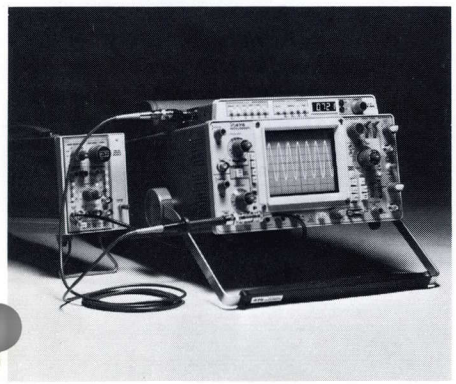
P6420 Rf Probe

RECEIVED
1977
TEKTRONIX
2007557
MARY LEWIS
CLEVELAND



Modular Construction
Converts Dc Voltmeters to High-Frequency Ac Voltmeters
Frequency Range of 10 kHz to 1 GHz
Flat Frequency Response
Compatible with Digital Multimeters
Uses Most Standard Miniature Probe Tip Accessories



The P6420 Rf Probe conveniently converts 10 MΩ input dc voltmeters into high-frequency ac voltmeters by producing a dc voltage equal to the rms value of a sine wave input over a frequency range of 10 kHz to 1 GHz.

The P6420 can be used in communications to sweep test filter and amplifier bandwidths. Because of the flat frequency response of the P6420, the output flatness of a sine wave generator can be easily measured. In another application, the flatness of a circuit can be checked by applying the output of the sine wave generator to the circuit . . . while the output is simultaneously measured with the P6420.

Designed to be used with digital multimeters which have 10 MΩ inputs, the P6420 is compatible with the TEKTRONIX DM 44, DM 501, DM 502 and 7D12/M1. When used with oscilloscopes which have 1 MΩ inputs and other types of dc-sensing instruments with input resistance other than 10 MΩ, the output is directly proportional to the input but not equal to the rms value.

This new probe is easy to repair. The cable easily unplugs from the probe body and the BNC connector. And the P6420 uses the same modular cable and the same cable BNC connector as the other TEKTRONIX Modular Probes. For added convenience of repair, the circuit board in the probe body is replaceable.

The miniature probe-tip size allows the P6420 to use most of the standard TEKTRONIX miniature probe tip accessories such as the probe tips, adapters, and probe holders designed to fit on the TEKTRONIX Modular Probes.

The standard length of the P6420 is two meters. However, one and three meter length cables, which do not alter the performance, can be purchased separately.

Call your nearest field office to order the P6420 or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077.

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P6420 Rf Probe

Specifications

Voltage Range
.5 V to 25 V rms (70.7 V p-p)

Ac to Dc Transfer Ratio Accuracy
0.5 V to 5 V rms ±10% (15° to 35° C)
5.0 V to 25 V rms ± 5% (15° to 35° C)

Frequency Response
100 kHz to 300 MHz (±0.5 dB)
50 kHz to 500 MHz (±1.5 dB)
10 kHz to 1 GHz (±3.0 dB)

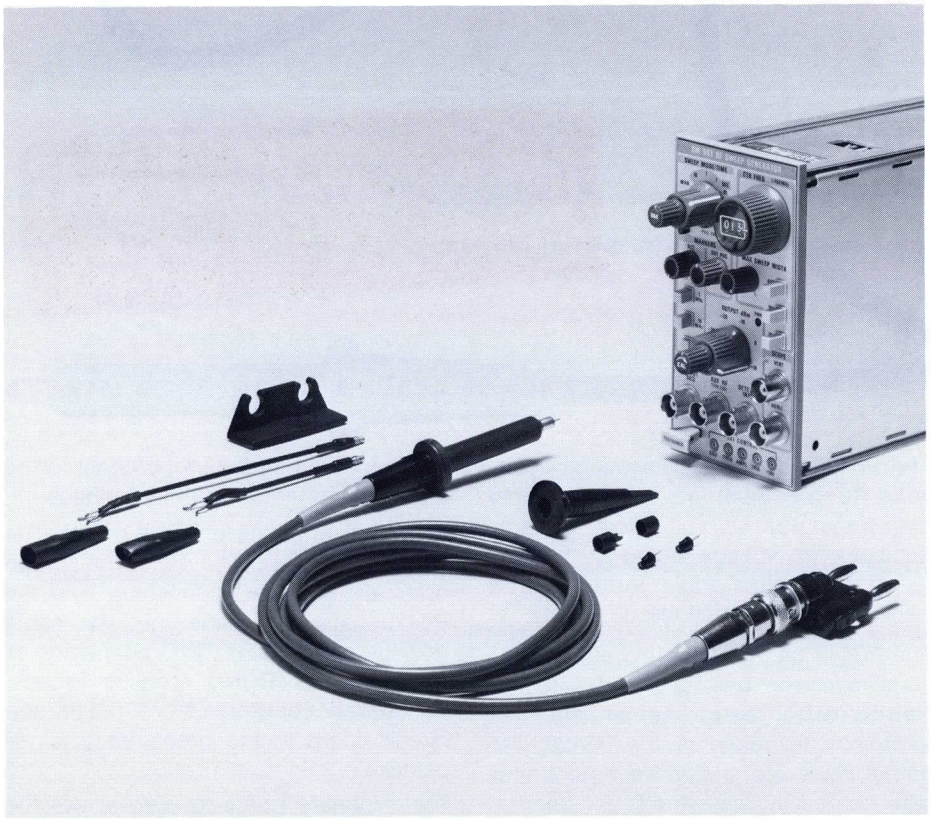
Input Capacitance
approximately 3.7 pF

Maximum Input Voltage
42.4 V (peak ac + dc)

Temperature Range
Nonoperating –55° to +75° C
Operating +15° to +35° C

Length
Probe Only 9.6 cm
Cable Only 200 cm

Ordering Information
P6420 Probe Package, includes a 2 meter length cable,
Order 010-6420-03 .....$85



Package Includes:
1 Probe Tip: Retractable hook assembly
1 Elec Lead: Probe ground 8 cm
1 Elec Lead: Probe ground 13 cm
2 Elec Clips: Alligator type with cover
1 Probe Tip: IC Test
1 Probe Holder
2 Probe Tips
1 Elec Insulating Sleeve: for 0.188 dia probe nose
1 Data Card: Probe Accessory
1 Accessory Pouch
1 BNC to Dual Banana Adapter

Replaceable Modular Parts:
One meter length cable only,
Order 175-1661-00 .....$20
Two meter length cable only,
Order 175-1661-01 .....$20
Three meter length cable only,
Order 175-1661-02 .....$20
BNC connector,
Order 103-0189-00 .....$14
Probe lead,
Order 206-0236-00 .....$46
Circuit board,
Order 206-0236-01 .....$35

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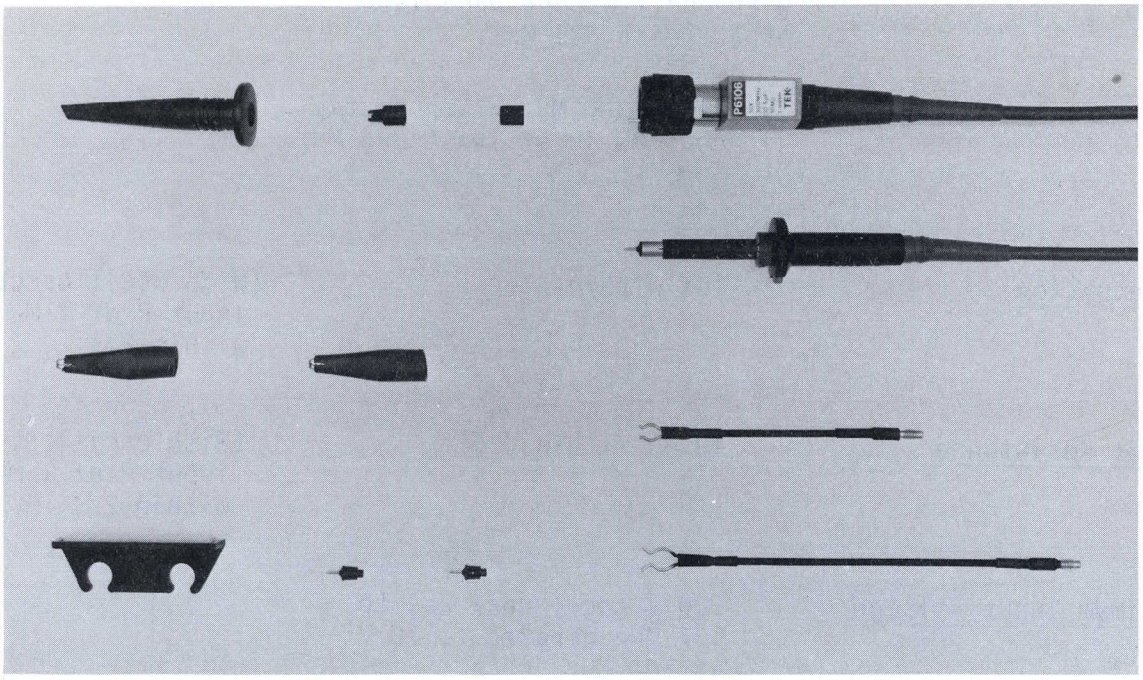
MARKETING SALES RELEASE

FILE #622

DATE January 10, 1977

P6106

HIGH-FREQUENCY MODULAR PROBE



2007599
BOB PADGETT
CLEVELAND

The P6106 is a 300MHz 10X passive probe for DC-to-350 MHz scopes with inputs of 1MΩ and 15 to 24 pf. It's miniature, it's modular, it has readout and ground reference, and is available in cable lengths of one, two, and three meters.

The P6106 will ease the selection of probes for you and your customers by replacing three probes:

P6053B
P6054A
P6075A

The P6106 will be a standard accessory for the Types 475 and 475A Oscilloscopes.

COMPANY CONFIDENTIAL

P6106

PERFORMANCE CHARACTERISTICS

	Bandwidth*	Input Capacitance
1 Meter Cable	≥ 300 MHz†	≈ 10.5 pf
2 Meter Cable	≥ 250 MHz	≈ 13.0 pf
3 Meter Cable	≥ 150 MHz	≈ 15.5 pf

*With oscilloscope bandwidth of at least 325 MHz.

†Typically 300 MHz at probe tip if scope BW is at least 325 MHz

Attenuation	10X within 3%	(With oscilloscope input R of 1 MΩ within 2%)
Input Resistance	10 MΩ within 0.5%	(With oscilloscope input R of 1 MΩ within 2%)
Maximum Input Voltage	500 V (dc + peak ac) to 1.7 MHz derated to 70 V at 100 MHz	
Compensation Range	15 pf to 24 pf	
Temperature Range		
Storage	-55°C to +75°C	
Operating	-15°C to +75°C	
Altitude		
Storage	To 50,000 feet	
Operating	To 15,000 feet	

READOUT & GROUND REFERENCE

The P6106 has a ground-reference push button on the probe body, and a coding pin on the BNC output connector to encode the probe's 10X attenuation on those scope types that have CRT or knobskirt readout. The output connector is compatable with all BNC input connectors.

3 COLOR-CODED CABLE LENGTHS

The probe head, compensation box, and cable are color coded to distinquish the three lengths the P6106 is available in: blue for one meter, yellow for two meters, and red for three meters.

MODULAR CONSTRUCTION

As with our other type modular probes, the P6106 probe head and compensation box easily unplug from the cable for convenient repair or replacement.

P6106	Probe Head $32	Compensation Box $47	Cable $20
1 meter	206-0216-00	206-0237-00	175-1661-00
2 meter	206-0217-00	206-0238-00	175-1661-01
3 meter	206-0218-00	206-0239-00	175-1661-02

OBSOLESCENCE SUPPORT PROGRAM

The standard six-year support program for the three probe types replaced* by the P6106 starts February 7th, 1977; they are as listed:

Type P6053B	Type P6054A	Type P6075A
010-6053-11	010-6054-11	010-6075-12
010-6053-12	010-6054-13	010-6075-13
010-6053-13	010-6054-15	010-6075-16 (IBM only)
010-6053-15	010-6054-16 (IBM only)	

* At the present build schedule and order rate, we'll still have some of these three probe types on hand and for sale at the time the P6106 shipments start next February. We'll continue to list them on the "PAL" as being available in "limited supply" until the stock is depleted.

Standard Accessories Included

2	Probe Tips [1]	--- ---- --
1	Retractable Hook Tip	013-0107-03
2	Minigator Clips	344-0046-00
1	13 cm (5 inch) Ground Lead	175-0124-01
1	7.6 cm (3 inch) Ground Lead	175-0263-01
1	Insulating Sleeve	166-0404-01
1	Integrated Circuit Test Tip (installed on probe) [2]	--- ---- --
1	Probe Holder	352-0351-00
1	Accessory Pouch	016-0521-00
1	Accessory Information Card	062-1803-00
1	Data Sheet	062-2765-00

[1] Available only in packs of 10 by Tek part number 206-0191-01 or in packs of 100 by part number 206-0191-02.

[2] Available only in packs of 10 by Tek part number 015-0201-01, or in packs of 100 by part number 015-0201-02.

PROBE ORDERING INFORMATION

P6106 (With Accessories)

1 meter: Order 010-6106-01 . . . . . $82.00

2 meter: Order 010-6106-03 . . . . . $82.00

3 meter: Order 010-6106-05 . . . . . $82.00

P6106 (Probe only, without accessories)

1 meter: Order 010-6106-00 . . . . . $79.00

2 meter: Order 010-6106-02 . . . . . $79.00

3 meter: Order 010-6106-04 . . . . . $79.00

SCHEDULE OF EVENTS

Announcement:	By News Release Week 1, AP 709 (1-7-77)
Start Shipments To Customers:	Week 5, AP 709 (2-4-77)
Demo Availability:	Week 5, AP 709 (2-4-77)
P.A.L. Initial Quote:	Stock
Probe Spec. Sheet:	Week 2, AP 709 (1-14-77)

Beaverton Personnel

Engineering:	Bob Johnson
Manufacturing:	Tom Thayer
Marketing:	Earl Williams
Advertising:	Maury Floathe
Service Support:	Max Brown

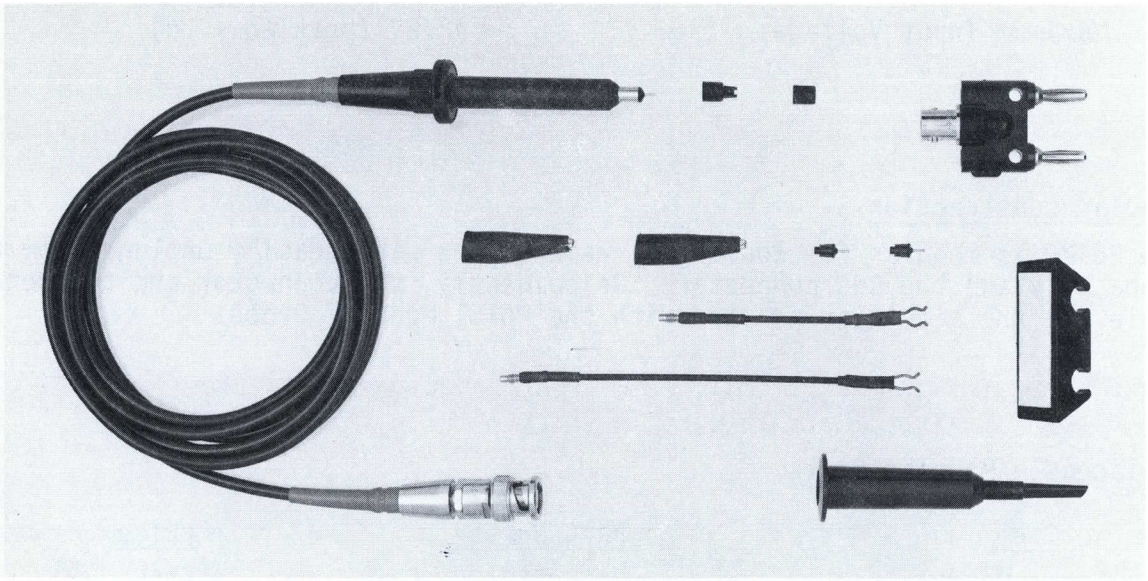
Earl Williams
Accessories Marketing
Service Instrument Division
58/129 Ext. 7465
January 7, 1977

MARKETING SALES RELEASE

FILE #614

DATE December 16, 1976

P6420 R.F. PROBE



The P6420 conveniently converts dc voltmeters into high-frequency ac voltmeters by producing a dc voltage proportional to the rms value of a sine wave input over a frequency range of 10KHz to 1GHz. It's designed to work into dc meters that have an input resistance of 10MΩ, such as our DM501, DM502, DM44.

The P6420 can also be used with 1MΩ-input oscilloscopes and other types of dc-sensing instruments that have an input resistance of less than 10MΩ, but only for relative measurements. This is because a load resistance less than 10MΩ reduces the probe's dc output voltage proportionally and it wouldn't represent the rms value of the ac input.

Of course the user could always calibrate the probe/instrument system by his own methods and standards for absolute measurements.

The P6420's ac-to-dc transfer ratio accuracy is specified for a 10MΩ load only.

COMPANY CONFIDENTIAL

PERFORMANCE CHARACTERISTICS

Voltage Range:	0.5V to 25V RMS (70.7V peak to peak)
Ac to dc Transfer Ratio Accuracy:	(Assuming an input R to the dc meter of 10MΩ within 2%)
0.5V to 5V (rms)	within 10% (15°C to 35°C)
5.0V to 25V (rms)	within 5% (15°C to 35°C)
Frequency Response:	0dB ref. @ 100KHz
100KHz to 300 MHz:	within 0.5dB
50KHz to 500 MHz:	within 1.5dB
10KHz to 1 GHz:	within 3.0dB
Input Capacitance:	Approximately 3.7pF.
Maximum Input Voltage:	42.2V (peak ac + dc)

Modular Construction

The P6420 is modular for convenient repair: the cable easily unplugs from the probe body and the BNC connector. Coincidently, the connector and two-meter cable are the same type as used with the P6101 Modular Probe.

Replaceable Modular Parts

Item	Part Number	Price
Probe Head	206-0236-00	$46
Cable	175-1661-01	$20
BNC Connector	103-0189-00	$14

The circuit board in the probe head is also replaceable:

Item	Part Number	Price
Probe Head Sub-assembly (Circuit board)	206-0236-01	$35

Accessories

The P6420 has the same size body as a P6202 which is larger in diameter than our standard miniprobe body. However, the P6420 has the same size tip as a miniprobe and will accept all the standard miniprobe accessories except those designed to fit over the probe body.

A larger-diameter retractable hook tip is supplied with the P6420.

Cable Options

The P6420 is supplied with a two-meter-length cable but one-meter and three-meter length cables can be ordered separately and used with the P6420 without altering its performance.

1 meter cable	175-1661-00
3 meter cable	175-1661-02

ORDERING INFORMATION

P6420 Order 010-6420-03 . . . . . .$85

Standard Accessories Included

1	Tip, Probe: Ret Hook Ass'y	013-0097-01
1	Lead, Elec: Probe Gnd 8 cm (3 inch)	175-0849-00
1	Lead, Elec: Probe Gnd 13 cm (5 inch)	175-1017-00
2	Clip, Elec: Minigator w/cover	344-0046-00
1	Tip, Probe: IC Test	--- ---- --[1]
1	Holder, Probe	352-0351-00
2	Tip, Probe	--- ---- --[2]
1	Insul. Slvg, Elec: For 0.188 dia probe nose	166-0404-01
1	Data Sheet	062-2764-00
1	Data Card: Probe Accessory	062-1803-00
1	Accessory Pouch	016-0521-00
1	BNC to Dual Banana Adapter	103-0090-00

[1]Available only in packs of 10, by Tektronix part number 015-0201-01, or in packs of 100 by part number 015-0201-02.

[2]Available only in packs of 10 by Tektronix part number 206-0230-01, or in packs of 100 by part number 206-0230-02.

Schedule of Events

Announcements:	By this MSR, and a News Release in Week 50, AP707 (12-17-76)
First shipments to customers:	Week 50, AP708 (12-17-76)
Demo Availability:	Week 50, AP708 (12-17-76) Order from stock.
P.A.L. initial quote:	Stock
Probe Spec. Sheet #A 34500	Week 51, AP708 (12-20-76)
News Release:	Week 50, AP708 (12-17-76)

Beaverton Personnel

Engineering:	Bob Johnson
Manufacturing:	Tom Thayer
Marketing:	Earl Williams
Advertising:	Maury Floathe
Service Support	Max Brown

Earl Williams
Accessories Marketing
Service Instrument Division
58/129 Ext. 7465
December 2, 1976

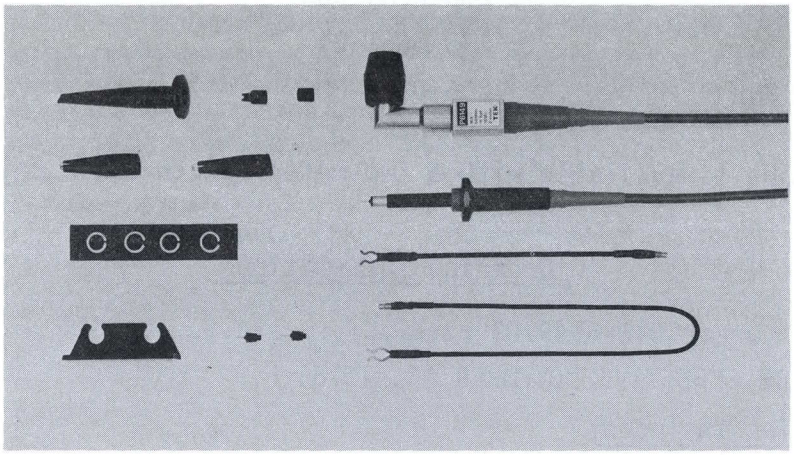
MARKETING SALES RELEASE

FILE

DATE November 2, 1976

P6149 MODULAR PROBE

NOW AVAILABLE. Manufacturing can support the expected demand.



The P6149 10X 50MHz passive probe is the latest addition to the growing family of Tektronix modular probes. It has a two-meter length cable and a right-angle BNC on the compensation box for easy connection to Sony/Tektronix portable oscilloscopes.

The P6149 replaces the P6049B and will be shipped as a standard accessory with all Sony/Tektronix 300-Series Oscilloscopes.

SPECIFICATIONS

Attenuation	10X within 3%	(Assuming oscilloscope input R of 1 MΩ within 2%)
Input Resistance	10MΩ within 1.5%	
Input Capacitance	Approximately 15.5 pf.	
Compensation Range	20 pf to 62 pf.	(Covers input C for both the VERTICAL and EXTERNAL TRIGGER inputs of 300-Series scopes)
Bandwidth	DC to at least 50MHz.	
Maximum Input Voltage	500 V (dc + peak ac) to 1.7 MHz derated to 30 V at 50 MHz.	

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The P6149 probe has a ground reference push button on the probe body.

Modular construction of the probe simplifies repairs, as both the probe body and compensating box can be unplugged from the cable for replacement.

Replaceable Modular Parts

Item	Part Number	Price
Probe Body	206-0234-00	$22*
Cable	175-1661-01	$20*
Compensation Box	206-0235-00	$37*

The P6149 Probe is available with a two-meter length cable only.

Ordering Information

P6149 Order 010-6149-03 ..... $61*

* PRICES TO BE EFFECTIVE NOVEMBER 15, 1976.

Standard Accessories Included

1	Retractable Hook Tip	013-0107-03
2	Minigator Clips	344-0046-00
1	13 cm (5 inch) Ground Lead	175-0124-01
1	30 cm (12 inch) Ground Lead	175-0125-01
1	Insulating Sleeve	166-0404-01
1	Integrated Circuit Test Tip (Installed on Probe)	----- -----[2]
1	Accessory Pouch	016-0521-00
1	Probe Holder	352-0351-00
1	Accessory Information Card	062-1803-00
1	Data Sheet	062-2766-00
2	Probe Tip	----- -----[1]
2	Band, Marker (Silver Gray)	334-2794-02
2	Band, Marker (Gray)	334-2794-03

[1]Available only in packs of 10, Tektronix part number 206-0191-01.

[2]Available only in packs of 10, Tektronix part number 015-0201-01 or packs of 100 part number 015-0201-02.

Obsolescence Support Program

The standard six-year support program for the now replaced P6049B Probe, 010-6049-11, starts October 22nd, 1976.

Schedule of Events

Announcement:	By this MSR; none direct to customer.
First shipments to customers:	Week 42, 706 (October 18th, 1976)
Demo Availability:	706; order from stock.
P.A.L. initial quote:	Stock.
Brochure: Will be included in comprehensive revision of Modular Probe-family brochure.	Week 5, 709 (January 4th, 1977)
News Release:	None planned.

Beaverton Responsibilities

Engineering:	Bob Johnson
Manufacturing:	Tom Thayer
Marketing:	Earl Williams

Earl Williams
Accessories Marketing
Service Instrument Division
58/129 Ext. 7465
October 18, 1976

#597

MARKETING SALES RELEASE

FILE

DATE October 25, 1976

CORRECTION TO P6302 DATA SHEET

(062-2322-00 Dated Sept. 1976)

The intent was not to have a "probe only" part number set up and available for the customer. Inadvertently, a probe only number was published in the data sheet. This number, 010-6302-00 will not be available. This number is also in the N.P.R. -- it's status will change to "Replaced by" 010-6302-01.

The probe package, 010-6302-01, contains the probe, two ground leads, and two alligator clips. The difference in sale price between the probe only and probe package would be only about $1. The probe package is priced at $305.

The data sheet will be changed, although there may be some data sheets with the 010-6302-00 probe only number sent with probes until they can be corrected.

The marketing specification sheet will be distributed the week of October 25, 1976. (P6302/AM503)

Shipments will start the week of October 18, 1976. The PAL is 7 weeks. (P6302/AM503)

Ordering information:

P6302 current probe, 010-6302-01.....$305

Ron Lang
5133
58-129

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CLEVELAND OFFICE
TEKTRONIX, INC

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