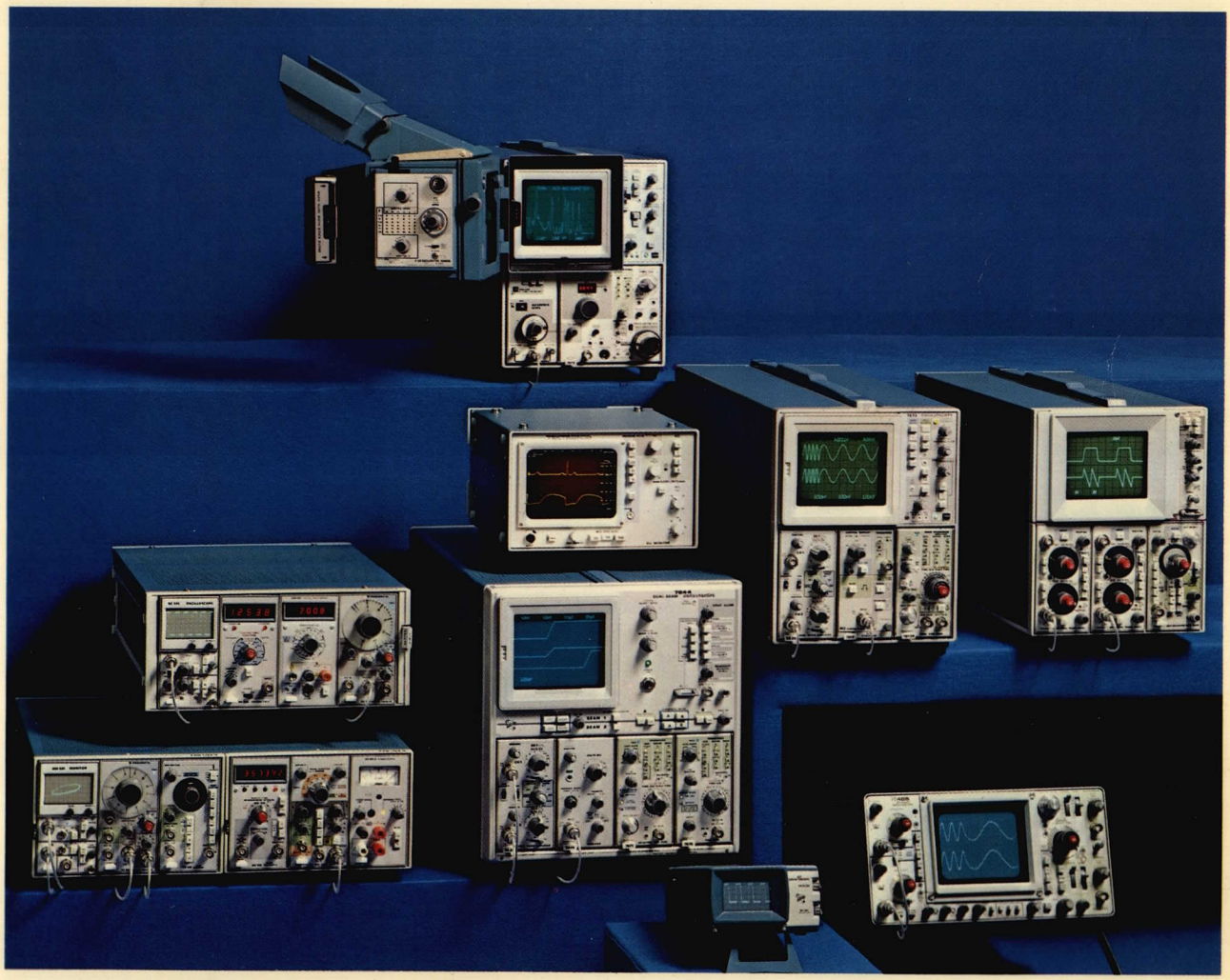
TEKTRONIX®

committed to technical excellence

1975 PRODUCTS



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Cleveland F.O.

MARY, LEWIS

FOR DESK RACK USE

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5000-Series Oscilloscopes—
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Portable Oscilloscopes—Two new storage models and a new Miniscope. Digital multimeter capability added

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Spectrum Analyzer—
New low frequency plug-in

TELEQUIPMENT Oscilloscopes—
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A handy reference to the right pages if your best clue is merely part of a product description or how a product is used.

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Sometimes our customers don't realize what an active part they play in Tektronix products and policies.

Because of this, we want to explore your role before you look at us this year. We feel your job is just as important as ours.

After all, you're the one who uses our ideas, products and services.

The products are described in this book. The ideas and services are synonymous with the 12,000 people at Tektronix . . . where each individual is encouraged to develop his own potential by giving you the best value for your needs.

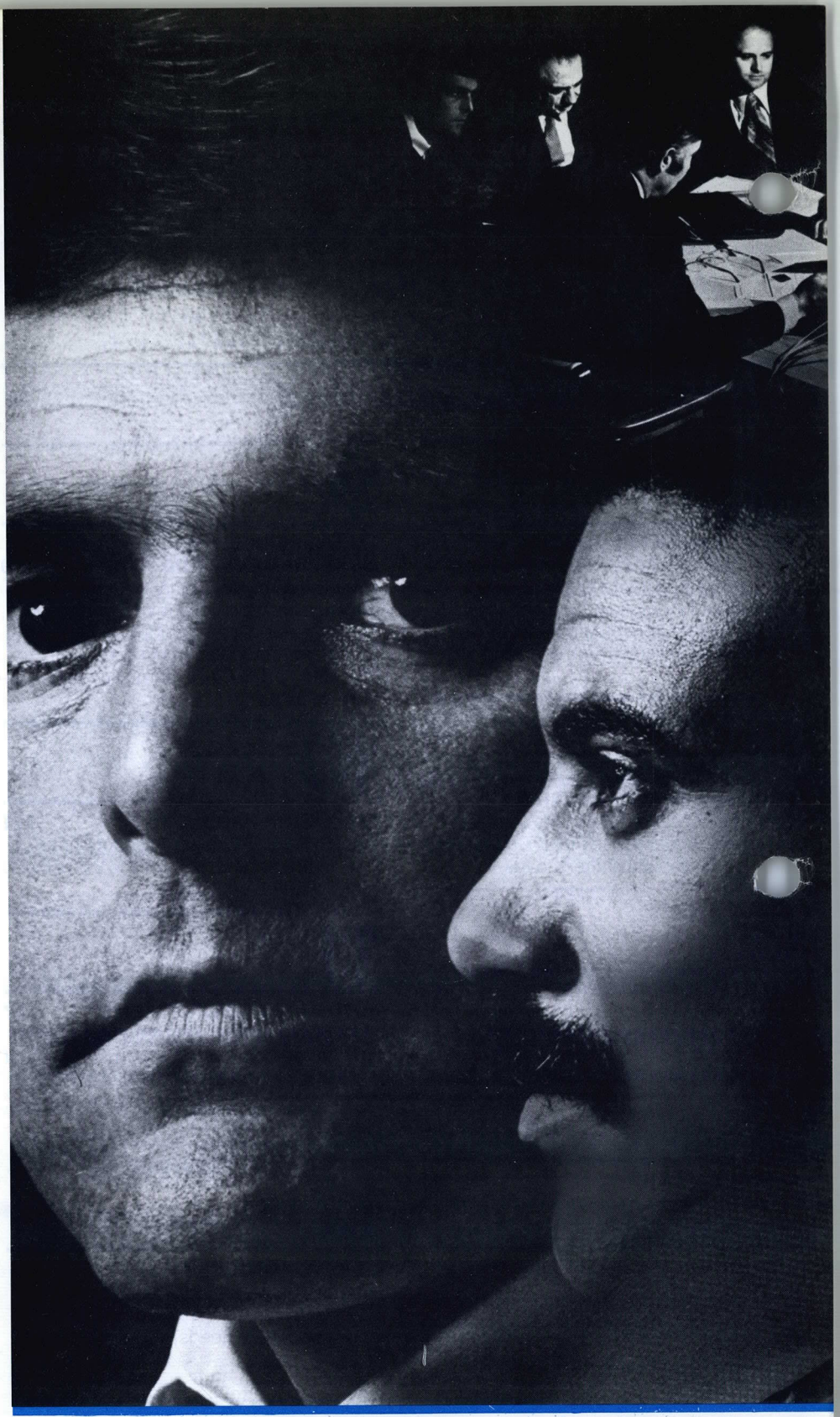
We look to your needs and technological challenges to motivate all our efforts. As a customer, you have a share in these goals.

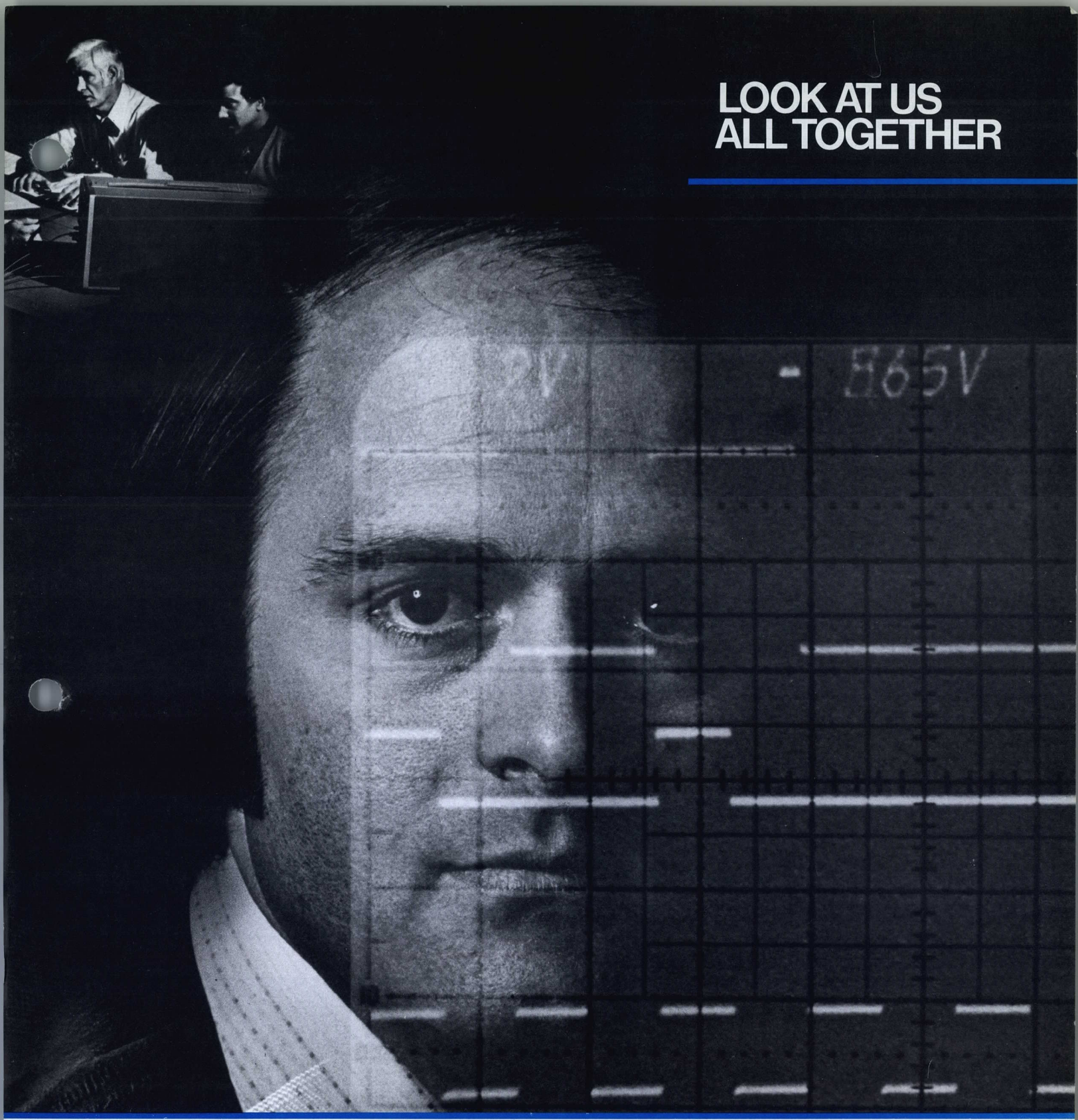
You, too, have measureless talents to be challenged. You, too, have value on your mind when you scan products. You, too, want products of the highest technological ingenuity to fit your needs.

In fact, to really understand what any product in this book can do, you first think about what you'd *like* it to do.

Chances are, that's what we designed it to do; economically, and reliably.

Look at us altogether: your needs and our product capability. Bringing your needs and our product capability together is the primary purpose of this book.




LOOK AT US
ALL TOGETHER

When you need an oscilloscope, we try to make the decision to buy from Tektronix easy. We realize your scope and accessory requirements are determined after all available product data has been researched.

This chart ought to make your selection most clear. Begin at the top, and your needs will tell you which arrows to follow.

Once a mainframe is chosen, the page references will lead you to helpful plug-in charts.

On down the line, it remains true: with every dollar, you buy just the capability you need. State-of-the-art technology means economy as well as performance. And plug-in design allows expansion with a minimum additional outlay.

Other accessories (p. 174) solve specialized probing problems, and provide probe power sources and amplifiers.

We want to make it easier for you to broaden your scope.

HOW TO CHOOSE THE RIGHT OSCILLOSCOPE

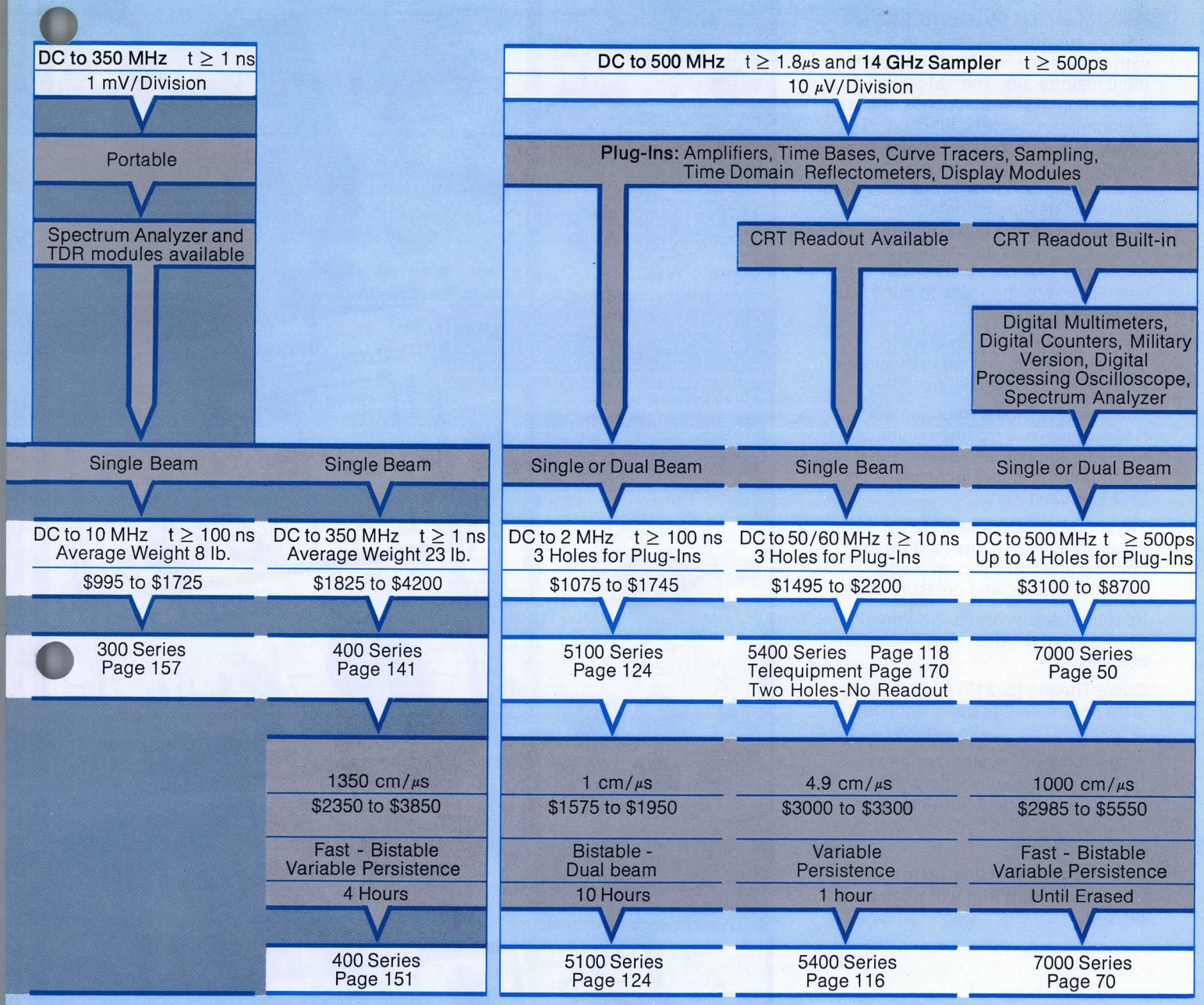
Follow the arrows through the various criteria which are most important in your applications. See detailed specifications on pages noted.

CRITERIA OF CHOICE

FREQUENCY, Sweep Rate (t)	DC to 50 MHz t ≥ 10 ns	
SENSITIVITY (maximum)	1 mV/Division	
VERSATILITY	Non-Plug-In	
	Single Beam	Single Beam
		DC to 5 MHz t ≥ 1 μs Average Weight 3.5 lb.
PRICE RANGES	$280 to $1375	$595 to $755
OSCILLOSCOPE LINES	Telequipment Page 167	200 Series Page 161
STORAGE CAPABILITY		
Maximum Writing Speed	0.25 div/μs	0.25 cm/μs
Price Ranges/ Storage Scopes	$1095	$985
Type of Storage	Bistable	Bistable
Maximum View Time	1 Hour	1 Hour
STORAGE OSCILLOSCOPE LINES	Telequipment Page 171	200 Series Page 162

GENERAL PERFORMANCE NOTE:
The maximum performances are generally not simultaneously achieved. For example "Bandwidth=DC-500 MHz—Maximum sensitivity 10 μV/div" does not mean there is an oscilloscope with a bandwidth of DC-500 MHz *at* 10 μV/div.

BROADEN YOUR SCOPE



GENERAL PRICE NOTE:
Price ranges are just for general information.
See actual prices in the catalog. Lowest price is based on a package including a single beam mainframe, one full bandwidth dual trace amplifier and a single time base. Highest price is based on a package including a single or dual beam mainframe, one full bandwidth dual trace amplifier, and a dual time base.

You'll find a big array of instrumentation to meet your measurement and display requirements.

The growing TM 500 line (p. 249) is a flexible system of 28 plug-ins, now with one-, three- and four-compartment mainframes. The TM 500 offers a selection of power supplies, digital multimeters, counters, function generators and compact scope monitors. It can be a bench or portable set-up. Use the TM 500 for electronic design, manufacturing, production testing and education. Besides this you can combine some of these digital capabilities with calculator intelligence with our 31/53 system (p. 315).

Time Domain Reflectometers (p. 101, 111) probe transmission or electrical cable to locate irregularities.

The portable Digital Photometer/ Radiometer (p. 278) tests illumination levels for lighting engineers, street light crews, tv studio technicians and LED manufacturers.

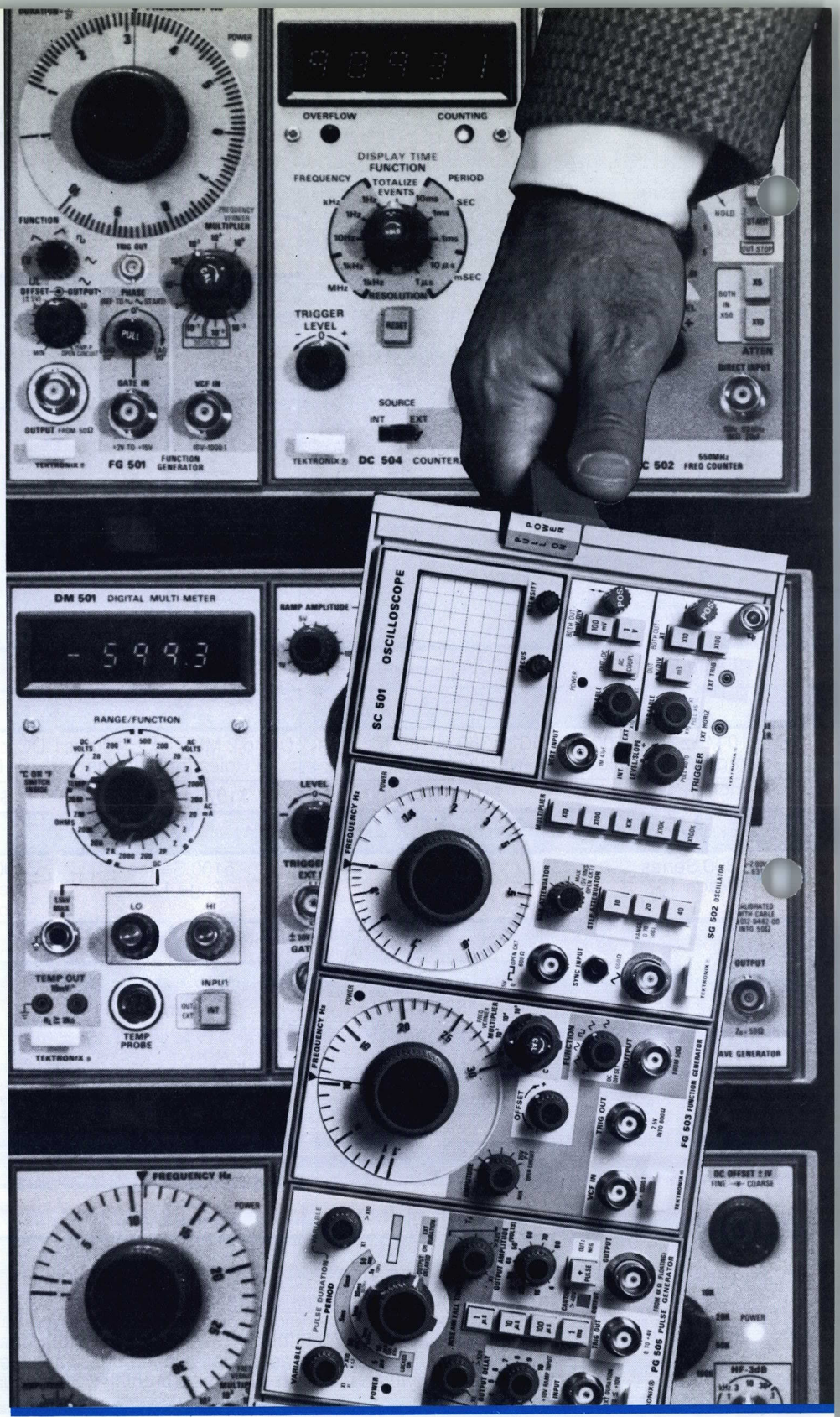
Tektronix offers single and dual trace Physiological Monitors (p. 318) to help the medical clinician read a patient's cardiac and pressure story.

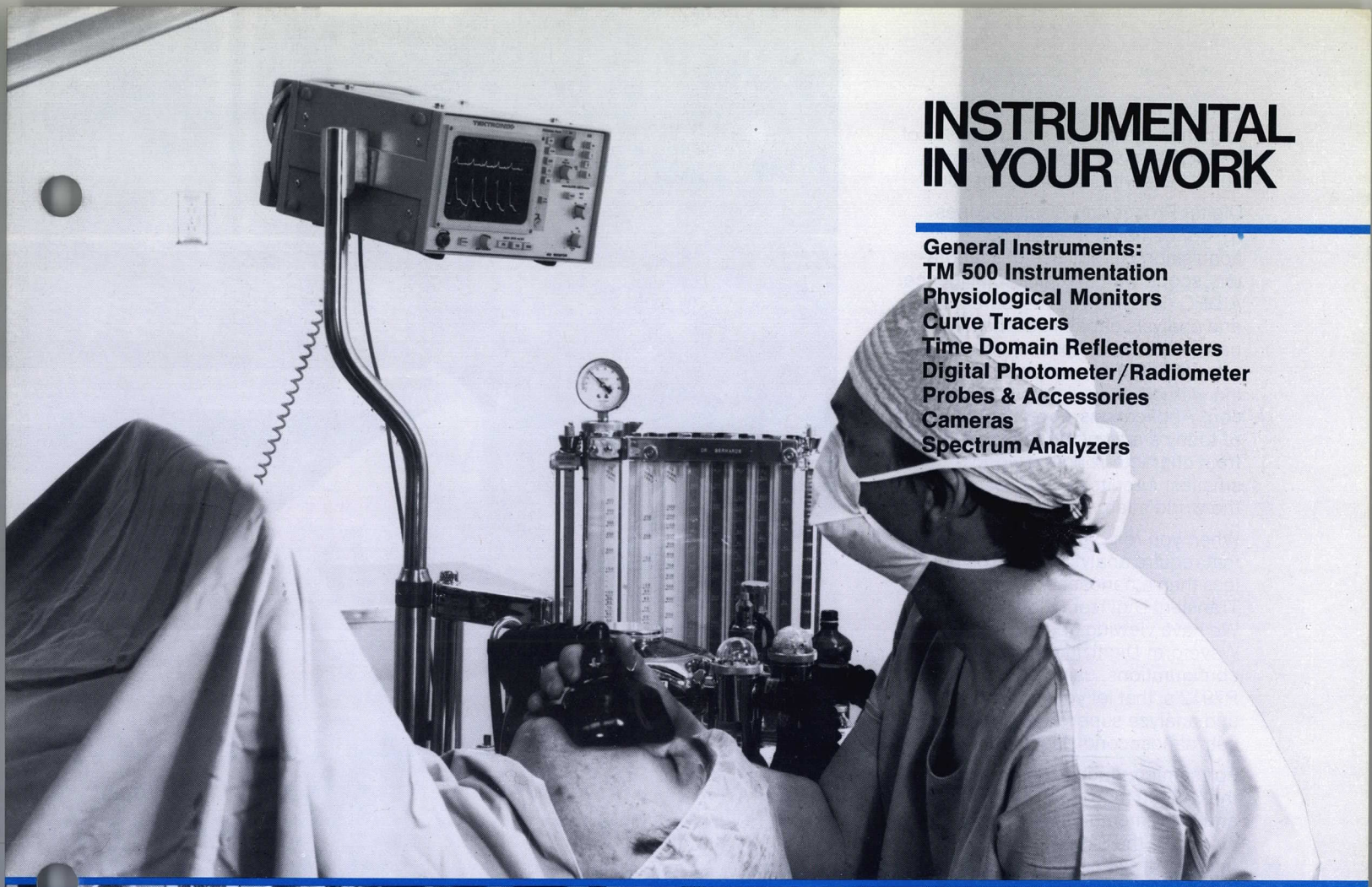
Spectrum Analyzers (p. 201) break events into individual frequencies for analysis.

Curve Tracers (p. 213) display solid-state parameters of transistors, FETs, diodes and ICs.

A special line of custom cameras (p. 229) permanently record the waveforms and data from your oscilloscope, spectrum analyzer or curve tracer.

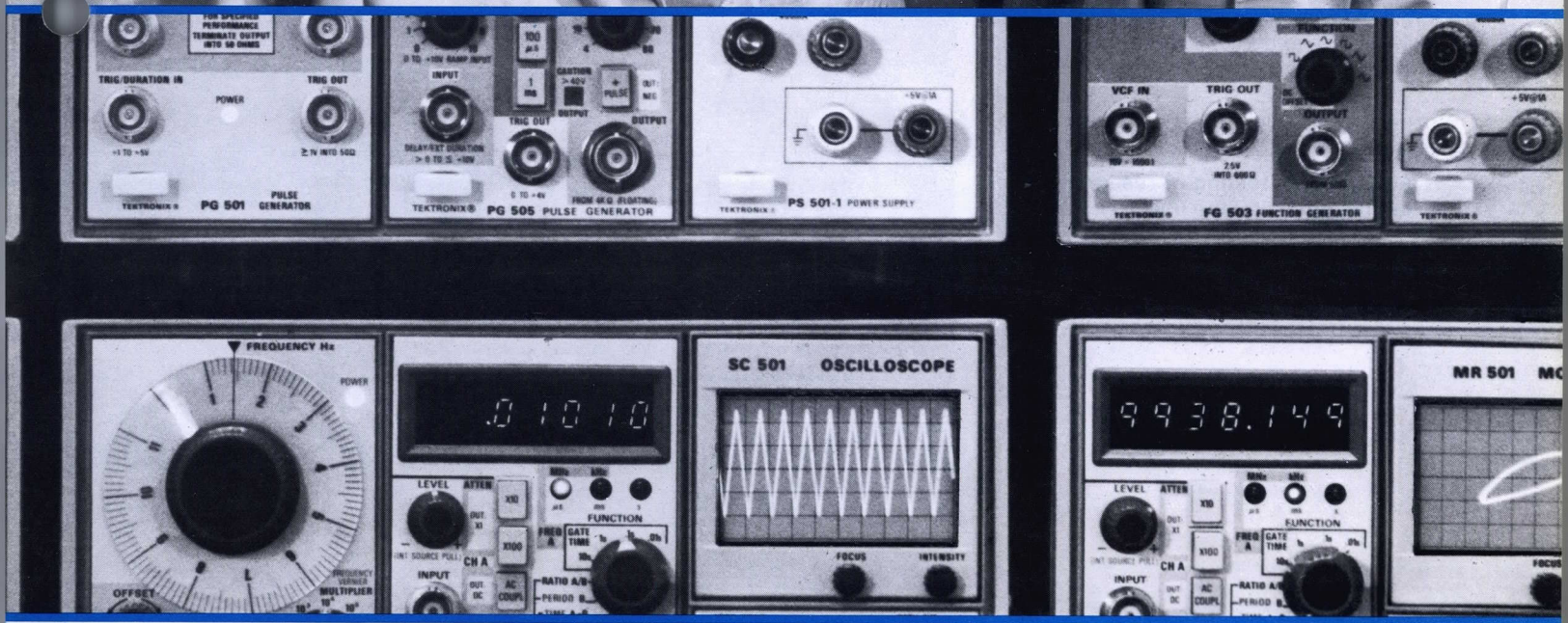
Look through this line-up for instrumentation that will work hard for you.





INSTRUMENTAL IN YOUR WORK

General Instruments:
TM 500 Instrumentation
Physiological Monitors
Curve Tracers
Time Domain Reflectometers
Digital Photometer/Radiometer
Probes & Accessories
Cameras
Spectrum Analyzers



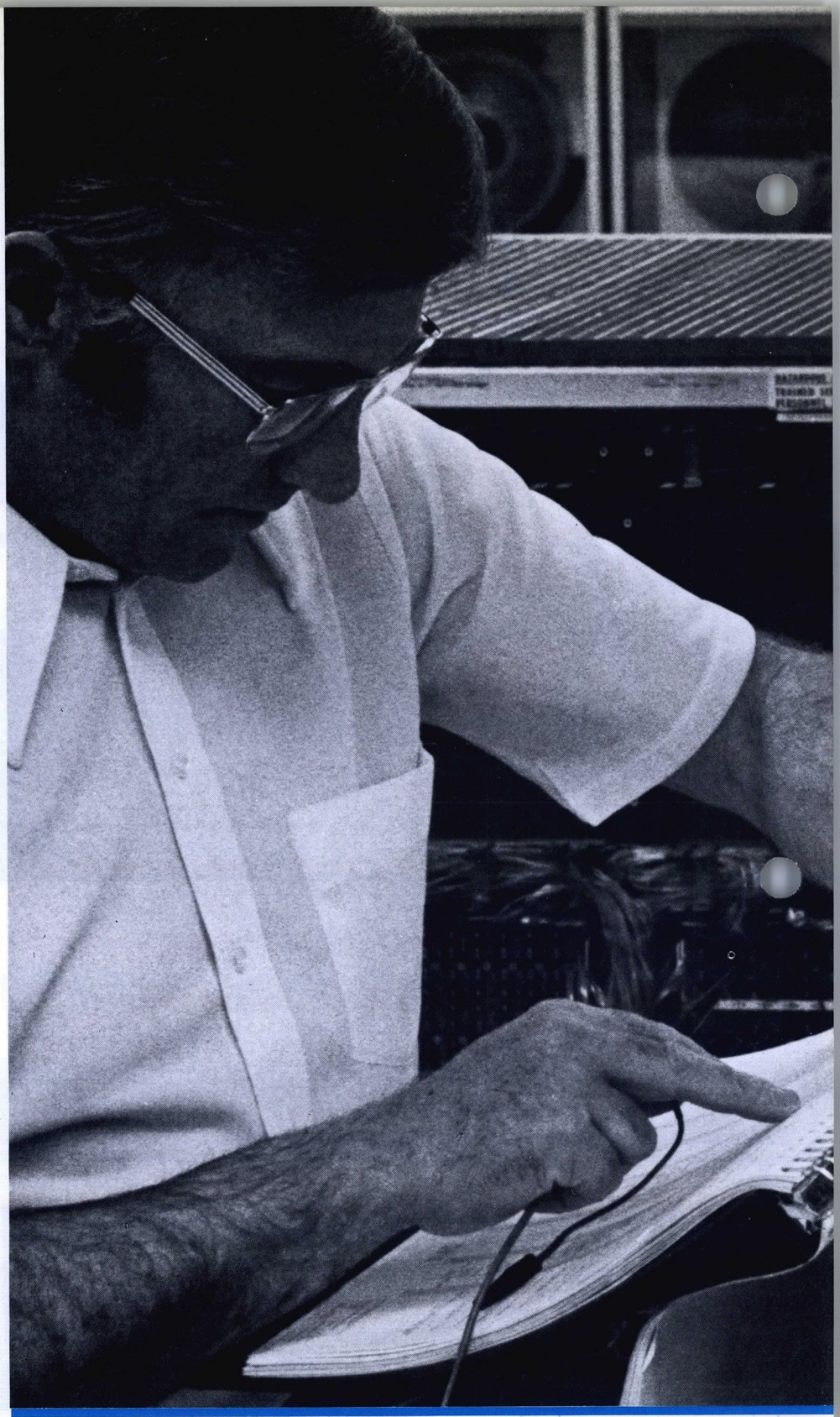
If you're experiencing problems in gathering and analyzing masses of analog data, we have some unique and time-saving solutions for you.

Digital Processing Oscilloscopes (p. 38) combine the flexible acquisition capabilities of a laboratory scope with machine intelligence. A DPO can give you measurement and analysis capabilities that, in the past, were either not available or were too complex and time consuming with other available instrumentation. Applications cover the spectrum of today's advancing technology—from characterizing the world's smallest circuits to troubleshooting the world's largest computers.

When you're confronted with events that require analysis, and exist for less than a nanosecond, the R7912 Transient Digitizer (p. 44) can help. We have viewing and analysis Waveform Digitizing Instrument (WDI) configurations, using one or several R7912's, that let you monitor, digitize, and analyze super-fast signals with sub-nanosecond risetimes.

For semiconductor memory testing, the S-3400 thoroughly tests bipolar and MOS memory IC's (p. 289). We also build the S-3260 (p. 288), an integrated system for testing and engineering analysis of all types of MOS, TTL and ECL devices, circuit modules, and printed circuit boards. With 128 active pins the S-3260 will perform functional and dynamic tests at rates to 20 MHz.

For complex testing or research needs, get us on the line.



THE LINE UP FOR ANALYSIS

Digital Processing Oscilloscopes
Transient Digitizer
Automated Test Systems

If your work is monitoring the quality of tv signals, you are probably already surrounded by Tektronix nameplates.

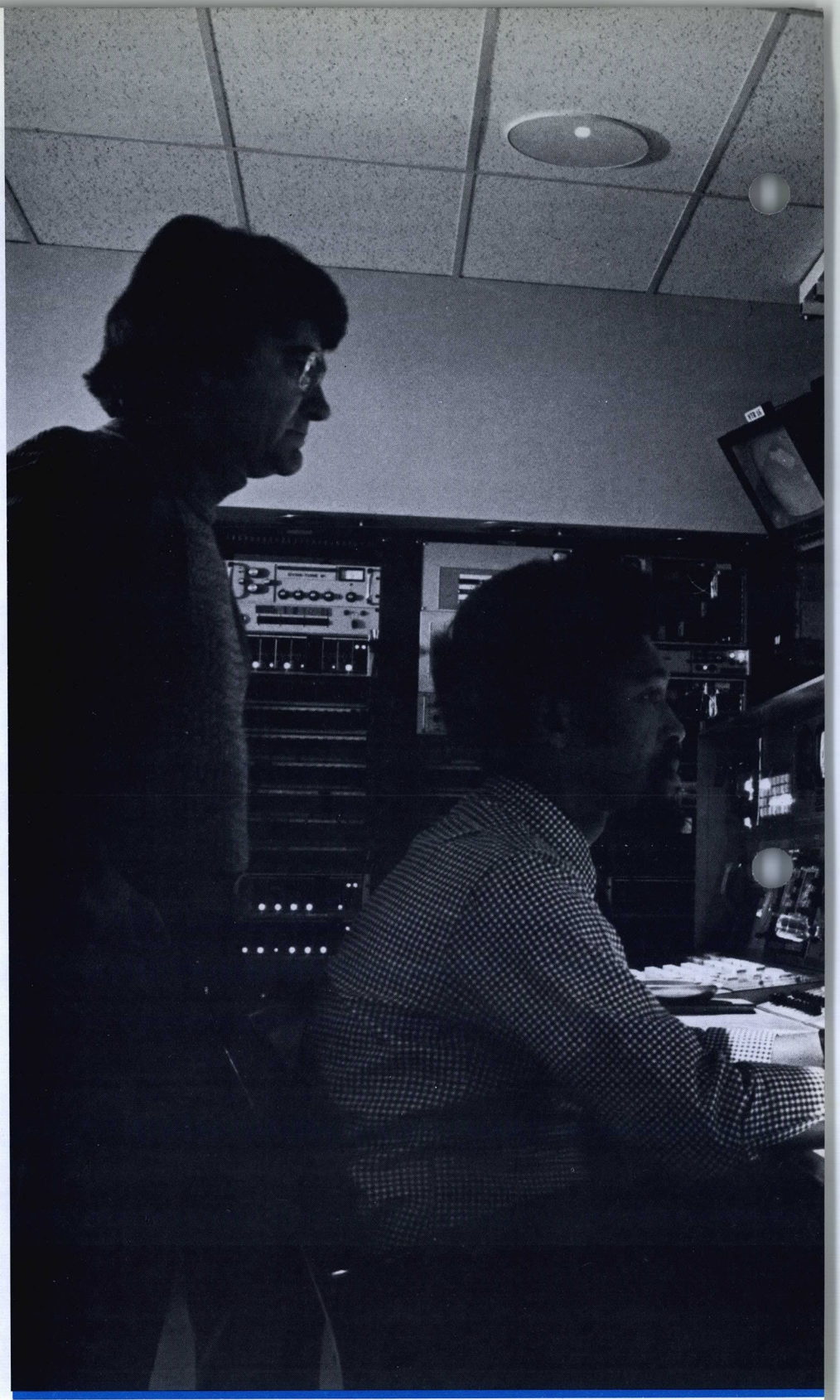
You've also probably grown pleasantly used to "one-store" shopping at Tektronix. You get state-of-the-art electronics for signal quality: signal generators, waveform monitors, and vectorscopes, to conform to every national or international standard under the sun. You get black-and-white and color picture monitors, and you've been welcoming the advanced VIRS Automatic Video Corrector system.

TDRs (p. 101, 111) help you find transmission cable irregularities, while spectrum analyzers (p. 201) and special scopes (p. 281) cope with the special requirements of tv.

Vectorscopes (p. 282) help you examine the chrominance components of video signals, to keep everything precisely in balance.

You'll find us increasingly interested in your requirements, whether your concerns are cable or closed-circuit tv, domestic or international.

Tektronix is broadening the broadcast line.



OUR MOST COLORFUL LINE

TV Products:
Spectrum Analyzers
Time Domain Reflectometers
Special Oscilloscopes
Vectorscopes

All our computing products, from terminals to calculators, are designed both to help and inspire you. Information display is the mind's eye, and it's looking toward tomorrow:

Calculators and software are making radioimmunoassay a statistically trustworthy medical technique for pregnancy tests, allergy screening, and other antigen-based diagnoses.

Terminals and software are enabling the U. S. Bureau of Mines to graph underground data, to squeeze that last drop out of "dry" oil fields.

The 4010-Series of low-cost storage crt computer graphics terminals (p. 305) can handle words, numbers or graphics, inter-actively. It lets you talk to your computer and see the answers.

You can get our PLOT-10 Software (p. 309) to teach your terminal graphics. And you can get free application write-ups to teach yourself graphics.

The 4023 Computer Display Terminal (p. 308), a non-graphic, refreshed tube terminal, has field capabilities that make forms entries a breeze.

The 4610 Hard Copy Unit (p. 303) makes paper copies of 4010-Series (storage tube) displays. For paper copies of 4023 displays (or other video-signal displays), use a 4632 Video Hard Copy Unit (p. 304).

Storage and Refreshed Monitors (p. 296).

Other peripherals (p. 310) expand your off-line graphic input and storage possibilities.

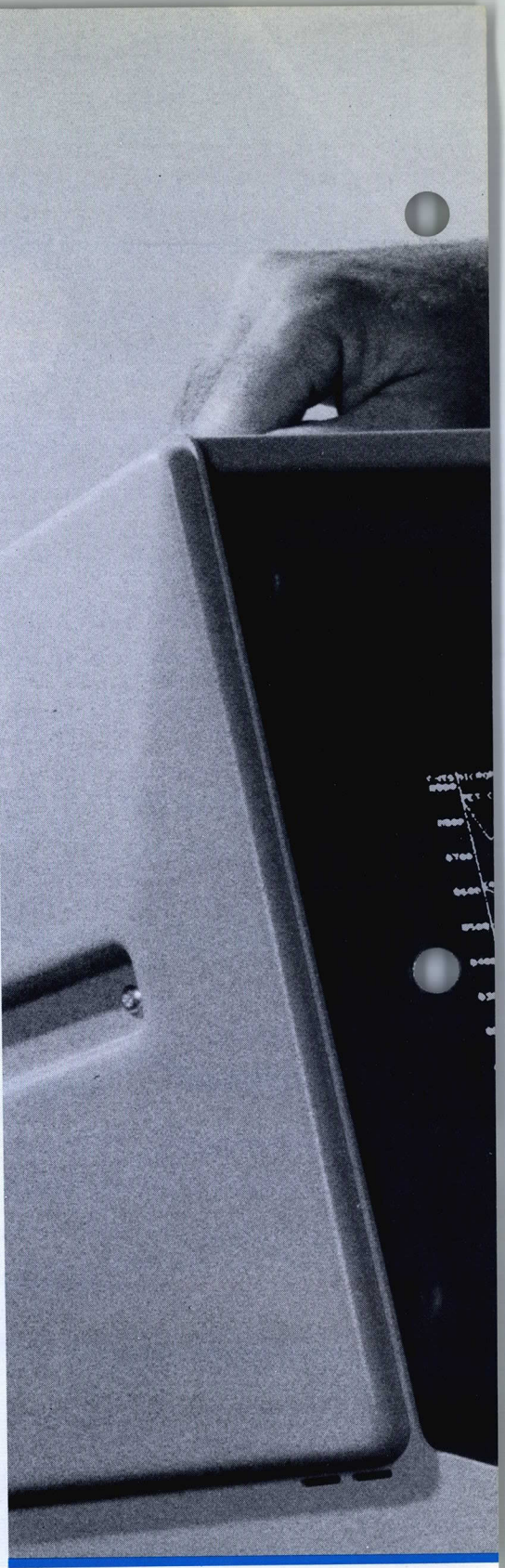
The computer-think expertise that came out of our crt-terminal growth has produced the 21 and 31 Programmable Calculators (p. 312).

If you need capability between an adding machine and a computer for your analytical work, talk to these machines—in natural math, not machine language. Calculator Program Libraries (p. 311) will aid you.

To combine analysis with automatic instrumentation control, look into our 31/53 Calculator Instrumentation System (p. 315).

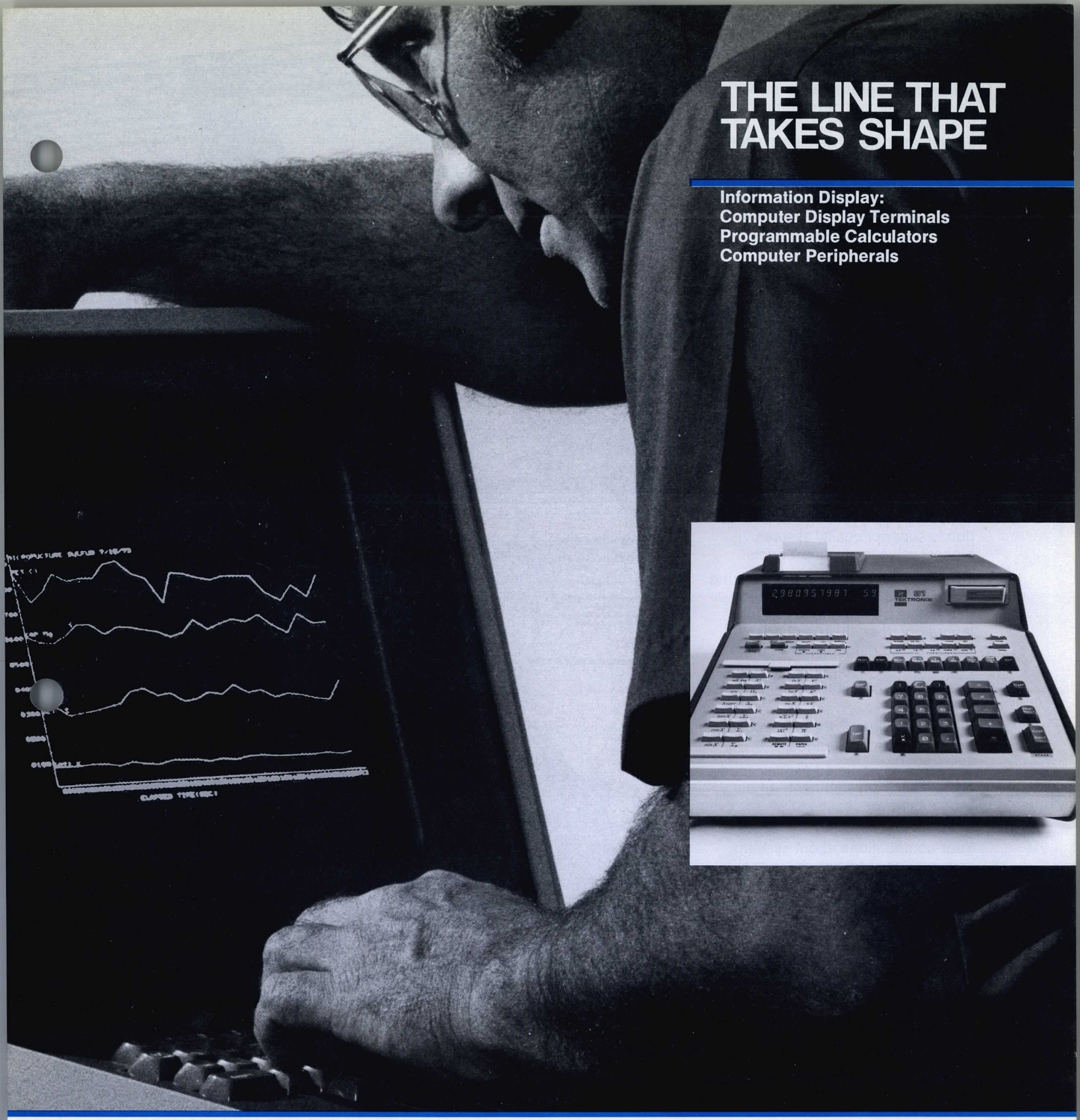
To use a calculator to drive a Graphic Display Terminal, check out the 31/10 Calculator Display system (p. 314).

This line is the shape of things to come.



THE LINE THAT TAKES SHAPE

Information Display:
Computer Display Terminals
Programmable Calculators
Computer Peripherals



A Tektronix representative is your key to our product development process. He's learned to listen. Each conversation helps define a customer's needs. Your combined ideas go into a field report. Reports go home to Beaverton, right up to top management. A lot of reports are collected and they are filtered back down, covered with initials and comments, until they have stimulated dozens of people into action.

About that time, you out there with the problem are beginning to wonder when somebody's ever going to make something to solve it.

And now it's our job to let you know, that somebody has the answer.

Our representative isn't your only help. You can also count on the Tektronix engineering department (which experts place among the top twenty in America), and the other Tektronix employees whose dedication to superior quality assures highest value in all our products.

You can count on the manufacturing team, to habitually mass-produce things that others only try in the laboratory, if at all. They perfected the ceramic crt, for one example, just because longer tube life waited beyond all the manufacturing obstacles.

It was a challenge. People around here thrive on challenges.

They're also addicted to your feedback. Your "development" of our products never ceases to amaze even our product development experts.

Your contributions about systems, software, or shortcuts make the rounds as fast as family gossip.

You really can look at all the products that follow as projections of your needs.

You can look to Tektronix as your research, development and manufacturing facility.

KEEPING THE LINES OPEN

OUR NEWEST PRODUCTS

DIGITAL PROCESSING OSCILLOSCOPE

The role of the oscilloscope as a flexible general-purpose instrument is rapidly changing in today's world. New applications, inside and outside the traditional electronics markets, are placing diverse requirements on scope technology. In many cases, measurements must be supplemented by computations in order to provide users with meaningful information.

The Digital Processing Oscilloscope, WP1100 Series, represents a natural merger of the signal acquisition flexibility of a laboratory oscilloscope (TEKTRONIX 7704A/P7001) and the computational capabilities of an easy-to-use programmable calculator (TEKTRONIX 31). In effect, the WP1100 Series provides a two-way link between the world of analog quantities and the digital processing world.

The DPO contains A/D, D/A, control, crt readout, interface, and other circuitry, including a memory that stores up to four waveforms and their scale factors.

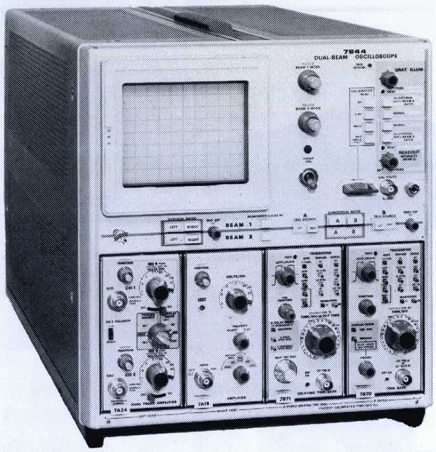
For signal acquisition flexibility, the DPO mainframe accepts up to four TEKTRONIX 7000-Series plug-ins. Currently, over 30 plug-ins are available. These include: a spectrum analyzer, a sampler/TDR, a curve tracer, a digital multimeter, a digital delay unit, a digital counter, and a digital counter/timer, as well as a selection of vertical amplifiers and time bases.

A TEKTRONIX Programmable Calculator acts as the system controller in the WP1100 Series. It contains a large memory capacity, magnetic tape storage capability for data and programs, a silent thermal alphanumeric printer, a general I/O structure, and an English-like programming language that uses a natural math hierarchy. Hard-wired operations include exponential, logarithmic, and trigonometric functions, conditional tests, and subroutine calls and returns.

For complete details on Digital Processing Oscilloscopes, see pages 38-43.

7000-SERIES OSCILLOSCOPES

The 7844 and 7-inch rackmount R7844 are wide-bandwidth, dual-beam oscilloscopes designed primarily for fast single-event applications. Bandwidth is 400 MHz at 20 mV/div (or

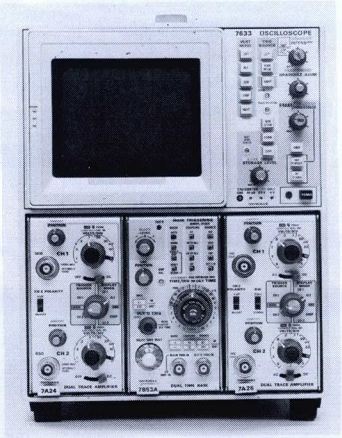


1 GHz using direct access). Unique features such as pulsed graticule and pulsed crt readout allow the pre- or post-photographic recording of important information such as vertical and horizontal scale factors, dates of tests, test number, and other pertinent data when recording single events.

Vertical-signal crossover switching permits viewing a single event from a single probe at two sweep speeds.

The 7844 and R7844 are essentially two oscilloscopes in one providing versatility such as direct crt access and high sensitivity inputs, or spectrum analysis and real time measurements, simultaneously.

For complete description of the 7844, see Page 54.



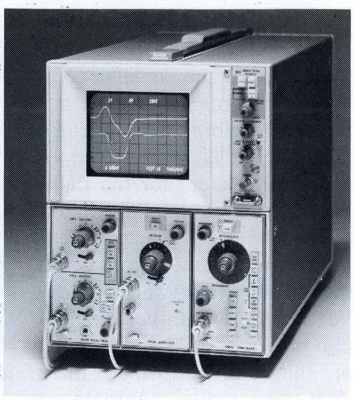
The 7633 Storage Oscilloscope is a 100-MHz direct-view storage oscilloscope with a stored writing speed capability of 1000 cm/μs. The instrument features multi-mode storage including variable persistence, bistable and conventional non-store modes. In addition, a fast writing 8 x 10 div (.45 cm/div) mode is included which provides the instrument's top writing speed.

Crt readout provides quick on-screen reference of measurement parameters. And a selection of 30 different 7000-Series plug-ins permits 'custom-tailoring' the instrument to the job from the outset, and expansion of its capabilities as the needs arise.

The 7623A Storage Oscilloscope is electrically the same as the 7633 without the fast-writing reduced scan mode of operation. All other operating modes are included, with a stored writing speed of 135 cm/μs in the fast storage mode. The 7623A offers low-cost multi-mode storage for those applications not requiring the faster stored writing speed of the 7633.

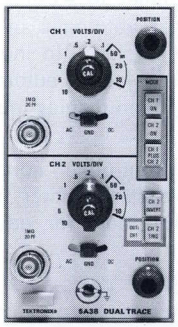
For complete description of the 7633, see page 71.

5000-SERIES OSCILLOSCOPES



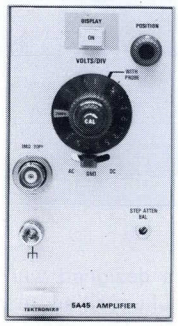
The 5403/D41 Variable Persistence Storage Oscilloscope provides a low cost means of conveniently displaying hard-to-view waveforms. Low rep rate signals are easily viewed as continuous traces. With the 5 μs/div writing speed, single-shot phenomena and extremely low rep rate signals can be readily viewed in normal room light. As part of the versatile 5400-Series, the 5403/D41 includes 60-MHz bandwidth, crt readout of deflection factors, three-plug-in capability, easy bench-to-rack-mount convertibility, and a choice of 21 plug-ins.

For complete description of the 5403/D41, see pages 116-117.



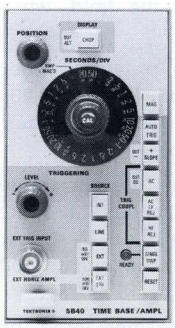
The 5A38 Dual-Trace Amplifier is designed for use in the 5400-Series Oscilloscopes. It provides two input channels with 35 MHz bandwidth and deflection factors ranging from 10 mV/div to 10 V/div. Operating modes include channel 1 only, channel 2 only (normal or inverted), dual trace (alternate or chopped), and added. Crt readout of the deflection factor is included in the 5A38.

For complete description of the 5A38, see page 120.



The 5A45 Single-Trace Amplifier provides the 5400-Series Oscilloscope with 60 MHz bandwidth and deflection factors from 1 mV/div to 10 V/div (25 MHz bandwidth below 5 mV/div). Crt readout of the deflection factor is included.

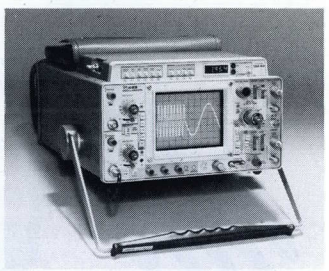
For complete description of the 5A45, see page 121.



The 5B40 Time Base operates in the 5400-Series Oscilloscopes to provide sweep rates from 0.1 μs/div to 5 s/div. Sweep rate is extended to 10 ns/div by the 10X magnifier. Capabilities include internal and external triggering to 60 MHz and single sweep operation. Circuitry for crt readout of sweep rate is included.

For complete description of the 5B40, see page 122.

PORTABLE OSCILLOSCOPES



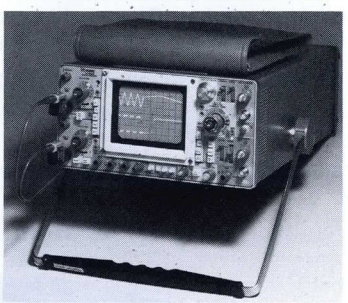
The 465/475 DM40 and DM43 add unique digital readout of delayed time measurement and digital multimeter capability to the popular 465 and 475 Portable Oscilloscopes. The resolution of delayed time measurements is improved and ease of measurement and freedom from error are enhanced since there is no need for mental calculations and interpretation of dial settings.

The digital multimeter measures dc voltages to 1.2 kV within 0.1% of reading ± 1 count, and resistances up to 20 MΩ. The DM43 includes temperature measuring capability from −55°C to +125°C. The DM40 has all the features of the DM43 except temperature measurement capability.

The readout is a 3½-digit display using 7-segment LED's.

Designed as an integral part of the 465/475, this new measurement capability is provided in a single, easy-to-carry package only slightly larger than the 465/475.

For complete description of the 465/475 DM40/43, see page 145.



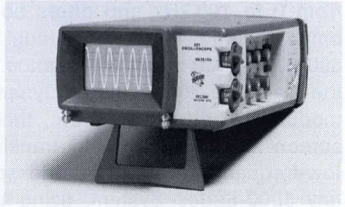
The 466 Storage Portable extends laboratory-standard storage oscilloscope measurements from the test bench into the field. The 466 features variable persistence and fast transfer modes of storage; and in fast, reduced scan operation can achieve a stored writing rate of 1350 cm/μsec. Its bandwidth is dc to at least 100 MHz within −3 dB. Using its X10 magnifier, the 466 achieves a 5-nsec/division sweep rate. Vertical deflection sensitivity is 5 mV/division.

With many features and operator conveniences based on the well-proven 465 portable oscilloscope, the 466 is designed for use with minimal operator training. Its easy-to-use controls are functionally grouped to facilitate operation.

Without panel cover or accessories, the 466 weighs just 26 pounds.

For complete description of the 466, see page 151.

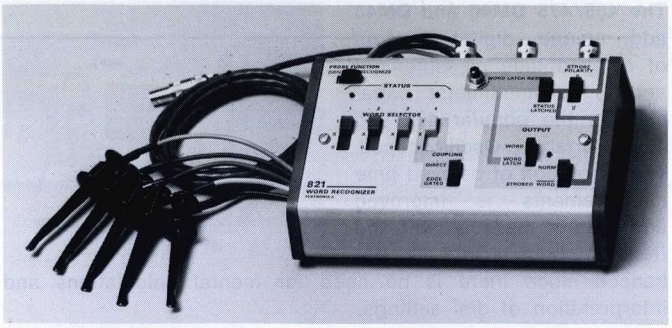
The 464 Storage Portable is identical to the 466 except it does not have the reduced scan and faster writing capability of the 466. Stored writing speed is 110 div/μs in the fast mode. The 464 offers low-cost portable storage for those applications not requiring the faster stored writing speed of the 466.



The 221 Portable Oscilloscope adds 5 MHz bandwidth to Tektronix' growing line of miniscopes. 'Measurement by the handful' truly describes this fully portable instrument, weighing just 3.5 pounds, complete with internal battery, battery charger, line cord and probe. Vertical sensitivity for the 221 is 5 mV/div, and sweep speed is 0.1 μs/div (using X10 magnifier).

For complete description of the 221, see page 161.

800-SERIES PRODUCTS



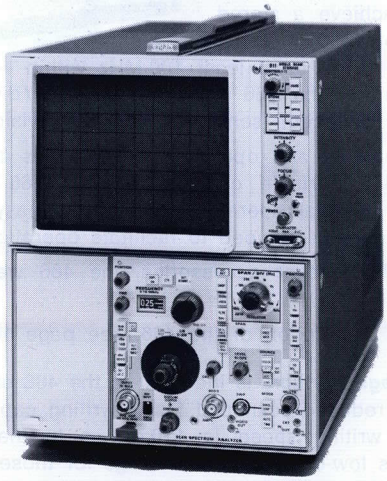
The 821 Word Recognizer is a versatile accessory for designing and servicing TTL and other digital logic circuits. In its primary mode — word recognizer — it is essentially a four-input AND gate with an oscilloscope trigger output. Thus display triggering can be based on logic combinations. And, sequentially chaining additional 821's enables the output trigger to be based on 8-, 12-, or 16-bit logic, or more.

Additional modes of operation expand the versatility for other digital servicing uses. As a logic babysitter, the 821 gives a lighted indication upon first occurrence of a selected logic word. Individual status indicator lights permit its use as a four-bit logic probe. Or, switching to a signal source role, the 821 can be used as a TTL logic driver.

Weighing just 13 ounces, the 821 is a convenient carry-along accessory. It can operate from oscilloscope probe power, or other dc sources.

For complete description of the 821, see page 166.

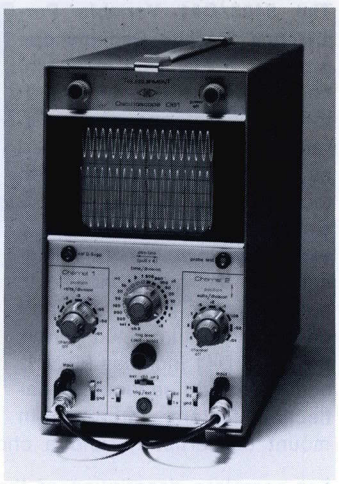
SPECTRUM ANALYZER



The 5L4N Spectrum Analyzer covers the low-frequency range from 0 to 100 kHz and offers both high performance and economy. Unique features include pushbutton selection of 50 Ω, 600 Ω or 1 MΩ input impedance with calibration appropriate to the selected impedance. Dynamic range is 80 dB with intermodulation distortion 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 System, using two of the three compartments. We recommend the 5L4N Spectrum Analyzer with a 5103N/D11 Storage Oscilloscope as the optimum system for all applications.

For complete description of the 5L4N, see page 202.

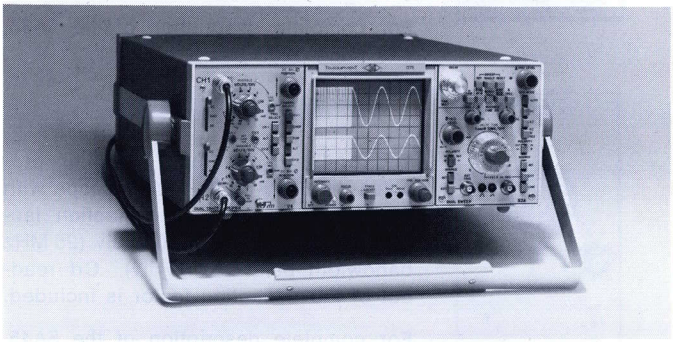
TELEQUIPMENT OSCILLOSCOPES



The TELEQUIPMENT D61 Oscilloscope is a low priced, 10 MHz, dual-trace oscilloscope which features calibrated deflection factors with accuracies within 5%. It is fully transistorized except for the cathode-ray tube and is lightweight at only 15 lbs. The two identical input channels provide 10 mV/division to 5 V/division deflection factors. Either channel can be used independently or they can be used in a dual-trace mode; alternate or chopped operation is selected automatically depending upon sweep rate. X-Y operation is also available for vector displays. Sweep rates range from 500 ms/division to 0.5 μs/division with X5 magnifier to extend the fastest sweep rate to 100 ns/division. Either automatic or selectable trigger level is provided for stable displays. In the TV trigger position, frame or line triggering is selected automatically, depending upon sweep rate. The 8 x 10-cm display makes accurate measurements easy.

Even a new oscilloscope user finds the front-panel controls uncomplicated. Easy operation and low-cost, together with large, bright, stable displays make the D61 ideal for educational or servicing applications.

For complete description of the D61, see page 169.



The TELEQUIPMENT D75 Oscilloscope was designed with the electronic serviceman in mind. The multi-position handle doubles as a tiltstand for the instrument. The low-profile cabinet, light weight, and rugged construction of the D75 make it the ideal instrument for measurements in the field, wherever they are.

The dual-channel, 50-MHz vertical system provides deflection factors from 5 mV/div to 20 V/div (bandwidth limited to 20 MHz above 2 V/div). Accuracy is within 3%. Chopped, alternate, and summed dual-trace modes are available.

The full-feature horizontal system provides flexible triggering over the vertical bandwidth. Time base modes of operation include A Only, A Single Sweep, A Intensified by B, A and B Mixed, and B Delayed By A. Sweep rates extend to 100 ns/div and can be magnified to a maximum of 10 ns/div.

A 6½-inch crt, built by Tektronix, Inc., provides large, bright, waveform displays. A trace locator button positions overscanned traces on screen for quicker sensitivity, sweep rate, and position settings.

For complete description of the D75, see page 170.

TEST SYSTEMS

S-3400 Systems. Tektronix signals a major commitment to the semiconductor memory test systems market by announcing a new series of systems. Four models are initially offered designated S-3420 through S-3450. The low cost S-3420 is configured for general receiving inspection applications. The S-3430 and S-3440 are function testers equipped for bipolar (ECL, TTL) and MOS memory ICs, respectively. The S-3450 provides both function and dc parametric test capabilities. Each system features interactive keyboard as well as stored program operation. Stored programs are loaded with paper tape. Because of the modular nature and bus structure of the S-3400 systems, each offers many options and each is field expandable.

For further information on the S3400, see page 289.

PROBES

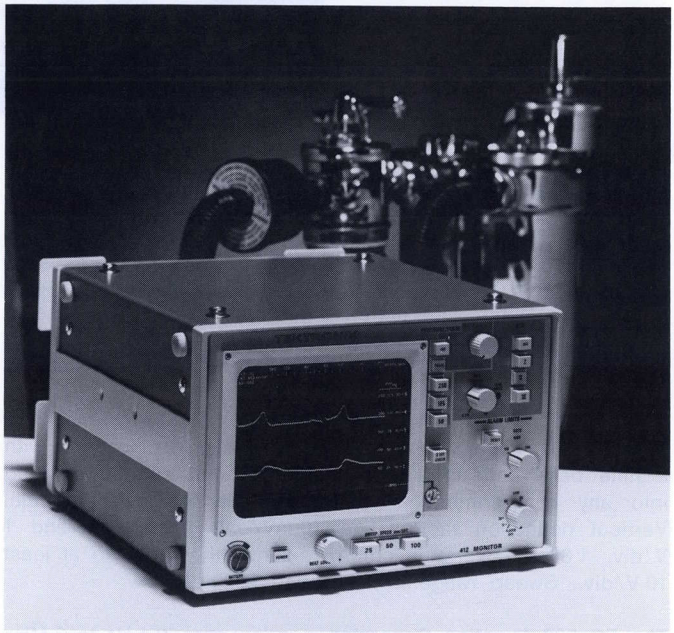
The P6062A is a passive dual attenuation probe designed for TEKTRONIX oscilloscopes with bandwidths to 100 MHz. A sliding switch on the probe body selects 1X or 10X attenuation. The probe provides readout coding and a pushbutton for actuating a ground reference in the 1X or 10X position. The ground reference can be used as a means of trace identification for a multi-trace display.

The 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. Bandwidth of the 10X probe is at least 100 MHz when used with a 466 or 464 Oscilloscope.

The P6063A probe is physically similar to the P6062A but is designed for TEKTRONIX oscilloscopes with bandwidths greater than 100 MHz. Bandwidth is at least 200 MHz when used with an oscilloscope having a bandwidth greater than 225 MHz.

For complete description of these and other probes, see pages 174 - 188.

MONITORS



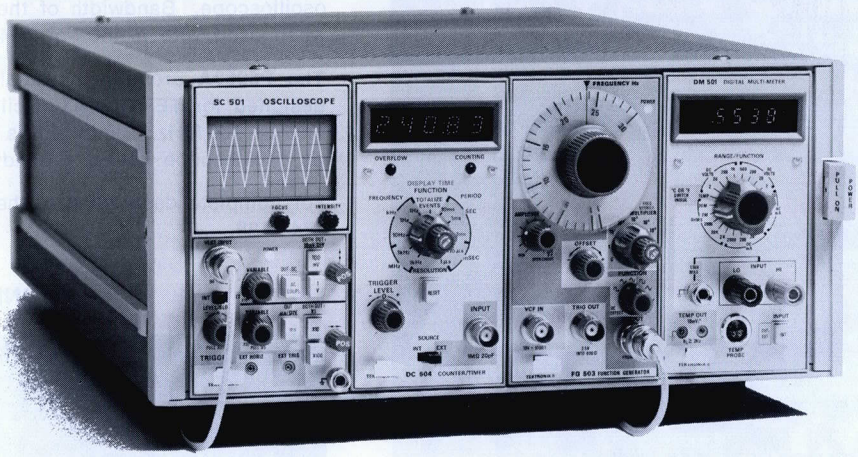
The 408 and 412 Monitors bring safety and convenience to physiological monitor applications. The 412 provides dual-trace displays of ECG and blood pressure or ECG and optically sensed peripheral pulse. A rate alarm with stable limits operates in conjunction with either the ECG channel or systole events in the PRESSURE/PULSE channel. A unique QRS detector which ignores pacemakers, amplitude variations, and most muscle artifacts holds troublesome false alarms to a minimum. Another first is a built-in test signal which quickly confirms proper operation of the patient leads and the instrument's ECG channel. A convenient front-panel ECG lead-fault light indicates loss of electrical contact with the patient.

The 408 is a single-trace monitor providing the same ECG features and alarm capability as the 412.

Safety is a basic feature of both monitors. The fully-isolated ECG patient circuit holds leakage current to less than 5 microamperes. Both instruments provide battery operation in a compact package weighing under 12 pounds. A fitted accessory pouch is included for handy storage of patient lead accessory packages. A variety of options is available to adapt the 408 or 412 to your monitoring requirements.

For complete description of the 408 and 412, see pages 318-320.

TM500 SERIES PRODUCTS



The TM 504 Power Module is a four-compartment mainframe for any combination of up to four TM 500-Series plug-in modules.

The right-hand compartment is capable of supplying high power for instruments with high input requirements. The case is designed for heavy duty usage and has a flexible handle for portability and stand offs for setting the case either on its end or side for ease of use.

The SC 501 Oscilloscope is a dc to 5 MHz oscilloscope with a time base and an auto trigger. The unit can be plugged into any compartment of a TM 500 Series power module. Vertical deflection factors are 10 mV/div, 100 mV/div and 1 V/div, ±3%. A variable control extends the range to at least 10 V/div. Sweep range is 1 s/div to 200 ns/div.

The FG 503 Function Generator is a low-cost, 0.1 Hz to 3 MHz function generator providing sine, square, and triangle waveforms. Sine wave distortion is <0.5% to 20 kHz and square wave distortion is <5% p-p. Risetime of the square wave is ≈80 ns. Linearity of the triangle waveform is better than 1%. VCF range is 1000:1. Output impedance is 50 Ω.

The DC 504 Counter/Timer is a low-cost, five-digit counter with a bandwidth of 80 MHz. It measures frequency from 0.1 Hz to 80 MHz, period from 1 μs 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. The decimal point is automatically positioned. Sensitivity is ±20 mV rms at <15 MHz. Input coupling is selectable ac or dc, and a trigger level control permits offsets of nominally ±1.5 V inputs. Control and data lines, including BCD serial-by-digit outputs, are available at the back-plane interface for customized synergistic applications. There is also an Option 1 available which provides a higher stability, temperature compensated, crystal time base.

The AF 501 Bandpass Filter plug-in is a combination amplifier, filter and oscillator. It can be used alone (for some applications) or in conjunction with a counter, dmm or monitor to form a small portable instrument package which is extremely useful in the mechanical measurement area.

The amplifier has a bandwidth of 50 kHz and a gain of from 1 to 500 selectable in nine steps. The bandpass filter has a center frequency range of 3 Hz to 35 kHz selectable in four decades with the variable frequency control calibrated in Hz and cycles-per-minute (cpm) and has 2 bandwidths, narrow and wide. The oscillator covers a range from 3 Hz to 35 kHz with peak-to-peak output up to 5 volts.

The DD 501 Digital Delay provides digital events delay in a TM 500 plug-in, A trigger out is initiated after the number of input events, selected by the five thumb-wheel front-panel switches, have occurred. A delay-interval output is provided, suitable for driving TTL logic and for Z-axis intensification. Maximum events frequency is 85 MHz, and repetitive divide-by-"N" is possible up to 40 MHz.

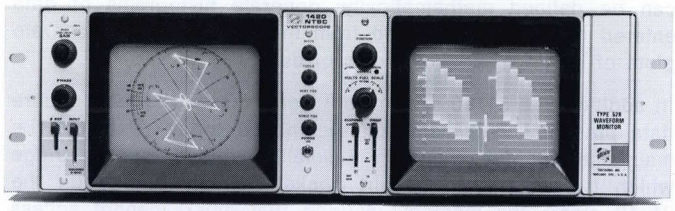
Delaying by event rather than time removes display jitter caused by mechanical speed variances in rotating memories and also allows the scope operator to easily spread out his displayed train of pulses for detailed examination.

The PS 505 Power Supply is a variable, low voltage, high current dc power supply. It is designed to operate in the high-power compartment of a TM 504 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 a TM 500 Series Power Module, the PS 505 will supply at least 1 A non-floating (negative ground).

The DM 502 Digital Multimeter is a 3½-digit multimeter which measures dc and ac voltage and current, resistance, temperature and decibels. Maximum resolution as a voltmeter is 100 μV; as an ammeter, 0.1 μA; as an ohmmeter, 0.1 ohms; temperature, 0.1°, and 0.01 dB in the dB mode. Accuracy is 0.1% in dc volts, 0.5% in ac volts and 0.3% in ohms.

For complete description of TM500 products, see pages 250 to 275.

TELEVISION PRODUCTS



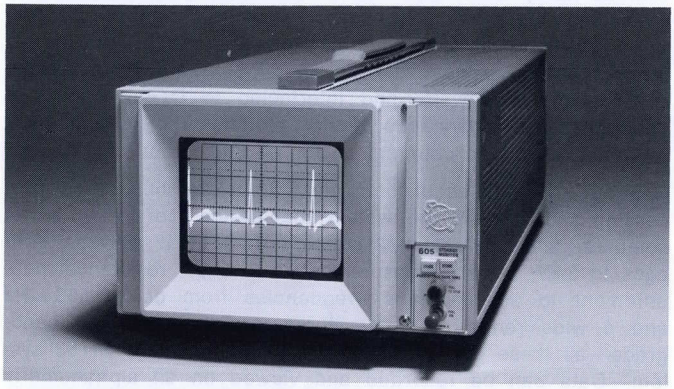
The 1420-Series Vectorscopes are compact, ½-rackwidth instruments designed to display vectors of the chrominance and burst components of either an NTSC (1420), PAL (1421) or PAL M (1422) composite video signal. This series provides a low-cost way to meet basic vectorscope requirements in CCU's, VTR's and similar applications. The instrument is particularly well suited for side-by-side rackmounting with the TEKTRONIX 528 Waveform Monitor. The 1420 weighs a little over 15 pounds with an optional carrying case.

Two loop-through inputs accept the signal for display on the crt or for externally locking the subcarrier regenerator oscillator. A front-panel lever switch selects the signal from either of the inputs for phase locking the subcarrier regenerator. A second front-panel lever switch selects the signal to be displayed on the crt and can attenuate one channel for viewing large signals. A front-panel GAIN control varies the size of the crt display above and below unity. A phase control provides continuous 360° rotation of the display.

PAL (1421) and PAL M (1422) displays are switchable to an "NTSC FORMAT".

For complete description of the 1420-Series see the Tektronix Television Products catalog.

DISPLAY PRODUCTS



The 605 Storage Display Monitor features variable-persistence storage and X-Y-Z display capability. Simply turning a dial varies the length of time a waveform or image is held on the crt from a fraction of a second to more than 5 minutes.

In addition to variable persistence, outstanding features include fast (1-div/μs) writing speed, 3-MHz X and Y axis bandwidth, front-panel controls, TTL compatible remote control lines, and an optional internal time base.

The variable persistence capability of the 605 is particularly useful for viewing slowly scanned gray scale images and low repetition rate biophysical or mechanical waveforms. Fast writing speed makes single shot phenomena viewable at normal intensity.

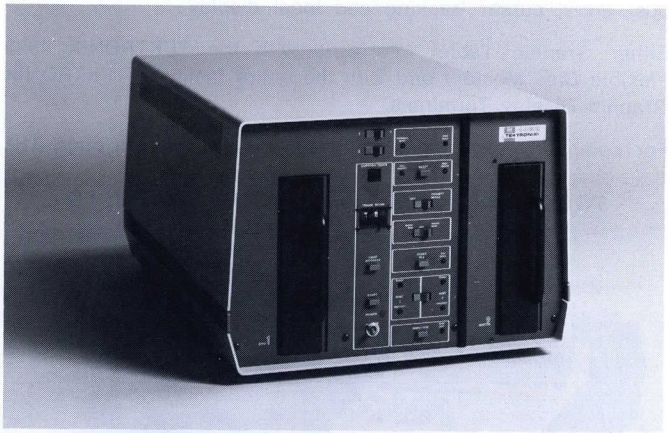
Both cabinet and rackmount versions of the 605 are available.

For complete description of the 605, see page 300.

COMPUTER TERMINAL PRODUCTS

The 4623 Hard Copy Unit is designed to produce permanent, high quality, 8½ x 11-inch copies from the 4023 refreshed terminal. Four-channel input permits one 4623 to provide copies from up to four terminals. The first copy is produced in about 18 seconds, with additional copies of the same display taking about 8 seconds each.

For complete description of the 4623, see page 303.



The 4922 Flexible Disc Memory provides a convenient, user-controlled data storage system for off-line or auxiliary use.

The memory has its own power supply and interface electronics to make it a stand-alone, local memory and terminal driver. The 4922, containing two disc drives, can duplicate discs and store or send lengthy, continuous data streams.

The memory is designed to work with TEKTRONIX 4010-Series Computer Display Terminals. The memory can store data from any of the terminal keyboards and send data up onto any terminal screen. It can send data to (or receive it from) a computer, or it can deal with a computer-terminal team.

The 4921 Flexible Disc Memory is a single disc unit similar to the 4922 and offers lower cost to those not requiring two-disc capability.

For complete description of the 4921 and 4922, see page 310.

COMPUTER TERMINAL PRODUCTS

The TEKTRONIX 4953 and 4954 Graphic Tablets provide a convenient means for inputting graphics data to a computer, or onto the terminal screen, or into any other data system. The 4953 tablet is 11 x 11 inches while the 4954 offers a drawing-board sized tablet, 40 x 30 inches.

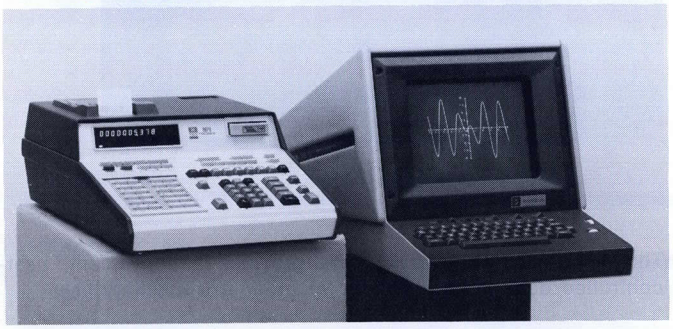
Input is made by pen, or where accuracy is required, by a "mouse" cursor. Users can input points, parts, or all of what is put on the tablet including maps, graphic hard copies, drawings, schematics, etc.

Resolution is 0.01 inch minimum with repeatability of ±1 point. Operating modes include single point entry, tracking (continuous) entry, cursor tracking and local display.

Either Graphic Tablet interfaces with the TEKTRONIX 4922 Flexible Disc Memory and with the entire family of TEKTRONIX Graphic Display Terminals.

For complete description of the 4953 and 4954, see page 310.

PROGRAMMABLE CALCULATOR PRODUCTS



The TEKTRONIX 31/10 Graphic Calculator System combines the powerful computational abilities of the TEKTRONIX 31 Programmable Calculator with the graphing capability of the TEKTRONIX 4010-1 Computer Display Terminal. The 31 Calculator features English-like programming and a simple keyboard that does math exactly the way it's written. Addition of the terminal provides large-screen graphic displays of data from the calculator and also provides access to the peripheral devices such as hard copy units and remote displays.

The 31/10 forms the ideal local data presentation system. It can provide immediate plots of data entered from the calculator keyboard or data resultant from calculations. Software is available either in software manuals or on a magnetic tape cartridge; keyboard overlays are provided with the tape cartridges to identify special key functions. This, combined with the simple keyboard and easy programming, enables even the beginning user to generate plots of almost any function which can be defined mathematically; generate histograms of data entered manually or recalled from magnetic tape; or generate plots of single or double arrays of data.

In addition, the 31/10 system represents one of the most secure data presentation systems on the market today. Data can be maintained confidentially on a small magnetic tape cartridge which fits easily into a shirt pocket. Simply turning off the 31/10 clears the memory, insuring that others cannot access either the program or the data.

A variety of options, interfaces, and peripherals is available for both the calculator and terminal to increase the effectiveness of the system. These include items such as additional steps of memory, alphanumeric thermal printer, hard copy unit, remote display units, or the Deluxe Data Communications Interface which allows operation of the 4010-1 as a computer terminal when not being used with the calculator.

For complete description of the 31/10, see page 314.

The 31/53 Computer Instrumentation System. Tektronix introduces a major innovation in computer instrumentation systems with its newly announced 31/53 system. The system contains an expandable memory processor, a wide range of program step capability, an alphanumeric keyboard and printer, digital tape cassettes, a complete library of standard mathematical and statistical software, and interfacing to D/As and to an optional high performance digital plotter. The system uses the multimeters and counters of the TM 500 Series of products.

Capable of data acquisition, data transformation, data processing and analysis, the system enables the user to log, store, compare, and analyze measurement data as it arrives. Voltages to 2 kV, current measurement to 2 amps, resistance measurement to 20 megohms, frequencies from dc to 550 MHz and a wide range of temperatures in Fahrenheit and centigrade—all these are available in a single standard 31/53 system. Data can be recorded and viewed on an alphanumeric thermal printer, an easy to observe readout and a high performance plotter. Data transformation and analysis are accommodated by the expandable programming capability of the system. 512 program steps is the system standard. Up to 1000 memory registers are available.

For complete description of the 31/53, see page 315.

The 4661 Digital Plotter provides low-cost high-performance graphics for calculator users. The plotting area is 10″ x 15″ and vectors of any length within this area are plotted at speeds from 15 to 22 inches per second. Front panel controls provide scale selection, independent pen control and a variable set zero point. Accuracy to ±0.0025 inch and ±0.4% of vector length, resolution to 0.005 inch and excellent repeatability are features of the 4661.

For complete description of the 4661, see page 316.

PLUG-IN OSCILLOSCOPES

Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
500 MHz†	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	500 ps/div	X	7904 R7903	50 50	$3400* 2900*
400 MHz†	20 mV/div at BW 10 μV/div 1 mA/div	up to 8 Dual Beam	1 ns/div	X	7844 NEW	54	5900*
250 MHz	20 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	7704A opt. 9	57	2600*
200 MHz	10 mV/div at BW 10 μV/div 1 mA/div	up to 4	2 ns/div	X	7704A	57	2600*
100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	5 ns/div	X	7603	61	1600*
60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	10 ns/div	X	5403/D40	118	1175*
50 MHz	5 mV/div at BW 50 μV/div	up to 2	10 ns/div	X	Telequipment D83	170	800*
2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8 Dual Beam	100 ns/div	X	5103N/D12	124	965*
2 MHz	1 mV/div at BW 10 μV/div 0.5 mA/div	up to 8	100 ns/div	X	5103N/D10	124	595*
Ruggedized Oscilloscope system [meets or exceeds mil-0-24311 (EC) (AN/USM 281 Specs)]	5 mV/div at BW	up to 2	5 ns/div	X	7603N opt. 11s	64	3025 with plug-ins

*Price does not include plug-ins.

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

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

PORTABLE OSCILLOSCOPES

Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
350 MHz	5 mV/div at BW	X	1 ns/div	X	485	141	$4200
200 MHz	2 mV/div at BW	X	1 ns/div	X	475	147	2650
100 MHz	5 mV/div at BW	X	5 ns/div	X	465	147	1825
10 MHz	10 mV/div at BW 1 mV/div	X	100 ns/div		326	157	1725
5 MHz	5 mV/div at BW	X	100 ns/div		221 NEW	161	775
4 MHz	10 mV/div at BW 1 mV/div		500 ns/div		323	159	995
500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		214	162	985
500 kHz	10 mV/div at BW 1 mV/div	X	1 μs/div		212	162	755
500 kHz	10 mV/div at BW 1 mV/div		1 μs/div		211	162	595

STORAGE OSCILLOSCOPES

Maximum Stored Writing Rate	Maximum View Time	Type of Storage	Bandwidth**	Minimum Deflection Factor	Number of Trace Operation	Delayed Sweep	Plug-in	Model Number	Page	Price
3,000 div/μs 3 div/μs	††15 s ††15 s	Fast Variable Persistence	100 MHz	5 mV/div at BW	up to 2	X		466 NEW	151	$3850
2,200 div/μs 400 div/μs 3 div/μs 2 div/μs	††30 s until erased ††30 s until erased	Fast Variable Persistence Fast Bistable Variable Persistence Bistable	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7633 NEW	70	3650*
150 div/μs 50 div/μs 0.5 dis/μs 0.03 div/μs	††30 s until erased ††30 s until erased	Fast Variable Persistence Fast Bistable Variable Persistence Bistable	100 MHz	5 mV/div at BW 10 μV/div 1 mA/div	up to 4	X	X	7623A NEW	70	3000*
110 div/μs 0.5 div/μs	††15 s ††15 s	Fast Variable Persistence	100 MHz	5 mV/div at BW	up to 2	X		464 NEW	151	3300
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	7613	73	2600*
5 div/μs	1 hr	Variable Persistence	60 MHz	5 mV/div at BW 10 μV/div 0.5 mA/div	up to 4	X	X	5403/D41 NEW	116	2275*
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	7313	75	2000*
5 div/μs	4 hrs	Bistable Split Screen	25 MHz	10 mV/div at BW 1 mV/div	up to 2			434	155	2350
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	5103N/D15	124	1170*
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	5103N/D13 Opt 3	124	1460*
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	5103N/D11	124	1095*
0.5 div/μs	1 hr	Bistable	500 kHz	10 mV/div at BW 1 mV/div	up to 2			214	162	985
0.25 div/μs	1 hr	Bistable	10 MHz	10 mV/div at BW 1 mV/div	up to 2			Telequipment DM64	171	1095

*Price does not include plug-ins.

**Bandwidths are realtime, 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.

NON-PLUG-IN OSCILLOSCOPES

Bandwidth	Minimum Deflection Factor	Dual-Trace	Maximum Sweep Rate	Delayed Sweep	Model Number	Page	Price
50 MHz	5 mV/div at BW 1 mV/div	X	10 ns/div	X	Telequipment D75 NEW	170	$1375
25 MHz	10 mV/div at BW	X	40 ns/div	X	Telequipment D67	169	1025
25 MHz	10 mV/div at BW 1 mV/div	X	20 ns/div		Telequipment D66	169	875
10 MHz	10 mV/div at BW	X	100 ns/div		Telequipment D61 NEW	169	475
3 MHz	100 mV/div at BW		≈500 ns/div		Telequipment S51B	171	280

BEHIND THE FRONT PANEL . . .

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

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

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

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

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

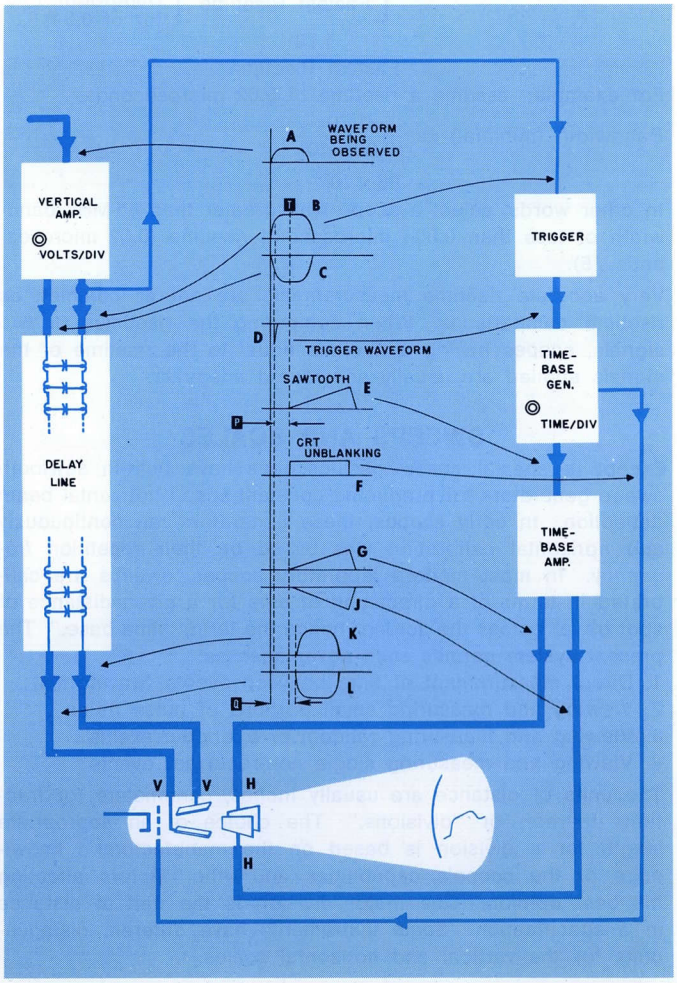
A rectangular "unblanking" wave *(F)* derived from the time-base generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds to the duration of the positive-going or run-up part of the time-base output, so that the beam is switched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

In the case shown, the leading edge of the waveform being displayed is used to actuate the trigger circuit. Yet we may want to observe this leading edge on the screen. Without additional circuitry this would be an impossibility, since the triggering and unblanking operations require a measurable time interval *(P)*, often about 0.15 microsecond. To permit us to see the leading edge, a delay *(Q)* of about 0.25 microsecond is introduced by the delay line in the vertical-deflection channel, after the point where the sample of the vertical signal is tapped off and fed to the trigger circuit.

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

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

THE OSCILLOSCOPE BLOCK DIAGRAM



Oscilloscope Glossary of Terms

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

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

RISETIME AND BANDWIDTH

The first qualification generally sought in a scope is adequate risetime or adequate response to high frequency sinewaves (bandwidth). Risetime is the more important specification for "faster" scopes, and bandwidth the more frequently used specification for "slower" scopes. The product of risetime and bandwidth should produce a factor whose value lies between 0.33 and 0.35 when the transient response is optimum. And, ideally, scopes should have a vertical system capable of rising in about one-fifth the time that the fastest step-signal applied rises. In such a case, the risetime of the signal (as indicated on the scope) will only be in error by approximately 2 percent.

When selecting an oscilloscope, the minimal requirements for its bandwidth can be estimated using the following rule of thumb:

$$\text{Bandwidth (minimal)} = 5\left[\frac{\text{Bandwidth Factor}}{\text{Fastest Risetime}}\right] \text{ (assuming a Bandwidth Factor of 0.34)}$$

$$= \frac{1.70}{\text{Fastest Risetime}}$$

For example: assume a risetime of 0.02 microseconds,

$$\text{Bandwidth (minimal)} = \frac{1.70}{0.02 \times 10^{-6}}$$

$$= 85 \times 10^{6}$$

In other words, select a scope with greater than 85 MHz bandwidth or less than 0.004 microsecond risetime (0.02 microseconds /5).

Very accurate risetime measurements are not as common as risetime comparisons. When comparing the risetimes of two signals, scopes having a risetime equal to the risetime of the signals applied are usually considered adequate.

SWEEPS AND SCALES

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

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

The units of distance are usually inches, centimeters (or fractions thereof) or "divisions." The choice of an appropriate length for a division is based on the manufacturer's knowledge of the scope's capabilities and other factors affecting his best opinion. One major division is the unit of distance in a specification. Some instruments have different distance-units for the vertical and horizontal scales.

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

Referring to time bases in terms of relative sweep speeds (horizontal velocity of the spot) is a common, but incorrect practice. Instead they are specified by a term which is actually the reciprocal of speed: time per division (Time/Div).

Fast and Slow Sweeps

Selecting an appropriate sweep rate is based on the nature of the investigation. Given a particular frequency response, a sweep is usually considered adequate if it is capable of displaying one cycle of the upper passband frequency across the full horizontal scale. High-frequency scopes seldom have sweeps which are that fast.

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

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

Sweep Magnification/Sweep Delay

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

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

Delaying/Delayed Sweep

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

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

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

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

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

Single-Sweep

In applications where the displayed signal is not repetitive or varies in amplitude, shape, or time a conventional repetitive display may produce a jumbled presentation. This can be avoided by using an oscilloscope with a single-sweep feature. To operate the single-sweep feature, first make certain the trigger circuit will trigger on the event to be displayed. Arming of the sweep is done typically with the push of a switch, a lamp should light and stay lit indicating the trigger circuit is armed and ready for a trigger signal. When the circuit is triggered the sweep will run, the ready light will go out, indicating that the circuit has been triggered. The sweep is then blocked until the sweep circuit is rearmed. This feature is particularly useful for photographic recording.

Sweep Switching

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

MULTIPLE INPUTS

It is very useful to permit viewing of any or all of a number of input signals without disturbing connections to the oscilloscope. Multiple-input amplifiers are available which will display signals in consecutive order.

Switched Inputs & Dual Beam

Oscilloscopes which feature either dual-trace or dual-beam circuitry are capable of displaying two input signals. The dual-trace scope incorporates electronic switching which alternates the single electron beam between the two displays generated by the input signals. However, the dual-beam scope has two electron beams within its crt which enables it to display two input signals separately and simultaneously.

There are distinct advantages to both types of scopes. Two simultaneous, non-recurrent signals of short duration may be displayed on a dual-beam scope, but not on a dual-trace scope. Also, some dual-beam scopes can display non-recurrent signals on different time bases. The principal advantages of dual-trace scopes are lower cost and intrinsically better comparison capabilities.

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

Steady displays of two signals which are not synchronous with each other may be displayed on dual-trace scopes. To achieve this result, the triggering signals may be switched in synchronism with the input signals. A useful application for this type of display involves using one of the available waveforms as a standard. Dual-beam scopes also permit this kind of comparison.

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

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

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

Differential, Balanced or Push-Pull Inputs

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

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

Common-Mode Rejection

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

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

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

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

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

Factors Which Affect Cmrr

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

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

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

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

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

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

Summing Inputs

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

SELECTING SPECIAL TYPES OF OSCILLOSCOPES

Plug-In and Non-Plug-In

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

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

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

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

The non-plug-in oscilloscope has all circuits included in the single instrument and usually is designed solely for voltage/time measurements. The advantage of the non-plug-in oscilloscope is that equal or better performance in any one measurement area usually can be obtained for less cost, compared to the plug-in type. Also, the non-plug-in type is usually smaller and sometimes provides the option of battery operation. Its chief disadvantage of course is its lack of versatility in comparison to the plug-ins.

Turn to pages 23 and 24 for a brief description of the outstanding features offered by each oscilloscope series.

Portable

There are high quality TEKTRONIX Portable Oscilloscopes to meet requirements of mobility, small size, light weight and durability. For a full description of the characteristics of the portable oscilloscopes, turn to page 138.

Storage

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

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

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

Recent developments in transmission storage tubes at Tektronix, Inc. have resulted in a very fast stored writing speed —3000 div/μs or 1350 cm/μs. Although similar types of storage have been used for retaining relatively slow signals, Tektronix, Inc. has refined the techniques to make them applicable to storage of high-speed oscilloscope displays.

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

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

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

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

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

Most bistable phosphor crt's have a split-screen viewing area which allows each half to be used individually for storage displays. The split-screen feature provides many unique applications. With this system, a reference waveform can be stored on one half of the screen and the other half can be used to store the effect that calibration adjustments or the insertion of filters, etc., have on circuit operation. If desired, this technique can be used where the reference portion operates in the stored mode and the other half of the display monitors an external input. A unique application of this split-screen technique involves speech therapy where the normal speech pattern is recorded on the upper half of the storage screen and the patient's attempts to match this pattern are recorded on the lower half. Of course with split-screen operation, the lower half may be erased as many times as desired without affecting the stored information on the upper screen.

Sampling Oscilloscopes

A very significant advancement in the art of oscilloscope design is a system employing sampling techniques. The technique is very similar, in principle, to the use of stroboscopic light to study fast mechanical motion. Progressive samples of adjacent portions of successive waveforms are taken; then they are "stretched" in time, amplified by relatively low-bandwidth amplifiers and finally shown, one sample at a time, on the screen of a cathode-ray tube. The graph then produces a replica of the sampled waveforms. The principal difference in ap-

pearance, between displays made by sampling techniques and conventional displays, is that those made by sampling are comprised of separate segments or dots. This technique is limited to depicting repetitive signals, since no more than one sample is taken and displayed each time the signal recurs.

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

A recent innovation to sampling is the random sampler. The random sampler constructs a display of a repetitive waveform in a manner much like a conventional sampling oscilloscope; 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 risetime limitation of signal delay lines is eliminated.
3. It is no longer necessary to work into the 50-Ω characteristic impedance of a delay line, so high impedance can be retained.
4. External triggers may occur prior to, coincident with, or *after* the displayed signal with lead time still visible in the display.
5. Display time jitter otherwise caused by pretrigger-to-signal jitter is eliminated.

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

Digital Processing Oscilloscopes

Digital Processing Oscilloscopes (DPO's) represent a new concept in instrumentation. Flexible signal acquisition supplemented by information processing capabilities gives you unequaled measurement and analysis performance. Fingertip command of program functions enables complex analysis of acquired data in seconds. For more information, refer to pages 38-43.

Transient Digitizer

The R7912 Transient Digitizer in Waveform Digitizing Instrument (WDI) configurations enables you to observe, measure, digitize, and analyze events that occur once or seldom, and exist for less than a nanosecond. For more information on the R7912 Transient Digitizer and WDI configurations refer to pages 44-47.

OTHER INSTRUMENTS

Time-Domain Reflectometers

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

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

Spectrum Analyzers

TEKTRONIX Spectrum Analyzers, built as plug-in accessories for oscilloscopes and as complete portable instruments, cover frequencies from 0 Hz to 40 GHz (Gigahertz).

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

ENVIRONMENTAL CHARACTERISTICS

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

Temperature, Altitude, Humidity, Vibration, Shock and Electromagnetic interference (emi, previously rfi).

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

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

For more specific information on the environmental charcteristics 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 newer instruments provide quick-change line-voltage selectors for convenient selection of line-voltage operating ranges. Transformer taps in other instruments can be changed to accommodate specific line-voltage operating ranges or can be factory wired for a specific range if specified on the purchase order. TEKTRONIX instruments are designed with electronically-regulated power supplies to compensate for changing line voltages.

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

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 frame, and is intended to ground the instrument 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

CATHODE-RAY TUBE PHOSPHOR DATA

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

Human Eye Response

An important factor in selecting a phosphor is the color or radiant energy distribution of the light output. The human eye responds in varying degrees to light wavelength from deep red to violet. The human eye is 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 and is based upon measurements made with a sensor having a spectral sensitivity curve corrected to that of the average human eye. The unit commonly used for luminance measurements is the footlambert. The term *luminance* implies that data has been measured in a manner, or has been so corrected, to incorporate the CIE standard eye response curve for the human eye. CIE is an abbreviation for "Commission Internationale de l'Eclairage" (International Commission on Illumination). The luminance graphs and tables are therefore useful *only* when the phosphor is being *viewed.*

Phosphor Burning

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

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

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

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

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

PHOSPHOR DATA CHART

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

[1]Taken with a Spectra Brightness Spot Meter which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.
[2]P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.
[3]Low level lasts over one minute under conditions of low ambient illumination.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

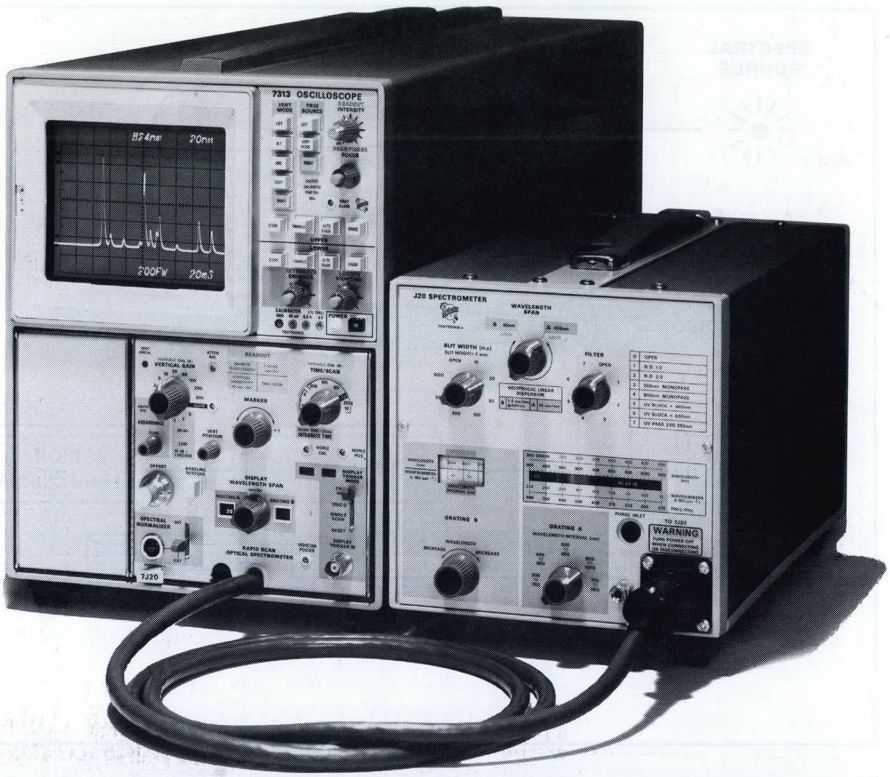
signal delay—In an oscilloscope, the time required for a signal to be transmitted through a channel or portion of a channel. The time is always finite, may be undesired, or may be purposely introduced as in a delay line.

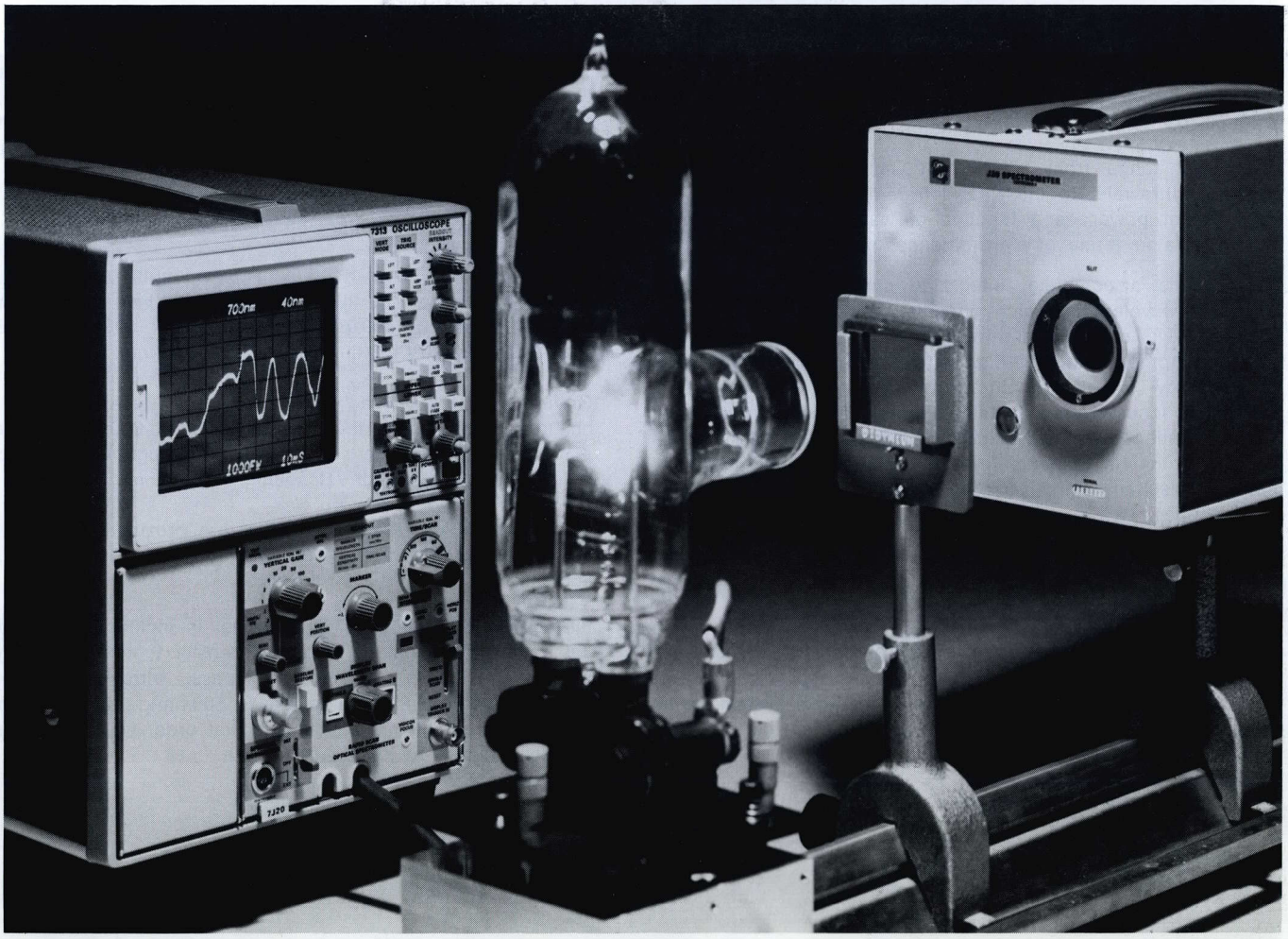
tangential noise measurement—A procedure to determine displayed noise wherein a flat-top pulse or squarewave input signal is adjusted in amplitude until the two traces (or portions of two traces), thus produced, appear to be immediately adjacent or contiguous. Measurement of the resulting signal amplitude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

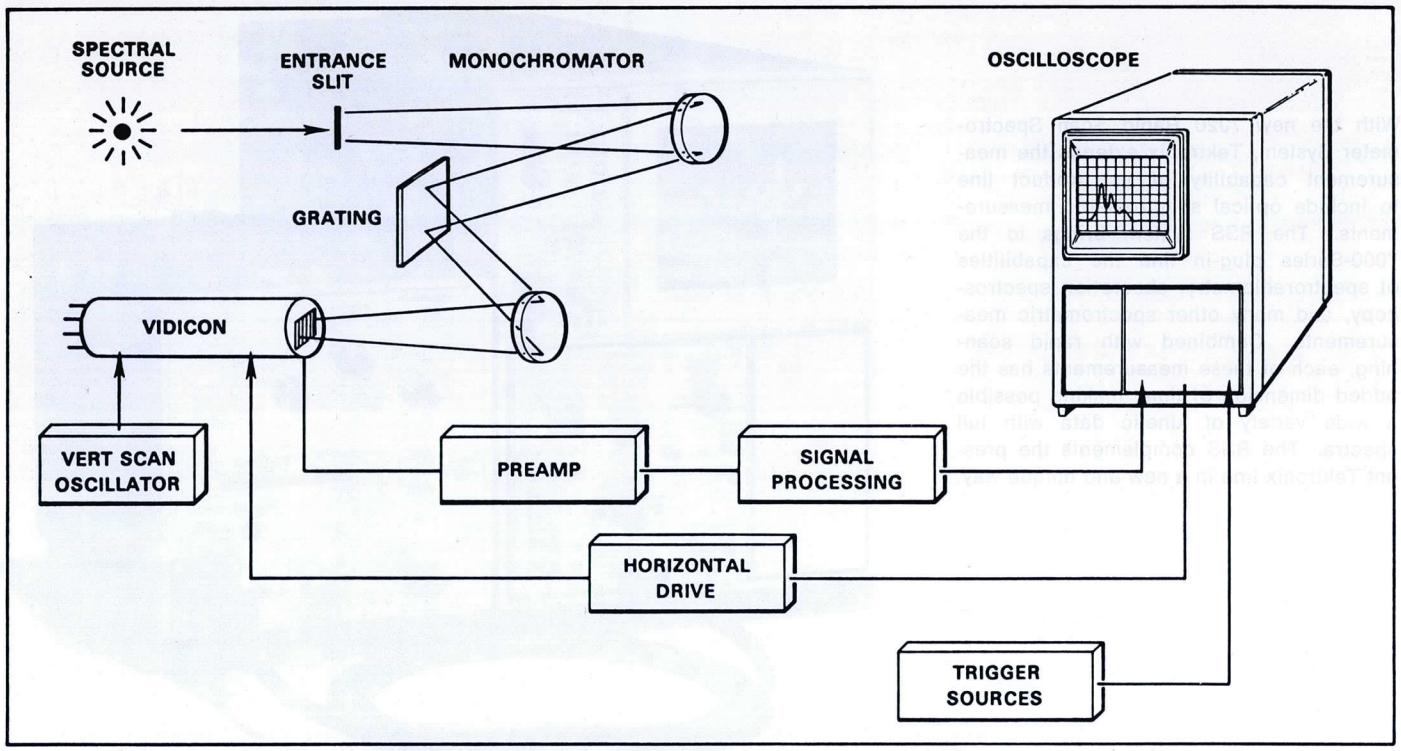
trigger—A pulse used to initiate some function (for example, a triggered sweep or delay ramp).

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

With the new 7J20 Rapid Scan Spectrometer System, Tektronix extends the measurement capability of its product line to include optical spectrometric measurements. The RSS system brings to the 7000-Series plug-in line the capabilities of spectroradiometry, absorption spectroscopy, and many other spectrometric measurements. Combined with rapid scanning, each of these measurements has the added dimension of time, making possible a wide variety of kinetic data with full spectra. The RSS complements the present Tektronix line in a new and unique way.







The 7J20 Rapid Scan Spectrometer (RSS) can measure and record spectral information of dynamic events with durations of milliseconds. Spectral information can be gathered over a wide range, with scan times as low as 4 ms, and displayed instantly for convenient examination.

A spectral range from 250 to 1100 nm permits observation from the Ultraviolet to the Near Infrared Region. It can measure radiant power as a function of wavelength and absorption spectra in terms of transmittance or absorbance.

The RSS is a complete, integrated spectrometric unit calibrated in wavelength, which appears digitally on the display screen. It is compact, lightweight and rugged. It consists of a spectrometer and an electronic plug-in. Light dispersed by a Czerny-Turner monochromator with two interchangeable gratings is focused onto a vidicon target, which gathers spectral information at all wavelengths simultaneously. This spectral information is then electronically scanned from the target and the resultant signal can be displayed on the crt of an oscilloscope.

The TEKTRONIX RSS may be used with any of the oscilloscope mainframes comprising the TEKTRONIX 7000-Series Oscilloscope line.

Computer real-time treatment of spectral data is provided by the TEKTRONIX 7000-Series Digital Processing Oscilloscope, which can be made an integral part of the RSS system, or to other computers taking the signals provided at the interface plug on the 7J20 plug-in unit.

THE SPECTROMETER UNIT

The Spectrometer contains a Czerny-Turner monochromator, two interchangeable gratings, silicon-vidicon target and electronic circuitry. This circuitry transforms a selectable portion of the spectrum into electronic signals ready for further processing by the Plug-In Unit.

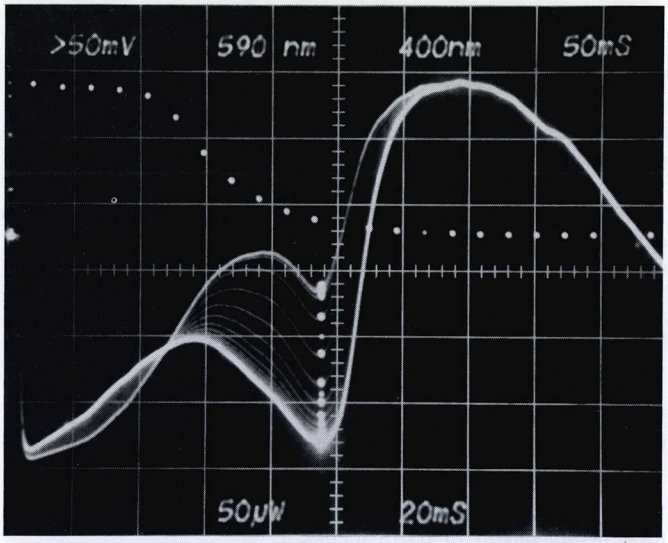
Gratings—Two interchangeable gratings can be selected.

Grating A—This has a 400 nm wavelength span with 32 nm/mm dispersion at the vidicon target. Five step intervals can be selected: 300-700 nm, 400-800 nm, 500-900 nm, 600-1000 nm and 700-1100 nm. Resolution $\leq$ 4 nm.

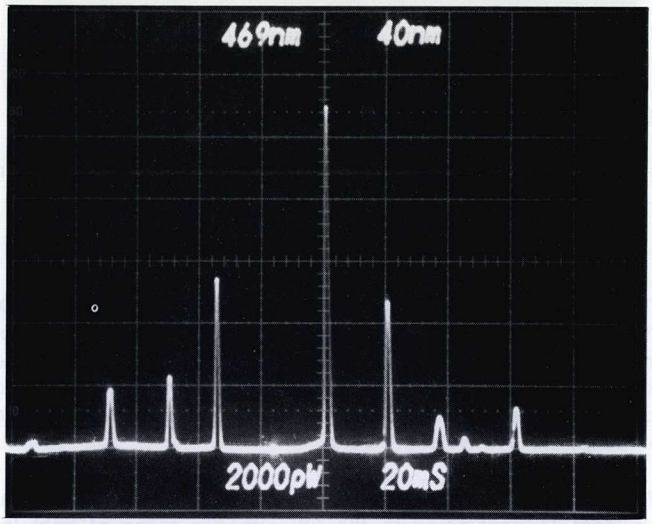
Grating B—This has a 40 nm wavelength span with a 3.2 nm/mm dispersion at the vidicon target at 600 nm. It allows a continuously variable scan of 40 nm throughout the spectral range of the instrument. Resolution $\leq$ 0.4 nm.

Slit Widths—Eight fixed slit widths are provided, each 10 mm high. The widths are 10, 20, 50, 100, 200, 500, 1000, and 5000 μm (or open).

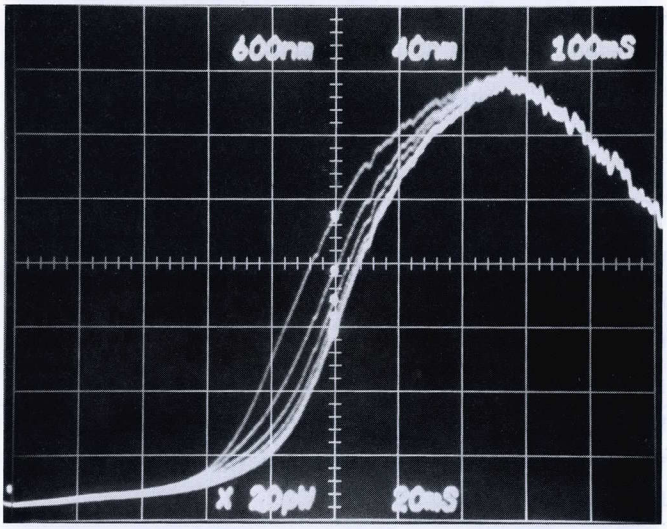
Filters—An eight position filter wheel is included in the optical path. These include a neutral density 1, neutral density 2, 500 nm monopass, 800 nm monopass, ultraviolet blocking ($\leq$400 nm), ultraviolet blocking ($\leq$500 nm), ultraviolet pass (passes 250 to 330 nm and blocks first order wavelengths from 400 to 650 nm), and open (no filter).



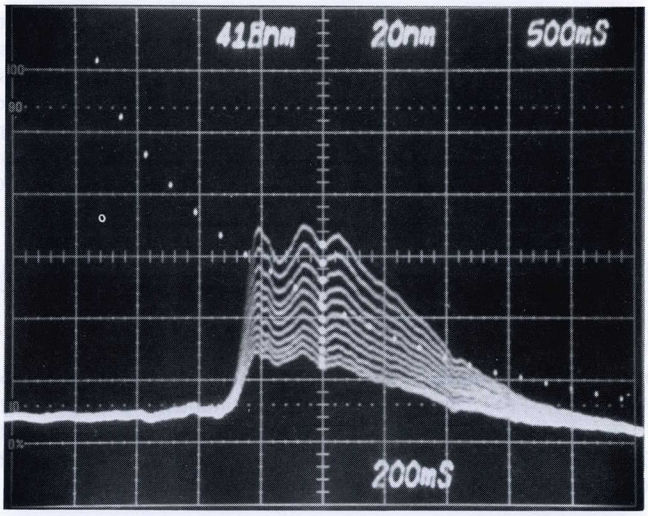
A family of spectra during the dehydration of CO_2 reaction using bromphenol blue indicator. The superimposed intensity versus time plot has a time coordinate of 50 ms per division and is taken at 590 nm.



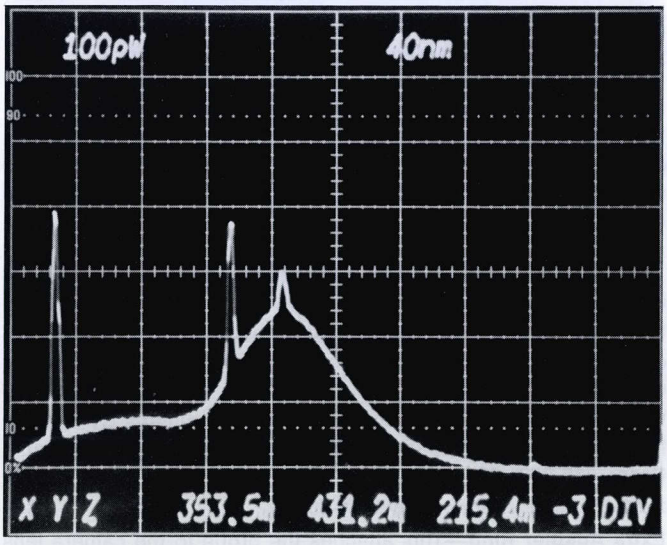
The spectrum of a low-pressure mercury arc in the 300-700 nm spectral range. The intensified spot is located at 469 nm.



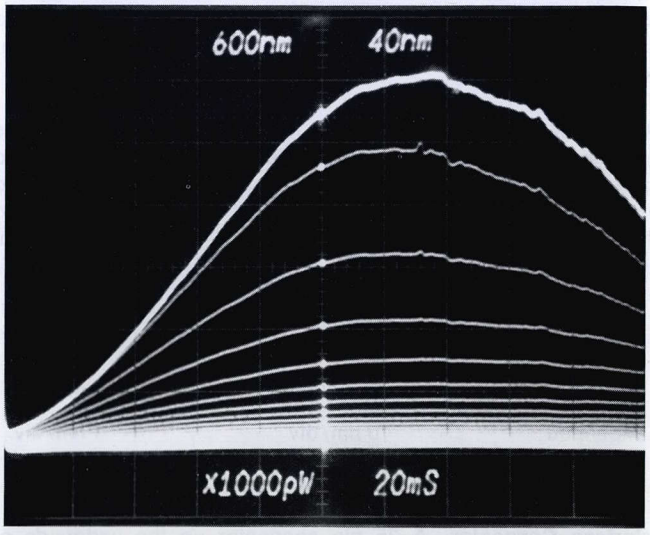
A family of spectra during the reaction of 0.01 M Fe^{3+} with 0.01 M CNS^-. The scan duration is 20 ms with a separation of 40 ms.



Diphenylamine phosphorescence showing the decay of the spectrum after shutting off the excitation.



The power spectrum of a fluorescent lamp in the 400 to 800 nm spectral range. The computer-calculated color coordinates (x, y and z) appear below the spectrum.



Spectra of a tungsten lamp at and immediately after turn-off. The crt readout indicates the wavelength of the marker at the center of the display as 600 nm, the horizontal scale factor as 40 nm/div. The vertical scale factor is uncalibrated but is about 1000 pW/div and the spectra were viewed every 20 ms.

Field of View—Horizontal 8.2 degrees
Vertical 9.5 degrees

Equivalent f-Number—f/6.3 non-vignetting

Stray Light— ≤1% at 600 nm to a notch filter with tungsten illumination.

THE PLUG-IN UNIT

The Plug-In Unit is designed to operate with the TEKTRONIX 7000-Series family of oscilloscopes. It functions as an electronic signal processor and control unit. A signal from the Spectrometer Unit is further amplified, filtered and processed to provide vertical deflection on the oscilloscope crt. The horizontal is a wavelength scan.

Vertical Gain Control—This controls the sensitivity of the instrument to accommodate the full dynamic range of light intensities. Three types of vertical deflection are provided: linear, logarithmic and absorbance.

Time/Scan—This seven position switch selects mode and time of scanning the vidicon target. In the 10 and 20 ms positions, the vidicon is continuously scanned by successive sweeps. In the 50 through 1000 ms positions, the vidicon is scanned by successive 20 ms sweeps with a delay time that adds up to the integration time selected. A variable times/scan provides a continuously variable scan. This increases the speed to at least 4 ms.

Baseline Restore—This switch closes the entrance slit shutter to provide a zero-light level reference baseline in the crt display and reset the dark current restoring circuit.

Display Trigger Mode—Four modes of display trigger are provided: (1) Free Run—Display is continuously provided; (2) Triggered—Automatically triggers scan by an external signal; (3) Single Scan—Triggers scan once with signal, until reset; (4) Reset—Rearms the system for a single scan sweep.

Spectral Normalizer—Selection is between normalized and unnormalized mode. Internal normalization means that the system is radiometrically calibrated. Use of an external normalizer optional accessory allows tailoring of the responses to allow for spectral characteristics of external filters and light sources.

Display Wavelength Span—This four position switch enables expansion of the display at any selected point. An intensified spot on the crt can be moved horizontally along the trace to the desired position. The display can be expanded around the central spot to get a magnified view of the desired area.

	Grating A	Grating B
Full Scan	40 nm/div	4 nm/div
Expanded	20 nm/div	2 nm/div
Expanded	10 nm/div	1 nm/div
Expanded	4 nm/div	0.4 nm/div

Interface Connector—A 25 pin connector on the underside of the instrument is used to facilitate interconnection with a computer or other associated equipment.

OPTIONAL ACCESSORIES

RSS External Normalizer—This uses 19 slide potentiometers to adjust the response of the RSS, such that the spectrum of a smooth continuous light source (e.g. tungsten lamp) can appear as a flat line allowing one to measure transmittance or absorbance of a substance, with the flat line as a 100% T (or 0% absorbance) reference. It may also be used to do a custom radiometric calibration over a 40 or 400 nm spectral window.

ENVIRONMENTAL SPECIFICATIONS

Temperature—Operating +15°C to +35°C. Non-operating −30°C to +50°C.

Altitude—Operating 15,000 ft. Non-operating 50,000 ft.

Humidity— ≤ 95% relative humidity non-condensing from +15°C to +35°C, operating or non-operating for 4 hours.

Vibration— 15 minutes along each of the 3 major axes, at a total displacement of 0.015 inches.

Shock— 30 g's, ½ sine, 11 ms duration. Two guillotine type shocks per axis in each direction total of twelve shocks.

Transportation—Tested to National Safe Transit Committee procedure 1A with a 36 inch drop.

DIMENSIONS & WEIGHTS

Spectrometer—

Dimensions	in	cm	Weights	lb	kg
Height	8	≃20	Net Weight with connection cable	16.5	≃7.5
Width	7	≃18			
Depth	13	≃33	Shipping Weight	21.6	≃9.8

Plug-In—

Dimensions	in	cm	Weights	lb	kg
Height	5.0	≃12.7	Net Weight	4.3	≃2.0
Width	5.5	≃14.0	Shipping Weight	9.3	≃4.2
Depth	14.5	≃36.8			

Complete RSS Shipping Weight 32 lb ≃14.5 kg

INCLUDED ACCESSORIES

7J20 Operators Instruction Manual.
7J20 RSS Service Instruction Manual.

ORDERING INFORMATION

7J20 Rapid Scan Spectrometer & Plug-In with Radiometric Calibration **$12,000**
Opt. 1 RSS without Radiometric Calibration ..... **Sub $1,000**
Mainframe Prices listed under 7000 Series

OPTIONAL ACCESSORIES

External Normalizer (016-1000-00) **$360**

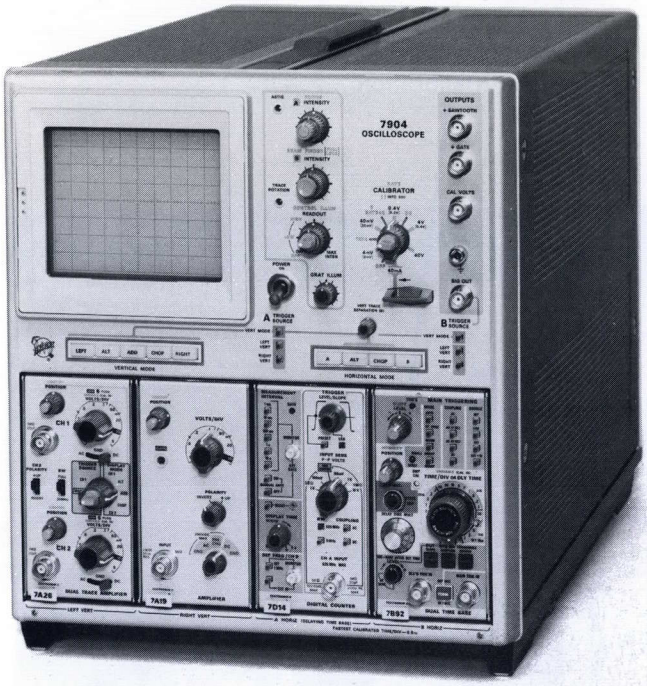
Fiber-Optics Probe—This facilitates transferring light to the entrance slit of the spectrometer (up to 36"). Includes adapter ring. **Order 016-0580-00** **$190**

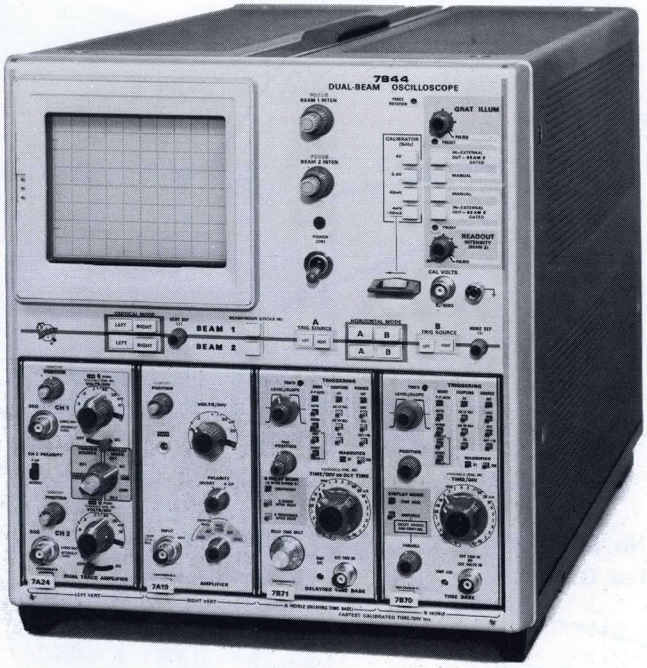
UV Fiber-Optics Probe—This quartz probe facilitates UV transfer to the entrance slit of the spectrometer. Includes adapter ring. **Order 016-0603-00** **$390**

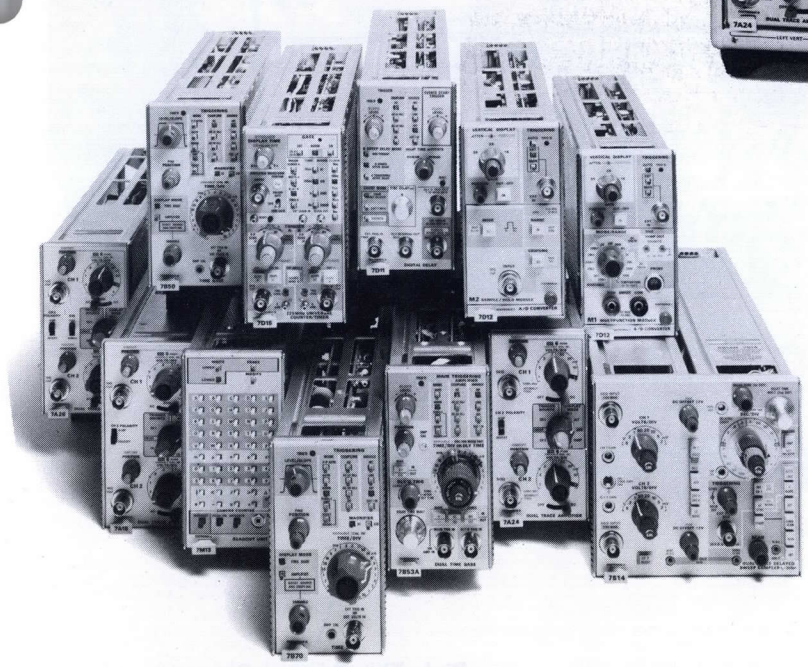
2 x 2 in Filter Holder (016-0581-00) **$45**

Extra Adapter Ring—This attaches the probe to the camera lens ring at the front of the spectrometer.
Order 016-0582-00 ..... **$30**

7000-Series Oscilloscopes

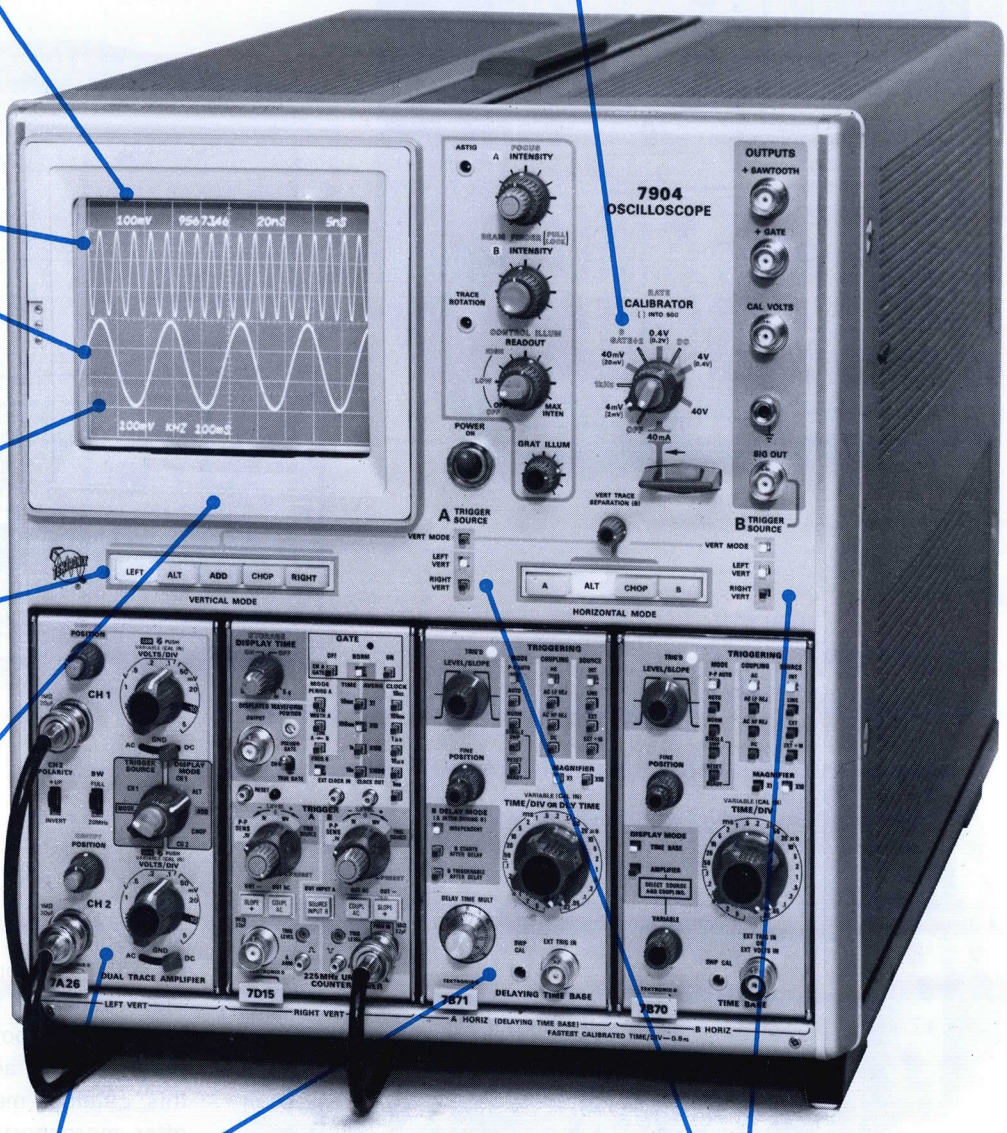


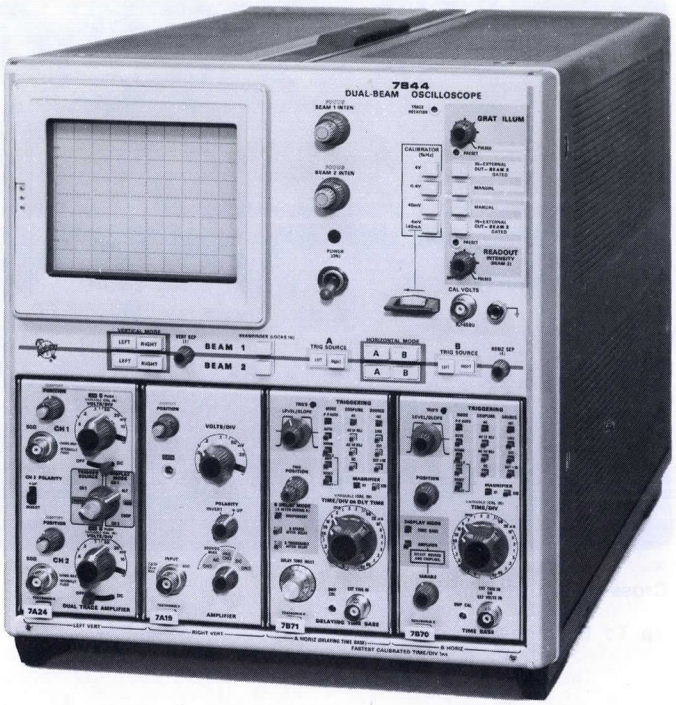


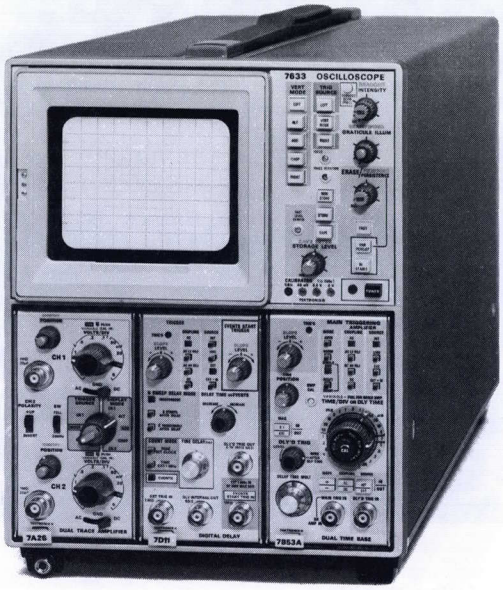


Tektronix, Inc. has always sought to provide superior products and services. They excel in today's technology, and have growth potential. The 7000-Series products and accessories, described in this catalog, meet these criteria. They offer more performance than any other general-purpose plug-in oscilloscope system available.

Please read the next pages. They describe the overall advantages and features of the 7000 Series, and tell you why the 7000 Series is more than just an oscilloscope.


Crt Readout
Full Function "Standard" For Calibration
Bright Traces
Large "No Parallax" Illuminated Graticules
Easy Display Selection
Convenient Camera Mountings And Connections
Plug-In Flexibility
Pick The Trigger Source
7904 OSCILLOSCOPE
7A26
7D15
7B71
7B70





7000-Series . . . more than just an oscilloscope

Crt Readout

Crt readout gives you all the data right on the crt. It takes the guesswork out of oscilloscope measurements by displaying the parameters on the crt. You can make your measurements quicker, and with increased accuracy. You can also photograph the data for further reference.

Bright Traces

All 7000 Series crt's are bright with excellent photographic writing speeds. For applications requiring maximum photographic writing speeds some mainframes have an optional 4 x 5 cm reduced-scan crt.

Large "No Parallax" Illuminated Graticules

The display area is 8 x 10 cm with a parallax-free illuminated graticule. 10 x 12 cm areas are available on some crts.

Convenient Camera Mountings and Connections

A standard bezel connector matches all TEKTRONIX C-50 Series Cameras and 7000 Series mainframes.

Independent Intensity Controls

Three separate intensity controls allow independent adjustment of "A" sweep, "B" sweep, and readout brightness. When in use the intensity of each sweep can be adjusted to the level that suits your applications.

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.

Eliminate Wrong Answers

Incorrect answers due to overlooked control settings are no longer a problem. The crt readout actively displays your measurement parameters, which is not only convenient, but also results in faster and clearer readings.

The Mainframe

Full Function "Standard" for Calibration

The calibrator is a multi-function generator, intended for use as a standard for calibrating plug-ins and compensating probes. Calibrated signal outputs are also available for use when a signal generator is not handy.

Pick the Trigger Source

Internal trigger selection is available. In the VERT Mode, this eliminates the need to continually select the source, which is selected via the mainframe mode switching.

Easy Display Selection

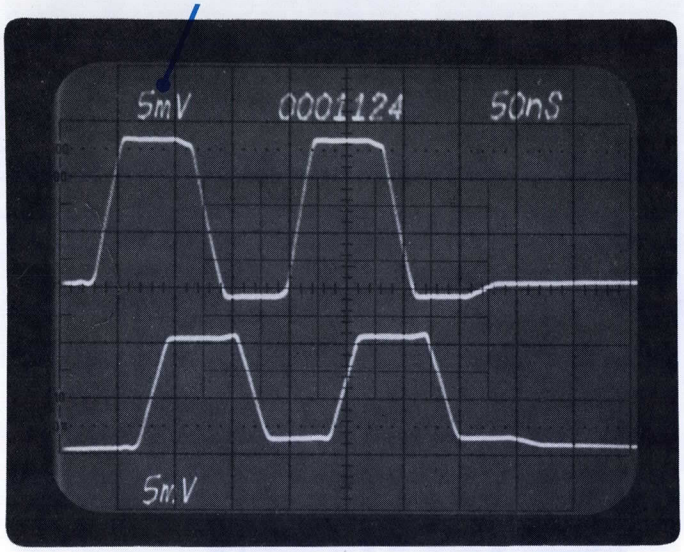
Mainframe vertical and horizontal mode switching allows you wide flexibility in choice of either two vertical plug-ins, or two independent/slaved time bases. These combinations give you dual-beam simulation and a wide selection of multitrace performance options.

Mainframe Flexibility

There are options for "customizing" your oscilloscope to specific measurement requirements, above the three or four-hole configuration.

STORAGE

Readout Stored With The Waveform



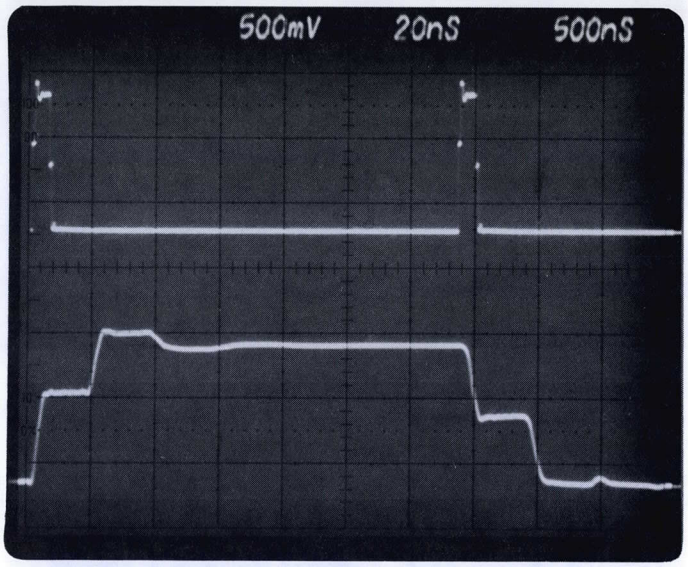
Fast Stored Writing Speeds

Multimode (7600)

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

DUAL BEAM

400 MHz Bandwidth

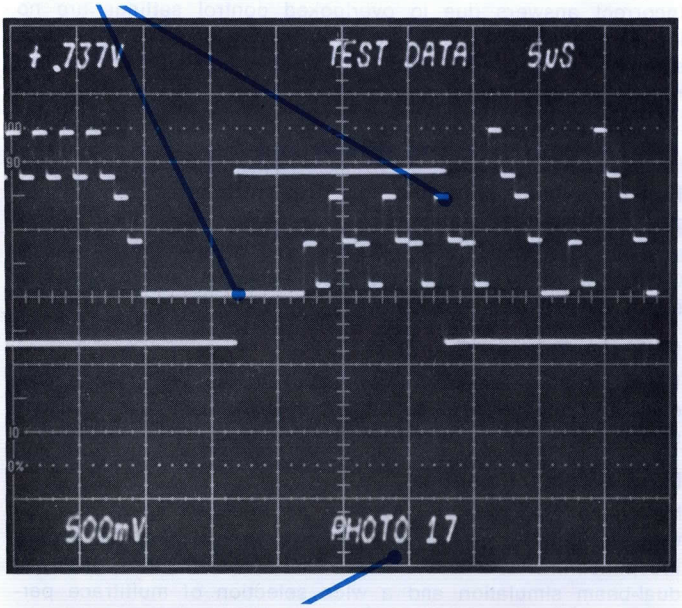


Cross-Over Switching

Up To 8 Traces

DIGITAL

Sample And Hold DVM Measures Difference Voltage Between Two Points On Complex Waveform



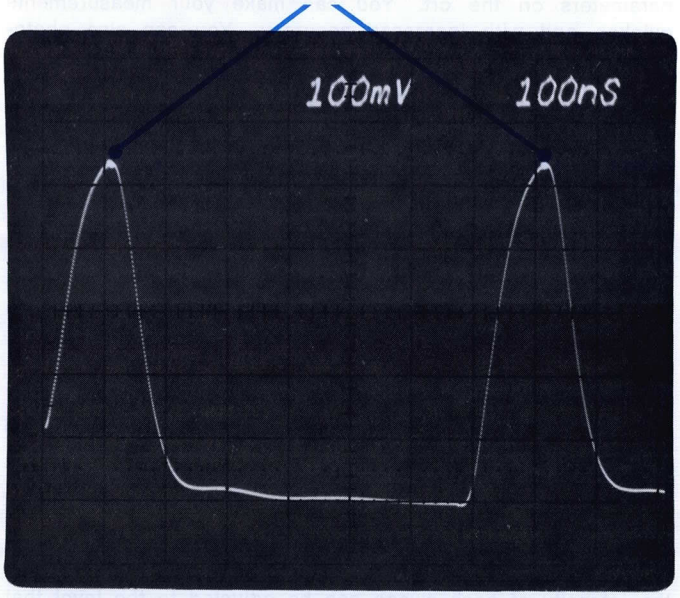
Readout Unit Identifies This Waveform As TEST DATA-PHOTO 17

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

Storage

The 7000 Series Storage offers high-speed trace retention ability and long display times—hours, even days if necessary. The displays are bright; even under high ambient light your display can be easily viewed. All are compatible with a large selection of plug-ins to fit most requirements.

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

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

Two types of storage are available to meet your varied needs.

Multimode

Multimode Storage has four modes of operation: Normal and Fast Bistable, Variable Persistence, and Nonstore. The newest 7000 Series Storage oscilloscope offers nine operating modes. In addition to the above, it offers fast Variable Persistence, plus a 3.6 x 4.5 cm scan which operates in all modes. This provides the instrument's top writing speed.

Variable Persistence

Variable Persistence is particularly useful when a high contrast is needed between the stored image and the crt background.

Split-Screen Bistable

Split-Screen Storage permits joint or independent storage on the two halves of the crt. Both halves can be operated either jointly or independently.

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

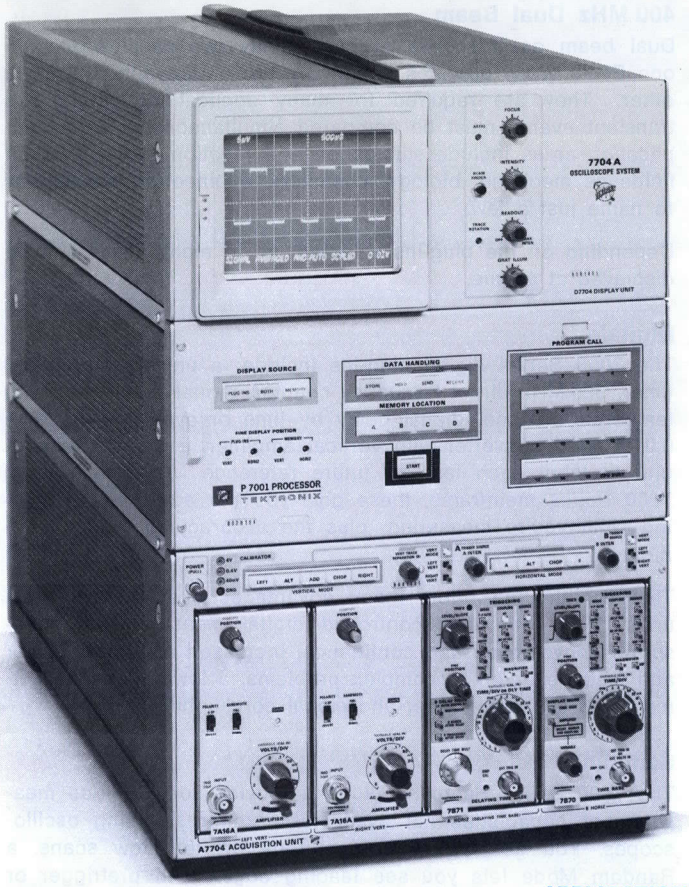
The 7000 Series digital plug-ins include: a universal counter/timer, 525 MHz direct frequency counter, digital multimeter with temperature mode, digital delay by time or events, a versatile 0.01% A/D converter with vertical amplifier, a special readout unit to label each test for future reference. Together 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.



DISPLAY UNIT

The DPO Display Unit is equipped with a bright, fast-writing crt. Measurement parameters are displayed with waveforms on the crt.

PROCESSOR

The P7001 Processor is designed to provide maximum flexibility as a signal interface. It contains signal routing, analog-to-digital (A/D) and digital-to-analog (D/A) circuitry, and up to 4,000 words of 10-bit memory for storage of digitized waveforms and alphanumeric information for the crt readout.

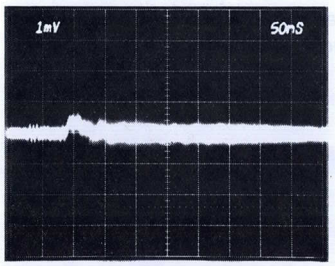
ACQUISITION UNIT

Compatible 7000-Series plug-ins give DPO's flexible data-acquisition capabilities.

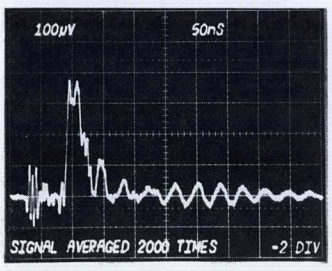
APPLICATIONS LIMITED ONLY BY YOUR IMAGINATION

Any Waveform on the Display May Be Stored in Memory and Processed

All Stored or Processed Waveforms May Be Displayed on the Crt

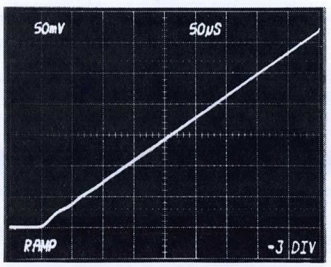


A signal, barely visible due to noise, averaged 2000 times, rescaled for optimum viewing, and displayed with appropriate scale factors. A DPO makes it easy enough to be accomplished by pressing one button.

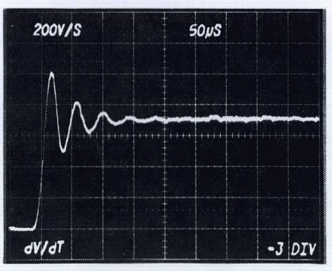


Display a Signal in the Frequency Domain by Calculating Its Fourier Transform

Signal Average to Extract Signals from Noise, or to Improve Resolution

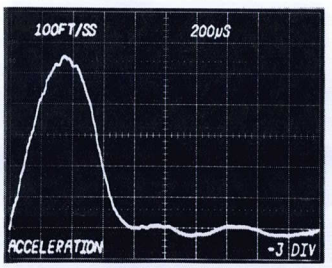


Differentiating a ramp to determine its linearity.

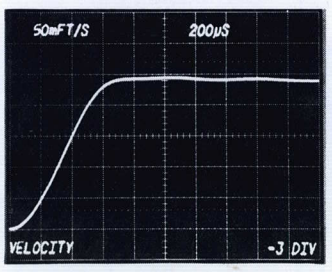


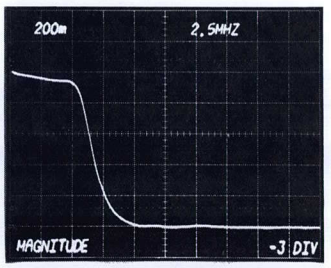
Pushbutton Access to Full Processing Power

Message Display—Two Lines of Forty Characters

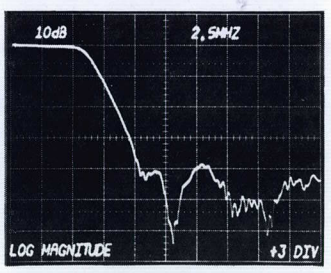


Determining velocity by integrating the acceleration . . . a computation made easy with the DPO.





Magnitude to log magnitude conversions made easy with the DPO.



Measurement requirements and technologies are changing rapidly. Improved bandwidths, sensitivities, triggering circuits, and storage capabilities have done a great deal to enhance the value of oscilloscopes as general-purpose measurement equipment. In many areas however, measurements must be supplemented by computations in order to provide users with information that is easier to interpret.

Where masses of analog data must be analyzed before meaningful conclusions can be made, the conventional scope can help by acquiring and displaying signals to be photographed. Analysis requires a computer or programmable calculator to process the acquired data. However, the analog data must be digitized before this is possible. Often, the digitizing process is long and complex.

In response to this need for a means of acquiring data, processing it, and displaying it in a more useable format, Tektronix has introduced the Digital Processing Oscilloscope (DPO). DPO's represent the natural merger of the signal-acquisition flexibility of laboratory oscilloscopes and machine intelligence.

In effect, DPO's provide a two-way link between the world of analog quantities and the digital processing world.

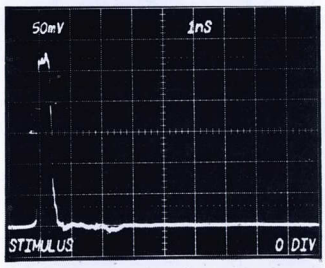
As a result, DPO's are versatile and powerful measurement instruments that let you acquire waveforms in normal oscilloscope format, digitize these waveforms, and, finally, process them.

To meet varying measurement requirements, Tektronix offers two series of DPO configurations. The WP1100 Series DPO's use TEKTRONIX 31 Programmable Calculators, and the WP1200 Series DPO's use TEKTRONIX CP1100 Series controllers to process acquired data. The CP1100 Series controllers are compatible with PDP-11® software and peripherals.

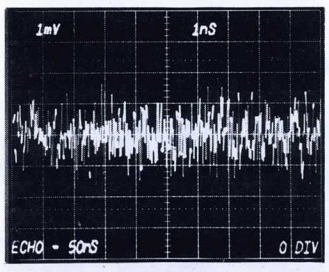
Some examples of DPO measurement capabilities have been included. The list is by no means complete. Any signal that can be displayed can be processed. DPO programming has been simplified, even the most complex computation, can be quickly programmed, and executed at the touch of a button.

®PDP-11 is a registered trademark of the Digital Equipment Corporation.

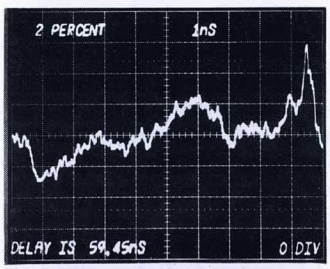
Cross Correlations—The technique of cross-correlation can be used to locate an echo following a stimulus pulse.



Stimulus pulse

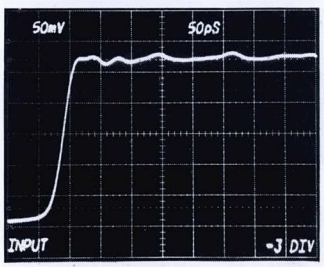


Echo not clearly visible due to noise

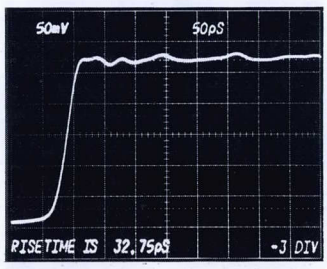


Cross-correlation determines that the echo followed the stimulus by 59.45 ns

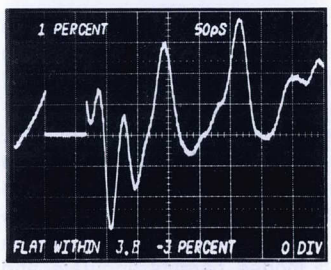
Pulse Parameter Measurements



Input



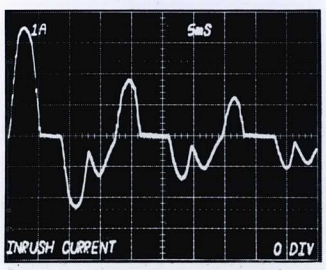
DPO calculates risetime from 10-% to 90-% points of input waveform



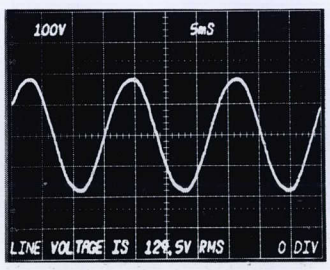
Deviations of the input pulse from an ideal pulse, calculated by the DPO. The flat zone represents the risetime and was not included in the deviation calculations.

Simplified Power Calculations

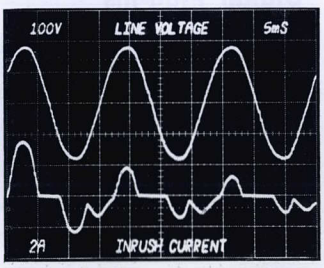
Multiplying the magnetic inrush current by the line voltage to determine peak power.



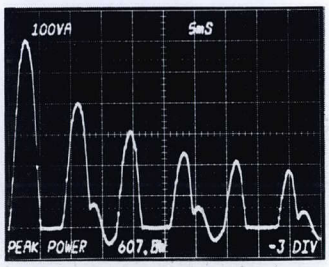
Inrush current



Line voltage



Current and voltage simultaneously displayed on DPO's crt.



Power waveform resulting from multiplying current by voltage.

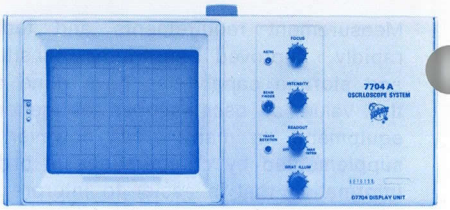
The DPO acquisition system . . .

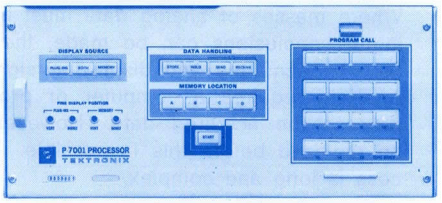
Digital Processing Oscilloscopes are parts of the TEKTRONIX 7000-Series measurement equipment. That point is significant. It means that the wide and flexible array of signal-acquisition units (plug-ins) already available for the 7000 Series applies to this new marriage of machine intelligence and the waveform power of a general-purpose laboratory oscilloscope.

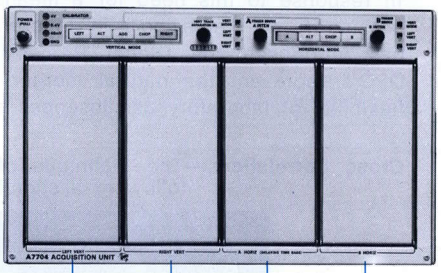
The DPO Acquisition Unit accepts up to four 7000-Series plug-in units. The 7000-Series plug-in family includes over 30 plug-ins with more to come. An enormous range and variety of signals may be captured for processing. Conventional plug-ins include single-trace amplifiers, dual-trace amplifiers, single time-base units, and dual time-base units. Other plug-ins include digital units, a general-purpose sampling and Time Domain Reflectometry (TDR) unit, a spectrum analyzer, and a Rapid Scan Spectrometer (RSS).

The single- and dual-trace vertical amplifier plug-ins have sensitivities ranging from 10 microvolts per division to many kilovolts per division. Since most TEKTRONIX signal acquisition probes can be used, signal amplitudes up to 40 kV peak values may be accepted. Bandwidths from dc to 175 MHz are available in conventional plug-ins; sampling plug-ins offer bandwidths to 14 GHz.

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



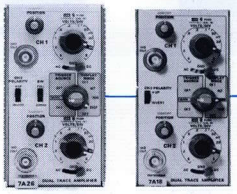




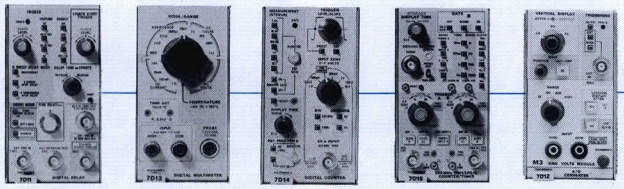
Amplifiers

Amplifiers

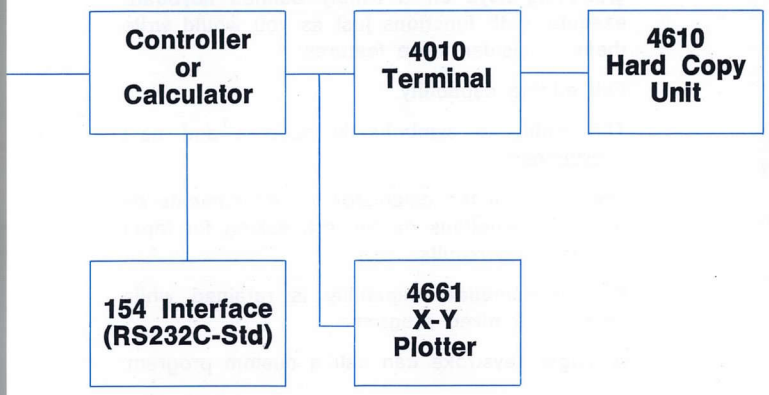
Dual-Trace Amplifiers



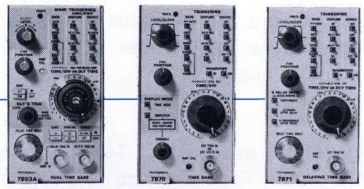
Digital Plug-Ins



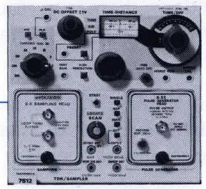
Flexible acquisition system lets you choose functions for four separate channels



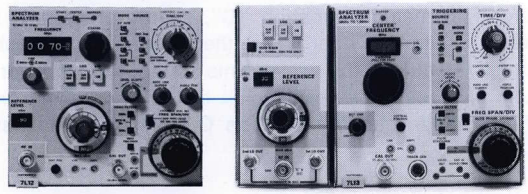
Time Bases



Sampling Plug-Ins/TDR



Spectrum Analyzers



Rapid Scan Spectrometer

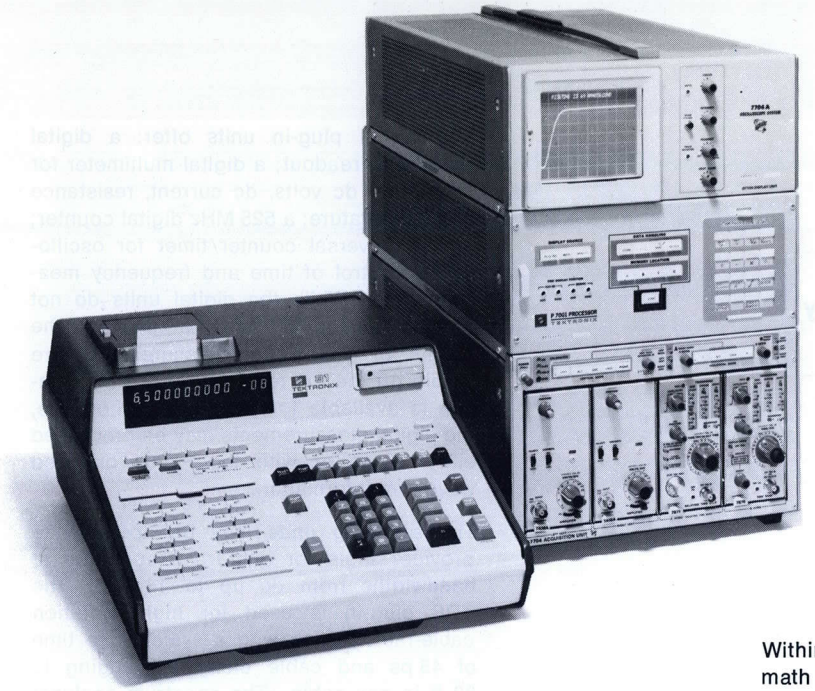
and more plug-ins on the way

The digital plug-in units offer: a digital delay with readout; a digital multimeter for measuring dc volts, dc current, resistance and temperature; a 525 MHz digital counter; and a universal counter/timer for oscilloscope control of time and frequency measurements. While the digital units do not provide analog signals for display, the results of the digital measurements are visible on the crt readout. All crt information is available for processing; therefore, the digital measurements may be processed either alone or with the P7001 digitized waveform information.

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

The Acquisition Unit will operate with as many as four of the plug-in units. For time-based measurements, a vertical amplifier unit and a time base may be paired. At the same time, if one parameter is to be plotted as a function of another, a vertical deflection plug-in unit may be installed in one of the horizontal deflection compartments of the acquisition unit for an X-Y plot display. X-Y displays may be stored directly for processing, provided that Y is a single-valued function of X. The ability to use different plug-ins to meet differing requirements enhances DPO flexibility. As new 7000-Series plug-ins become available, this flexibility will further increase.

For observation, measurement, and analysis of dynamic optical events the TEKTRONIX RSS and the DPO provide new and versatile capabilities. The RSS, with a spectral range from 250 to 1100 nm, permits observations extending from ultraviolet to the near infrared region. Radiometric calibration allows a measurement of radiant power as a function of wavelength. Spectral absorption may be analyzed in terms of transmittance or absorbence.



WP1100 SERIES
DIGITAL PROCESSING OSCILLOSCOPES

Programmable calculator-aided instrumentation systems offer the computational capabilities required to solve a wide variety of data acquisition and analysis problems. The WP1100 Series DPO's are excellent examples, and offer users some unique advantages.

Low Cost
The initial price of a WP1100 Series DPO is substantially less than controller based DPO's (WP1200's). The WP1100 Series DPO's are ideally suited to applications where the processing speed is not critical but where the price levels of equipment required to do a job are critical.

Stand Alone Operation
One of the unique advantages of the WP1100 Series DPO's is the value that each unit has when used independently. Indeed, there are applications where the DPO is significantly more versatile than the general-purpose scope from which it was built. In go/no-go testing for example, the DPO can store calculator/determined waveform parameters in the Processor Unit for visual comparisons with the output of the device under test. While the DPO is used for go/no-go testing, the 31 Calculator can be used elsewhere as a stand-alone, programmable, scientific calculator for any number of applications from circuit design to cost accounting.

Expandability
When time requirements exceed the capabilities of the 31 Calculator, or budgetary limitations change, users will find that they can make the transition from a calculator-based DPO to a CP1100 Series Controller-based DPO very easily. In addition, they free the programmable calculator for stand-alone operation when they make the conversion.

Programming Ease
One feature that sets the 31 Calculator apart from others in its field is its natural math language. Tektronix has successfully removed the machine-language barrier. The English-like programming keys on a simply defined keyboard execute math functions just as you would write them. Consider these features:

Full editing capability.

The ability to symbolically address and nest subroutines.

The ability of the calculator to communicate by writing instructions on the crt, asking for input and labeling results.

Full mathematical capability is retained while using customized programs.

A single keystroke can call a custom program.

Within the TEKTRONIX 31 Calculator there are over 30 built-in math functions. There are 24 keys that can be user-defined to perform special, frequently used functions. Up to 8192 program steps with 256 memory registers are available along with a switch that enables you to increase the number of registers at the expense of program steps available.

Programs
To allow easily accessible waveform processing, Tektronix has developed the Keyboard Interpreter Program and a Program Keyboard Overlay. The interpreter contains programs to add, subtract, multiply, divide, log x, integrate, differentiate, x^2, signal average, and determine rms. In addition, there are four keys and corresponding space available for your user-defined functions.

The Keyboard Interpreter Program will automatically scale waveforms, process scale factors from the plug-ins, and process waveform arrays just as the calculator normally processes a single variable.

For example, to multiply a waveform in memory location "A" by a waveform in memory location "B" and deposit the resulting waveform in memory location "C", simply press A X B = C on the calculator keyboard and the interpreter program will automatically multiply the waveforms using the appropriate scale factors, rescale the result to fit in the area of the crt, and place the result in memory location C along with the new scale factor.

Data Logging
Another important feature of the WP1100 Series DPO is its data logging capability. You can store entire waveforms on the magnetic tape cartridge at the push of a button (along with scaling and scale factor information, and message text). These waveforms can be stored for any duration and redisplayed at will. The silent, alphanumeric thermal printer can be used to record each digital, horizontal waveform element along with the appropriate scale factor. The optional TEKTRONIX 4661 X-Y Plotter can also be used with the WP1100 DPO to record waveforms in a convenient hard copy form.

For more information on the WP1100 Series Digital Processing Oscilloscopes, contact your nearest Tektronix Digital Applications Engineer, use the reply card, or write to: Tektronix, Inc., P.O. Box 500A, Beaverton, OR 97005.

WP1200 SERIES DIGITAL PROCESSING OSCILLOSCOPES

With I/O options, memory options, and a variety of labor-saving peripherals available, the WP1220 Series Digital Processing Oscilloscopes represent comprehensive, powerful, and flexible data-acquisition and analysis systems. These DPO configurations have a variety of time and money saving applications in the fields of physics, optics, chemistry, mechanical studies, and biology, as well as electronics.

With suitable transducers ahead of the DPO vertical-amplifier plug-ins, researchers can quickly acquire and process masses of information and have meaningful results in moments instead of the days or weeks required by conventional techniques.

DPO TEK BASIC SOFTWARE

A key to the value and flexibility of the WP1200 Series DPO's is the software, DPO TEK BASIC. Dartmouth BASIC software was chosen as a starting point for DPO TEK BASIC because it is a simple, easily learned, general-purpose programming language that uses statements closely resembling English and algebra.

New statements have been added to permit improved waveform processing and to support the hardware. Whenever possible, the software has been designed to minimize storage requirements and speed waveform processing.

Waveforms can be transferred between the controller and the Processor Unit as well as mathematically processed with simple commands. For example:

LET A = SQR (D*B + C*C)

LET PA = A

DPO TEK BASIC is an interpretive language. This permits you to write a program, run it, modify it, and run it again without delay. DPO TEK BASIC automatically adjusts to use the full amount of memory available in the CP1100 Series Controller.

While it is very simple, DPO TEK BASIC is also quite powerful. Even without a prior knowledge of programming, you can use BASIC to perform useful calculations. Operations and functions defined in DPO TEK BASIC include: standard math functions, sine, cosine, tangent, logarithm, arc tangent, exponent, square root, integer function, random numbers, and algebraic sign indication.

These operations and functions can also be used in any statement in a BASIC program. A feature of DPO TEK BASIC is that the software will rescale a waveform to fill as much of the crt as practical. The software will also automatically correct the displayed scale factors for the resized waveform.

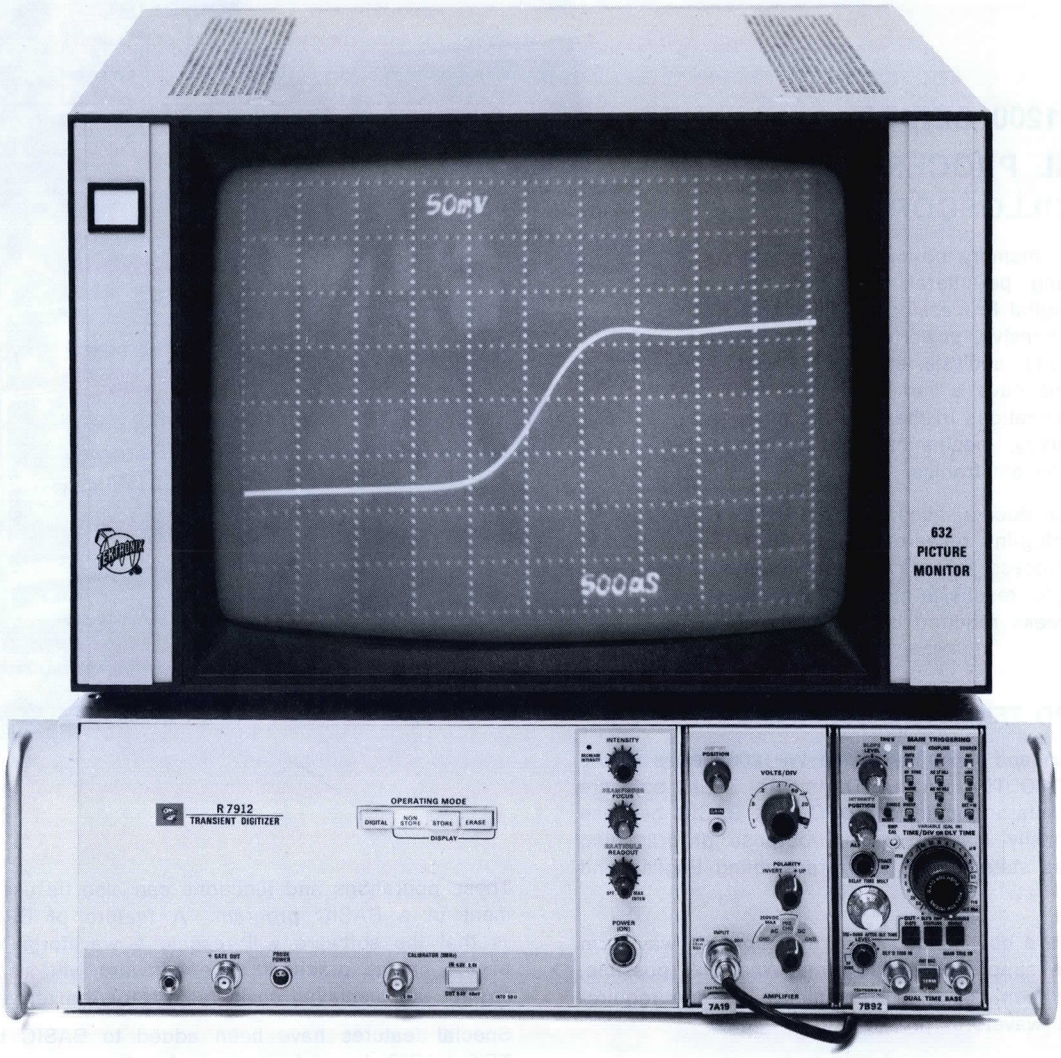
Special features have been added to BASIC to permit DPO TEK BASIC to perform such functions as: a) compute the minimum, mean, maximum, or rms values of a waveform; b) integration; c) differentiation; d) signal averaging; e) fast Fourier transforms; f) convolution; and g) correlation.

DPO TEK BASIC contains the necessary operational instructions that permit you to display messages and numbers on the DPO's crt. This feature may be used to give instructions to the operator or to label waveforms. Scale factors from the 7000-Series plug-ins being used may be stored and used in DPO TEK BASIC. The software automatically maintains correct scale factors and units after waveform processing. Some features of DPO TEK BASIC are optional and may be selected during load time. Storage space for programs is gained when optional features are not needed.

For more information on the WP1200 Series Digital Processing Oscilloscopes, contact your nearest Tektronix Digital Applications Engineer, check the reply card, or write to Tektronix, Inc., P.O. Box 500A, Beaverton, OR 97005.

Transient Digitizer

Transient Analysis, and Digital Storage at 8,000 div/μs



Analog Bandwidth:
1 GHz at 4 V/div
500 MHz at 10 mV/div

Resolution: (Best case)
400 by 320 lines
512 by 512 addressable points

Writing Rate:
8,000 div/μs DIGITAL mode
30,000 div/μs NON-STORE (tv) mode

Sampling Rate (effective):
10 psec (100 GHz) or slower

Before very fast transients can be studied in detail, they must be captured in analyzable form. The R7912 Transient Digitizer in Waveform Digitizing instrument (WDI) configurations has been designed specifically for these high-speed signals. It combines the elements of efficiency, accuracy, and flexibility into an easy-to-operate system that can quickly give you results in a meaningful form from captured transient data.

Applications for WDI transient analysis systems are far ranging. Researchers in many fields, including those involved in the study of laser pulses, super-fast electro-chemical measurements, fluorescence decay, non-destructive device testing, EMP, and ECM, will find the R7912's capability to digitize single events with subnanosecond risetimes unmatched by conventional instrumentation.

In the DIGITAL mode, the R7912 operates as a fast analog-to-digital converter. It takes 512 samples of a waveform in a time window as short as 5 ns. This digital information can be stored in a self-contained memory (optional), or sequenced to a computer, or other peripheral such as a digital-to-analog converter for display on an X-Y monitor.

In the NON-STORE mode, the R7912 processes waveforms into a tv compatible format (525 lines, 60 Hz field, 2:1 interlace) for bright, large-screen displays on conventional tv monitors. This mode is intended primarily for repetitive signals.

Currently, many standardized TEKTRONIX 7000-Series oscilloscope acquisition plug-ins are available for the R7912. These make WDI systems versatile signal acquisition systems featuring flexibility as well as compatibility with many other instruments in the 7000-Series family.

WDI configurations have been designed to take advantage of the flexible R7912 capabilities. Examples of the configurations for both transient display or monitoring, and transient analysis are on the following pages.

WDI TEK BASIC SOFTWARE

Once captured by the R7912, a signal can be processed with the WDI TEK BASIC software. Based on the interactive, easy-to-learn Dartmouth BASIC software, WDI TEK BASIC incorporates powerful waveform-analysis functions. Callable commands provide for waveform parameter measurements, multiplication, division, convolution, correlation, and the more complex fast Fourier transform and its inverse.

VERTICAL SYSTEM

Channels—Left-hand plug-in compartment; compatible with 7000-Series plug-ins. Bandwidth (up to 1 GHz) determined by mainframe and plug-in unit.

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

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

HORIZONTAL SYSTEM

Channels—Right-hand plug-in compartment; compatible with time bases of the 7B70 and 7B90 Series.

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

SCAN CONVERTER CRT

Type—Double-ended, dual-gun crt.

Resolution—DIGITAL mode: binary, 512 point matrix; resolution elements, 320 vertically by 400 horizontally. NON-STORE mode: at least 400 tv lines per picture width at 50% response.

Writing Rate (+10°C to +40°C)*—NON-STORE mode: visual writing rate 30 div/ns when viewed on TEKTRONIX 632 Picture Monitor. DIGITAL mode: 8 div/ns digital storage writing rate.

*0°C to +10°C—at least one-half of the +10°C to +40°C values.

MEMORY OPTION

Type—Static semiconductor memory, non-destructive readout.

Size—4096 words by 10 bits.

Cycle Time— 1 μs per word or slower.

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

OUTPUTS

Signal Outputs—Plus Gate; Output voltage: 0.5 V (±10%) into 50 Ω or 10 V (±10%) into 1 MΩ. Risetime; 2 ns or less into 50 Ω; output resistance is 950 Ω ±2%.

Fast Rise Calibrator (BNC) Waveshape—Positive-going square-wave with baseline approximately at ground. Duty cycle is approximately 50%. Amplitude Accuracy: Switch selectable, open circuit (4 V, 400 mV) ±0.5% from 0°C to +40°C, 50 Ω (400 mV, 40 mV) ±1.0% from 0°C to +40°C. Frequency: Internally selectable, 1 MHz ±0.1%, 1 kHz ±20%. Risetime: 1.2 ns or less at 400 mV or 40 mV into 50 Ω.

Video Outputs—Conforms to EIA RS-170 (525/60). Video Linear (BNC): 1 V into 75 Ω per full white signal. Video Binary (BNC): Either low-level 0 V to +0.3 V max, or high-level +1.0 V ±0.1 V into 75 Ω. Video Composite (BNC): Binary video plus sync, 1 V p-p nominal. Sync Out (BNC): At least 4 V into 75 ohms. Sync In (Loop Through) (BNC): 2 V to 8 V, 75 Ω.

Data Outputs—Data Out Connector (104 Pin Connector): 12 data out lines (2 reserved), 4 ground lines, 6 control and status lines. All are TTL levels except single sweep indicators.

ELECTRONIC GRATICULE

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

Display—8 x 10 major divisions consisting of a dot matrix. Selectable—5 dots/div or 1 dot/div.

Intensity—Adjusted or disabled from front panel.

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

POWER REQUIREMENTS

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

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

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

SYSTEM ENVIRONMENTAL SPECIFICATIONS

Operating Temperature Range—From 0°C to +40°C.

Operating Altitude—To 15,000. Non-operating to 50,000 feet.

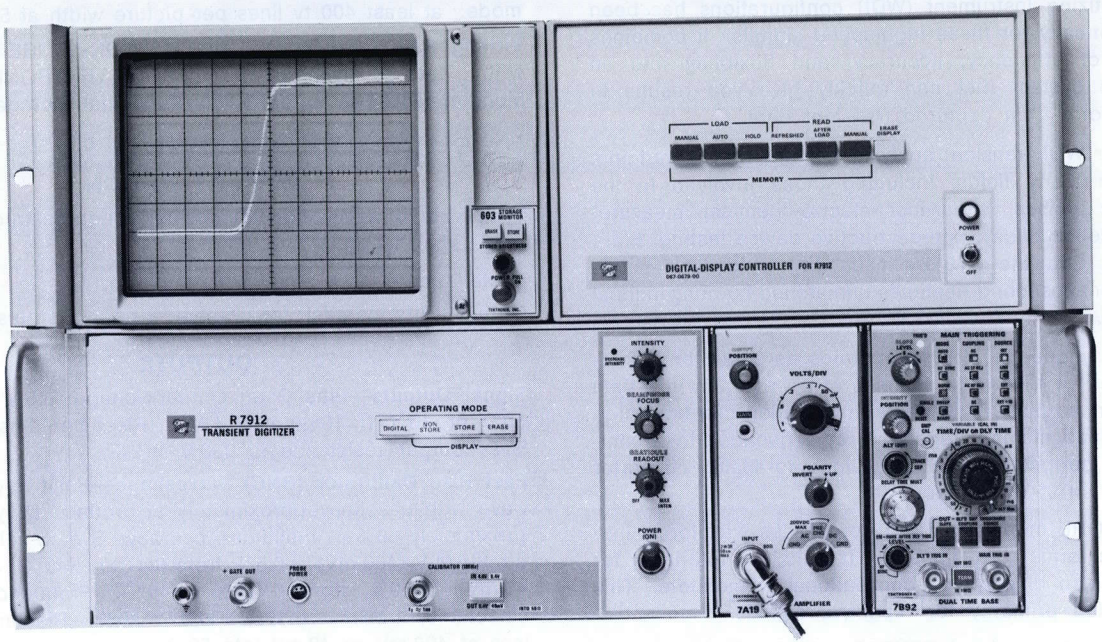
DIMENSIONS AND WEIGHTS

Height	Width	Length
5.2 in	17.6 in	26.9 in
13.2 cm	44.7 cm	68.3 cm

Shipping
72.0 lb
32.6 kg

For more information on the R7912 and WDI configurations, contact your nearest Tektronix Digital Applications Engineer, or use the reply card, or write: Tektronix, Inc., P.O. Box 500A, Beaverton, OR 97005

TRANSIENT VIEWING CONFIGURATIONS



HIGH PERFORMANCE ACQUISITION

500 MHz at 10 mV/div

1 GHz at 4 V/div

To 0.5 ns/div sweep speeds

Display scale-factor settings

WP2001

R7912 with Plug-Ins (7A19, 7B92), Monochrome Picture Monitor, Cabinet, Manuals, and Accessories.

High-brightness oscilloscope package to view high-speed, low-rep-rate signals under high ambient light conditions.

Visual writing speed of 30,000 div/μs.

View signals from across the room on the large 15″ (diagonal) display.

Dual-beam configuration available.

Can be connected to a video tape recorder for waveform recording.

WP2002

R7912, Plug-Ins (7A19, 7B92), Display Controller, Display Monitor, Cabinet, Manuals, and Accessories.

High-speed digital waveform storage.

Bright, refreshed 6″ display.

Can display waveform contained in digital memory.

Cameras are adaptable for permanent records.

WP2003

R7912, Plug-Ins (7A19, 7B92), Display Controller, Display Monitor, Monochrome Picture Monitor, Cabinet, Manuals, and Accessories.

Combines large-display and digital-storage capabilities.

Incorporates the features of the WP2001 and WP2002 configurations into one package.

WP2004

R7912, Plug-Ins (7A19, 7B92), Display Controller, Display Monitor, Storage Display Unit, Hard Copy Unit, Cabinet, Manuals, and Accessories.

High-speed, digital waveform storage-package.

Incorporates the features of the WP2002 configuration plus:

A large 11″ storage display.

8½″ x 11″ hard copies of the displayed waveform in seconds.

TRANSIENT ANALYSIS CONFIGURATIONS

Repetitive or Single Transient Acquisition and Analysis

High Performance Acquisition—

500 MHz at 10 mV/div

1 GHz at 4 V/div

To 0.5 ns/div sweep speeds

512 by 512 addressable points

8000 div/μs Digital Storage Writing Rate

Full Waveform Measurement Capability—

Signal averaging

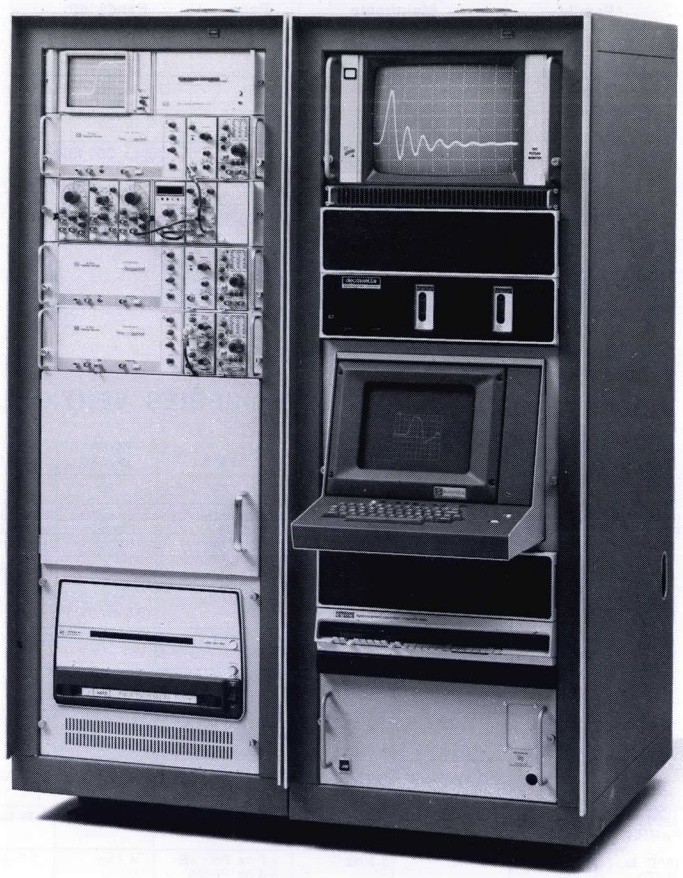
Waveform multiply and divide

Correlation

Convolution

Integrate, differentiate

FFT and inverse



WP2221

R7912, CP1151 Controller, CP1100 Series Controller Interface, Graphics Terminal, Plug-Ins (7A19, 7B92), Monochrome Picture Monitor, Software, Dual Cassette, Cabinet, Manuals, and Accessories.

A complete high-speed waveform-acquisition and analysis package.

One R7912 acquisition unit with plug-ins (7A19 and 7B92) supplied.

Full, on-site one-year system warranty.

WP2222

R7912, CP1151 Controller, CP1100 Series Controller Interface, Plug-Ins (7A19, 7B92), Monochrome Picture Monitor, Graphics Terminal, Hard Copy Unit, tv Switcher, Software, Dual Cassette, Cabinet, Manuals and Accessories.

A complete high-speed waveform-acquisition and analysis package designed for those who need multiple acquisition units.

Up to six acquisition units (R7912's) possible.

One R7912 acquisition unit and plug-ins (7A19 and 7B92) supplied.

Includes 8½" x 11" Hard Copy Unit.

Full, on-site, one-year system warranty.

WP2321

R7912, CP1160 Controller, CP1100 Series Controller Interface, Plug-Ins, Monochrome Picture Monitor, Graphics Terminal, Hard Copy Unit, tv Switcher, Software, Dual Cassette, Cabinet, Manuals and Accessories.

A complete high-speed multiple-unit acquisition and analysis configuration.

Up to four R7912's (one R7912 with 7A19 and 7B92 plug-ins is supplied).

Processing time is considerably faster than WP2221 and WP2222 configurations.

Includes 8½" x 11" Hard Copy Unit.

Full, on-site, one-year system warranty.

R7912, CP1160 Controller, CP1100 Series Controller Interface.

WP2322

R7912, CP1160 Controller, CP1100 Series Controller Interface, Plug-Ins (7A19, 7B92), Monochrome Picture Monitor, Graphics Terminal, Hard Copy Unit, tv Switcher, Software, Dual Cassette, Cabinet, Manuals and Accessories.

A complete high-speed multiple-unit acquisition and analysis configuration.

Up to 8 R7912's (one R7912 with 7A19 and 7B92 plug-ins is supplied).

Processing time is considerably faster than WP2221 and WP2222 configurations.

Includes 8½" x 11" Hard Copy Unit.

Full, on-site, one-year system warranty.

BANDWIDTH FAMILIES

Family	Mainframe	Page	Bandwidth
7900	7904/R7903 R7912†	50	Dc to 500 MHz*
7800	7844/R7844	54	Dc to 400 MHz*
7700	7704A Opt 9	57	Dc to 250 MHz
	7704A	57	Dc to 200 MHz
	R7704	57	Dc to 175 MHz
7600	7603/R7603 7603N Opt 11**	61	Dc to 100 MHz

*1 GHz Direct Access with 7A21N plug-in.

**Refer to Ruggedized Oscilloscope System.

†Refer to Transient Digitizer.

SPECIAL APPLICATION OSCILLOSCOPE FAMILIES

Family	Mainframe	Page	Application
Storage	7633/R7633	70	1,000 cm/μs Stored Writing Speed, Multi-mode Storage.
	7623A/R7623A	70	135 cm/μs Stored Writing Speed, Multi-mode Storage.
	7613/R7613	73	Variable Persistence Storage
	7313/R7313	75	Split-Screen Bistable Storage
Ruggedized Oscilloscope System	7603N Opt 11S	64	Qualified under MIL-O-24311(EC) and appears on U. S. Navy OPL 24311.

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER			7A11	7A13	7A15A 7A15AN	7A16A	7A17	7A18 7A18N	7A19	7A21N	7A22	7A24	7A26
PAGE			78	79	80	80	81	82	83	83	84	85	85
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-ohm Input Amplifier	Direct Crt Access	Dc-Coupled, High-Gain Differential Amplifier	Dual-Channel 50-Ω Amplifier	Dual-Channel Amplifier
MIN DEFL FACTOR			5 mV/div	1 mV/div	5 mV/div (0.5 mV/div)[2]	5 mV/div	50 mV/div	5 mV/div	10 mV/div	<4 V/div	10 μV/div	5 mV/div	5 mV/div
ACCURACY[1] WITHOUT PROBE			2% (Integral)	1.5%	2%	2%	———	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)	7844R	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.

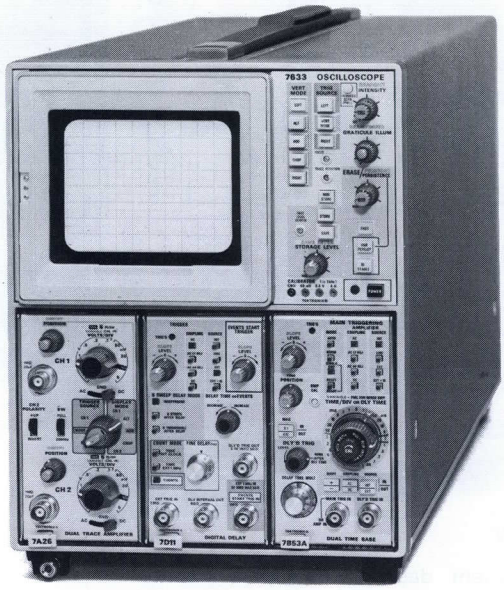
[3]Bandwidth is 325 MHz to 10 mV/div.

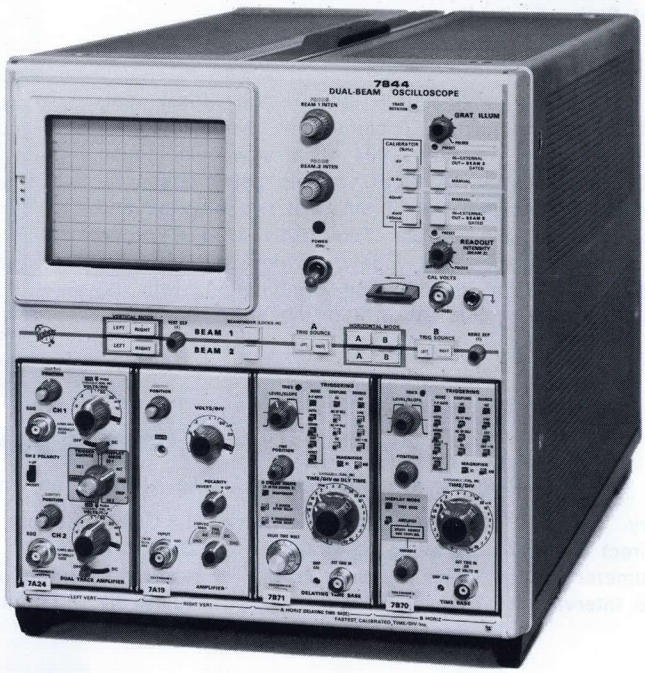
[4]Bandwidth is 200 MHz at 10 mV/div.

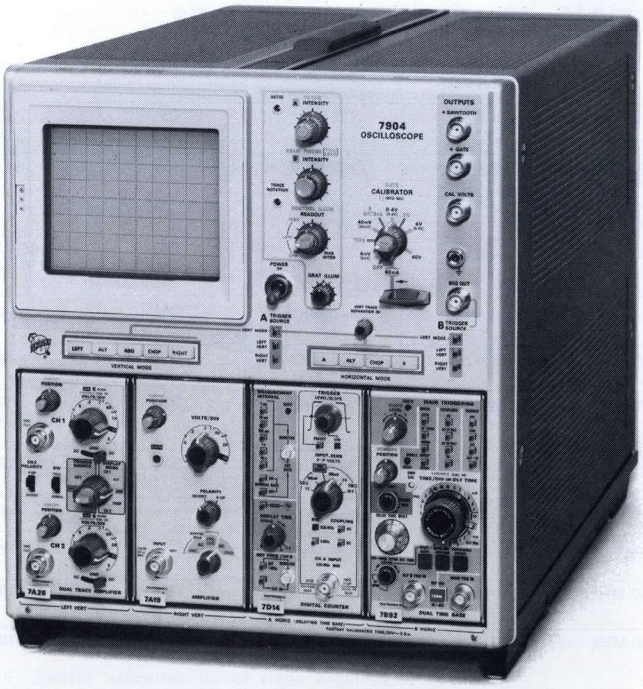
[5]All 7000 Series plug-ins are compatible with the 7603N opt 11. However they do not meet the rigid environmental specifications required by the military.

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

7000-Series Mainframes







The 7000-Series mainframes are the basic building blocks for a high-performance measurement system. Each mainframe consists of a power supply, crt, deflection systems, and the switching necessary to interface and accommodate all the 7000-Series plug-ins. The following pages describe each performance characteristic and help you choose a system to accommodate your needs.

Added performance this year consists of a high writing speed storage mainframe (7633) and a wide-bandwidth dual-beam (7844 at 400 MHz).

500 MHz at 10 mV/div

1-GHz Direct-Access Plug-in (less than 4 V/div)

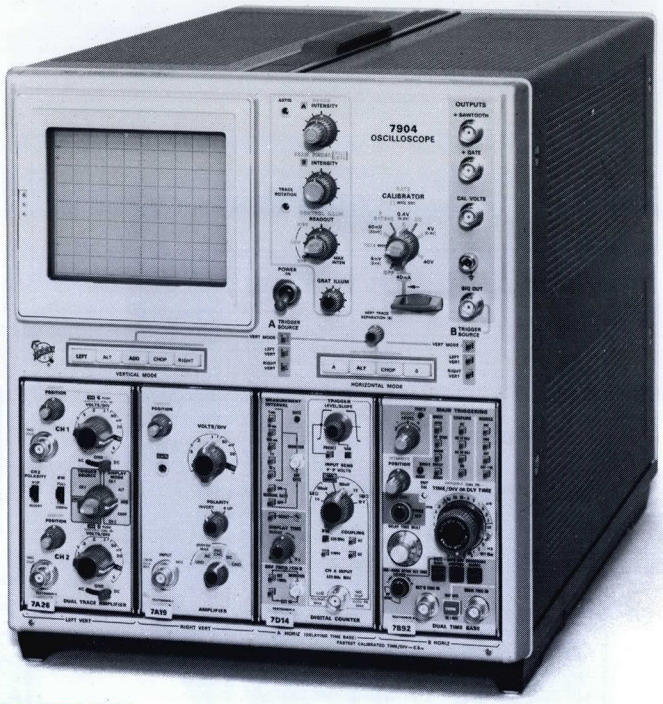
500 ps/div Delayed Sweep

Greater Than 15 cm/ns Enhanced Writing Speed

Crt Readout

Over 30 Compatible Plug-ins

900-MHz Fet Probe Available



The 7904 and 5¼-inch rackmount R7903 are the widest, real-time-bandwidth, general-purpose oscilloscopes available today. For instance, the 7A19 Amplifier/7904 Mainframe combination delivers 500 MHz at 10 mV. A 7A19 variable delay option allows the matching of signal transit times of two plug-ins and their probes to better than 50 ps. The P6201 1X FET probe brings you high impedance and wide bandwidth performance. It has a 900-MHz BW by itself and in combinations with the 7A19/7904, provides a system BW of 450 MHz at 10 mV.

PLUG-IN VERSATILITY

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

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

500 MHz — 7900 FAMILY — VERTICAL SYSTEMS SPECIFICATIONS

Plug-in Amplifier	Performance Feature	Min Defl Factor	Bw	Tr	Sig Out Bw	Accuracy*	Price
7A11[1]	Low-Capacitance Built-in FET Probe Amplifier	5 mV/div	250 MHz	1.4 ns	140 MHz	2%	**$950**
7A13	Differential Dc Offset, High-Freq cmrr Amplifier	1 mV/div	P6053B 105 MHz	3.4 ns	100 MHz	1.5%	**$1250**
			P6055 65 MHz	5.4 ns	65 MHz		
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	80 MHz	4.4 ns	70 MHz	2%	**$280 (7A15A) $250 (7A15AN)**
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	225 MHz	1.6 ns	140 MHz	2%	**$475**
7A17	Low-Cost, Easy-to-Customize 50-Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	———	**$95**
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	70 MHz	2%	**$535 (7A18) $500 (7A18N)**
7A19[2]	Wide-Bandwidth 50-ohm Input Amplifier	10 mV/div	500 MHz	**0.8 ns**	300 MHz	3%	**$700**
7A21N**	Direct Crt Access	<4 V/div	1 GHz	350 ps	———	———	**$400**
7A22	Dc-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	**$610**
7A24[3]	Dual-Channel, 50-Ω Input Amplifier	5 mV/div	350 MHz	1.0 ns	140 MHz	2%	**$1050**
7A26[4]	Dual-Channel Amplifier	5 mV/div	200 MHz	1.8 ns	140 MHz	2%	**$1050**

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

[1]7A11 system bandwidth is derated to 225 MHz from 30°C to 50°C.

[2]7A19 system bandwidth is derated to 400 MHz from 30°C to 50°C.

[3]7A24 system bandwidth is derated to 300 MHz from 30°C to 50°C.

[4]7A26 system bandwidth is derated to 160 MHz from 30°C to 50°C.

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

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

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

SPECIALIZED PLUG-INS

Measurement Requirement	Plug-in	Page	Performance Feature	Price
Curve Tracing	7CT1N	226	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	91	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	93	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1060 $1420 $1225
Digital Multimeter	7D13	95	Digital Multimeter Plus a unique Temperature Probe	$ 570
Digital Counting	7D14	96	Directly Gated Counter to 525 MHz	$1400
Universal Counter/ Timer	7D15	97	DC - 225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	204	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	204	1 kHz to 1.8 GHz Spectrum Analyzer	$6750
Delay Line	7M11	104	High Quality Dual 50-Ω Delay Line	$ 370
Readout Unit	7M13	99	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	100	Accepts Plug-In Sampling Heads	$ 595
TDR and Sampling	7S12	100	TDR and Sampling Applications	$1280
Calibrated Delayed Sweep Sampler	7S14	102	General Purpose Dual-Channel Sampler	$1950
Sampling Sweep	7T11	103	Random or Sequential, Equivalent or Real-Time Sampling	$1725

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

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

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

TIME BASES

Time Base	Page	Performance Feature	Price
7B70	89	Single Time Base (Used also as Delayed Time Base)	$675
7B71	89	Single Time Base with delaying Swp Function	$775
7B92	90	Dual Time Base with Display Switching	$1400

7904 and R7903 — VERTICAL SYSTEM

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

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

Chopped Mode—Repetition rate is approximately 1 MHz.

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

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

7904 — HORIZONTAL SYSTEM

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

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

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

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

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

7904 and R7903 — CRT AND DISPLAY FEATURES

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

Option 1, Without CRT READOUT—Deletes CRT READOUT.

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

Option 78, P11 Phosphor—No charge.

Option 10, Pulsed Graticule (R7903 only)—Provides a means of pulsing the graticule lights, at a preset level, coincident with a single shot event in one exposure. The graticule lights can be pulsed by the event, an external ground closure, or a front panel push button. If the mainframe is equipped with CRT READOUT, Opt 10 provides additional controls and inputs for CRT READOUT pulsed operation.

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer. In typical applications P31 phosphor has approximately 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	5.0	C-51-R	f/1.2 1:0.5

The following table lists the approximate 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	(Reference) 1	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 apparant writing speed.

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

Beam Finder—Limits display within graticule area.

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

7904 — CALIBRATOR

Output Waveshape—Rectangular positive-going from ground, 1 kHz, dc or B Gate ÷ 2.

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

Current Output—40 mA dc or 1 kHz.

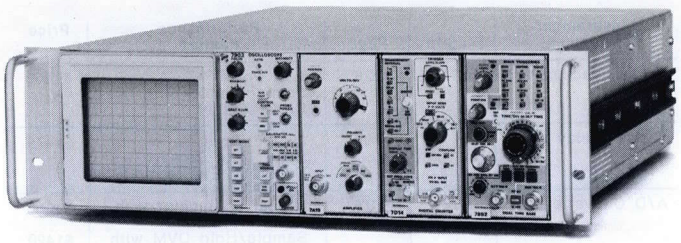
R7903 — CALIBRATOR

(Not available with Opt 10)

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

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

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



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

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. Risetime is 5 ns or less into 50 Ω; output R is approx 950Ω.

Sig Out—Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in. See the 7900 Family Vertical System Specifications Chart. Output R is approx 950 Ω.

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

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

R7903 — OUTPUTS/INPUTS

(Standard)

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

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

Sig Out—Selected by TRIGGER SOURCE switches. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends on the vertical plug-in. See the 7900 FAMILY Vertical System Specifications Chart. Output R is approx 950 Ω.

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

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

CRT READOUT, Single Shot—Ground closure, rear panel BNC input initiates one frame of CRT READOUT. Not available with Option 10 separately, but in combination with the pulsed graticule input.

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

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

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

R7903 — OUTPUTS/INPUTS OPTIONS

Option 10, Pulsed Graticule—CRT READOUT Single-Shot input, CRT READOUT Inhibit input, Calibrator, and Probe Power are deleted. Single-Shot Graticule and CRT READOUT (ground closure) rear panel BNC input is added. Initiates one frame of CRT READOUT and pulses graticule. CRT READOUT inputs are not functional with Option 1.

POWER REQUIREMENTS

7904 Power Requirements—Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 190 W, 2.5 A at 115 V line, 60 Hz.

R7903 Power Requirements—Line voltage ranges, 90 to 132 V ac and 180 to 264 V ac. Line frequency, 48 to 440 Hz. Max power consumption, 160 W, 2 A at 115 V line, 60 Hz.

DIMENSIONS AND WEIGHTS

Dimensions	Height		Width		Length	
	in	cm	in	cm	in	cm
7904	13.5	34.2	12.0	30.5	23.3	59.0
R7903	5.3	13.5	19.0	48.3	22.8	57.9
Single-width Plug-ins	5.0	12.7	2.8	7.1	14.5	36.9
Double-width Plug-ins	5.0	12.7	5.5	14.0	14.5	36.9

Weights (Approx)	Net		Shipping	
	lb	kg	lb	kg
7904	32.0	14.5	44.0	20.0
R7903	27.0	12.3	52.0	23.5
Single-width Plug-ins	2.0	0.9	5.0	2.3
Double-width Plug-ins	9.0	4.1	12.0	5.4

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

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

7904 ORDERING INFORMATION

(Plug-ins not included)

7904 Oscilloscope **$3400**

7904 OPTIONS

Option 1	**Without Crt Readout**	**Sub $400**
Option 2	**X-Y Horiz Comp**	**Add $75**
Option 3	**Emi Modification**	**Add $75**
Option 4	**Max Brightness Crt (Specify phosphor)** ..	**Add $350**
Option 78	**P11 Phosphor**	**No Charge**

7904 CONVERSION KITS

040-0605-02	**Crt Readout**	**$400**
040-0606-00	**X-Y Horiz Comp**	**$75**
040-0570-00	**Emi Modification**	**$105**

R7903 ORDERING INFORMATION

(Plug-ins not included)

R7903 Oscilloscope **$2900**

R7903 OPTIONS

Option 1	**Without Crt Readout**	**Sub $400**
Option 3	**Emi Modification**	**Add $75**
Option 4	**Max Brightness Crt (Specify phosphor)** .	**Add $350**
Option 10	**Pulsed Graticule**	**Add $100**
Option 78	**P11 Phosphor**	**No Charge**

R7903 CONVERSION KITS

040-0605-02	**Crt Readout**	**$400**
040-0647-00	**Emi Modification**	**$110**

400 MHz Bandwidth

Dual Beam

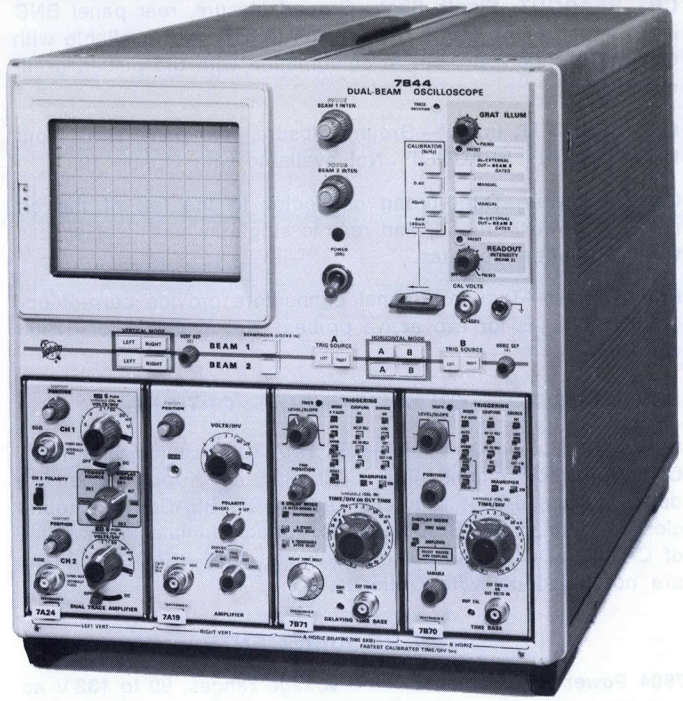
Full Vertical Crossover Switching

8 x 10 cm Full Scan Overlap Crt

Crt Readout

1 ns/div Maximum 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-event applications. Unique features such as pulsed graticules and pulsed CRT READOUT allow the pre- or post-photographic recording of important information such as vertical and horizontal scale factors, dates of tests, test number, and other pertinent data when single events are recorded. Vertical signal crossover switching permits viewing a single event from a single probe at two sweep speeds. The 7844 and R7844 are essentially two oscilloscopes in one which allows versatility such as direct crt access and high sensitivity inputs, or spectrum analysis and real-time measurements simultaneously.

PLUG-IN VERSATILITY

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

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

500 MHz — 7844 FAMILY — VERTICAL SYSTEMS SPECIFICATION

Plug-in Amplifier	Performance Feature	Min Defl Factor	Bw	Tr	Accuracy Without Probe	Price
7A11	Low-Capacitance Built-In FET Probe Amplifier	5 mV/div	200 MHz	1.8 ns	2%	$950
7A13	Differential Dc Offset, High-Freq Cmrr Amplifier	1 mV/div	100 MHz	3.5 ns	1.5%	$1250
7A15A **7A15AN****	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	80 MHz	4.4 ns	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	175 MHz	2.0 ns	2%	$475
7A17	Low-Cost, Easy-to-Customize 50-Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	———	$95
7A18 **7A18N****	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	2%	$535 (7A18) $500 (7A18N)
7A19	Wide-Bandwidth 50-ohm Input Amplifier	20 mV/div to 1 V/div 10 mVdiv	400 MHz†† 325 MHz	0.9 ns 1.1 ns	3%	$700
7A21N**	Direct Crt Access	<4 V/div	1 GHz	350 ps	———	$400
7A22	Dc-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz Within 10%	350 ns Within 9%	2%	$610
7A24††	Dual-Channel, 50-Ω Input Amplifier	5 mV/div	300 MHz	1.2 ns	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	160 MHz	2.2 ns	2%	$1050

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

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

††Operating temperature range is from 0°C to +35°C, bw derated 10% from 35°C to 50°C.

*Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%. Add 1% for internal calibrator.

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

SPECIALIZED PLUG-INS

Measurement Requirement	Plug-in	Page	Performance Feature	Price
Curve Tracing	7CT1N	226	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	91	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	93	Digital Multimeter with M1 module Sample/Hold dvm with M2 module True RMS dvm with M3 module	$1060 $1420 $1225
Digital Multimeter	7D13	95	Digital Multimeter Plus a unique Temperature Probe	$ 570
Digital Counting	7D14	96	Directly Gated Counter to 525 MHz	$1400
Universal Counter/ Timer	7D15	97	Dc - 225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	204	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	204	1 kHz to 1.8 GHz Spectrum Analyzer	$6750
Delay Line	7M11	104	High Quality Dual 50-Ω Delay Line	$ 370
Readout Unit	7M13	99	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	100	Accepts Plug-in Sampling Heads	$ 595
TDR and Sampling	7S12	100	Tdr and Sampling Applications	$1280
Calibrated Delayed Sweep Sampler	7S14	102	General Purpose Dual-Channel Sampler	$1950
Sampling Sweep	7T11	103	Random or Sequential, Equivalent or Real-Time Sampling	$1725

TIME BASES

Time Base	Page	Performance Feature	Price
7B70	89	Single Time Base (Used also as an external amplifier or Delayed Time Base)	$ 675
7B71	89	Single Time Base with delaying Swp Function	$ 775
7B92	90	Dual Time Base with Display Switching	$1400

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—Deletes vertical crossover.

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

Delay Line—Permits viewing leading edge of displayed waveform when using 7B70 and 7B90 sequence Time Bases, not compatible with 7B50 Series.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate— 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 and a total of 2 cm.

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 initially set.

Beam Finder—Beam 1 and 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. Maximum input voltage is 15 V (dc + peak ac) and p-p ac. Input is dc coupled.

Minimum Photographic Writing Speed— 1.7 cm/ns using Polaroid type 47 film, C-51R and optional P11 phosphor. In typical applications, P31 phosphor has about ½ 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 approximate 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.

An alternative method of film enhancement is available for the 7844/R7844. Contact your local Tektronix Field Office for more information.

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 push button.

CALIBRATOR

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

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

Current Output— 40 mA 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. Risetime 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 Volts nominal (90-132 Volts), 230 Volts nominal (180-264 Volts).

Line Frequency— 48 to 440 Hz.

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

DIMENSIONS AND WEIGHTS

Dimensions	Height		Width		Length	
	in	cm	in	cm	in	cm
7844	12.9	32.8	12.0	30.5	23.8	60.5
R7844	7.0	17.8	19.0	48.3	24.8	62.9
Single-width Plug-ins	5.0	12.7	2.8	7.1	14.5	36.9
Double-width Plug-ins	5.0	12.7	5.5	14.0	14.5	36.9

Weights (Approx)	Net		Shipping	
	lb	kg	lb	kg
7844	36.0	16.3		
R7844	33.0	15.0		
Single-width Plug-ins	2.0	0.9	5.0	2.3
Double-width Plug-ins	9.0	4.1	12.0	5.4

INCLUDED ACCESSORIES

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

ORDERING INFORMATION

(Plug-ins Not Included)

7844 Oscilloscope **$5900**
R7844 Oscilloscope **$6000**

OPTIONS

Option 3 **Emi Modification** ..... **Add $75**
Option 21 **Without Vertical Crossover** ..... **Sub $400**
Option 78 **P11 Phosphor** ..... **No Charge**

Dc-to-200 MHz Optimum Pulse Response

Dc-to-250 MHz Bandwidth Option

Greater Than 15 cm/ns Enhanced Writing Speed

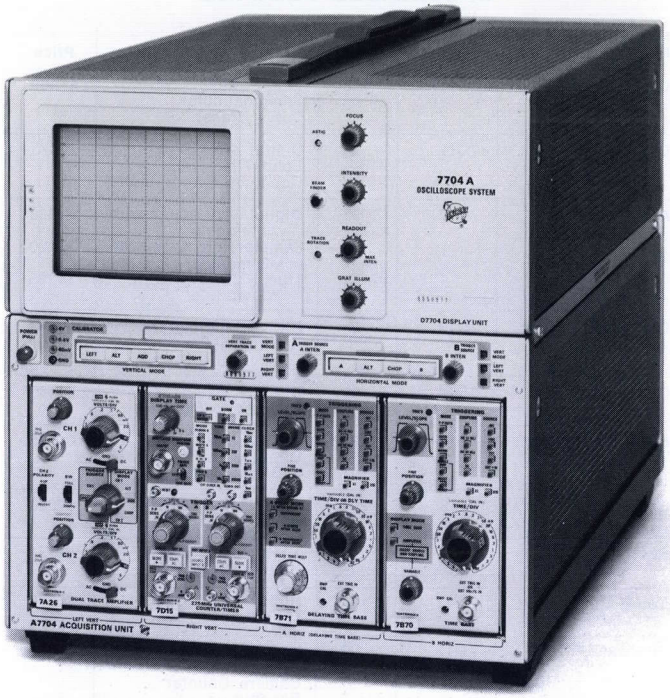
Crt Readout

Modular

Over 30 Compatible Plug-ins

900-MHz Fet Probe Available

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



PLUG-IN VERSATILITY

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

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

250 MHz——7700 FAMILY——VERTICAL SYSTEMS SPECIFICATIONS

Plug-in Amplifier	Performance Feature	Min Defl Factor	7704A Bw	7704A Tr	7704A Sig Out Bw	R7704 Bw	R7704 Tr	R7704 Sig Out Bw	Accuracy* Without Probe	Price
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	170 MHz	2.1 ns	70 MHz	150 MHz	2.4 ns	60 MHz	2%	$950
7A13	Differential Dc Offset High-Freq Cmrr Amplifier	1 mV/div	P6053B 100 MHz	3.5 ns	60 MHz	100 MHz	3.5 ns	55 MHz	1.5%	$1250
			P6055 65 MHz	5.4 ns	50 MHz	65 MHz	5.4 ns	45 MHz		
7A15A 7A15AN‡	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	75 MHz	4.7 ns	55 MHz	75 MHz	4.7 ns	50 MHz	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	160 MHz 170 MHz††	2.2 ns 2.1 ns	70 MHz	150 MHz	2.4 ns	60 MHz	2%	$475
7A17	Low-Cost, Easy to Customize 50-Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	150 MHz	2.4 ns	15 MHz	———	$95
7A18 7A18N‡	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	55 MHz	75 MHz	4.7 ns	50 MHz	2%	$535 (7A18) $500 (7A18N)
7A19	Wide-Bandwidth 50-Ω Input Amplifier	10 mV/div	200 MHz 250 MHz**	1.8 ns 1.5 ns	80 MHz	175 MHz	2.0 ns	65 MHz	3%	$700
7A22	Dc-coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	$610
7A24	Dual-channel, 50-Ω Input Amplifier	5 mV/div	200 MHz	1.8 ns	70 MHz	160 MHz	2.5 ns	60 MHz	2%	$1050
7A26	Dual-channel Amplifier	5 mV/div	150 MHz 170 MHz††	2.4 ns 2.1 ns	70 MHz	140 MHz	2.5 ns	60 MHz	2%	$1050

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

**Obtained with 7704A Option 9 (0°C to +30°C) at 20 mV/div.

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

††Obtained with 7704A Option 9 (0°C to +30°C).

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

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

SPECIALIZED PLUG-INS

Measurement Requirement	Plug-In	Page	Performance Feature	Price
Curve Tracing	7CT1N	226	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	91	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	93	Digital Multimeter with M1 module Sample/Hold Dvm with M2 module True RMS Dvm with M3 module	$1060 $1420 $1225
Digital Multimeter	7D13	95	Digital Multimeter Plus a unique Temperature Probe	$ 570
Digital Counting	7D14	96	Directly Gated Counter to 525 MHz	$1400
Universal Counter/ Timer	7D15	97	Dc - 225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	204	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	204	1 kHz to 1.8 GHz Spectrum Analyzer	$6750
Delay Line	7M11	104	High Quality Dual 50-Ω Delay Line	$ 370
Readout Unit	7M13	99	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	100	Accepts Plug-In Sampling Heads	$ 595
TDR and Sampling	7S12	100	TDR and Sampling Applications	$1280
Calibrated Delayed Sweep Sampler	7S14	102	General Purpose Dual-Channel Sampler	$1950
Sampling Sweep	7T11	103	Random or Sequential, Equivalent or Realtime Sampling	$1725

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

The modular design of the 7704A makes service and maintenance much easier, but most important it permits the addition of a Processing Module. With this addition and a general-purpose minicomputer, the 7704A is converted into a Digital Processing Oscilloscope. See pages 38 thru 43 for more details and check the appropriate box on the reply card inside the front cover of this catalog to receive an illustrated booklet with complete specifications.

There are two crt designs available for the 7704A: the standard 8 x 10-cm crt and an optional 4 x 5-cm reduced-scan crt for high writing-speed applications. The standard crt affords 5.3 cm/ns writing speed (C-51-R Camera, P11 phosphor and 10,000 ASA film) without enhancement and 8 cm/ns with the TEKTRONIX Writing Speed Enhancer. With the optional crt and our new film fogging technique, writing speed can be increased to at least 15 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition.

TIME BASES

Time Base	Page	Performance Features	Price
7B53A	87	Dual Time Base with Mixed Swp	$850
7B53A Opt. 5	87	7B53A with Tv Sync Triggering	$910
7B53AN	87	No READOUT Dual Time Base with Mixed Sweep	$750
7B53AN Opt. 5	87	7B53AN with Tv Sync Triggering	$810
7B70	89	Single Time Base (Used also as Delayed Time Base)	$675
7B71	89	Single Time Base with delaying Sweep Function	$775
7B92	90	Dual Time Base with Display Switching	$1400

Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit; see 7700-FAMILY Vertical System Specification Chart.

Option 9 Bandwidth Change (250 MHz)— 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz at 20 mV/div (upper —3 dB) when 7A19 is used. Provides additional performance for those working in 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 approx 1 MHz.

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

Delay Line—Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate— 2 ns/div with 7B70, 7B71 or 7B92.

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

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

Option 2, X-Y Horizontal Compensation (R7704 only)—Provides phase shift compensation to less than 2° from dc to 2 MHz.

CRT

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

Option 1, Without Crt Readout—Deletes CRT READOUT.

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

Option 78, P11 Phosphor—No charge.

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information). In typical application P31 phosphor has approximately one-half the writing speed of P11 phosphor.

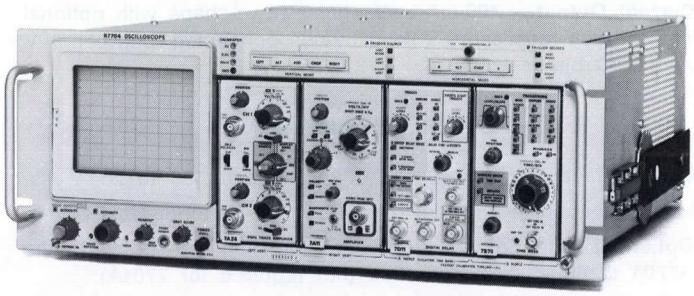
Mainframe	P11 Writing Speed cm/ns		Camera	Lens
	Type 410	Type 47		
7704A R7704 8 x 10 cm	5.3	2.7	C-51-R	f/1.2 1:0.5
7704A Option 4 4 x 5 cm	10.0	5.0	C-51-R	f/1.2 1:0.5

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

Beam Finder—Limits display within graticule area.

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

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



The 7704 requires 7 inches of rack height and offers 175 MHz bandwidth.

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

OUTPUTS/INPUTS

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

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

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

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

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

Camera Power—Three-prong 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 40 mV available when selected by internal jumper.) Ranges are 40 mV, 0.4 V, 4 V into 1 MΩ; 20 mV, 0.2 V, 0.4 V into 50 Ω. Amplitude accuracy is within 1% (+15°C to +35°C); within 2% (0°C to +50°C). Repetition rate is approx 1 kHz.

Current Output— 400 mA rectangular wave-shape with optional current-loop accessory (012-0259-00) connected between 4 V and GND pin jacks.

POWER REQUIREMENTS

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

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

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

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

Dimensions	Height		Width		Length	
	in	cm	in	cm	In	cm
7704A	13.6	34.5	12.0	30.6	22.7	57.7
R7704	7.0	17.8	19.0	48.2	22.4	56.9
Single-Width Plug-Ins	5.0	12.7	2.8	7.1	14.5	36.9
Double-Width Plug-Ins	5.0	12.7	5.5	14.0	14.5	36.9

Weights (Approx)	Net		Shipping	
	lb	kg	lb	kg
7704A	30.0	13.6	43	19.5
R7704	44.0	20.0	77	34.9
Single-Width Plug-Ins	2.0	0.9	5.0	2.3
Double-Width Plug-Ins	9.0	4.1	12.0	5.4

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

ORDERING INFORMATION

(Plug-ins not included)

7704A	Oscilloscope	$2600
R7704	Oscilloscope	$2850

7704A OPTIONS

Option 1	Without Crt Readout and Probe Power	Sub $400
Option 3	Emi Modification	Add $75
Option 4	Max Brightness Crt (Specify phosphor)	Add $350
Option 7	Without Sig Out/In	Sub $50
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 $75
Option 3	Emi Modification	Add $75
Option 5	Line Freq Change (50 - 400 Hz) (Not required for 7704A)	Add $50
Option 78	P11 Phosphor	No Charge

7704A CONVERSION KITS

040-0613-00	Crt Readout and Probe Power	$400
040-0612-00	Emi Modification	$105
040-0619-00	Sig Out/In	$50

R7704 CONVERSION KITS

040-0533-01	Crt Readout	$400
040-0529-00	X-Y Horiz Comp	$75
040-0562-00	Emi Modification	$110

DIGITAL PROCESSING OSCILLOSCOPE

The modular design of the 7704A enables it to be expanded into a Digital Processing Oscilloscope (see pages 38 thru 43), with many capabilities never before available in any oscilloscope system. To receive an illustrated booklet with complete details, check the appropriate box on the reply card inside the cover of this catalog.

Dc-to-100 MHz Bandwidth

6½-inch Crt

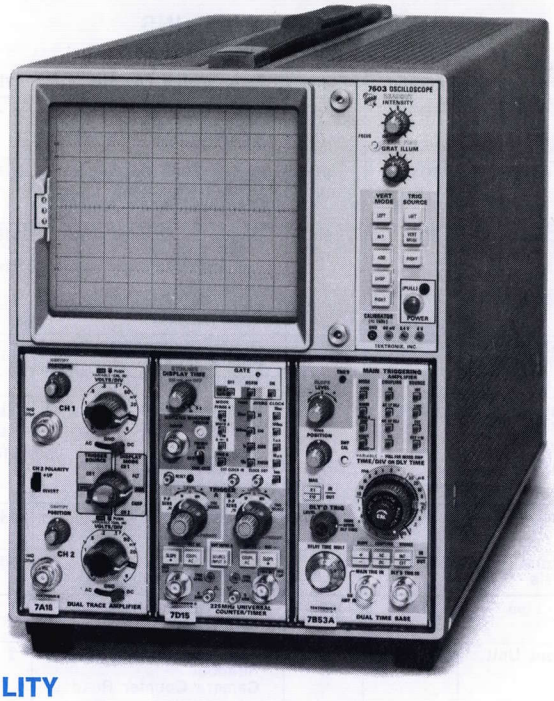
Crt Readout

5¼-inch Rackmount

Over 30 Compatible Plug-ins

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

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



PLUG-IN VERSATILITY

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

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

100 MHz—7600 FAMILY—VERTICAL SYSTEM SPECIFICATIONS

Plug-in Amplifier	Performance Feature	Min Defl Factor	Bw	Tr	Sig Out Bw	Accuracy* Without Probe	Price
7A11	Low-Capacitance Built-in FET Probe Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$950
7A13	Differential Dc Offset, High-Freq Cmrr Amplifier	1 mV/div	P6053B 75 MHz	5.0 ns	55 MHz	1.5%	$1250
			P6055 55 MHz	6.4 ns	45 MHz		
7A15A 7A15AN**	Low-cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	65 MHz	5.4 ns	50 MHz	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$475
7A17	Low-Cost Easy-to-Customize 50-Ω Input Amplifier	50 mV/div	100 MHz	3.5 ns	15 MHz	———	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	50 MHz	2%	$535 (7A18) $500 (7A18N)
7A22	Dc-Coupled, High Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	$610
7A24	Dual Channel, 50-Ω Input Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	$1050

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

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

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

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

SPECIALIZED PLUG-INS

Measurement Requirement	Plug-in	Page	Performance Feature	Price
Curve Tracing	7CT1N	226	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	91	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	93	Digital Multimeter with M1 module Sample/Hold Dvm with M2 module True RMS Dvm with M3 module	$1060 $1420 $1225
Digital Multimeter	7D13	95	Digital Multimeter Plus a unique Temperature Probe	$ 570
Digital Counting	7D14	96	Directly Gated Counter to 525 MHz	$1400
Universal Counter/Timer	7D15	97	Dc-225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	204	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	204	1 kHz to 1.8 GHz Spectrum Analyzer	$6750
Delay Line	7M11	104	High Quality Dual 50-Ω Delay Line	$ 370
Readout Unit	7M13	99	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	100	Accepts Plug-In Sampling Heads	$ 595
TDR and Sampling	7S12	100	TDR and Sampling Applications	$1280
Calibrated Delayed Sweep Sampler	7S14	102	General Purpose Dual-Channel Sampler	$1950
Sampling Sweep	7T11	103	Random or Sequential, Equivalent or Real-Time Sampling	$1725

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainframe and plug-in unit, see 7600 Family Vertical System Specifications Chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate— 5 ns/div.

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

CRT AND DISPLAY FEATURES

Standard—Internal 8 x 10 div (1.22 cm/div) graticule with variable illumination. Accelerating potential is 15 kV with P31 phosphor.

Option 1, Without Crt READOUT—Deletes CRT READOUT.

TIME BASES

Time Base	Page	Performance Features	Price
7B50	86	Single Time Base	$450
7B53A	87	Dual Time Base with Mixed Sweep	$850
7B53A Opt. 5	87	7B53A with TV Sync Triggering	$910
7B53AN	87	No READOUT Dual Time Base with Mixed Sweep	$750
7B53AN Opt. 5	87	7B53AN with TV Sync Triggering	$810

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

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

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

Minimum Photographic Writing Speed—Using Polaroid film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information). In typical application P31 phosphor has approximately one-half the writing rate of P11.

Mainframe	Writing Speed cm/μs		Camera	Lens
	Type 410 P31	Type 47 P11		
Standard 8 X 10 div (1.22 cm/div)	1320	660	C-51-R	f/1.2 1:0.5
Option 4 8 X 10 cm	2000	1000	C-51-R	f/1.2 1:0.5

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

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

Beam Finder—Limits display within graticule area.

OUTPUTS/INPUTS

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

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

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div (±10%) into 50 Ω, 0.5 V/div (±10%) into 1 MΩ. The bandwidth depends upon vertical plug-in, see 100-MHz Family Vertical System Specification Chart. Output R is 950 Ω within 2%.

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

Single-Sweep Ready Indicator—Rear panel BNC provides 5 V for single-sweep ready condition.

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

CAMERA POWER OUTPUT

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

CALIBRATOR

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

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

POWER REQUIREMENTS

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

Line Frequency—50 Hz to 400 Hz (7603), 50 Hz to 60 Hz (R7603).

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

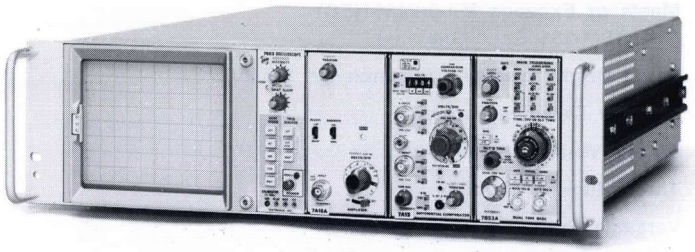
Max Power Consumption—180 Watts, 2.0 Amps at 115 V line, 60 Hz. Cooling is provided by a fan for the R7603.

DIMENSIONS AND WEIGHTS

Dimensions	Height		Width		Length	
	In	cm	In	cm	In	cm
7603	11.4	28.9	8.7	22.1	24.0	60.9
R7603	5.25	13.3	19.0	48.2	24.7	62.9
Single-Width Plug-ins	5.0	12.7	2.8	7.1	14.5	36.9
Double-width Plug-ins	5.0	12.7	5.5	14.0	14.5	36.9

Weights (Approx)	Net		Shipping	
	lb	kg	lb	kg
7603	30.0	13.6	46.0	20.9
R7603	30.0	13.6	62.0	28.1
Single-Width Plug-ins	2.0	0.9	5.0	2.3
Double-width Plug-ins	9.0	4.1	12.0	5.4

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



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

ORDERING INFORMATION

(Plug-ins not included)

7603 Oscilloscope	**$1600**
R7603 Oscilloscope	**$1700**

7603 OPTIONS

Option 1	**Without Crt Readout**	**Sub**	**$400**
Option 3	**Emi Modification**	**Add**	**$75**
Option 4	**Max Brightness Crt (Specify phosphor)**	**Add**	**$75**
Option 7	**Without Sig Out/In**	**Sub**	**$50**

R7603 OPTIONS

Option 1	**Without Crt Readout**	**Sub**	**$400**
Option 3	**Emi Modification**	**Add**	**$75**
Option 4	**Max Brightness Crt (Specify phosphor)**	**Add**	**$75**
Option 5	**Line Freq Change (50 - 400 Hz) (Not required for 7603)**	**Add**	**$100**
Option 7	**Without Sig Out/In**	**Sub**	**$50**

7603 CONVERSION KITS

040-0654-01	**Crt Readout**	**$400**
040-0662-00	**Emi Modification**	**$100**
040-0629-00	**Sig Out/In**	**$50**
040-0686-00	**Lighted Push Buttons**	**$15**

R7603 CONVERSION KITS

040-0674-01	**Crt Readout**	**$400**
040-0679-00	**Emi Modification**	**$100**
040-0633-00	**Sig Out/In**	**$50**
040-0686-00	**Lighted Push Buttons**	**$15**

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-0-24311(EC)
(AN/USM-281 Specifications)

Large Bright Display— 6½-inch Crt (15 kV)

5 ns/div Delaying Sweep

0.5 mV Vertical Sensitivity

Three-plug-in Flexibility

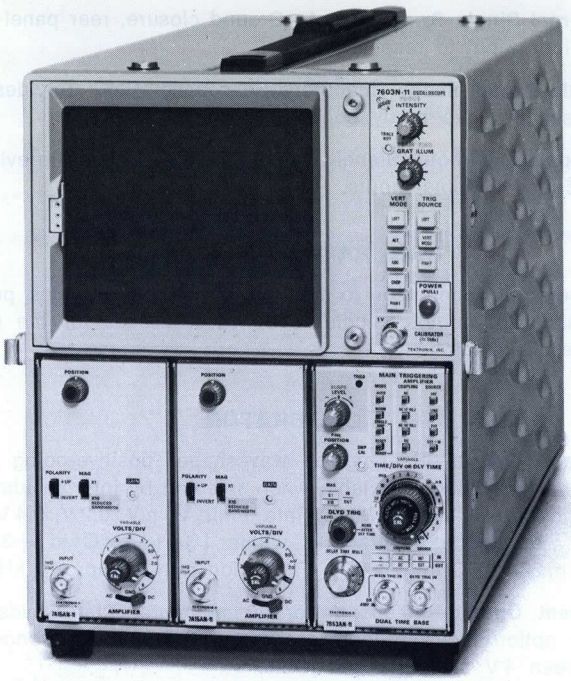
Versatile Trigger Source Selection

Push-Button Switching

Illuminated No Parallax Graticule

Color-Keyed Panels

Protective Cover With Accessories



The 7603N Option 11S Ruggedized Oscilloscope System meets rigid environmental and electrical specifications required by the military. The complete system is qualified under MIL-0-24311 (EC) and appears on U.S. Navy QPL-24311. Tektronix, Inc. has developed and built into this system, performance which is unmatched in versatility and flexibility. The System consists of a three-plug-in mainframe, two single-trace amplifiers, a dual time base, and a front-panel cover with probes and accessories.

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

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

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

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

ENVIRONMENTAL

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

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

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

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

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

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

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:

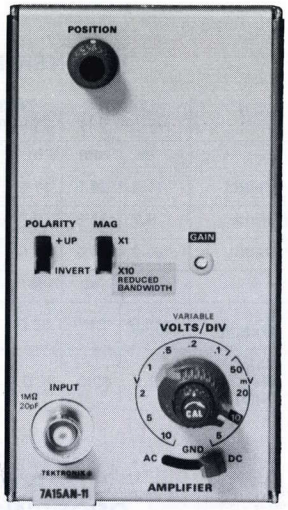
CE01	30 Hz to 20 kHz	Power lead emission
CE03	20 kHz to 50 MHz	Power lead emission
CS01	30 Hz to 50 kHz	Power lead, radiation susceptibility
CS02	50 kHz to 400 MHz	Power lead, radiation susceptibility
CS06	Spike Test	Power lead, spike susceptibility
RE01	30 Hz to 30 kHz	Instrument radiation, magnetic
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 is provided during continuous or interrupted operation. The MIL-0-24311(EC) MTBF requirement of greater than 600 hours is met as tested under the following conditions: Temperature +40°C ±2°C; Relative Humidity 70% ±5%; Vibration 25 Hz at 0.040 inches ±0.008 inches p-p amplitude for 10 minutes of each "Power On" hour during each day of the 8-hour manned schedule; Power cycled at 4-hour intervals with 10 minutes power off for each 4-hour period of the manned test schedule. An MTBF of greater than 2000 hours was actually achieved during testing.

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

VERTICAL SYSTEM

(Includes two 7A15AN Option 11 plug-ins)



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

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

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

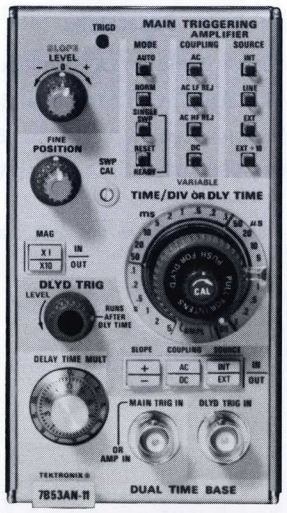
Input R and C— 1 MΩ within 2%, less than 27 pF.

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

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

HORIZONTAL SYSTEM

(Includes one 7B53AN Option 11 plug-in)



Channels—One right-hand plug-in compartment. All 7000-Series plug-ins are compatible (except those which require CRT READOUT).

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

X-Y Mode—The phase shift between vertical and horizontal channels is less than 2° from dc to 35 kHz. Bandwidth is at least 2 MHz. Risetime is less than 175 ns. Using the 7B53AN Option 11 time-base external amplifier, 10 mV, 100 mV and 1 V sensitivities (±10%) are available. Input R and C for 7B53AN Option 11 is 1 MΩ within 2%, 20 pF within 2 pF. Any vertical plug-in, such as the 7A15AN Option 11, may be used in the horizontal compartment providing a greater number of sensitivities for calibrated X-Y displays.

Sweep Display Modes—Main Sweep, Main Sweep Intensified by Delayed Sweep, Delayed Sweep.

MAIN (DELAYING) SWEEP

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

Sweep Accuracy—Within 3% from 0.05 μs/div to 5 s/div, within 5% at 5 ns/div.

Sweep Modes—Normal, Auto, Single Sweep.

Delay Time—Multiplier range is 0 to 10 times the Time/Div setting. Accuracy is within 1% from 0.5 s/div to 0.5 μs/div, within 2% from 5 s/div to 1 s/div. Incremental linearity is within 0.2% of full scale. Jitter is less than 1 part in 20,000 of X10 Time/Div setting.

Triggering (source/sensitivity)—Internal, 0.5 cm to 50 MHz. External, 0.25 V to 20 MHz, 0.5 V to 50 MHz. Ext ÷ 10, 2.5 V to 20 MHz, 5 V to 50 MHz. Triggering extends to 100 MHz with reduced sensitivity in both Internal and External modes. Input R and C is 1 MΩ within 2%, 20 pF within 2 pF.

Triggering Frequency Range—Ac, 30 Hz to 50 MHz; ac lf Rej, 30 kHz to 50 MHz; ac hf Rej, 30 Hz to 50 kHz; dc, dc to 50 MHz. Slope is plus or minus with external level range ±30 V.

DELAYED SWEEP

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

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

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

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

CRT

Accelerating Potential—15 kV.

Phosphor—P31.

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

7603N Option 11S Ruggedized Oscilloscope System

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

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

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

OUTPUTS

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

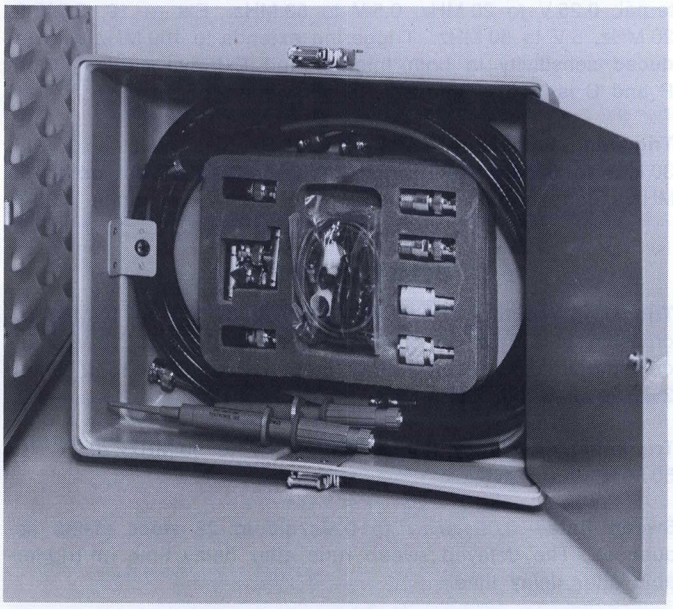
Horizontal—Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 kΩ and 15 pF.

POWER REQUIREMENTS

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

C281 COVER WITH ACCESSORIES

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



INCLUDED ACCESSORIES

(All packaged in cover)

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

DIMENSIONS AND WEIGHTS

	7603N Option 11S		7603N Option 11		7A15AN Option 11		7B53AN Option 11		C281	
	in	cm	in	cm	in	cm	in	cm	in	cm
Height	11.5	29.2	11.5	29.2	5.0	12.7	5.0	12.7	10.9	27.7
Width	9.7	24.6	9.7	24.6	2.8	7.1	2.8	7.1	9.7	24.6
Depth	25.2	64.0	23.5	59.7	14.5	36.9	14.5	36.9	3.3	8.3
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net Weight	45.0	21.0	36.0	16.3	1.8	0.8	2.8	1.3	2.8	1.3
Shipping Weight (approx)	72.0	32.6	42.0	19.0	4.0	1.8	6.0	2.7	7.0	3.2

ORDERING INFORMATION

7603N Option 11S Oscilloscope System (AN/USM-281C) $3025

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

To Order Separately:

7603N Option 11 Oscilloscope (OS-245(P)/U) $1500

7A15AN Option 11 Amplifier Plug-in (AM-6565/U) $275

7B53AN Option 11 Time Base Plug-in (TD-1085/U) $885

016-0553-00, C281 Cover W/Accessories $100

System Without MIL-Nomenclature

7603N Option 11SA Oscilloscope System $3025

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

To Order Separately:

7603N Option 11A Oscilloscope $1500

7A15AN Option 11A Amplifier Plug-in $275

7B53AN Option 11A Time Base Plug-in $885

016-0553-01, C281A Cover W/Accessories $100

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

Storage Features

Applications

Storage Oscilloscope Selection Chart

STORAGE FEATURES

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

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

For further information on other TEKTRONIX storage instruments and products, see the appropriate catalog section; e.g., Computer Display Terminals, Portables, Storage Display Units, Telequipment, and 5000 Series.

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

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

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

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

Another feature the 564 introduced was Split-screen Storage. This TEKTRONIX innovation permitted joint or independent storage or conventional operation on the two halves of the crt.

Storage device research yielded improvements in Bistable Phosphor performance and led to the design and development of the TEKTRONIX 549 Storage Oscilloscope, introduced in 1965. The major performance improvement was an increase of stored writing speed from 0.5 cm/μs in the 564 to 5 cm/μs in the 549. In 1971, storage was introduced in TEKTRONIX 7000-Series with the 7514. The latest 7000-Series Storage oscilloscope, the 7633 has a writing speed of 1,000 cm/μs.

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

Research and design, for satisfying these requirements, resulted in the development of the three storage crt designs in the 7000-Series Storage Family. The new family was introduced in July 1972. It consists of the Multimode Storage 7633/R7633 and 7623A/R7623A, the Variable Persistence Storage 7613/R7613, and the Bistable Phosphor Storage 7313/R7313.

WRITING SPEED IN TERMS OF SIGNAL AMPLITUDE

Writing Speed	Sinewave 5 or More Cycles/Display	Step Response		
		Risetime	Amplitude	Suggested Sweep Speed
5 div/μs 7613, 7313	6.3 div of 250 kHz 3.1 div of 500 kHz 1.5 div of 1 MHz	500 ns	2.8 div	0.5 ms/div
150 div/μs (135 cm/μs) 7623A & 7633 in Fast Var. Persist.	6.3 div of 7.5 MHz 3.1 div of 15 MHz 1.5 div of 30 MHz	27 ns 54 ns	4 div 8 div	10 ns/div 20 ns/div
50 div/μs (45 cm/μs) 7623A & 7633 in Fast Bistable	6.3 div of 2.5 MHz 3.1 div of 5 MHz 1.5 div of 10 MHz	20 ns 50 ns 100 ns	1.1 div 2.8 div 5.6 div	20 ns/div 50 ns/div 0.1 ns/div
2200 div/μs (1000 cm/μs) 7633 in Fast Var. Persist. & Reduced Scan	7.1 div of 100 MHz	3.5 ns	8 div	5 ns/div
400 div/μs (180 cm/μs) 7633 in Fast Bistable & Reduced Scan	6.3 div of 20 MHz 3.1 div of 40 MHz 1.5 div of 80 MHz	5 ns 10 ns 20 ns	1.1 div 2.2 div 4.4 div	5 ns/div 10 ns/div 20 ns/div

APPLICATIONS

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

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

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

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

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

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

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

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

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

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

STORAGE OSCILLOSCOPE SELECTION CHART

Oscilloscope	Page	Performance Features	Measurement Requirements and Applications (Refer to above applications)
7633/R7633	**70**	Multimode Storage 1000 cm/μs stored writing speed Long Viewing Time Dc-to-100 MHz bandwidth Reduced Scan Mode	Nine Operating Modes: Non-Store, Normal and fast Variable Persistence and normal and fast Bistable Applications: all Captures high-speed single-shot events Stores for long viewing time
7623A/R7623A	**70**	Multimode Storage 135 cm/μs stored writing speed Long viewing time Dc-to-100 MHz bandwidth	Five Operating Modes: Non-Store, Normal and fast Variable Persistence and normal and fast Bistable Applications: all Captures high-speed single-shot events Stores for long viewing time
7613/R7613	**73**	Variable Persistence Dc-to-100 MHz bandwidth	Variable Persistence and nonstore operation Applications: 1, 2, 3, 4, 5, 6 Especially useful when a high contrast is needed between stored image and crt background
7313/R7313	**75**	Split-screen Bistable Storage Dc-to-25 MHz bandwidth	Split-screen Bistable and nonstore operation Applications: all except number 6

PLUG-IN VERSATILITY

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

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

STORAGE FAMILY — VERTICAL SYSTEM SPECIFICATIONS

Amplifier Plug-in	Performance Feature	Min Defl Factor	7313		7613, 7623A, 7633		Sig Out Bw (MHz)	Accuracy* Without Probe	Price
			Bw (MHz)	Tr (ns)	Bw (MHz)	Tr (ns)			
7A11	Low-Capacitance Built-In FET Probe Amplifier	5 mV/div	25	14	100	3.5	60	2%	$950
7A13	Differential dc Offset, High-Freq Cmrr Amplifier	1 mV/div	P6065A 25 P6055 24	14 15	75 55	4.8 6.4	55 45	1.5%	$1250
7A15A 7A15AN**	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	25	14	65	5.4	50	2%	$280 (7A15A) $250 (7A15AN)
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	25	14	100	3.5	60	2%	$475
7A17	Low-Cost, Easy-to-Customize 50-Ω Amplifier	50 mV/div	25	14	100	3.5	15	———	$95
7A18 7A18N**	Dual-Channel Amplifier	5 mV/div	25	14	75	4.7	50	2%	$535 (7A18) $500 (7A18N)
7A22	Dc-Coupled, High-Gain Differential Amplifier	10 μV/div	1 ± 10%	350 ±9%	1 ±10%	350 ±9%	1 ± 10%	2%	$610
7A24	Dual-Channel 50-Ω Amplifier	5 mV/div	25	14	100	3.5	60	2%	$1050
7A26	Dual-Channel Amplifier	5 mV/div	25	14	100	3.5	60	2%	$1050

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

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

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

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

TIME BASES

Time Base	Page	Performance Features	Price
7B50	86	Single Time Base	$450
7B53A	87	Dual Time Base with Mixed Sweep	$850
7B53A Opt. 5	87	7B53A with Tv Sync Triggering	$910
7B53AN	87	No READOUT Dual Time Base with Mixed Sweep	$750
7B53AN Opt. 5	87	7B53AN with Tv Sync Triggering	$810

7000-SERIES STORAGE FAMILY

There are eight models to choose from in the TEKTRONIX 7000-Series Storage FAMILY: Four cabinet models and four 5¼-inch rackmount versions. Each mainframe has three-plug-in versatility and is compatible with the over 30 TEKTRONIX 7000-Series plug-ins, available for making virtually any measurement.

SPECIALIZED PLUG-INS

Measurement Requirement	Plug-In	Page	Performance Feature	Price
Curve Tracing	7CT1N	226	Low Power Semiconductor Curve Tracer	$ 400
Digital Delay Unit	7D11	91	Digital Time Delay Echo Time Delay Count by Events mode	$1475
A/D Converter	7D12	93	Digital Multimeter with M1 module Sample/Hold DVM with M2 module True RMS DVM with M3 module	$1060 $1420 $1225
Digital Multimeter	7D13	95	Digital Multimeter Plus a unique Temperature Probe	$ 570
Digital Counting	7D14	96	Directly Gated Counter to 525 MHz	$1400
Universal Counter/Timer	7D15	97	Dc-225 MHz Direct Count 8 Basic Modes	$1475
Spectrum Analysis	7L12	204	100 kHz to 1.8 GHz Spectrum Analyzer	$4850
Spectrum Analysis	7L13	204	1 kHz to 1.8 GHz Spectrum Analyzer	$6750
Delay Line	7M11	104	High Quality Dual 50-Ω Delay Line	$ 370
Readout Unit	7M13	99	Keyboard Access to Readout Camera Counter Readout	$ 375
Sampling	7S11	100	Accepts Plug-In Sampling Heads	$ 595
TDR and Sampling	7S12	100	TDR and Sampling Applications	$1280
Calibrated Delayed Sweep Sampler	7S14	102	General Purpose Dual-Channel Sampler	$1950
Sampling Sweep	7T11	103	Random or Sequential, Equivalent or Real-Time Sampling	$1725

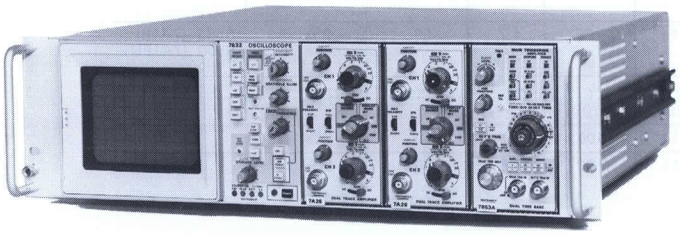
7633

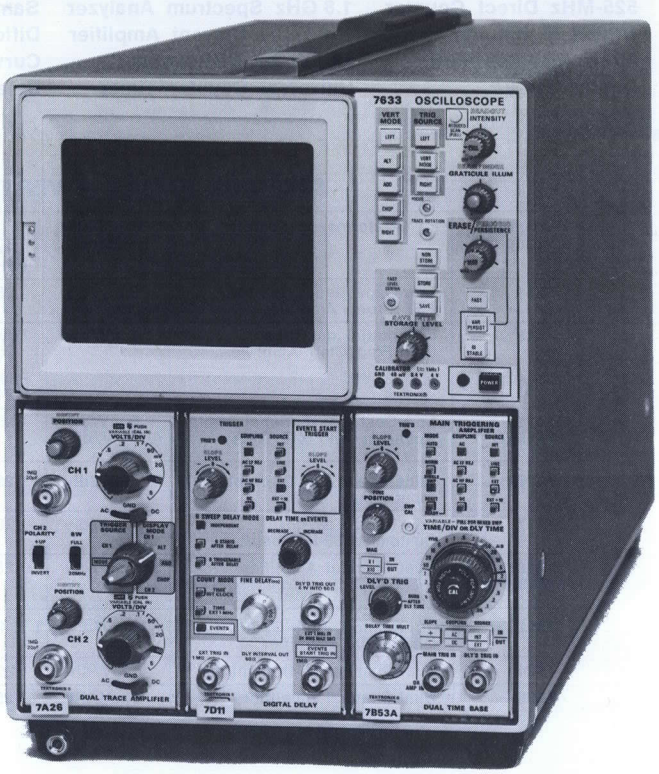
1000 cm/μs Stored Writing Speed

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: Stored, Non-store and Save; and four storage modes: Bistable, Variable Persistence, Fast Bistable, and Fast Variable Persistence. The separate Reduced Scan selector is used, when needed, to get the top writing speed of 1000 cm/μs (using the center 8 x 10 reduced scan divisions, (.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 the 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 can 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 permits retention and viewing of fast-rise, low repetition rate, single-shot or slow-moving waveforms. Its capability and versatility make this instrument a problem solver in computer sciences, aerospace, ballistics, communications, and many other fields.

7623A

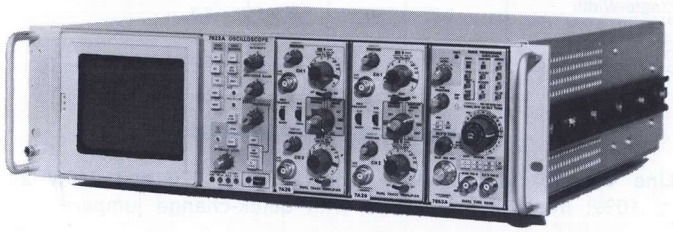
135 cm/μs Stored Writing Speed

Long View Time

Multimode Storage

Dc-to-100 MHz Bandwidth

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



Specifications 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 approximately 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-division (0.9 cm/div) and 8 x 10-division (0.45 cm/div) graticule with variable illumination.

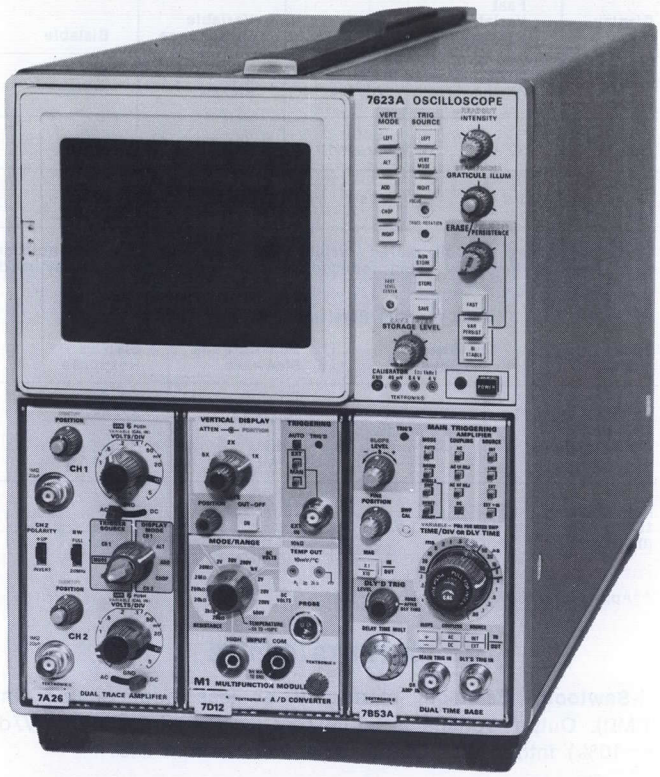
Option 1, without crt readout—Deletes crt readout.

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

Phosphor—P31

Storage Display Modes—Nonstore, Fast Variable Persistence, Fast Bistable, Variable Persistence, Bistable (normal and reduced scan).**

**Applies to 7633 only.



Persistence—Continuously variable, when set to maximum, provides the longest retention of high contrast stored displays, without the characteristic fading of variable persistence.

Periodic Erase—Continuously variable up to 10 seconds.

Save—Prevents erasing and storing additional displays, also extends viewing 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. Maximum input voltage is 10 V (dc + peak ac) and p-p ac.

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

Beam Finder—Limits display within graticule area.

STORAGE WRITING SPEED

Full Scan (Center 6 x 8 divisions 0.9 cm/div)

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	150 div/μs	50 div/μs	0.5 div/μs	0.03 div/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.

Reduced Scan (8 x 10 divisions 0.45 cm/div)**

Display Mode	Fast Variable Persistence	Fast Bistable	Variable Persistence	Bistable
Stored Writing Speed	2,200 div/μs	400 div/μs	3 div/μs	2 div/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.

Fast Variable Persistence Writing Speed

Scan Mode	Sweep Speed	Peak-to-Peak Sinewave	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.

OUTPUTS/INPUTS

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

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

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. The bandwidth depends upon 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 Without Signals Outputs/Inputs—Deletes previously described OUTPUTS/INPUTS.

CAMERA POWER OUTPUT

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

CALIBRATOR

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

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

DIMENSIONS AND WEIGHTS

Dimensions	Height		Width		Length	
	in	cm	in	cm	in	cm
7633, 7623A, 7613, 7313	12.0	30.5	8.7	22.1	23.5	60
R7633, R7623A, R7613, R7313	5.25	13.3	19.0	48.2	22.3	56.5
Single-Width Plug-Ins	5.0	12.7	2.8	7.1	14.5	36.9
Double-Width Plug-Ins	5.0	12.7	5.5	14.0	14.5	36.9

Approx Weights	Net		Shipping	
	lb	kg	lb	kg
7633, 7623A, 7613, 7313	30.0	13.6	42.0	19.0
R7633, R7623A, R7613, R7313	32.0	14.5	62.0	28.1
Single-Width Plug-Ins	2.0	0.9	5.0	2.3
Double-Width Plug-Ins	9.0	4.1	12.0	5.4

POWER REQUIREMENTS

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

Line Frequency— 50 Hz to 60 Hz.

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

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

Included Accessories—(For 7633-7623A and R7633-R7623A) 20-inch 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 **$3650**
R7633 Storage Oscilloscope **$3750**
7623A Storage Oscilloscope **$3000**
R7623A Storage Oscilloscope **$3100**

OPTIONS

Option 1 Without crt Readout ..... **Sub $400**
Option 3 Emi Modification ..... **Add $ 75**
Option 5 Line Freq Change (50 - 400 Hz) ..... **Add $100**
Option 7 Without Sig Out/In ..... **Sub $ 50**

CONVERSION KITS

Crt Readout (040-0656-01 Cabinet) **$400**
(040-0676-01 Rackmount) **$400**
Emi Modification (040-0663-00 Cabinet) **$100**
(040-0678-00 Rackmount) **$100**
Sig Out/In (040-0629-00 Cabinet) ..... **$ 50**
(040-0633-00 Rackmount) ..... **$ 50**
Lighted Push Buttons (040-0686-00) ..... **$ 15**

Variable Persistence Storage

Dc-to-100 MHz Bandwidth

Burn Resistant Crt

5¼-inch Rackmount

The TEKTRONIX 7613 Storage Oscilloscope offers Variable Persistence operation with a stored writing speed of 5 div/μs or conventional (nonstorage) operation. Stored traces can be viewed up to 60 minutes on a display area of 8 x 10 div (0.9 cm/div). The 7613 crt is 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 Storage Family Vertical System Specification Chart.

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate— 5 ns/div.

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

CRT AND DISPLAY FEATURES

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

Option 1, Without Crt Readout—Deletes CRT READOUT.

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

Accelerating Potential— 8.5 kV.

Phosphor—P31.

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

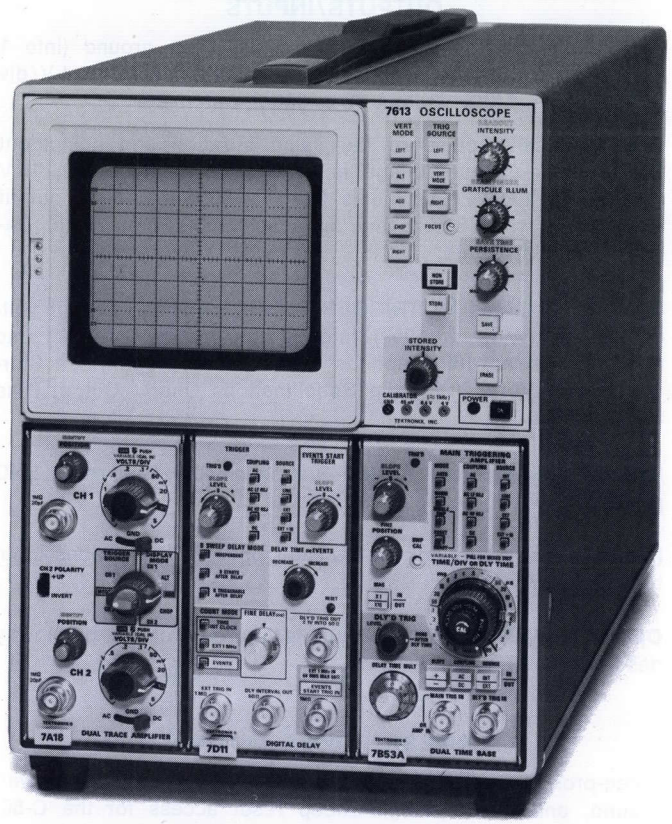
Store Mode—For displaying waveforms utilizing the variable persistence storage feature.

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

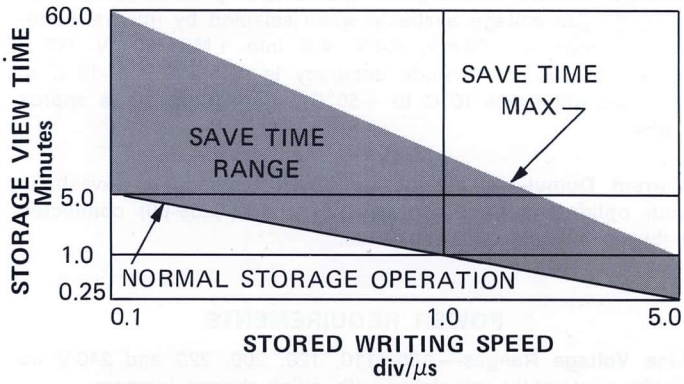
Storage View Time—(See chart) may be increased by selecting SAVE and adjusting for reduced viewing brightness with SAVE TIME control.

Erase Time— 0.5 s or less.

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



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



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

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

Beam Finder—Limits display within Graticule area.

OUTPUTS/INPUTS

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

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

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

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

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

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

CAMERA POWER OUTPUT

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

CALIBRATOR

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

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

POWER REQUIREMENTS

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

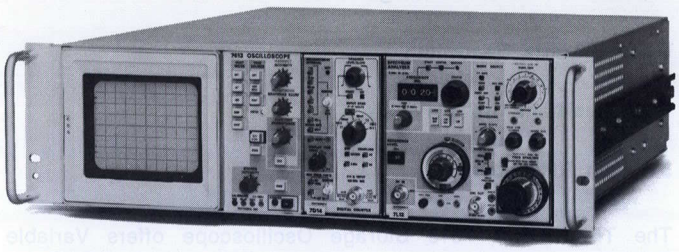
Line Frequency— 50 Hz to 60 Hz.

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

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

DIMENSIONS AND WEIGHTS

Please refer to the 7633 dimensions and weights chart.



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

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

ORDERING INFORMATION

(Plug-ins not included)

7613 Storage Oscilloscope	**$2600**
R7613 Storage Oscilloscope	**$2700**

7613 OPTIONS

Option 1	**Without Crt Readout**	**Sub $400**
Option 3	**Emi Modification**	**Add $75**
Option 5	**Line Freq Change (50 - 400 Hz)**	**Add $100**
Option 6	**Special Int Graticule (Spectrum Analyzer)**	**No Charge**
Option 7	**Without Sig Out/in**	**Sub $50**

R7613 OPTIONS

Option 1	**Without Crt Readout**	**Sub $400**
Option 3	**Emi Modification**	**Add $75**
Option 5	**Line Freq Change (50 - 400 Hz)**	**Add $100**
Option 6	**Special Int Graticule (Spectrum Analyzer)**	**No Charge**
Option 7	**Without Sig Out/in**	**Sub $50**

7613 CONVERSION KITS

040-0656-01	**Crt Readout**	**$400**
040-0663-00	**Emi Modification**	**$100**
040-0629-00	**Sig Out/In**	**$50**
040-0686-00	**Lighted Push Buttons**	**$15**

R7613 CONVERSION KITS

040-0676-01	**Crt Readout**	**$400**
040-0678-00	**Emi Modification**	**$100**
040-0633-00	**Sig Out/In**	**$50**
040-0686-00	**Lighted Push Buttons**	**$15**

Split-screen Bistable Storage

Dc-to-25 MHz Bandwidth

Burn Resistant Crt

5¼-inch Rackmount

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

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

VERTICAL SYSTEM

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

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

Chopped Mode—Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of waveform.

HORIZONTAL SYSTEM

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

Fastest Calibrated Sweep Rate— 20 ns/div.

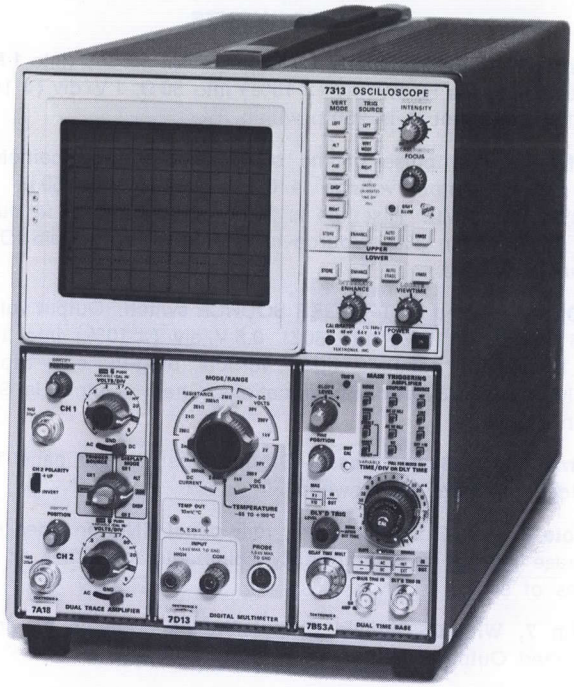
X-Y Mode—The phase shift between vertical and horizontal channels is 2° from dc to 35 kHz. Bandwidth is dc to at least 2 MHz.

STORAGE CRT AND DISPLAY FEATURES

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

Accelerating Potential—4 kV.

Phosphor—P1.



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

Storage View Time—Up to 4 hours.

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

Erase Time— 400 ms or less.

Enhance Mode—Controls single-sweep writing capabilities of the storage crt. Up to 5000 cm/ms or better can be stored with minimal loss of resolution and contrast.

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

Auto Erase Mode—Viewing time continuously variable up to 10 s. The sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep, the stored display is retained and further sweeps are locked out for the viewing interval selected by the VIEW TIME Control. Then, the display is erased and the time-base is enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MANUAL control.

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

Beam Finder—Limits display within graticule area.

7313 Bistable Storage Oscilloscope

OUTPUTS/INPUTS

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

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

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

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

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

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

CAMERA POWER OUTPUT

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

CALIBRATOR

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

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

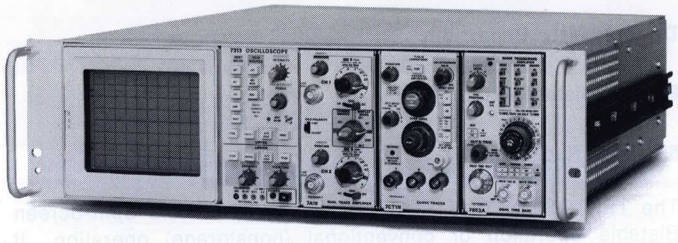
POWER REQUIREMENTS

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

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

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

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



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

DIMENSIONS AND WEIGHTS

Please refer to the 7633 dimensions and weights chart.

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

ORDERING INFORMATION

(Plug-ins not included)

7313 Storage Oscilloscope		$2000
R7313 Storage Oscilloscope		$2100

7313 OPTIONS

Option 1	Without Crt Readout	Sub	$400
Option 3	Emi Modification	Add	$75
Option 7	Without Sig Out/In	Sub	$50

R7313 OPTIONS

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

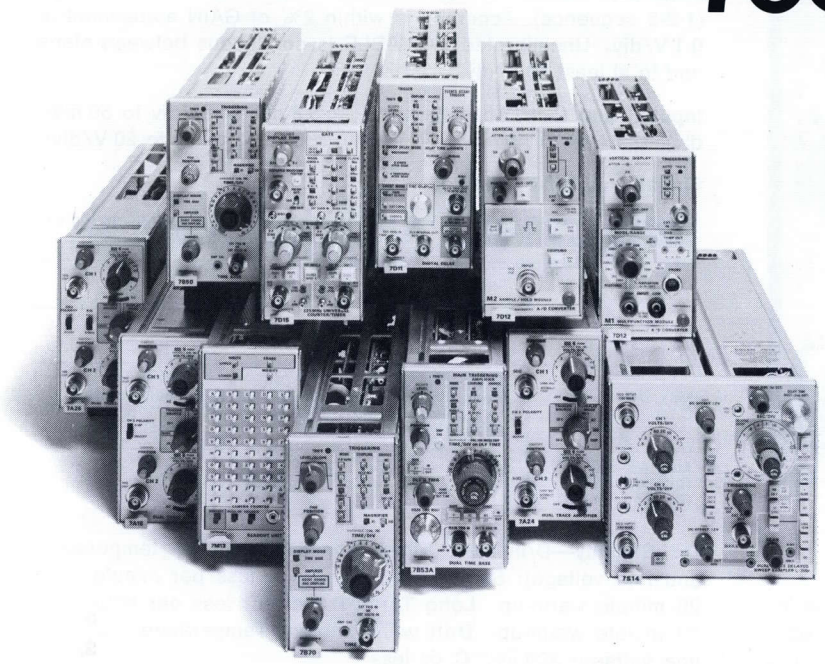
7313 CONVERSION KITS

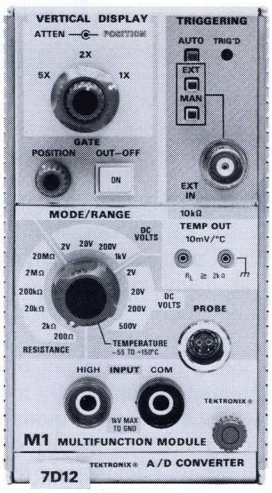
040-0655-01	Crt Readout	$400
040-0664-00	Emi Modification	$100
040-0629-00	Sig Out/In	$50
040-0686-00	Lighted Push Buttons	$15

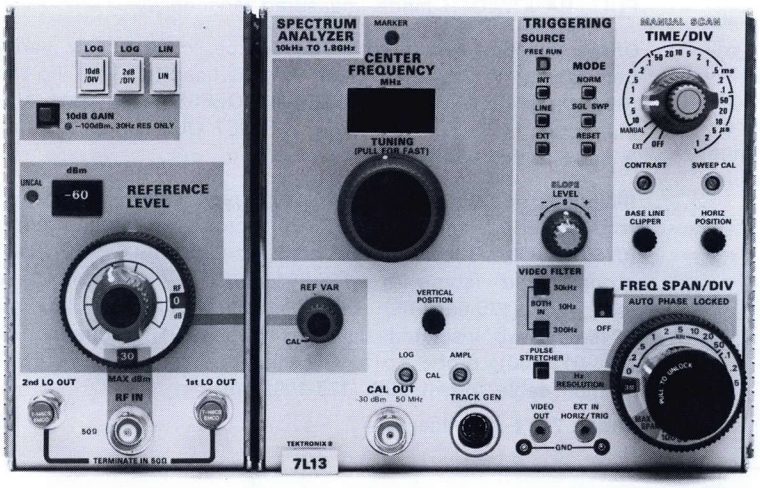
R7313 CONVERSION KITS

040-0675-01	Crt Readout	$400
040-0678-00	Emi Modification	$100
040-0633-00	Sig Out/In	$50
040-0686-00	Lighted Push Buttons	$15

7000-Series Plug-ins







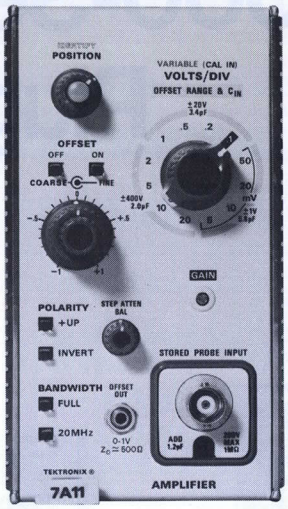
For the 7000 Series you can select from over thirty different plug-ins. For example, digital multimeters, counters and A-D converters. With this plug-in selection you can solve problems in many applications including spectrum analysis, curve tracing, spectroscopy, logic analysis, and sampling. This variety lets you tailor your instrument to meet your immediate need. And to expand its capabilities later as your needs change.

Built-in Fet Probe

Dc-to-250 MHz Bandwidth (7900 Family)*

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

Dc Offset



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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903 R7912	250 MHz*	1.4 ns
7800 Family	7844/R7844	200 MHz	1.8 ns
7700 Family	7704A Opt 9	170 MHz*	2.1 ns
	7704A	170 MHz	2.1 ns
	R7704	150 MHz	2.4 ns
7600 Family	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
Storage Family	7633/R7633	100 MHz	3.5 ns
	7623A/R7623A	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

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

*System bandwidth temperature range from 0°C to +30°C.

**Refer to Ruggedized Oscilloscope System.

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

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

Signal and Offset Range

Deflection Factor Settings	5 mV/div to 50 mV/div	0.1 V/div to 1 V/div	2 V/div to 20 V/div
Offset Range	+1 V to —1 V	+20 V to —20 V	+400 V to —400 V
Offset Range To Offset Out	1:1 within 1% +0.5 mV	20:1 within 1.5% +0.5 mV	400:1 within 2% +0.5 mV
Max Dc Coupled Input	200 V (dc + Peak ac, ac Component to 50 kHz)	200 V (dc + Peak ac, ac Component to 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 which may be used to offset the trace. (See chart for OFFSET RANGE.) An OFFSET OUT Jack allows monitoring of the offset voltage. OFFSET OUT source resistance is 500 Ω within 3%.

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

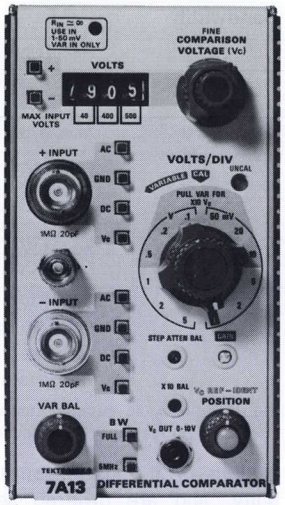
Order 7A11 Amplifier **$950**

Dc-to-105 MHz Bandwidth (7900 Family)

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

20,000:1 Cmrr

10,000 cm Effective Screen Height



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

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

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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903/R7912	105 MHz	3.4 ns
7800 Family	7844/R7844	100 MHz	3.5 ns
7700 Family	7704A Opt 9	100 MHz	3.5 ns
	7704A	100 MHz	3.5 ns
	R7704	100 MHz	3.5 ns
7600 Family	7603/R7603 7603N Opt 11*	75 MHz	4.7 ns
Storage Family	7633/R7633	75 MHz	4.7 ns
	7623A/R7623A	75 MHz	4.7 ns
	7613/R7613	75 MHz	4.7 ns
	7313/R7313	25 MHz	14 ns

Dc to 5 MHz within 500 kHz, 5 MHz bandwidth mode.
10 Hz or less, ac coupled (lower —3 dB).
*Refer to Ruggedized Oscilloscope System.

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

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

Signal Range

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

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

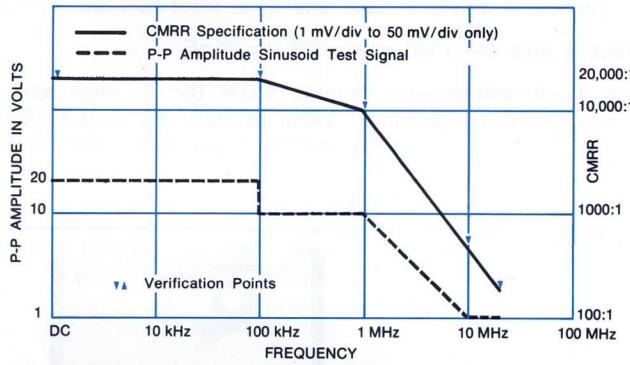
Dc Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 1 mV p-p or 0.1 div, or less (whichever is greater) over any 1-minute interval after 20 minutes warm-up. Long-Term; 1 mV p-p or 0.1 div, or less (whichever is greater) during any 1-hour interval after 20 minutes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

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

Overdrive Recovery— 1 μs to recover to within 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, +5 mV); electrical zero, 0.5 mV or less Vc output R, approx 15 kΩ.

Common-Mode Rejection Ratio

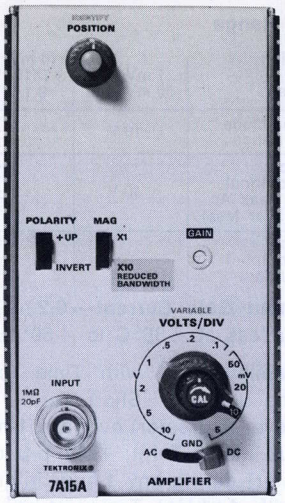


At least 2000:1, 10 mV/div to 50 mV/div (X10 Vc out) and 0.1 V/div to 5 V/div. Ac coupled input at least 500:1 at 60 Hz.

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Full Sensitivity	P6011	1X	All	185
Wide Bandwidth	P6063A	Switchable 1X, 10X	All	188
Wide Bandwidth	P6053B	10X	All	186
Differential	P6055	10X	All	187
Low Capacitance	P6009	100X at 1.5 kV	All	185
1X FET	P6201	1X, 10X, 100X	7700, 7800 7900	180
1X FET	P6045	1X, 10X, 100X	7600, 7313	178
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182

Order 7A13 Amplifier **$1250**



Dc-to-80 MHz Bandwidth (7900 Family)

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

500 μV/div at 10 MHz (X10 Gain)

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

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

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

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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903 R7912	80 MHz	4.4 ns
7800 Family	7844/R7844	80 MHz	4.4 ns
7700 Family	7704A Opt 9	75 MHz	4.7 ns
	7704A	75 MHz	4.7 ns
	R7704	75 MHz	4.7 ns
7600 Family	7603/R7603 7603N Opt 11*	65 MHz	5.4 ns
Storage Family	7633/R7633	65 MHz	5.4 ns
	7623A/R7623A	65 MHz	5.4 ns
	7613/R7613	65 MHz	5.4 ns
	7313/R7313	25 MHz	14 ns

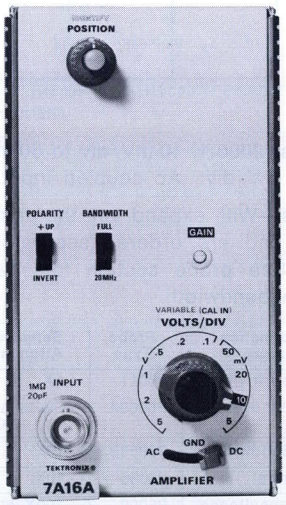
10 Hz or less, ac coupled (lower —3 dB).
*Refer to Ruggedized Oscilloscope System.

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Full Sensitivity	P6011	1X	All	185
Switchable Attenuation	P6062A	Switchable 1X, 10X	All	188
Low Cost	P6065A	10X	7313, 7600	188
Wide Bandwidth	P6053B	10X	7700, 7800, 7900	186
Low Capacitance	P6009	100X at 1.5 kV	All	185
1X FET	P6201	1X, 10X, 100X	7700, 7800, 7900	180
1X FET	P6045	1X, 10X, 100X	7600, 7313	178
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182

Order 7A15A Amplifier **$280**

Order 7A15AN Amplifier **$250**



Dc-to-225 MHz Bandwidth (7900 Family)

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

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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903 R7912	225 MHz	1.6 ns
7800 Family	7844/R7844	175 MHz	2.0 ns
7700 Family	7704A Opt 9	170 MHz*	2.1 ns
	7704A	160 MHz	2.2 ns
	R7704	150 MHz	2.4 ns
7600 Family	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
Storage Family	7633/R7633	100 MHz	3.5 ns
	7623A/R7623A	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

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

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

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

Input R and C—1 MΩ within 2%; ≈20 pF.

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

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

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Full Sensitivity	P6011	1X	All	185
Wide Bandwidth	P6063A	Switchable 1X, 10X	All	188
Wide Bandwidth	P6053B	10X	All	186
Low Capacitance	P6009	100X	All	185
1X FET	P6201	1X, 10X, 100X	7700, 7800 7900	180
1X FET	P6045	1X, 10X, 100X	7600, 7313	178
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182
Ac Current Probe	P6021	2 mA/mV or 10 mA/mV	All	181
Ac Current Probe	P6022	1 mA/mV or 10 mA/mV	All	181

Order 7A16A Amplifier **$475**

1

7000-Series Oscilloscopes

Single-Trace Amplifier

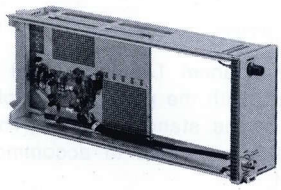
7A17

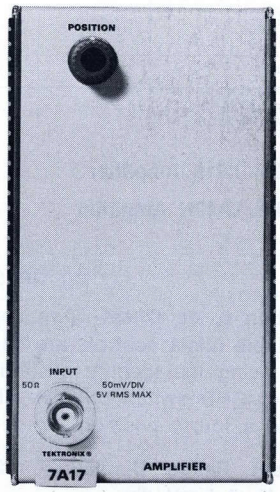
Low Cost

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

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

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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903 R7912	150 MHz	2.4 ns
7800 Family	7844/R7844	150 MHz	2.4 ns
7700 Family	7704A Opt 9	150 MHz	2.4 ns
	7704A	150 MHz	2.4 ns
	R7704	150 MHz	2.4 ns
7600 Family	7603/R7603 7603N Opt 11*	100 MHz	3.5 ns
Storage Family	7633/R7633	100 MHz	3.5 ns
	7623A/R7623A	100 MHz	3.5 ns
	7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14 ns

*Refer to Ruggedized Oscilloscope System.

Input Z—50 Ω.

Max Input Voltage—5 V rms.

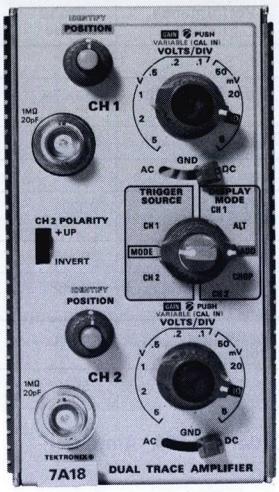
Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Wide Bandwidth 50 Ω	P6056	10X	All	179
Wide Bandwidth 50 Ω	6057	100X	All	179
1X FET	P6201	1X, 10X, 100X	7700, 7800 7900	180
1X FET	P6045	1X, 10X, 100X	7600, 7313	178
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182

Order 7A17 Amplifier **$95**

Dc-to-75 MHz Bandwidth

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



The 7A18/7A18N are dual-trace plug-in amplifiers for use with the 7000-Series mainframes. They are the basic building block for 3- or 4-trace operation. They feature constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selectivity and color-keyed control grouping. The trace IDENTIFY function is operative on 7A18 only. The 7A18N does not incorporate CRT READOUT, all other specifications are identical.

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903 R7912	75 MHz	4.7 ns
7800 Family	7844/R7844	75 MHz	4.7 ns
7700 Family	7704A Opt 9	75 MHz	4.7 ns
	7704A	75 MHz	4.7 ns
	R7704	75 MHz	4.7 ns
7600 Family	7603/R7603 7603N Opt 11*	75 MHz	4.7 ns
Storage Family	7633/R7633	75 MHz	4.7 ns
	7623A/R7623A	75 MHz	4.7 ns
	7613/R7613	75 MHz	4.7 ns
	7313/R7313	25 MHz	14 ns

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

*Refer to Ruggedized Oscilloscope System.

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

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

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

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

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

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Full Sensitivity	P6011	1X	All	185
Switchable Attenuation	P6062A	Switchable 1X, 10X	All	188
Low Cost	P6065A	10X	7313, 7600	188
Wide Bandwidth	P6053B	10X	7700, 7800, 7900	186
Low Capacitance	P6009	100X at 1.5 kV	All	185
1X FET	P6201	1X, 10X, 100X	7700, 7800, 7900	180
1X FET	P6045	1X, 10X, 100X	7600, 7313	178
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182

Order 7A18 Amplifier **$535**

Order 7A18N Amplifier **$500**

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 pushbuttons of the standard 7A18. The ac-dc-GND switch of each channel is expanded to accommodate a fourth position for dc offset.

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

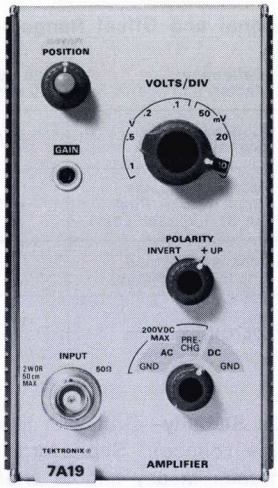
Accuracy—When in DC OFFSET the deflection accuracy is derated by 1%.

Order Opt 6 Dc Offset ..... **Add $115**

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, but is compatible with all 7000-Series mainframes. The polarity of the display is selectable, either normal or inverted.

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903, R7912	500 MHz*	0.8 ns
7800 Family	7844/R7844	400 MHz**	0.9 ns
7700 Family	7704A Opt 9 7704A R7704	250 MHz* 200 MHz 175 MHz	1.5 ns 1.8 ns 2.0 ns
7600 Family	7603/R7603 7603N Opt 11	100 MHz	3.5 ns
Storage Family	7633/R7633 7623A/ R7623A 7613/R7613 7313/R7313	100 MHz 100 MHz 100 MHz 25 MHz	3.5 ns 3.5 ns 3.5 ns 14 ns

1 kHz, ac coupled (lower —3 dB).
* System bandwidth temperature range from 0°C to + 30°C.
** System bandwidth temperature range from 0°C to + 35°C.

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. The range is ±500 ps.

Max Input—2 watts rms or 50 div peak in both the ac and dc coupled mode. 200 V (dc + peak ac) in the ac coupled mode.

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Wide Bandwidth 50 Ω	P6056	10X	All	179
Wide Bandwidth 50 Ω	P6057	100X	All	179
1X FET	P6201	1X, 10X, 100X	All	180
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182
High Frequency Ac Current Probe	CT-1	5 mA/div	All	183

Order 7A19 Amplifier **$700**

7A19 OPTION

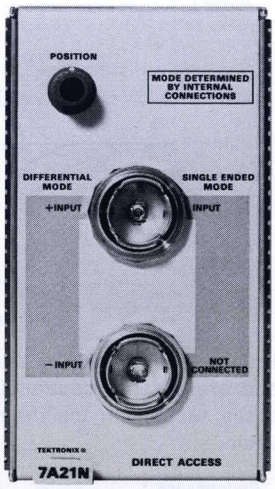
Order Option 4 Variable Sig Delay ..... **Add $250**

Bandwidth to 1 GHz (7900 & 7800 Family Only)

Less than 4 V/Div Deflection Factor

Single and Diff Inputs

Positioning Control



The 7A21N plug-in is designed specifically for the ac coupling of high-frequency or fast-risetime signals directly into the wide-bandwidth crt of the 7900 and 7800-FAMILY Oscilloscopes. Two front-panel input connectors allow either single-ended or differential operation (internally selected). Vertical-trace positioning is accomplished by a front-panel control.

The direct access feature of this plug-in dictates by-passing the vertical amplifier. 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 and CRT READOUT are inoperative, and the use of other plug-ins in the adjacent vertical channel is not possible.

When used in 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 **$400**

Dc-to-1 MHz Bandwidth

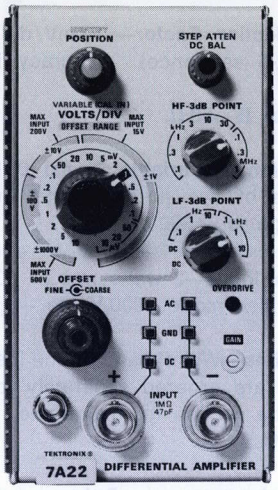
10 μV/div to 10 V/div Calibrated Deflection Factors

100,000:1 Cmrr

Selectable Upper and Lower —3 dB Points

Dc Offset

10 μV/Hour Dc Drift*



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

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

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

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

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

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

*With constant temperature. See dc stability specifications.

1

Signal and Offset Range

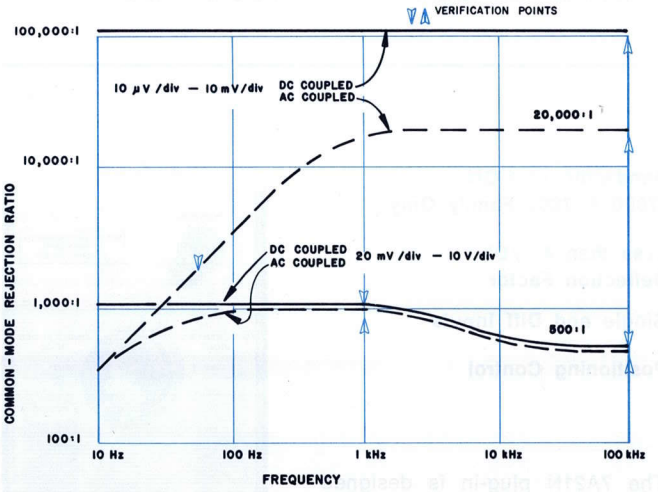
Deflection Factor Settings	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
Common-Mode Signal Range	±10 V	±100 V	±500 V	
Max dc Coupled Input (dc + Peak ac at 1 kHz or Less)	±15 V	±200 V	±500 V	
Max ac Coupled Input (dc Voltage)	±500 V Dc rejection, at least 4 x 10^5:1			
Dc Offset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

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

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

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



Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Switchable Attenuation	P6062A	Switchable 1X, 10X	All	188
Low Capacitance	P6009	10X at 1.5 kV	All	185
Ac Current Probe	P6021	2 mA/mV or 10 mA/mV	All	181
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182

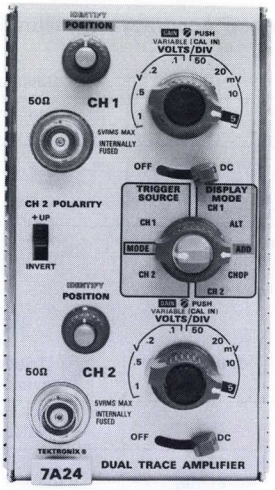
Order 7A22 Amplifier **$610**

DC-to-350 MHz Bandwidth (7900 Family)

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

50 Ω Input

The 7A24 is a dual-trace plug-in amplifier for use with the 7000-Series mainframes. It is a basic building block for 3- or 4-trace operation. The plug-in features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control grouping. Polarity of the display is selectable.



7A24—50-Ω INPUT

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

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

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

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

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

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903, R7912	350 MHz*	1.0 ns
7800 Family	7844/R7844	300 MHz**	1.2 ns
7700 Family	7704A Opt 9 7704A R7704	200 MHz 200 MHz 160 MHz	1.8 ns 1.8 ns 2.2 ns
7600 Family	7603/R7603 7603N Opt 11	100 MHz	3.5 ns
Storage Family	7633/R7633 7623A/R7623A 7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14.0 ns

10 Hz or less, Ac coupled (lower - 3 dB).

* System bandwidth temperature range 0°C to + 30°C.

** System bandwidth temperature range 0°C to + 35°C.

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the application. See probe section for mainframe, amplifier and probe system bandwidth.

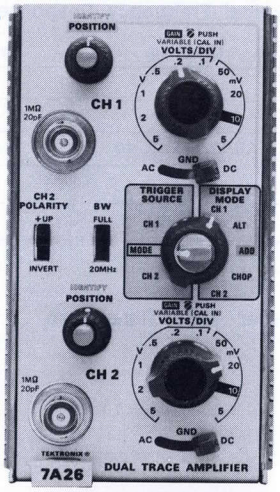
Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Wide Bandwidth 50 Ω	P6056	10X	All	179
Wide Bandwidth 50 Ω	P6057	100X	All	179
1X FET	P6201	1X, 10X, 100X	All	180
High Frequency Ac Current Probe	CT-1	5 mA/div	All	183

Order 7A24 Amplifier **$1050**

DC-to-200 MHz Bandwidth (7900 Family)

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

The 7A26 is a dual-trace plug-in amplifier for use with the 7000-Series mainframes. It is a basic building block for 3- or 4-trace operation. The plug-in features constant bandwidth for all deflection factors, 5 operating modes (CH 1, CH 2, ALT, CHOP, ADD), trigger source selection (CH 1, CH 2, MODE), and color-keyed control grouping. Polarity of the display is selectable. Bandwidth can be either FULL or limited to 20 MHz for low frequency applications.



7A26—1-MΩ INPUT

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

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

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

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.

Bandwidth

	Mainframe	Bandwidth	Risetime
7900 Family	7904/R7903, R7912	200 MHz*	1.8 ns
7800 Family	7844/R7844	160 MHz	2.2 ns
7700 Family	7704A Opt 9 7704A R7704	170 MHz* 150 MHz 140 MHz	2.1 ns 2.4 ns 2.5 ns
7600 Family	7603/R7603 7603N/Opt 11	100 MHz	3.5 ns
Storage Family	7633/R7633 7623A/R7623A 7613/R7613	100 MHz	3.5 ns
	7313/R7313	25 MHz	14.0 ns

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

* System bandwidth temperature range 0°C to + 30°C

Probes—Will expand on the instrument's measurement capability, and are ordered separately to fit the needed application. See probe section for mainframe, amplifier and probe system bandwidth.

Performance Feature	Probe Type	Sensitivity/ Attenuation	Recommended Family	Page
Full Sensitivity	P6011	1X	All	185
Wide Bandwidth	P6063A	Switchable 1X, 10X	All	188
Wide Bandwidth	P6053B	10X	All	186
Low Capacitance	P6009	100X	All	185
IX FET	P6201	1X, 10X, 100X	All	180
Dc to 50 MHz Current Probe	P6042	1 mA/div to 1 A/div	All	182
Ac Current Probe	P6021	2 mA/mV or 10 mA/mV	All	181

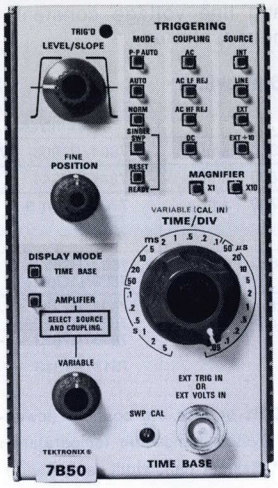
Order 7A26 Amplifier **$1050**

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

Peak-to-Peak Auto Triggering

Triggering to 100 MHz

Single-Sweep Operation



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

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

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

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

Sweep Accuracy—Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

TRIGGERING

Coupling	Triggering Frequency Range	Min Signal Required	
		Int	Ext
Ac	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV
Ac Lf Rej*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 150 mV 750 mV
Ac Hf Rej	30 Hz - 50 kHz	0.3 div	150 mV
Dc	Dc - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

EXT HORIZONTAL INPUT

Deflection Factor—Minimum deflection factor is 90 mV/div within 10 mV/div when in EXT source with variable fully CW; minimum deflection factor is 900 mV/div within 110 mV/div when in Ext ÷ 10 source position with variable fully CW. The VARIABLE is continuous between steps and to at least 9 V.

Typical Frequency Response

Coupling	Lower —3 dB	Upper —3 dB
Ac	16 Hz	500 kHz
Ac Lf Rej	50 kHz	500 kHz
Ac Lf Rej ÷ 10	15 kHz	500 kHz
Ac Hf Rej ÷ 10	16 Hz	75 kHz
Ac Hf Rej	16 Hz	120 kHz
Dc	Dc	500 kHz

Order 7B50 Time Base **$450**

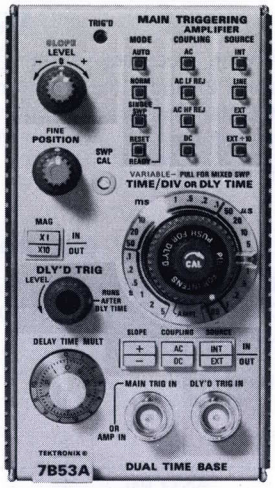
5 ns/Div to 5 s/Div Calibrated Time Base

Calibrated Mixed Sweep

Triggering to 100 MHz

Single-Sweep Operation

Optional TV Sync-Separator Triggering



The 7B53A and 7B53AN Dual Time Bases are recommended for use with the 7600 and Storage FAMILIES to provide bandwidth/sweep speed compatibility. Both time bases have identical characteristics except the 7B53AN does not incorporate CRT READOUT.

These Dual Time Bases feature four sweep display modes: normal, intensified delaying, delayed and mixed.

Normal Sweep (nondelayed) is selected when the DLY'D TIME/DIV switch is pushed in and set to the same sweep rate as the TIME/DIV switch. The switches will latch in this mode.

Intensified Delaying Sweep is accomplished by pulling out the DELAYED SWEEP TIME/DIV knob. The delaying (main) sweep is intensified for a period of time determined by the delayed sweep setting. The intensified zone may be initiated at any point on the delaying sweep determined by the DELAY TIME MULT (DTM). The DELAYING and DELAYED TIME/DIV controls can be independently set. MAIN TRIGGERING controls are used to control the delaying sweep.

Delayed Sweep is selected by pushing in the DELAYED SWEEP TIME/DIV knob. The intensified segment of the delaying sweep is now displayed over the full 10 div of the crt. The delayed sweep may be operated in either a "triggered" or "runs-after-delay" mode.

Mixed Sweep is accomplished by pulling the VARIABLE knob out, combining the slower and faster sweep speeds into one display. The main sweep is displayed at the slower speed from the sweep start to a selectable point on the main sweep. Past this point, the sweep is displayed at the faster of the two sweep speeds. The intensified zone, delayed sweep and mixed sweep may be initiated at any point on the main sweep determined by the DLY TIME MULT.

TV SYNC

Option 5, TV Sync Separator Triggering—Permits stable internal Line or Field rate triggering from displayed composite video or composite sync waveforms. Conventional waveform displays and measurements can be made from standard broadcast or closed-circuit TV systems, domestic or overseas, with up to 1201-line, 60-Hz field rates. Individual lines can be displayed with the delayed sweep features. The wide range of delayed sweeps permits accurate alternate-frame, color-burst observations in the PAL color system.

DELAYING SWEEP

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

Sweep Accuracy—Measured over the center 8 div.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.05 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

Delay Time Multiplier Range— 0 to 10 times the DELAY TIME/DIV setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy— 5 s/div to 1 s/div: ±(1.4% of measurement + 0.3% of full scale); 0.5 s/div to 1 μs/div: ±(0.7% of measurement +0.3% of full scale). Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 major DTM divisions from +15°C to +35°C.

Jitter— 1 part or less in 20,000 of X10 the TIME/DIV setting.

Triggering

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV
Ac Lf Rej*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div ——— 1.5 div	——— 100 mV 500 mV
Ac Hf Rej	30 Hz - 50 kHz	0.3 div	100 mV
Dc	Dc - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

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

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

DELAYED SWEEP

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

7B53A and 7B53AN Dual Time Bases

Sweep Accuracy—Measured over the center 8 div.

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

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

Triggering

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

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

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

MIXED SWEEP

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

EXT HORIZONTAL INPUT

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

Bandwidth

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

Order 7B53A Dual Time Base **$850**

Order 7B53AN Dual Time Base **$750**

7B53A/AN OPTION

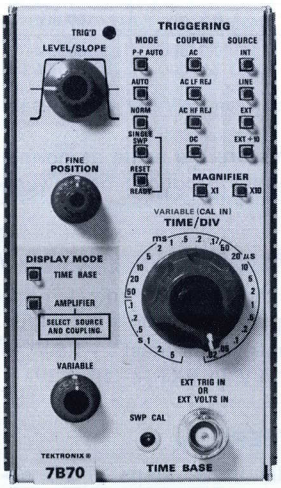
Order Option 5 TV Triggering ..... **Add $60**

7B70
7B71

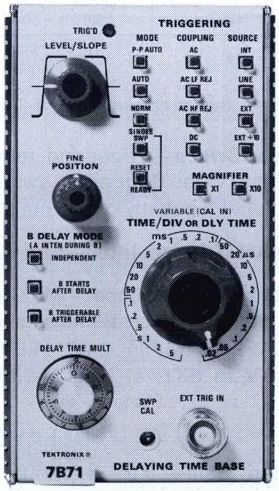
7000-Series Oscilloscopes

Delayed and Delaying Time Bases

1



7B70



7B71

FEATURES OF BOTH TIME BASES

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

Peak-to-Peak Auto Triggering

Triggering to 200 MHz

Single-Sweep Operation

The 7B70 and 7B71 are horizontal TIME-BASE units intended primarily for use with the 7700- and 7800-Series mainframes to provide bandwidth/sweep speed compatibility. However, the 7B70 and 7B71 may be used with any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B71 being the DELAYING SWEEP and the 7B70 the DELAYED SWEEP. The 7B70 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.

The calibrated TIME/DIV range is from 2 ns/div to 5 s/div. The 2 ns/div rate, obtained with the X10 MAGNIFIER, complements the risetime capability of the 7700-FAMILY vertical systems.

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

The triggering frequency range is from dc to 200 MHz, selectable within that range by the method of COUPLING. Ac Lf Rej attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); Ac Hf Rej attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B71 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B70 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

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

Characteristics are common to both units unless otherwise noted.

Sweep Rate— 0.02 μs/div to 5 s/div in 26 steps (1-2-5 sequence). 2 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div, with the 7704A mainframe.

Time/Div	Unmagnified		Magnified	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/div and 0.2 μs/div to 0.02 μs/div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP CHARACTERISTICS (7B71 ONLY)

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting from 5 s/div to 1 μs/div.

Differential Delay Time Measurement Accuracy— 5 s/div to 1 s/div: ±(1.5% of measurement + 0.3% of full scale); 0.5 s/div to 1 μs/div: ±(1% of measurement + 0.3% of full scale). Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 major DTM divisions from +15°C to +35°C.

Jitter— 1 part or less in 50,000 of X10 the TIME/DIV setting.

TRIGGERING

Coupling	Triggering Frequency Range	Min Signal Required Int	Min Signal Required Ext
Ac	30 Hz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
Ac Lf Rej*	30 kHz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV
Ac Hf Rej	30 Hz - 50 kHz	0.3 div	75 mV
Dc	Dc - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div	75 mV 375 mV

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P Auto Operation— 0.5 div INT, 125 mV EXT from 200 Hz to 20 MHz; 1.5 div INT, 375 mV EXT from 20 MHz to 200 MHz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

Internal Trigger Jitter— 1 ns or less at 150 MHz.

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

EXT HORIZONTAL INPUT (7B70 ONLY)

Deflection Factor—Minimum deflection factor is 25 mV/div within 5 mV/div when in EXT source with variable fully CW; minimum deflection factor is 250 mV/div within 50 mV/div when in EXT ÷ 10 source with variable fully CW. The VARIABLE is continuous between steps and to at least 2.5 V.

Frequency Response (measured in 7700-FAMILY mainframes)

Coupling	Lower —3 dB	Upper —3 dB
Ac, Ac Lf Rej, Ac Hf Rej	10 Hz	200 kHz
Dc	Dc	200 kHz

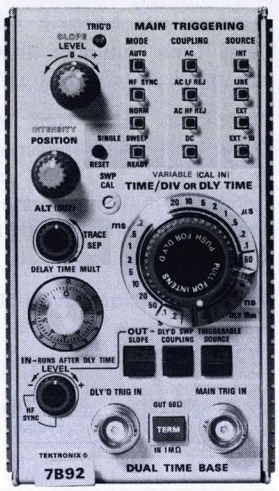
Order 7B70 Time Base **$675**

Order 7B71 Delaying Time Base **$775**

0.5 ns/Div to 0.2 s/Div Calibrated Time Base*

Triggering to 500 MHz*

Display Switching—Alternate Display of Intensified Delaying & Delayed Sweeps



The 7B92 is recommended for use with the 7700 and 7900 FAMILIES. Its exceptionally fast sweep (500 ps/div) ideally matches the ultra-high bandwidth of the 7900 FAMILY and provides full bandwidth triggering for the 7700 FAMILY. Since the 7B92 uses only one horizontal compartment it permits usage of the other horizontal compartment for specialized measurements.

The 7B92 features four display modes: normal, intensified delaying sweep (controlled contrast), delayed sweep and alternate (excepting alternate in R7704).

DELAYING SWEEP

Sweep Rate—10 ns/div to 0.2 s/div in 23 steps (1-2-5 sequence). The uncalibrated VARIABLE is continuous between steps and to 0.5 s/div. Variable control is internally switchable between delaying and delayed sweeps.

Sweep Accuracy—Measured over the center 8 div in the 7900-FAMILY Oscilloscope mainframe.

Time/Div	+15°C to +35°C	0°C to +50°C
0.2 s/div	within 4%	within 5%
All other sweep rates	within 3%	within 4%

Delay Time Multiplier Range— 0 to 9.9 times the TIME/DIV setting from 0.2 s/div to 10 ns/div (0 to 1.98 seconds).

Differential Delay Time Measurement Accuracy— 0.2 s/div: ±(1.4% of measurement + 0.3% of full scale); 0.1 s/div to 0.1 μs/div; ±(0.7% of measurement + 0.3% of full scale); 50 ns/div to 10 ns/div: ±(1.5% of measurement + 0.5% of full scale).

Absolute Time Measurement Accuracy—(Measurement from start of Delaying Sweep.) 0.2 s/div to 1 μs/div: Within 1% of full scale plus differential time measurement accuracy; 0.5 μs/div to 0.1 μs/div: Within 1% of full scale plus differential time measurement accuracy plus 0.1 μs; 50 ns/div to 10 ns/div: Within 1% of full scale plus differential time measurement accuracy plus 20 ns.

Full scale is 10 times the DELAY TIME/DIV setting. Accuracy applies over the center 8 major DTM divisions from +15°C to +35°C.

*The two fastest sweep speeds (0.5 ns/div and 1 ns/div) are not usable in the 7700-FAMILY mainframes; also internal triggering is limited to 250 MHz.

Jitter—1 part in 50,000 of maximum available delay time or 500 ps whichever is greater. (Not applicable for first 2% of available delay range.)

Triggering

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

HF Sync—Triggering frequency range is from 100 MHz to 500 MHz with increased sensitivity, this mode may be used with any coupling mode except Ac Hf Rej.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

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

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (dc + peak ac) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +3.5 V to −3.5 V in EXT, at least +35 V to −35 V in EXT ÷ 10.

DELAYED SWEEP

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

Sweep Accuracy—Measured over the center 8 div in the 7900-FAMILY Oscilloscope mainframe.

Time/Div	+15°C to +35°C	0°C to +50°C
0.1 s/div to 50 ns/div	within 3%	within 4%
0.2 s/div and 20 ns/div to 1 ns/div	within 4%	within 5%
0.5 ns/div	within 5%	within 6%

HF Sync—Triggering frequency range is from 100 MHz to 500 MHz with increased sensitivity.

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

Triggering

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

External Trigger Input—Selectable 50 Ω or 1 MΩ inputs. Max input voltage 250 V (dc + peak ac) for 1 MΩ input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 MΩ paralleled by approx 20 pF. LEVEL range is at least +2.5 V to −2.5 V.

Order 7B92 Dual Time Base **$1400**

Digital Delay Readout to 7½ Digits

Delay by Time or Events

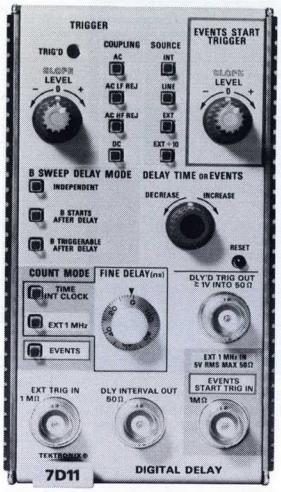
100 ns to 1 s Delay Time

1 ns Resolution

Less than 2.2 ns Jitter

0.5 ppm (±2 ns) Accuracy

Delay Interval Crt Display



The 7D11 Digital Delay plug-in provides a means of accurate and stable delayed triggers for measurements requiring low jitter and precision time delays. With the capability of being used in any compartment of a 7000-Series mainframe equipped with CRT READOUT, the 7D11 provides a variety of outputs. Upon the receipt of a trigger, the 7D11, in the Delay By Time mode, counts a highly accurate clock and at the selected delay time, delivers a delayed trigger to its front panel connector and to the mainframe in which it is installed. (See Fig 1.)

In the Delay By Events mode, the 7D11 will count arbitrary trigger events, periodic or aperiodic, and will deliver an output after the preselected count has been reached. In both modes, the delay time or the number of events to be counted is selected by a single front panel control. A reset button initializes the delay to 100 ns or one event when depressed.

The 7D11 generates signals which are applied to the vertical channel and Z-axis to 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 can be displayed together with the signal waveform on which the 7D11 is triggered. From a vertical compartment, the 7D11 can trigger a time base, such as 7B70, 7B53A or another 7D11, through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 will generate a blanking pulse for the duration of the delay interval. This provides a display similar to the "A Intensified By B" mode of conventional delayed sweep operation. (See Fig 2.) When used in the A Horizontal compartment, the 7D11 B Sweep delay mode controls will permit the B Sweep to either run or be triggerable after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In the Delay By Events operation, an external pulse (Events Start Trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the Events Start Trigger. Then the 7D11 counts "n" number of horizontal sync pulses (Events) into the field or frame (See Fig 3). In a similar manner, the origin pulse of a disc memory can be used as the Events Start Trigger, and the disc clock pulses become the events that are counted.

For timing measurements requiring a higher degree of accuracy than the 0.5 ppm source available in the 7D11, the Delay By Time clock may be referenced to an external 1-MHz timing standard through the EXT 1-MHz input.

Time delay resolution up to 1 ns can be obtained by using the front panel Fine Delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc., the CRT READOUT would display the "one-way-trip" time.

The 7D11 Digital Delay Unit is very helpful in making measurements under complex timing conditions such as those encountered in troubleshooting modern digital circuitry.

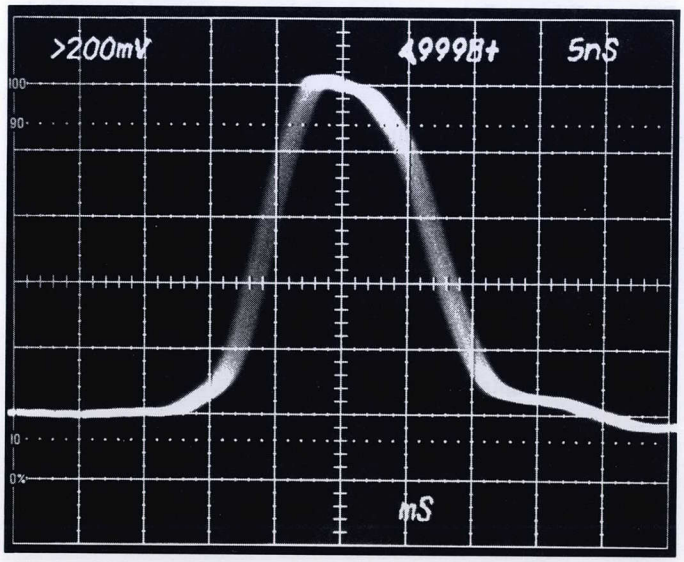


Fig. 1: 0.2 μs time marker delayed 4.9998 ms by the 7D11 and displayed at 5 ns/div.

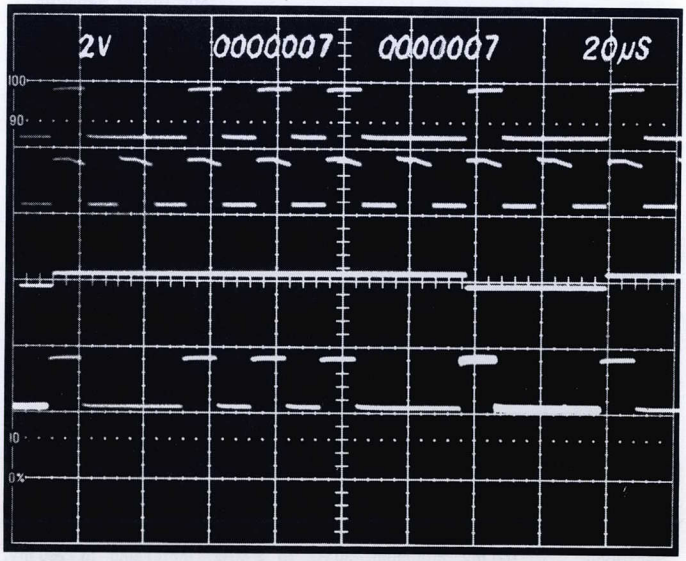


Fig. 2: Events Delay Mode (delay equals seven events). The top trace is a digital wavetrain and the second waveform is its clock. The third waveform represents the delay interval generated by the 7D11 in a vertical compartment; this began on the 1st clock pulse and ended on the 7th. The lower trace shows the display obtained with a 7D11 in a horizontal compartment (double exposure).

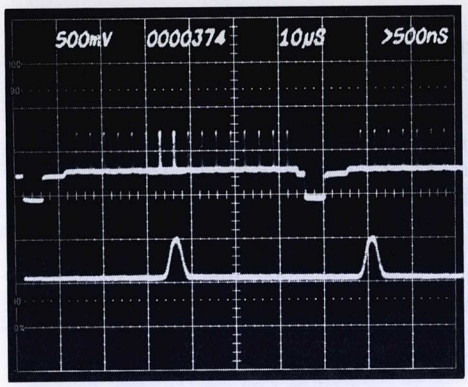


Fig. 3: Digital Delay Analog-Delay operation. The 7D11 triggers Time Base A at the beginning of the 374th line (upper trace). The 7th and 8th vertical bars are intensified by Time Base B set by the 7B71 delay time multiplier. The lower trace shows video information on the B delayed sweep.

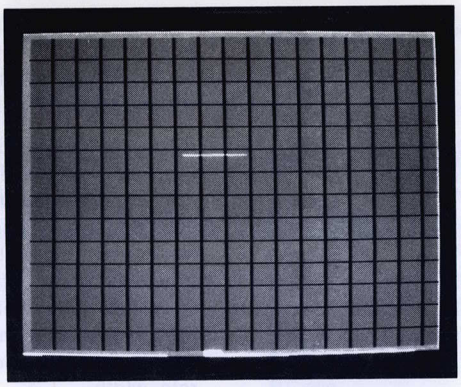


Fig. 4: The cross hatch signal is seen on a Video Monitor. The B sweep gate of Fig. 3 applied to the monitor shows the 7th and 8th vertical bars unblanked at the 374th line.

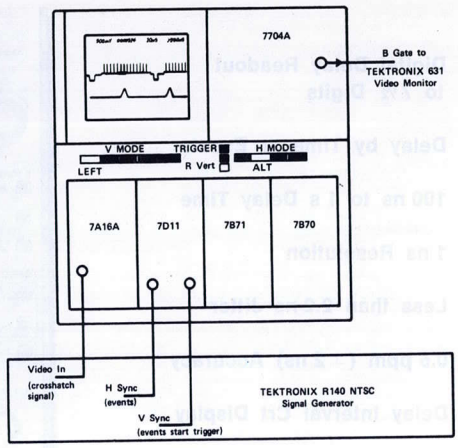


Fig. 5. Equipment set up for figures 3 and 4.

EVENTS DELAY

Events Delay Range—One to 10^7 events.

Delay Increment—One event.

Insertion Delay— 35 ns ±5 ns.

Recycle Time—Less than 500 ns.

Maximum Event Frequency—At least 50 MHz.

TRIGGERING

	External Trigger			
Source	Int, Line, Ext, Ext ÷ 10			
Coupling	Dc, Ac, Ac Lf, Rej, Ac Hf Rej			
Max Input Voltage	150 V dc + peak ac			
Level Range	±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 sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

	Events Start Trigger
Source	External Only
Coupling	Dc Only
Max Input Voltage	150 V dc + peak ac
Level Range	±3 V
Input R and C	1 MΩ within 5%, 20 pF ± 2 pF
Sensitivity	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 X 10^{-7}) whichever is greater.

Insertion Delay—Zero within 2 ns.

Recycle Time—Less than 575 ns.

Time Base— 500 MHz oscillator phase locked to internal or external clock.

Internal Clock— 5 MHz Crystal oscillator. Accuracy is 0.5 ppm.

External Clock— 1 MHz within 1%, ac coupled, 50 Ω.

OUTPUTS

Delayed Trigger Out—Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime into 50 Ω Load: 2 ns or less. Falltime into 50 Ω Load: 5 ns or less. Pulse width: 200 to 250 ns.

Delay Interval Out—Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω. Risetime and Falltime: 5 ns or less. Accuracy: Equal to Delay Interval less 20 to 30 ns.

READOUT

Display— 7½ digit with leading zero suppression, ms legend in Time Delay Mode. Plus (+) symbol reminds the operator to add on the FINE DELAY (ns) setting.

Order 7D11 Digital Delay Unit **$1475**

Versatile 0.01% A/D Converter with Vertical Amplifier

3 Plug-In Modules Available

Automatic, Manual or External Triggering

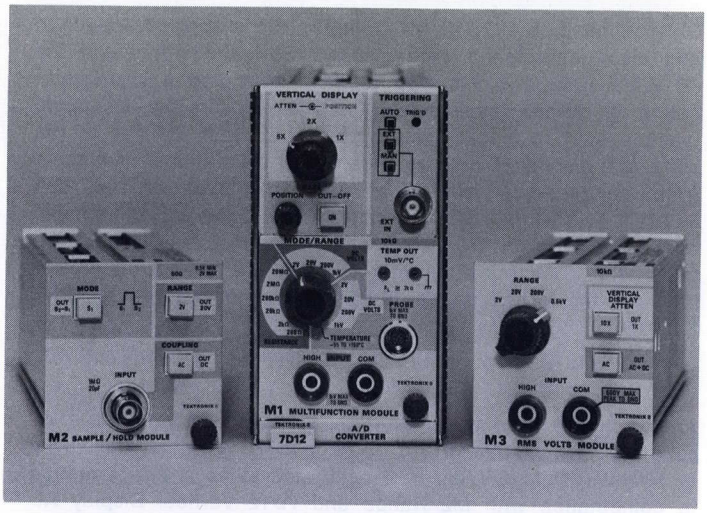
Automatic, Polarity and Overrange Indicators

100-MHz Vertical Analog-Display Capability

The 7D12 A to D Converter Plug-in utilizes modular construction, similar to the 7000-Series Sampling Plug-ins, to provide a versatile and expandable dvm measurement system. The 7D12 plug-in along with three interchangeable modules satisfies most dvm measurement applications including: dc volts, resistance, temperature, one- or two-point sample and hold, and true rms volts.

The 7D12 is designed for use with all 7000-Series Oscilloscope mainframes except those without CRT READOUT.

There are three interchangeable modules available for the 7D12. Their description and specifications are described in combination with the 7D12 A/D Converter.



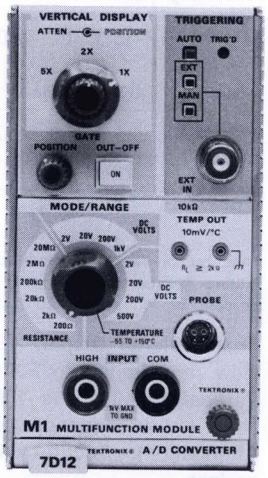
7D12/M1 MULTIFUNCTION MODULE

Temperature Mode

4½-Digit Crt Readout

100-μV Resolution

Probe Measures Temperature or Voltage



The M1 Multifunction Module in combination with the 7D12, measures dc volts, resistance, and temperature. The input can be elevated 1 kV above ground, with a 10-MΩ input impedance on the dc scale. When the temperature probe is used, a front-panel analog output of 10 mV/°C (0°C = 0 volts) is available 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. Maximum safe input is 1-kV Peak between either connector and ground. Polarity is automatic. Cmrr is at least 80 dB at 60 Hz (100 Ω imbalance). Normal-mode rejection ratio is at least 50 dB at 60 Hz.

Resistance Range— 0 to 20 MΩ in six ranges. 4½-digit presentation of 199.99 Ω, 1.9999 kΩ, 19.999 kΩ, 199.99 kΩ, 1.9999 MΩ, 19.999 MΩ full scale. Accuracy is ±0.09% of reading ± 0.01% of full scale from +15°C to +40°C. Input is fuse protected.

Temperature Range— −55°C to +150°C in one range. Accuracy (+15°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Temperature out is 10 mV/°C into a load of at least 2 kΩ. See P6058 voltage/temperature probe specifications included on 7D13 Digital Multimeter catalog page 95.

Settling Time— 2 s or less to within 1 count of final reading (voltage and resistance modes).

Measurement Rate—4 measurements per second in AUTO triggering; 1 to 12 measurements per second in EXT triggering, internally adjustable.

Overrange Indication—When overrange occurs, a > symbol appears to the left of the reading.

Included Accessories—P6058 voltage/temperature probe package (010-0260-00); pair of test leads (003-0120-00).

7D12/M2 SAMPLE/HOLD MODULE

Oscilloscope-Controlled Sampling Dvm

10 ns Aperture Uncertainty

Input Signal and Sample Points Displayed on Crt

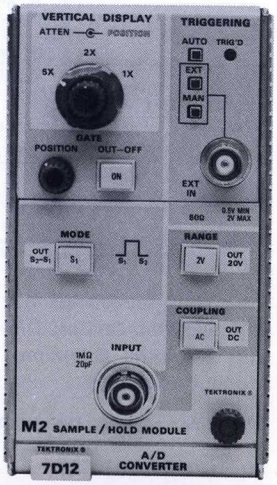
3½-Digit Crt Readout

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 in combination with the 7D12 measures voltage amplitude from ground to a selected point or the difference voltage between any two selected points (independent control of each point). The sample point(s) can be triggered automatically, manually, or externally from sources such as: the oscilloscope's Delayed B Gate, the 7D15 Universal Counter/Timer's Pseudo Gate, 7D11 Delayed Trigger Out, etc.

On command, the 7D12/M2 samples the displayed waveform and also generates a gate display. Both the signal and the 7D12/M2 gate are displayed together providing a visual indication of where the sample(s) are taken. In the S1 mode (sample one), a single sample coincident with the rise of the 7D12/M2 displayed gate is taken and the voltage amplitude, from the zero volt level, is digitally displayed on the CRT READOUT. In the S2-S1 mode (sample two minus sample one), two samples are taken, one at the rise and one at the fall of the 7D12/M2 displayed gate and the voltage difference between these two points is digitally displayed on the CRT READOUT.

Sample-Gate Display Amplitude— 2 divisions, risetime and falltime 5 ns or less.

Analog-Signal Display—Bandwidth is dc to 25 MHz (dc coupling), 3.4 Hz to 25 MHz (ac coupling). Vertical Sensitivity is 100 mV/div to 5 V/div in 6 calibrated steps (1-2-5 sequence in combination with M2 Range and 7D12 Vertical Display Attenuation). Accuracy is within 5%.

Input R and C— 1 MΩ and 20 pF.

Maximum Input Voltage— 100 V Peak.

Measurement Readout— 0 to 20 V in two ranges. 3½-digit presentation of 1.999 V and 19.99 V full scale, extended to 199.9 V with P6055 probe.

Overrange Indication—When overrange occurs, a > symbol appears to the left of the reading.

Aperture-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— 1 to 12 measurements per second, internally adjustable (EXT triggering). 4 measurements per second (AUTO triggering S1 mode only).

Settling Time— 40 ns.

Accuracy Without Probe (40 ns after input signal step function)

Temperature Range	S1 Mode	S2-S1 Mode
+ 20°C to + 30°C	± 0.15% of p-p input voltage, ± 0.1% of reading, ± 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, ± % ac of Decay*

*Applicable when M2 is ac coupled.

Included Accessories— 3.5 ft P6055 Probe pack (010-6055-01).

7D12/M3 RMS VOLTS MODULE

True Rms Measurements with Isolated-Analog Display (Floating Common-Mode Capability)

Measures Ac + Dc or Ac Only

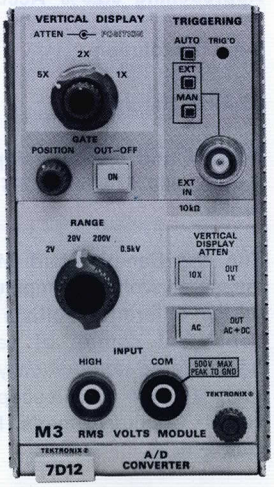
40 Hz-to-100 kHz Ac Voltage Range

0.25% Accuracy from 40 Hz to 40 kHz

3½-Digit Crt Readout

1-mV Resolution

500 V Maximum Peak Common-Mode Voltage



The M3 RMS Volts Module in combination with the 7D12 measures the true rms voltage of signals from 40 Hz to 100 kHz. Voltages up to 1-kV peak can be measured while floating the input connectors.

Input R and C— 1 MΩ; ≃50 pF.

Maximum Crest Factor— 5, (crest factor = $\frac{E_{pk}}{E_{RMS}}$)

Maximum Input Voltage

Range		2 V, 20 V, 200 V	0.5 kV
Ac† or Dc Coupled	Max Input Between Connectors	2.5 X Range Peak	500 V RMS, 1 kV Peak
	Max Input Between Either Connector and Chassis Ground	500 V Peak	500 V Peak

†Ac coupling adds an additional 200 V dc Isolation.

Digital System Cmrr— 66 dB at dc to 60 Hz, decreasing 20 dB per decade for higher frequencies (100 Ω imbalance load).

Measurement Readout— 0 to 500 V rms in four ranges. 3½-digit presentation of 1.999 V, 19.99 V, 199.9 V, .500 kV full scale.

Overrange Indication—When overrange occurs, a > symbol appears to the left of the reading.

Measurement Rate— 1 to 12 measurements per second internally adjustable (EXT triggering). 4 measurements per second (AUTO triggering).

Accuracy (stated with form factor of 1.2 or less, (form factor = $\frac{E_{RMS}}{E_{average}}$); +15°C to +40°C)*

Range	DC	40 Hz to 4 kHz	4 kHz to 40 kHz	40 kHz to 100 kHz
2 V, 20 V	±0.5%	±0.25%	±0.25%	±0.5%
200 V	±0.5%	±0.25%	±0.5% plus 1% of reading	±0.5% plus 1% of reading
500 V	±1%	±1%	±2% plus 1% of reading	±2% plus 1% of reading

*Accuracies represent a percentage of full scale. For signals with form factors greater than 1.2, add ± [0.1% x (form factor —1)] to the above percent of full scale accuracy specifications.

Analog-Signal Display—Bandwidth is dc to 700 kHz, maximum slew rate limited to Full-Scale-Voltage ÷ 1 μs (100 V/μs Max). Vertical sensitivity is 100 mV/div to 500 V/div in 12 calibrated steps (1-2-5 sequence, combining M3 and 7D12 Vertical Display Attenuation). Accuracy is within 5%, and aberrations are 5% or less.

Included Accessories—Pair of test leads (012-0427-00).

7D12/M1/M2/M3 ORDERING INFORMATION

7D12 A/D Converter (Modules Not Included) **$725**

M1 Multifunction Module **$335**

Option 2 without P6058 ..... **Sub $ 75**

M2 Sample/Hold Module **$695**

Option 2 without P6055 ..... **Sub $ 95**

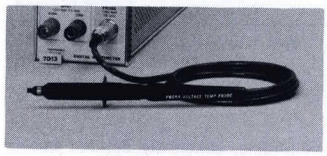
M3 RMS Volts Module **$500**

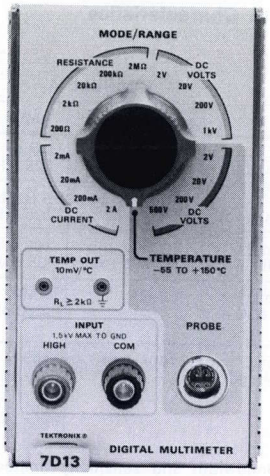
Temperature Mode

1.5 kV Maximum Common Mode Voltage

Probe Measures Temperature or Voltage

3½-Digit Crt Readout





The 7D13 is a Digital Multimeter plug-in designed for use in all 7000-Series Oscilloscope mainframes except those without crt READOUT. The 7D13 will function in any plug-in compartment.

In addition to measuring dc volts, dc current and resistance, temperature measuring capability is also featured in the 7D13, provided by a temperature sensor on the tip of the P6058 voltage/temperature probe. The temperature probe functions regardless of 7D13 mode or range setting and provides a front-panel analog signal output of 10 mV/°C (0°C = 0 volts). Thus, by using an external voltage indicator, temperature may be measured simultaneously along with any other function. Most any NPN transistor can be used as a separate sensor to make small space, "free air," measurements.

When the 7D13 is used, the character generator traces out a 3½-digit display on the face of the crt, along with a legend for units like kΩ, mA, C (temperature).

Dc Voltage Range— 0 to 1000 V in four ranges. 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. Maximum safe input is 1.5 kV peak between either contact and ground, 1.0 kV peak between voltage contacts.

Dc Current Range— 0 to 2 A in four ranges. 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. Maximum input is 3A (fuse protected). Input impedance is 0.2 V/full scale current +0.3 Ω.

Resistance Range— 0 to 2 megohms in five ranges. 3½-digit presentation 199.9 Ω, 1999 Ω, 19.99 kΩ, 199.9 kΩ, and 1999 kΩ full scale. Accuracy is ±0.5% of reading ±1 count from +15°C to +40°C, ±0.8% of reading ±2 counts from 0°C to +50°C. Input is fuse protected.

Temperature Measurement Range— −55°C to +150°C in one range. 3½-digit presentation to +150°C. Accuracy (+5°C to +40°C ambient) is ±1°C from −55°C to +125°C, ±2°C above +125°C. Accuracy (0°C to +50°C ambient) is ±2°C from −55°C to +125°C, ±3°C above +125°C.

Settling Time— 1.5 s or less (voltage, current, and resistance modes).

Polarity—Automatic indication.

Maximum Common-Mode Voltage— 1.5 kV peak between two terminals and ground.

Normal-Mode Rejection Ratio—At least 30 dB at 60 Hz increasing at 20 dB/decade.

Common-Mode Rejection Ratio—With a 1-kΩ imbalance it is at least 100 dB at dc; 80 dB at 60 Hz.

Overrange Indication—When overrange occurs, the readout goes into a "blinking" mode with the most significant digit displaying a 2.

Recycle Time— 5 measurements per second.

Temperature Out— 10 mV/°C into a load of at least 2 kΩ.

Included Accessories—P6058 Voltage/Temperature probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 Digital Multimeter **$570**

7D13 OPTION

Order Option 2 without P6058 Probe ..... **Sub $75**

P6058 PROBE

The P6058 Probe is a combination 1X dc voltage and temperature measuring device. The temperature-sensing element consists of a transistor installed in the nose tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and a five inch "common" (low) strap is provided, and is attached by threading into a hole in the side of the probe body. There is no external ground on the P6058 body; "ground" or the low-potential point of the circuit under test is obtained via the common strap or connector, which is a floating common that has no tie to chassis ground. This lead may be floated at up to 500 Vdc away from chassis ground. The retractable hook-tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

Dc Voltage Range— 0 to 1000 V. Accuracy is ±0.1% of reading ±1 count.

Maximum Safe Input— 500 V peak between either voltage contact and chassis ground. 40 V peak between voltage contacts.

Temperature Range—See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable— 46 inches including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight—Approximately 5 ounces.

P6058 Voltage/Temperature Probe. Order 010-0260-00 ... **$75**
Includes: P6058 Probe (010-0259-00): probe retractable hook tip (013-0121-00); 12-inch ground lead screw-in (175-0991-00); two miniature alligator clips (344-0046-00).

Frequency Measurements Directly to 525 MHz

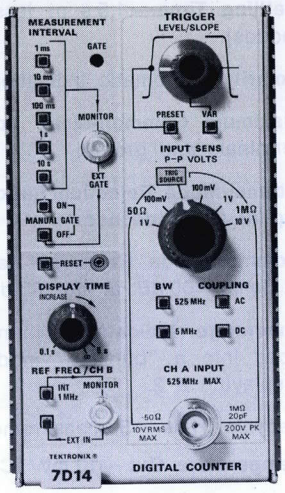
Trigger Indicator Display

No-Warm-Up Oscillator

50-Ω and 1-MΩ Inputs

10 μV Sensitivity at 1 MHz with 7A22

Full Signal Conditioning to 525 MHz



The 7D14 is a directly gated digital counter plug-in unit designed for use in all 7000-Series Oscilloscope mainframes except those without CRT READOUT. It will function in any plug-in compartment. The 7D14 has three modes of operation: Frequency—0 to 525 MHz, Frequency Ratio (A/B)—0 to 10^5:1, and Totalize—0 to 10^8.

The 7D14 counts directly to 525 MHz. The gated approach makes possible "single event" counting which is frequently very desirable in rapid burst measurements. The resolution and accuracy can be improved by increasing the measurement interval.

Measurements which were previously impossible can now be made with an oscilloscope having a digital counter plug-in. By locating the counter in one of the vertical compartments of the oscilloscope and operating the scope in the delaying time-base mode, the B sweep (delayed sweep) can drive the counter gate. By doing this, signals can be displayed on the screen with the ones being counted intensified.

With the 7D14 in a vertical compartment, the output of its trigger circuit can be displayed directly on the crt. This provides an indication of the actual triggering point, thus, many signals that were difficult to trigger on in the past can now be measured with much greater reliability. Not only is general-purpose triggering made easier, selective triggering is now possible.

When the 7D14 is used in a horizontal plug-in compartment, a signal connected to a vertical plug-in can be internally routed to it by the trigger source switches. All the 7000-Series vertical plug-ins are available as signal conditioners for the counter. Another advantage is the reduction of circuit loading. One connection to the oscilloscope deflects the vertical and provides the input for the counter.

FREQUENCY MEASUREMENTS

Input—Channel A, 0 to 525 MHz. Upper bandwidth can be restricted to 5 MHz to filter incoming high frequency noise.

Measurement Interval (Time Base)—1 ms to 10 s in five decade steps. Up to 0.1 Hz resolution can be obtained.

Accuracy—Within $\pm \frac{1}{\text{total count}} \pm$ time base.

Time Base Stability—Within ±0.00005%, 0°C to +50°C ambient temperature.

Long Term Drift—1 part or less in 10^7/month.

Input Characteristics

	CHANNEL A		CHANNEL B	INTERNAL TRIGGER SOURCE
	50 Ω	1 MΩ		
Dc Coupled	Dc to 525 MHz	Dc to 525 MHz	Ac Coupling only	Ac Coupling only
Ac Coupled	200 kHz to 525 MHz	5 Hz to 525 MHz	10 Hz to 2 MHz	5 Hz to 525 MHz*
Sensitivity	100 mV p-p (35 mV rms)	100 mV p-p (35 mV rms)	800 mV p-p	1.5 graticule div*
Input R & C	50 Ω	1 MΩ ≈20 pF	10 kΩ ≈30 pF	Depends on amplifier plug-in used
Max Voltage	10 V rms	200 V (Dc + peak ac) to 5 MHz 50 V (Dc + peak ac) 5 MHz to 525 MHz	15 V (Dc + peak ac) to 2 MHz	Depends on amplifier plug-in used

*Bandwidth and sensitivity limited by mainframe, sensitivity derated above 150 MHz.

FREQUENCY RATIO

Range—Channel A: 0 to 525 MHz.
Channel B: 10 Hz to 2 MHz.

TOTALIZE

Range—0 to 10^8.

Gating—Manual or with an electrical gate. The external gate input is compatible with the Sweep Gate from the oscilloscope mainframe. Reset and external gate signals compatible with TTL logic.

MONITORS

Monitor/Ext Gate—Provides crystal-based time markers of +5 V, the width is determined by the measurement interval.

REF FREQ/CH B Monitor—Provides a crystal-based, 1-MHz, +5 V output pulse. This connector functions as CH B input in the EXT IN mode.

READOUT

Display—8 digits with leading zero suppression, positioned decimal, MHz or kHz legend.

Display Time—0.1 to 5 s, also a preset position for infinite display time.

TRIGGERING

Level/Slope Range—+ and −0.5 V with INPUT at 100 mV.

Displayed Trigger Indicator—Displayed amplitude of Schmitt trigger output is approximately 0.2 div.

Included Accessories—BSM male to BNC female adapter (103-0036-00).

Order 7D14 Digital Counter **$1400**

Oscilloscope Controlled Time and Frequency Measurements

10 ns "Single Shot" Time Interval Measurement Resolution

Time Interval Averaging

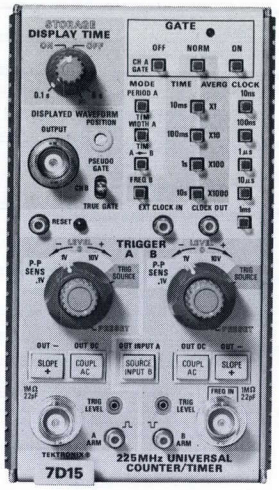
Crt Display of Counting Interval and Schmitt Trigger Signal

10 Picosecond Period Averaging Resolution

Signal Conditioning Via Mainframe Trigger Source

Frequency Measurements Directly to 225 MHz

Accurate "Time Mark" Outputs



The 7D15 is a Universal Counter/Timer Plug-In unit designed for use in all 7000-Series Oscilloscope mainframes except those without CRT READOUT.

The 7D15 offers all of the measurement capabilities known to the Counter/Timer world such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

The performance of the 7D15 is further enhanced by its ability to display the count interval or the output of the Channel B Schmitt trigger shaper on the crt. By utilizing the 7000-Series mainframe Vertical Mode switching, these outputs from the 7D15 can be displayed simultaneously with the actual signal being measured. The Pseudo Gate, which is a high rep-rate replica of the actual gate (True Gate), is independent of the Display Time control and therefore a more useful display. Three displays, the Pseudo Gate, Ch B Schmitt Trigger Output and True Gate are obtainable from a 7D15 front panel switch and are also available at a front panel connector.

Another 7D15 feature useful in complex timing or burst related measurements is its ability to be completely controlled by the oscilloscope's delayed or B Gate. "Arming" inputs are provided for each channel. By using the delayed B Gate to control the start and stop count points, "visually selective" measurements can be made at any desired point on the crt display. See Fig. 1.

Two identical high speed trigger circuits provide complete signal processing. Identical trigger circuits also allow "single shot" time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

The high resolution capabilities of the 7D15 are made possible by a 10-ns clock, one of five clock positions obtainable from the front panel. A front panel Clock Out connector makes the selected clock signal available at a front panel connector. This provides a "time mark" function that is TTL compatible, 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 is compatible in vertical or horizontal compartments of 7000-Series mainframes. It provides a full 8 digit crt display with leading zero suppression, and positioned decimal. Legend and averaging information appear at the bottom of the crt display.

The measurement versatility, high degree of accuracy and resolution, that the 7D15 introduces to the 7000-Series Oscilloscopes, will contribute significantly to the higher performance measurement of today's expanding technologies.

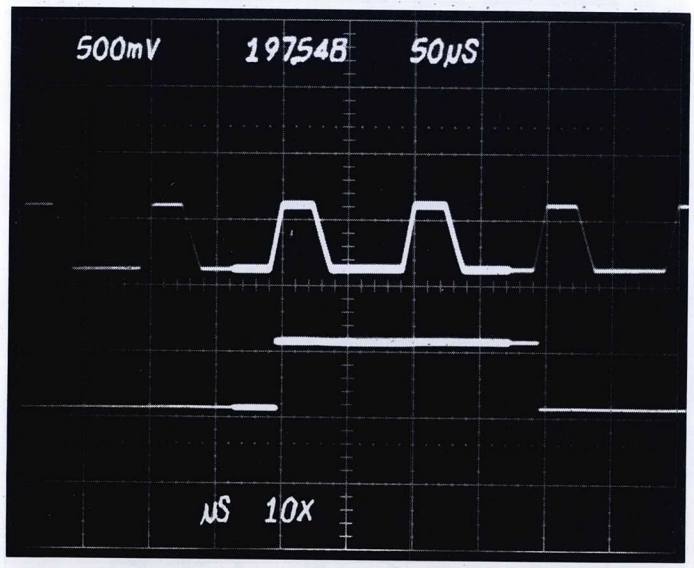


Fig 1: Oscilloscope controlled digital measurements using the delayed B Gate as the arming input logic allows user to make precise time measurement from third to fifth pulse on crt display. Counter Ch A is "armed" with leading edge of B Gate while Ch B Counter is "armed" with falling edge of B Gate. Lower trace is Pseudo Gate of 7D15. CRT READOUT displays the result of 197.548 µs.

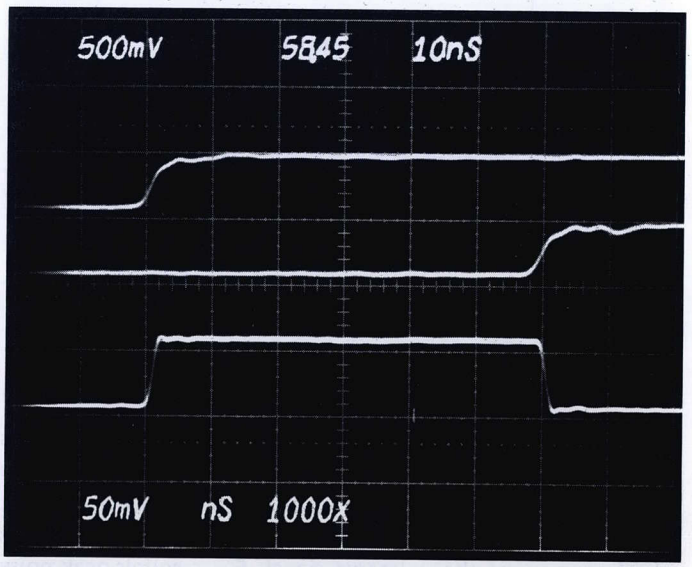


Fig 2: The delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 Pseudo Gate display. CRT READOUT displays the result of 58.45 ns.

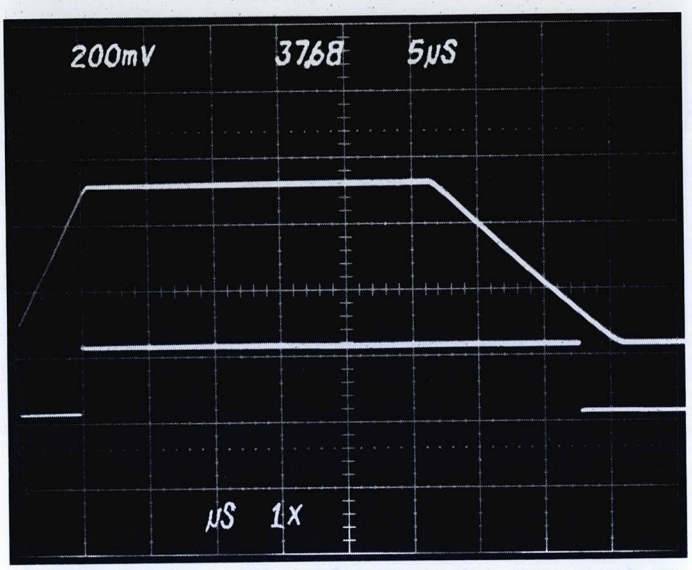
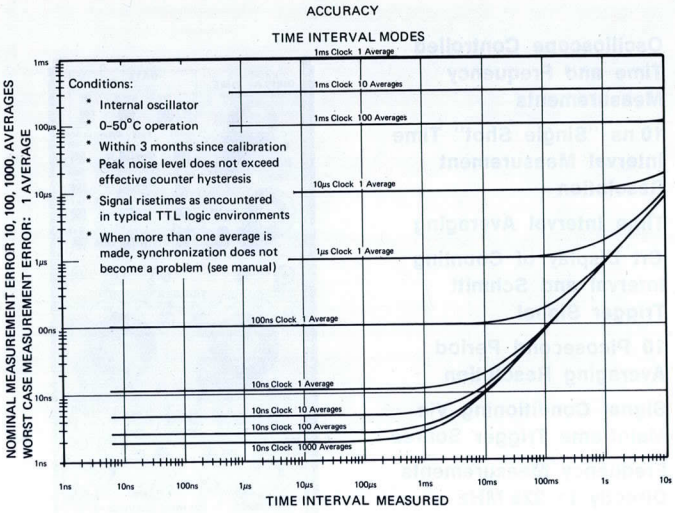
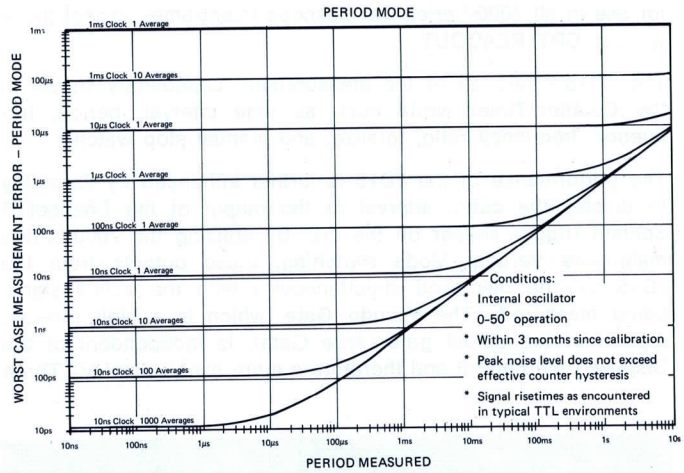


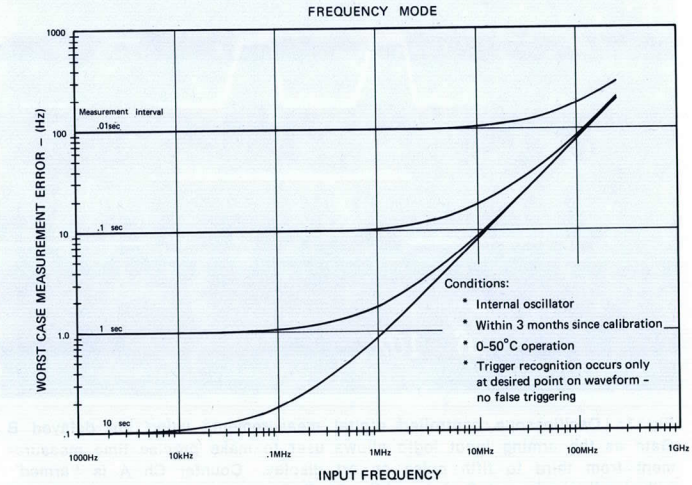
Fig 3: Independent Slope and Level control allows the user to select precise points on the waveform where the counter starts and stops. CRT READOUT displays the result of 37.68 μs.

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/second).







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. Osciilator is temperature compensated, no warm up is required.

OUTPUT SIGNALS

Clock Out—Logical "1" $\geq$ +0.5 V into 50 Ω. Logical "0" $\leq$ 0 V into 50 Ω. TTL compatible without 50 Ω Load (1.6 mA current capacity).

A and B Trigger Level—$Z_{out} \approx 1$ kΩ, $V_{out} = \pm 0.5$ V into 1 MΩ.

Displayed Waveform (internally connected)—Front panel switch selects either: "True Gate," "Pseudo Gate," or "Channel 'B'" signal out. Position: controlled by front panel screwdriver control.

External Display—Located on front panel, same as internal except position control has no effect.

Display Mode Switch—Front panel switch allows selection of readout "follow or store."

Display Time— 0.1 to 5 s, also a preset position for infinite display time.

Readout—Eight digit display, the four most significant have zero suppression. Overflow indicated by ">" arrow.

INPUT SIGNALS CH A & B

Frequency Range (CH B only)—Dc coupled: dc to 225 MHz, ac coupled: 5 Hz to 225 MHz.

Sensitivity—Ch A and B Inputs: 100 mV p-to-p. Trigger Source: 0.5 divisions of vertical deflection.

Input R and C— 1 MΩ and 22 pF.

Triggering—Preset Position: Automatically triggers at 0 volts.

Level Control Range (CH A and B Inputs)— 100 mV Range: ±500 mV; 1 V Range: ±5 Volts; 10 V Range: ±50 Volts.

Arming Inputs—Input R and C: 10 kΩ and 20 pF. Sensitivity Arm "A": Logical "1" $\geq$ +0.5 V, Logical "0" $\leq$ +0.2 V. Sensitivity Arm "B": Logical "1" $\leq$ +0.2 V, Logical '0" $\geq$ +0.5 V.

External Clock In— 20 Hz to 5 MHz.

Reset Front Panel—Reset initiates the instrument, all counters are affected, including averaging circuits.

Included Accessories—Two Cables RF 44" (012-0403-00), Sealectro to BNC connector).

Order 7D15 Univ. Counter Timer **$1475**

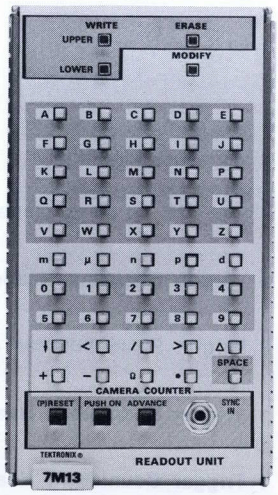
1

7000-Series Oscilloscopes
Readout Unit

7M13

Easy and Convenient Identification of Photographed Displays

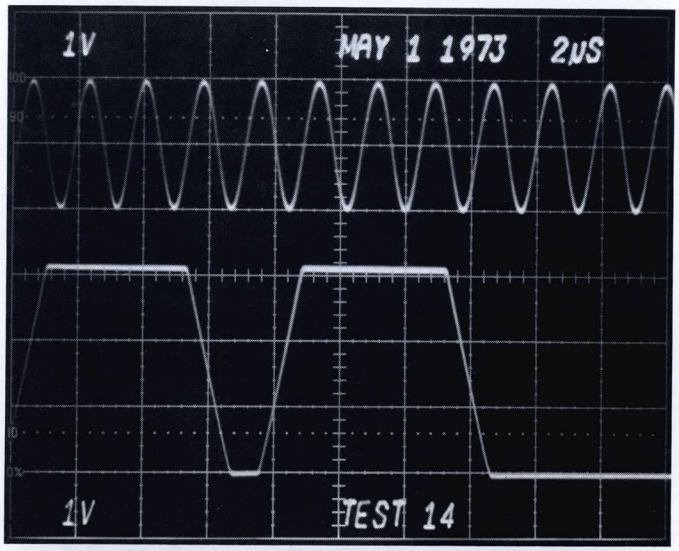
Automatic Sequence Advance with Each Camera Exposure



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 except those without CRT READOUT, and will function in any plug-in compartment. A remote-advance cable is supplied with the 7M13 to provide connection to the shutter x-sync connector of the C-50-Series Cameras. An optional cable is available for cameras using an ASA connector for x-sync.

Included Accessories—Remote-advance cable (012-0339-01).

Order 7M13 Readout Unit **$375**



The photograph above was dated and identified as TEST 14 by using the 7M13 in a 7704A Oscilloscope.

Optional Accessory—Remote-advance cable with ASA connector for camera x-sync, **Order 012-0364-01** **$10.00**

7S11 Sampling and TDR

Single Channel Sampling Unit

2 mV/Div to 200 mV/Div Calibrated Deflection Factors

Plug-In Sampling Heads

The 7S11 is a single-channel sampling unit for use in all 7000-Series mainframes. The input configuration employs the sampling "Plug-In Head" concept for maximum application range. The heads, which mount in the 7S11, cover a bandwidth from 350 MHz to 14 GHz. (See sampling head descriptions.)

The 7S11 can be used in a variety of combinations. Single channel sampling would use one 7S11, with a 7T11 Time Base. Two 7S11's and one 7T11 would provide dual-trace sampling. One 7S11 and one 7S12 provides dual-trace sampling. Two 7S11's can be used for X-Y operations.

An INTERNAL TRIGGER path is provided from the Plug-In Head (except for the S-3A) to the 7T11 Time Base when the INT TRIG mode is selected. When operating in dual-trace mode, either vertical channel may be used as the trigger source.

The 7S11 deflection factor is from 2 mV/div to 200 mV/div with a continuous VARIABLE control. The DOT RESPONSE control optimizes dot transient response in the NORMAL mode. The SMOOTH position reduces display noise at the more sensitive deflection factor settings.

The ±1 V DC OFFSET can be used as a vertical position control to view any segment of a signal within its range at any sensitivity, even when portions of the trace are off screen. The DC OFFSET voltage is available at the OFFSET OUT jack (X10) for external monitoring.

CHARACTERISTICS

Deflection Factor— 2 units/div to 200 units/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated VARIABLE is continuous (extends deflection factor from 1 unit/div or less to at least 400 units/div). Deflection factor (i.e., mV/div) is determined by the plug-in sampling head.

Bandwidth—Determined by the sampling head.

Input Impedance—Determined by the sampling head.

Dc Offset—Range, +1 V to −1 V or more. Offset Out is X10 the offset voltage within 2%. Source R 10 kΩ within 1%.

Delay Range—At least 10 ns (helps compare two signals in a dual-trace application).

Memory Slash— 0.1 div or less at 20 Hz.

Vertical Signal Out— 200 mV per displayed div within 3%.

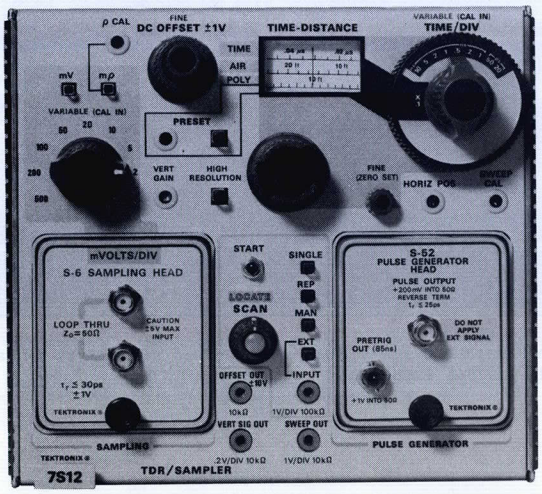
Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0°C to +50°C.

Weights		
Net weight	2 lb	0.9 kg
Shipping weight	≈6 lb	≈2.7 kg

Order 7S11 Sampling Unit without sampling head $595

7S12 Sampling and TDR

TDR and General Purpose Sampler



45-ps TDR or 30-ps General Purpose Sampler

6 Plug-In Sampling Heads Available

3 Plug-In Pulse Sources Available

1 Trigger Recognizer Head Available

1 Trigger Countdown Head Available

The 7S12 is a combined vertical-horizontal, double-width plug-in unit, designed to operate in all 7000-Series mainframes. It permits high-resolution TDR or general-purpose sampling measurements. As a TDR, using the S-6 Sampling Head and S-52 Pulse Generator Head, the 7S12 has a system risetime of 45 ps (return from short-circuit termination) and distance range to 290

ft in any cable. Its vertical scale is calibrated in reflection coefficient (ρ) from 2 mρ/div to 500 mρ/div and in voltage from 2 mV/div to 500 mV/div. Two-way time or one-way distance to a discontinuity of interest is read directly from tape dial calibrated for time, air polyethylene or your choice of dielectrics. As a long line TDR, using the S-5 Sampling Head and S-54 Pulse Generator Head, distance calibration extends to 4900 ft (airline) and discontinuities to twice this distance may be viewed. System risetime with this combination is 1.5 ns.

General-purpose measurements may be made by using an S-1, S-2, S-3A, S-4, S-5 or S-6 Sampling Head with an S-53 Trigger Recognizer Head or S-51 Trigger Countdown Head. For dual-trace sampling displays, use a 7S11 Sampling Unit with a 7S12. The addition of a 7M11 Dual Delay Line provides the signal delay necessary to view the triggering event when a pretrigger signal is not available. Very fast triggering events will not be displayed at 20 ns/div or slower.

CHARACTERISTICS

SYSTEM PERFORMANCE WITH S-6 AND S-52

System Risetime— 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distance to at least 400 ft (airline). Time range is at least .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 Risetime— 1.5 ns or less, for the displayed reflection from a short-circuited test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distances to 4900 ft (airline, 3240 ft solid 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 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated variable is continuous between steps.

Resolution—Reflection coefficients as low as 0.001 can be observed. Signal averaging reduces test-line noise in display.

Dc Offset Range— +1 V to —1 V. Allows open-circuit reflections to be displayed at full sensitivity. Monitor jack provides X10 actual dc offset through 10 kΩ.

Time/Distance—Tape dial is calibrated in time and distance: full-scale ranges of 4900 ft, 490 ft, 49 ft (air dielectric); 3200 ft, 320 ft, 32 ft (polyethylene dielectric); and 10 μs, 1 μs, 0.1 μs (time). Accurate within 1%. Distance calibration may be preset for dielectrics having propagation factors from 0.6 to 1.0.

Time/Div— 20 ps/div to 1 μs/div (1-2-5 sequence) in three ranges with direct-reading magnifier. Accurate within 3%. Uncalibrated variable is continuous between steps.

Locate Button—Provides instant return to unmagnified display showing entire full-scale range. Brightened portion of trace indicates time position and duration of magnified display.

Display Modes—Repetitive or single sweep, manual or external scan.

Signal Outputs—Pin jacks provide both vertical signal and sweep outputs.

Weights

Net weight	≈5 lb	2.1 kg
Shipping weight	≈12 lb	≈5.4 kg

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR slide rule (003-0700-00).

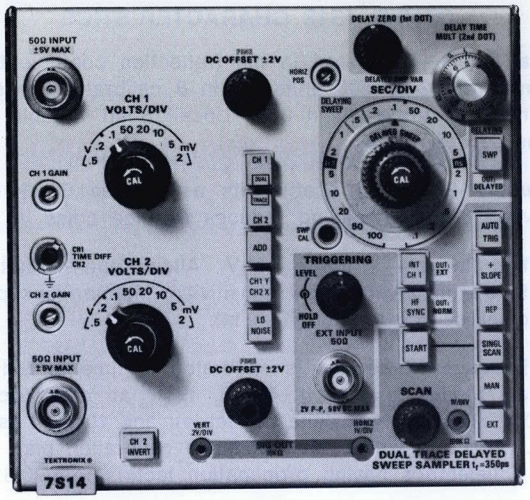
Order 7S12 TDR Sampling Unit (tape dial in feet) without sampling heads **$1280**

Order Option 3 Tape Dial Change (meters) ..... **No Charge**

OPTIONAL ACCESSORIES

Patch Cords—are available for the OFFSET OUT, EXT SWEEP INPUT, VERT SIG OUT and SWEEP OUT jacks of the 7S12. Pin-jack to pin-jack, 0.08 inch dia pin.

Red, 8 inch, Order 012-0179-00 ..... **$2.50**
Red, 18 inch, Order 012-0180-00 ..... **$2.50**
Black, 8 inch, Order 012-0181-00 ..... **$2.50**
Black, 18 inch, Order 012-0182-00 ..... **$2.50**
Tape Dial—calibrated in feet, **Order 331-0273-00** **$9.00**
Tape Dial—calibrated in meters, **Order 331-0276-00** **$9.00**



Calibrated Delayed Sweep

Two-Dot Time Measurements

Dc-to-1 GHz Bandwidth

Dual Trace, 2-mV Sensitivity

Crt Readout

Simplified Triggering

Operational Ease of a Conventional Oscilloscope

The 7S14 Sampling Unit combines vertical and time-base functions in one double-width plug-in unit designed to operate in all 7000-Series mainframes. Combining the Sampling vertical and time-base functions in one plug-in enables the 7S14 to provide new economy and ease of operation.

Two identical vertical channels provide dual-trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A new and unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next, a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time interval between the selected points is then determined by multiplying the number read directly from the Delay Time Mult Dial by the selected time per division.

Front-panel control grouping is identified by different shades of color on the panel and the control nomenclature relates closely to that encountered in conventional oscilloscopes. Learning to operate the 7S14 requires a minimum effort for those familiar with conventional oscilloscope operation.

VERTICAL CHANNEL CHARACTERISTICS

Modes—Channel 1 only; Channel 2 only; Dual Trace; Channel 1 added to Channel 2; Channel 2 subtracted from Channel 1 (CH 2 INVERT); Channel 1 vertical (Y), Channel 2 horizontal (X).

Input Impedance—Nominally 50 Ω.

Bandwidth—Equivalent to dc-to-1 GHz.

Risetime— 350 ps or less.

Step Aberrations— +2%, —4%, total of 6% p-p within first 5 ns, ±1% thereafter, tested with a 284 Pulse Generator.

Deflection Factor— 2 mV/div to .5 V/div in 8 calibrated steps (1, 2, 5 sequence). Continuously variable between steps by at least 2.5 to 1.

Accuracy—Within ±3%.

Maximum Input Voltage— ±5 V.

Input Signal Range— 2 V p-p maximum within a +2 V to —2 V window at any sensitivity.

Dc Offset Range—At least +2 V to —2 V.

Displayed Noise— 2 mV or less unsmoothed (Tangentially measured). Low noise pushbutton reduces random noise by factor of 4 to 1 or more.

Vertical Signal Output— 0.2 V/div of vertical deflection; 10-kΩ source resistance.

Channel Delay Difference—Adjustable to zero, or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

Scan Modes—Repetitive, Single, Manual or External.

Delaying Sweep—May be used as the crt time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep—This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the Delaying Sweep selected.

Horizontal Signal Output— 1.0 V per div of horizontal deflection; 10-kΩ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range— 10 ns/div to 100 μs/div in 13 steps (1, 2, 5 sequence).

Accuracy—Within ±3%, excluding first ½ division of displayed sweep.

Delayed Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the Delaying Sweep selected.

Delay Time (2nd Dot)—Adjustable to any portion of the time interval represented by ten divisions of the Delaying Sweep selected.

Delay Accuracy—Within ±1% of ten divisions when measurement is made within the last 9.5 divisions.

DELAYED SWEEP CHARACTERISTICS

Range— 100 ps/div to 100 μs/div in 19 calibrated steps (1, 2, 5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy—Within ±3% excluding first ½ division of displayed sweep.

Start Delay—Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by ten divisions of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

Delay Jitter—Less than 0.05% of the time represented by one division of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Sources—Internal from Channel 1 vertical input or external through front-panel connector.

External Triggering—Nominal 50-Ω input, ac coupled, 2 V p-p 50-V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less. 10 Hz to 100-MHz. Sinewave amplitude 10 mV p-p or more from 150-kHz to 100-MHz.

Internal Triggering—Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150-kHz to 100-MHz.

Triggered Mode—Trigger recognition may be made to occur at any selected voltage level between +.5 V and —.5 V on either a + slope or a — slope of the triggering signal.

Auto Trigger Mode—For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the peak-to-peak voltage of the signal.

Holdoff—Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode—For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

Order 7S14 Dual Trace Delayed Sweep Sampler **$1950**

A similar instrument is also available for the 5000-Series, see Page 135.

Sampling and TDR
Sampling Sweep Unit

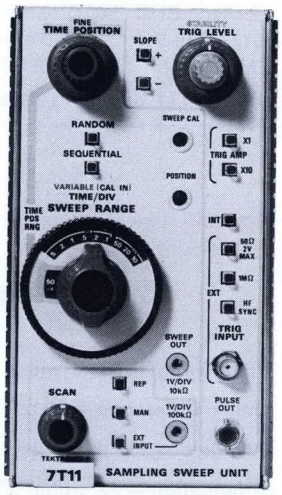
7T11

10 ps/Div to 5 ms/Div Calibrated Time Base

Random or Sequential Sampling

Equivalent or Real-Time Sampling

No Pretrigger Required



The 7T11 SAMPLING TIME BASE provides equivalent-time and real-time horizontal deflection for single or dual-trace sampling in all 7000-Series Oscilloscopes. The TIME/DIV range is calibrated from 10 ps/div to 5 ms/div, selectable with the concentric TIME POSITION RANGE, TIME/DIV and VARIABLE control. Timing accuracy is within 3% (see characteristics) and nonlinearity is well below 1%, making specification unnecessary. Triggering range is from ≃ 10 Hz (sequential mode) to above 12.4 GHz. The following describes the modes of operation.

RANDOM SAMPLING—In this mode the triggering event may be displayed without the need of a pretrigger or signal delay line. The sampling process is controlled automatically by circuits which allow samples to be taken before, during, and after the signal event of interest. The horizontal coordinate of each sample is then determined by a measurement of the time between the instant of sampling and the occurrence of a trigger. The random-sampling mode is most useful for displaying repetitive signals above 1 kHz.

SEQUENTIAL SAMPLING—When the signal repetition rate is between 10 Hz and 1 kHz, the most useful display is obtained in the sequential-sampling mode. In this mode, the sampling process is initiated by the trigger signal. As a result, either a pretrigger or signal delay line (such as the 7M11) is required to display the triggering event. Very fast triggering events will not be displayed at 100 ns/div or slower. For measurements which do not require display of the trigger-event (i.e., sinewaves) a pretrigger is not necessary and the decision to use random or sequential mode is based on repetition rate.

REAL-TIME SAMPLING—To provide a wide measurement range, the 7T11 automatically crosses from equivalent-time to real-time sampling for the three longest Time Position Ranges (50 ms, 5 ms, 0.5 ms). In this mode, sampling occurs at a free-running (50 kHz) rate with the horizontal coordinate determined in a manner similar to that described above for Random Sampling. Lead-time is fixed at about 3 μs for this mode but time-positioning is available as in equivalent-time sampling.

TIME-POSITION RANGE—Control selects the time window from 50 ms to 50 ns in 7 steps. The TIME/DIV controls can then select all or a portion of the time window for display. Each RANGE has 9 TIME/DIV steps (1-2-5 sequence) associated with it. The displayed portion of the time window is selectable with the TIME POSITION control.

TRIGGERING CONSIDERATIONS—The unit is capable of triggering on signals in the useful sampling range from 10 Hz to above 12.4 GHz. The EXT mode has 50 Ω, 1 MΩ, and HF SYNC positions, each with its special application advantage. The 50 Ω input complements sources requiring termination and provides an optimized signal path to the dc coupled trigger recognition circuit; operation extends to 1 GHz. The 1 MΩ input inserts a X1 FET amplifier in the 50 Ω path for minimum loading of the signal source at frequencies under 100 MHz. The HF SYNC position operates from 1 GHz to above 12.4 GHz as a trigger countdown device. An INT trigger source from the 7S11 is provided (except with the S-3A plug-in head) for frequencies up to 500 MHz.

CHARACTERISTICS

Time/Div Range— 10 ps/div to 5 ms/div (1-2-5 sequence) directly related to TIME POSITION RANGES. Uncalibrated VARIABLE is continuous between steps and to at least 4 ps/div.

Time Position Range—Equivalent time is 50 ns to 50 μs in 4 steps, real time is 0.5 ms to 50 ms in 3 steps.

Time/Div Accuracy—Within 3% for all TIME/DIV settings over center 8 cm.

TRIGGERING

Ext 50 Ω Input—Frequency range is dc to 1 GHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V p-p (dc to 1 GHz) in X1 TRIG AMP, 0.5 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 50 Ω within 10%. Max input voltage is 2 V (dc + peak ac).

Ext 1 MΩ Input—Frequency range is dc to 100 MHz in X1 TRIG AMP mode. Sensitivity range is 5 mV to 2 V p-p (dc to 100 MHz) in X1 TRIG AMP, 0.5 mV to 2 V p-p (1 kHz to 50 MHz) in X10 TRIG AMP. Input R is 1 MΩ within 5%. Max input voltage is 100 V p-p to 1 kHz, derating 6 dB/ octave to a minimum 5 V p-p.

Ext HF Sync—Frequency range is 1 GHz to 12.4 GHz. Sensitivity range is 10 mV to 500 mV p-p. Input R is 1 MΩ. Max input voltage is 2 V p-p.

Int Trigger Source (Sinewave Triggering)*—Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 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 minimum.

Display Jitter—Measured under optimum trigger conditions TIME/DIV switch cw.

*NOTE: Trigger circuits will operate to dc with pulse triggering, except for HF Sync.

Time Pos Rng	Sequential Mode	Random Mode
50 μs to 500 ns	0.4 div 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 risetime or less.

Trigger Kickout— 2 mV or less into 50 Ω (except HF SYNC).

Display Scan Rate—Continuously selectable from at least 40 sweeps/sec to less than 2 sweeps/sec.

External Scan—Deflection factor is continuously variable from 1 V/div to 10 V/div. Input R is 100 kΩ within 10%. Max input voltage is 100 V (dc + peak ac).

Sweep Out— 1 V/div within 2%, source R is 10 kΩ within 1%.

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

Weights

Net weight	2.8 lb	1.3 kg
Shipping weight	≈ 7 lb	≈3.2 kg

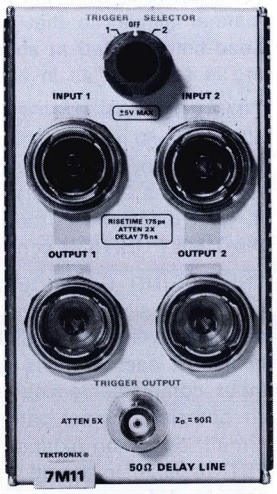
INCLUDED ACCESSORIES

42-inch BNC 50 Ω cable (012-0057-01); 10X, 50 Ω attenuator (011-0059-01); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874 adapter (015-1007-00).

Order 7T11 Sampling Sweep Unit **$1725**

7M11 Sampling and TDR

Dual Delay Line



75 ns Time Delay

Selectable Trigger Out

175 ps Risetime

The 7M11 is a passive dual DELAY LINE unit for use with the 7000-Series sampling system. In low-repetition rate applications, requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event at the faster time per division settings. Very fast triggering events will not be displayed at the slower time per division settings of most sampling sweep units.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50-Ω, 75-ns delay lines. The closely matched (30 ps) lines have GR874 INPUT-OUTPUT connectors, 175-ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

1

CHARACTERISTICS

DELAY LINE

Time Delay— 75 ns within 1 ns.

Delay Difference— 30 ps or less between channels.

Risetime— 175 ps or less.

Attenuation— 2X within 2% into 50 Ω.

Input Impedance— 50 Ω within 2%.

Maximum Input Voltage— ±5 V rms, 50 V peak.

TRIGGER OUTPUT

Risetime—600 ps or less.

Attenuation— 5X within 10% into 50 Ω (referred to INPUT).

Output Impedance— 50 Ω within 10%.

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

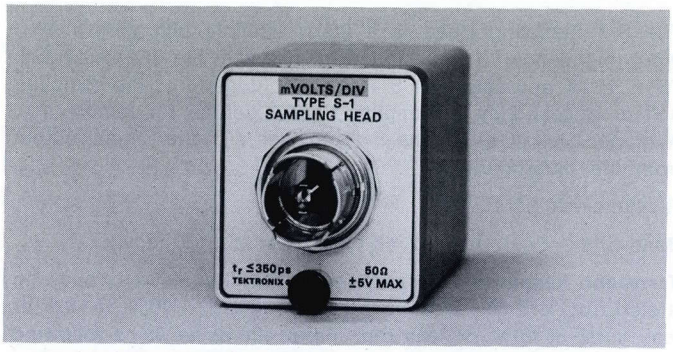
Weights

Net weight	5.8 lb	2.6 kg
Shipping weight	≈9 lb	≈4.1 kg

INCLUDED ACCESSORIES

10-inch BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00).

Order 7M11 Delay Line Unit **$370**



Clean Transient Response

The S-1 Sampling Head is a low-noise, 350-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

Risetime— 350 ps or less.

Bandwidth—Equivalent to dc to 1 GHz at 3-dB down.

Transient Response—Aberrations as observed with the 284 Pulse Generator are +0.5%, —3% or less, total of 3.5% or less p-p, first 5 ns following the step transition; +0.5%, —5% or less, total of 1% or less p-p after 5 ns.

Displayed Noise— 2 mV or less, unsmoothed; 1 mV, smoothed.

Signal Range—Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

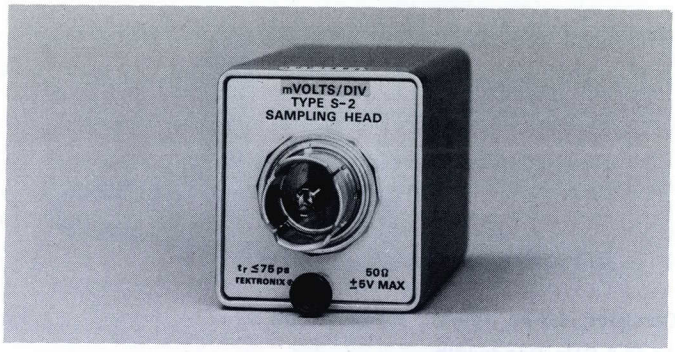
Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights

Net weight	≈1 lb	≈0.5 kg
Shipping weight	≈3 lb	≈1.4 kg

Included Accessories— 5-ns, 50-Ω RG58 A/U cable (017-0512-00); 10X, 50-Ω GR attenuator (017-0078-00).

Order S-1 Sampling Head **$400**



Displayed Noise Less than 6 mV (unsmoothed)

The S-2 Sampling Head is a 75-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-2 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-2 provides a trigger signal output from the plug-in unit.

Risetime—75 ps or less.

Bandwidth—Equivalent to dc to 4.6 GHz at 3-dB down.

Transient Response—Aberrations as observed with the 284 Pulse Generator are +5%, —5% or less, total of 10% or less p-p, first 2.5 ns following a step transition; +2%, —2% or less, total of 4% or less p-p after 2.5 ns.

Displayed Noise 6 mV or less, unsmoothed; 3 mV, smoothed.

Signal Range—Variable dc offset allows signals between +1 V and —1 V limits to be displayed at 2 mV/div. Signals between +2 V and —2 V limits may be displayed at 200 mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 200 mV p-p.

Input Characteristics—Nominally 50 Ω. Safe overload is ±5 V. GR874 input connectors.

Weights

Net weight	≈1 lb	≈0.5 kg
Shipping weight	≈3 lb	≈1.4 kg

Included Accessories— 5 ns, 50 Ω RG213/U cable (017-0502-00); 10X, 50-Ω GR attenuator (017-0078-00).

Order S-2 Sampling Head **$450**

OPTIONAL ACCESSORIES

P6040/CT-1 Current Probe, order (Std) 015-0041-00 ..... **$60**
CT-3 Signal Pickoff, order (Std) 017-0061-00 ..... **$50**
P6056 10X Passive Probe, order (Std) 010-6056-03 ..... **$55**
P6057 100X Passive Probe, order (Std) 010-6057-03 ..... **$55**

Coupling Capacitor, GR874-K, order 017-0028-00 ..... **$ 23**
Power Divider GR874-TPD, order 017-0082-00 ..... **$121**
VP-1 Voltage Pickoff "T", order 017-0073-01 ..... **$ 38**
GR to BNC Adapter, order 017-0063-00 ..... **$ 10**

Compact, 4.5-Ft, 100-kΩ, 2.3-pF Probe

Dc-to-1 GHz Bandwidth

Displayed Noise Less than 3 mV (unsmoothed)

The S-3A Sampling Head is an active sampling-probe unit with 100-kΩ, 2.3-pF input impedance. Up to 2 volts of dc offset may be used while maintaining a 2-mV/div deflection factor. The S-3A can be plugged in or attached by an optional extender for remote use with 7S11, 7S12, 3S2, 3S5, 3S6 and the 286.

Risetime—350 ps or less.

Bandwidth—Probe only is equivalent to dc-to-1 GHz at 3-dB down.

Transient Response (Probe Only)—Aberrations in the first 2 ns following a step are +8%, −2% or less, total of 10% or less p-p, +1%, −1% or less, total of 2% or less p-p after 2 ns, with 284 pulse displayed.

Displayed Noise (Probe Only)—3 mV or less referred to probe tip (includes 90% of dots).

Signal Range—Variable dc offset allows signals between +1 V and −1 V, X1 range; or +2 V and −2 V, X2 range to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the use of the probe attenuators.

Weights

Net weight	3 lb	1.4 kg
Shipping weight	≈5 lb	≈2.3 kg

Included Accessories— 10X attenuator head (010-0364-00); 100X attenuator head (010-0365-01); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); 5½-inch ground lead (175-1017-00); 12½-inch ground lead (175-1018-00); 3-inch cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50-Ω voltage pickoff (017-0077-01); carrying case (016-0121-01); 3-inch elec lead (175-0849-00); 6-inch elec lead (175-0849-01).

Order S-3A Sampling Head **$600**

25-ps Sampling Head

Dc-to-14 GHz Equivalent Bandwidth

Displayed Noise Less than 5 mV (unsmoothed)

The S-4 Sampling Head is a 25-ps risetime unit with a 50-Ω input impedance. It is designed for use with the 3S2, 3S5, 3S6, 7S11, 7S12, and 286. The S-4 can be plugged into the sampling unit or attached by a Sampling-Head extender for remote use. A trigger pickoff within the S-4 provides a trigger signal output from the plug-in unit.

Risetime—25 ps or less.

Bandwidth—Equivalent to dc-to-14 GHz at 3-dB down.

Transient Response—Aberrations in the first 400 ps following a step from a S-50 Pulse Generator Head are: −10%, +10% or less, total of 20% or less p-p. From 400 ps to 25 ns following a step from a 284 Pulse Generator, 0%, +10% or less, total of 10% or less p-p with 284 pulse displayed; after 25 ns, −2%, +2% or less, total of 4% or less p-p.

Displayed Noise— 5 mV or less, unsmoothed; 2.5 mV, smoothed (includes 90% of dots).

Signal Range—Variable dc offset allows signals between +1 V and −1 V limits to be displayed at 2 mV/div. For best dot-transient response with random-sampling sweep unit, signal amplitude should be less than 500 mV p-p.

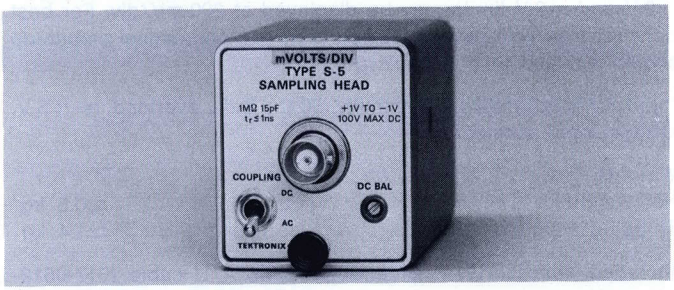
Input Characteristics—Nominally 50 Ω. Safe overload ±5 V. SMA (3-mm) input connector.

Weights

Net weight	≈1 lb	≈0.2 kg
Shipping weight	≈2 lb	≈0.9 kg

Included Accessories— 2-ns cable with SMA connectors (015-1005-00); 10X 50-Ω SMA attenuator (015-1003-00); GR874 to SMA male adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); 5/16-inch wrench (003-0247-00).

Order S-4 Sampling Head **$950**



1-MΩ, 15-pF Input Impedance

Passive Probe

Internal Trigger Pickoff

The S-5 Sampling Head is a low noise, 1-ns risetime sampling unit with a 1-MΩ, 15 pF input impedance. When used with the included P6010 passive probe the input impedance increases to 10 MΩ, 10 pF while maintaining the 1-ns risetime at the probe tip. A switch on the sampling head selects either ac or dc coupling of the input.

The S-5 Sampling Head is designed for use with the 7S11, 7S12, 3S2, 3S5, 3S6 and 286 and can be plugged in or attached by an optional Sampling-Head extender for remote use.

Risetime—S-5 only, 1 ns or less; with 3.5 foot 6010, 1 ns or less.

Bandwidth—Equivalent to dc-to-350 MHz at 3-dB down at input connector or probe tip.

Transient Response—S-5 only (driven with a 50-Ω source terminated in 50 Ω): aberrations +2.5%, −5% or less, total of 7.5% or less p-p within 17 ns after step +1%, −1% or less, total of 2% or less p-p thereafter.

S-5/P6010 (3.5-foot probe property 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 is 1 MΩ within 1% paralleled by 15 pF within 1 pF. S-5/P6010 is 10 MΩ paralleled by approx 10 pF.

Attenuation Accuracy—Probe attenuation is 10X within 3%.

Weights

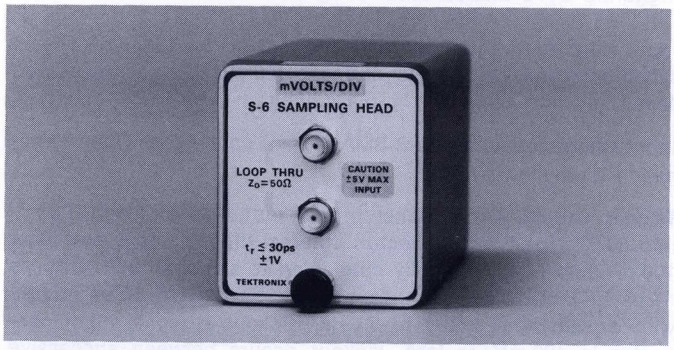
Net weight	≈9 oz	≈0.2 kg
Shipping weight	≈2 lb	≈0.9 kg

Included Accessories—P6010 probe package (010-0188-00), 50 Ω termination (011-0049-01).

Order S-5 Sampling Head **$400**

OPTIONAL ACCESSORIES

Probe tip-to-BNC adapter, order 013-0084-01 ..... **$ 5.85**
Probe tip-to-GR adapter, order 017-0076-00 ..... **$14.00**
Probe tip-to-GR terminated adapter, order 017-0088-00 .. **$27.50**



30 ps Risetime

Displayed Noise Less than 5 mV (Unsmoothed)

Loop-Through Input

The S-6 Sampling Head is a 50-Ω feed-through unit for high-speed applications in the 7S11, 3S2, 3S5, 3S6 or 286, and TDR applications in the 7S12 Time Domain Reflectometer.

Risetime— 30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

Bandwidth—Equivalent to dc to 11.5 GHz at 3-dB down.

Transient Response—Pulse aberrations following the step are: +7%, —7% total of 10% p-p within 1.8 ns of step with reference point at 1.8 ns from step; +2%, —2% total of 4% p-p after first 2.5 ns with reference point at 300 ns from step.

Display Noise— 5 mV or less, measured tangentially.

Signal Range— +1 V to —1 V (dc plus peak ac). 1 V p-p. Dc offset allows any portion of input signal to be displayed.

Input Characteristics—Nominally 50-Ω, loop-through system, unterminated. SMA (3-mm) connectors. Maximum safe overload is ±5 V.

Weights

Net weight	≈1 lb	≈0.5 kg
Shipping weight	≈2 lb	≈0.9 kg

Included Accessories— 50-Ω termination (015-1022-00); 1 ns, 50-Ω cable (015-1019-00); SMA (3-mm) female-to-female adapter (015-1012-00); SMA male-to-GR874 adapter (015-1007-00); combination wrench (003-0247-00); coaxial termination (015-1020-00).

Order S-6 Sampling Head **$950**

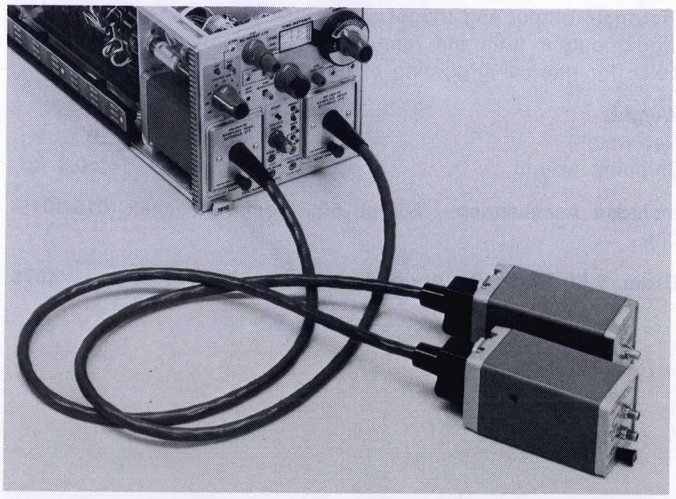
OPTIONAL ACCESSORIES FOR SAMPLING HEADS

With SMA (3 mm) Connectors

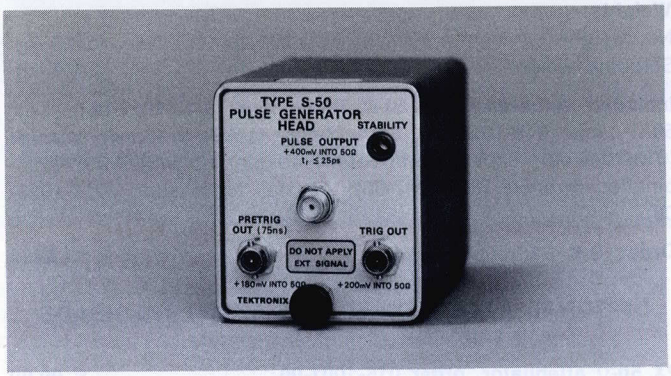
2X 50-Ω attenuator, order 015-1001-00 ..... **$ 90.00**
5X 50-Ω attenuator, order 015-1002-00 ..... **120.00**
10X 50-Ω attenuator, order 015-1003-00 ..... **120.00**
50-Ω termination, order 015-1004-00 ..... **44.00**
2-ns 50-Ω signal cable, order 015-1005-00 ..... **44.00**
5-ns 50-Ω signal cable, order 015-1006-00 ..... **55.00**
Male-to-GR874 adapter, order 015-1007-00 ..... **38.00**
Female-to-GR874 adapter, order 015-1008-00 ..... **30.00**
Male-to-N female adapter, order 015-1009-00 ..... **47.00**
Male-to-7-mm adapter, order 015-1010-00 ..... **130.00**
Male-to-male adapter, order 015-1011-00 ..... **10.00**
Female-to-female adapter, order 015-1012-00 ..... **7.50**
Coupling capacitor, order 015-1013-00 ..... **90.00**
50-Ω power divider T, order 015-1014-00 ..... **130.00**
500-ps 50-Ω semi-rigid cable order 015-1015-00 ..... **26.40**
SMA T adapter, order 015-1016-00 ..... **25.00**
SMA male-to-BNC female adapter, order 015-1018-00 . **5.00**
1-ns 50-Ω cable, order 015-1019-00 ..... **32.00**
SMA male short-circuit termination, order 015-1020-00 . **8.30**
SMA female short-circuit termination, order 015-1021-00 ..... **8.00**
SMA male 50-Ω termination, order 015-1022-00 ..... **32.00**

With BNC Connectors

50-Ω feedthrough termination, order 011-0049-01 ..... **$15.00**
50-Ω feedthrough (5 watt), order 011-0099-00 ..... **21.00**
50-Ω 2X attenuator, order 011-0069-02 ..... **20.00**
50-Ω 2.5X attenuator, order 011-0076-02 ..... **20.00**
50-Ω 5X attenuator, order 011-0060-02 ..... **20.00**
50-Ω 10X attenuator, order 011-0059-02 ..... **20.00**
50-Ω 18-in, coaxial cable, order 012-0076-00 ..... **7.00**
50-Ω, 42-in, coaxial cable, order 012-0057-01 ..... **7.00**



3-ft Sampling-Head extender, order 012-0124-00 ..... **$81.00**
6-ft Sampling-Head extender, order 012-0125-00 ..... **84.00**



25-ps Pulse Risetime

400-mV Into 50 Ω

Pretrigger Out

The S-50 Pulse Generator Head is a high-speed, tunnel-diode step generator designed for use in the 7S11, 7S12, 3S2, 3S5, 3S6, 285, and 286. The S-50 is also used for verification of sampling system risetimes. A pretrigger output allows operation with sequential sampling systems.

Pulse Output—Risetime is 25 ps or less. Amplitude into 50 Ω is at least 400 mV, positive going. Pulse duration is 100 ns, pulse repetition rate is 25 kHz. Pulse aberrations following the step are: −10%, +10% with a total of 20% or less p-p in the first 400 ps, −5%, +5% with a total of 8% or less p-p from 400 ps to 5 ns; −4%, +1% with a total of 5% or less p-p after 5 ns.

Pretrigger Output—Risetime is 400 ps or less. Amplitude into 50 Ω is at least 180 mV, positive going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 75 ns (±5 ns) before the pulse output. Pretrigger to pulse output jitter is 15 ps or less.

Trigger Output—Risetime is 200 ps or less. Amplitude into 50 Ω is at least 200 mV, positive going. Trigger pulse duration is 100 ns. The trigger output occurs in time coincidence with the pulse output.

Power Requirements—The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

Output Connectors—Pulse output uses a SMA (3-mm) connector. Pretrigger output and trigger output use BSM connectors. A pretrigger output from the rear of the S-50 provides a pretrigger pulse for internal triggering of the sampling sweep unit.

Weights

Net weight	≈1 lb	≈0.45 kg
Shipping weight	≈2 lb	≈0.9 kg

Included Accessories— 500 ps 50 Ω semi-rigid coax (015-1015-00).

Order S-50 Pulse Generator Head **$575**

18 GHz Countdown

10 ps or less Trigger Jitter

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 may be used with the 3S2, 3S5, 3S6, 7S11 Sampling Units and 7S12 TDR Unit or it may be operated separately with the 285 Power Supply or 286. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

Input Signal—Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV p-p, as measured separately into 50 Ω; 5 V, p-p maximum.

Input Characteristics—50-Ω SMA (3-mm) connector. Open termination paralleled by 1 pF.

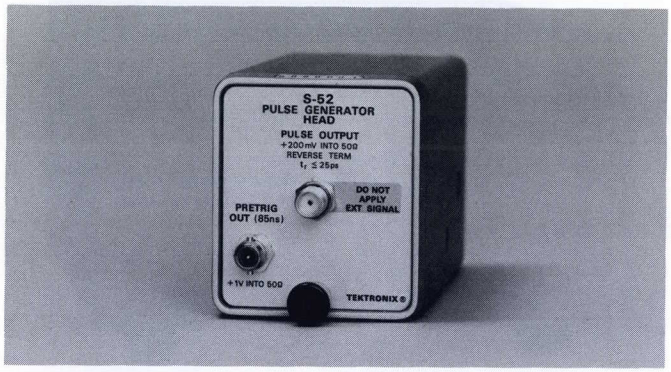
Trigger Output—Front panel trigger output is at least 200 mV into 50 Ω, Type BSM connector. Internal trigger output is at least 100 mV into 50 Ω, internally connected to sampling unit. Jitter is 10 ps or less, with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less, kickout occurs between successive samples.

Power Requirements—The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

Weights

Net weight	≈1 lb	≈0.45 kg
Shipping weight	≈5 lb	≈2.3 kg

Order S-51 Trigger Countdown Head **$550**



25-ps Risetime

200-mV into 50 Ω

50-Ω Source

Pretrigger Output

The S-52 Pulse Generator Head is a tunnel-diode step generator designed for use with the 7S12 as a high resolution Time Domain Reflectometer. The S-52 may be powered by the 7S11, 3S2, 3S5, 3S6, 285, or 286 for use as a fast, clean step signal source.

For TDR applications, the S-52 features automatic bias circuit control to eliminate effects of tunnel-diode and load changes. A 50-Ω reserve termination minimizes reflections. The pulse width is sufficient for distances up to 32 feet in any cable. A pretrigger output allows the S-52 to be operated in sequential sampling systems without a delay line.

Pulse Output—Risetime is 25 ps or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pulse duration 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—Risetime is 1 ns or less. Amplitude into 50 Ω is at least 1 V, positive-going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

Power Requirements—Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

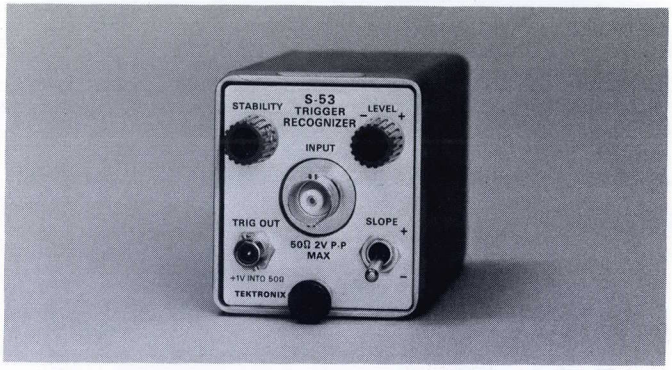
Output Connectors—Pulse output uses a SMA (3-mm) connector. Pretrigger output uses a BSM connector.

Weights

Net weight	≈¾ lb	0.3 kg
Shipping weight	≈1 lb	≈.45 kg

Included Accessories—1-ns, 50-Ω semi-rigid coax delay line (015-1023-00).

Order S-52 Pulse Generator Head **$595**



Dc-to-1 GHz Operation

10-mV Sensitivity

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12 or for other applications. The S-53 can also be powered from the 7S11, 3S2, 3S5, 3S6, 285, or 286.

Input Characteristics—Frequency range is dc to 1 GHz. Sensitivity range is 10 mV to 2 V p-p into 50 Ω. Kickout at input, ±5 mV or less.

Output Characteristics—Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into 50 Ω. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Trigger-to-signal delay is 15 ns or less; jitter is 15 ps or less.

Power Requirements—Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

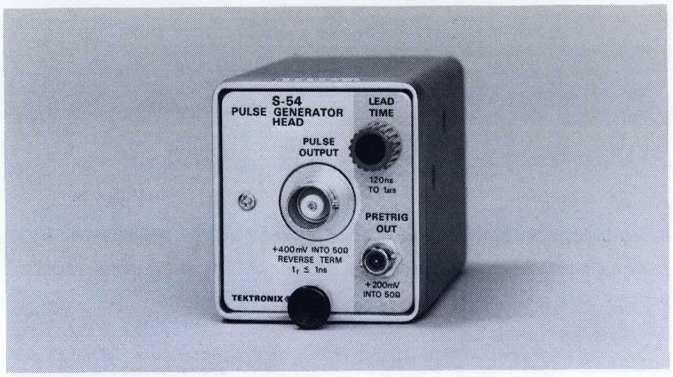
Connectors—Trigger input connector is BNC type. Front-panel, trigger output connector is BSM type. Trigger output is also available at rear connector for internal triggering.

Weights

Net weight	≈¾ lb	0.3 kg
Shipping weight	≈1 lb	≈.45 kg

Included Accessories—42-inch, 50-Ω cable (012-0057-01); 10X, 50-Ω attenuator (011-0059-01).

Order S-53 Trigger Recognizer Head **$465**



1-ns Risetime

Low Aberrations

400 mV Into 50 Ω

50 Ω Source

Variable Pretrigger Lead Time

The S-54 Pulse Generator Head is a step generator designed for use with the 7S12 as a long Line Time Domain Reflectometer Unit. The S-54 is also useful as a clean step signal source in the 7S11, 3S2, 3S5, 3S6, 285, or 286.

Intended for TDR applications, the S-54 is 50-Ω reverse-terminated to minimize reflections and a zero-volt baseline to eliminate baseline shift with load changes. A front-panel continuously variable control enables adjustment of pretrigger lead time. The pretrigger output allows the S-54 to be operated in sequential sampling systems without a delay line.

Pulse Output—Risetime is 1 ns or less. Amplitude into 50 Ω is +400 mV or greater. Pulse duration is 25 μs within 2 μs. Pulse aberrations following the step are: +1.5%, −1.5%, total of 1.5% p-p, as displayed with S-1 Sampling Head. Baseline level is 0 V within 20 mV, terminated in 50 Ω.

Pretrigger Output—Risetime is 5 ns or less. Amplitude into 50 Ω is at least 200 mV, positive-going. Pretrigger pulse duration is 20 ns or less at the 50% amplitude point. Pretrigger lead time is front-panel adjustable from 120 ns or less to 1 μs or greater. Pretrigger to pulse output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μs lead time.

Power Requirements—Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

Output Connectors—Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

Weights

Net weight	≈¾ lb	0.3 kg
Shipping weight	≈1 lb	.45 kg

Included Accessories—BNC T connector (103-0030-00); 8-inch, 50-Ω cable (012-0123-00).

Order S-54 Pulse Generator Head **$355**

Accepts One S-50 Series Head

Trigger Output Jack

The 285 Power Supply provides the regulated power supplies necessary to power one S-50 Series Head. It also has a front panel trigger output jack which delivers the trigger pulse from the plug-in Head to the front panel of the 285. It makes the S-50, S-52 or S-54 a complete pulse generator package.

Power Requirements— 90 V to 136 V or 180 V to 272 V, 50 Hz to 400 Hz, 8.5 watts at 115 V and 60 Hz. Slide switch on rear panel selects high or low voltage operation.

Trigger Output—BSM Connector provides internal trigger output of S-50 Series Heads to the front panel.

Dimensions and Weights

Height	≈3 in	7.6 cm
Width	5 in	12.7 cm
Depth	8 in	20.3 cm
Net weight	2 lb	0.9 kg
Shipping weight	≈5 lb	≈2.3 kg

Included Accessories— 18-inch trigger output cable (012-0127-00).

Order 285 Power Supply, without Heads **$245**

Detects and Locates Cable Faults to 10,000 Feet or 3,000 Meters

Accurate to Inches for Short Ranges

Self-Contained Rechargeable Battery

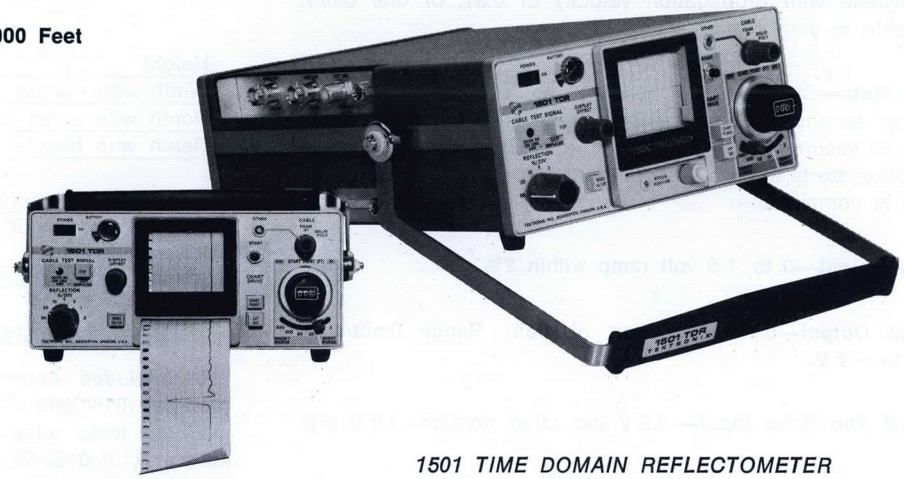
Ac Operated While Battery Charges

Less Than Eight Pounds

50-Ohm or 75-Ohm Source Impedance

Plug-In Strip Chart Recorder

Use with Oscilloscope Optional



1501 TIME DOMAIN REFLECTOMETER

The 1501 is a portable, battery-operated Time Domain Reflectometer (TDR) used to detect and locate faults and to measure impedance variations in transmission cables through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever communication or power transmission cable systems are used.

Two types of test signals and operating modes are provided . . . narrow pulses (IMPULSE mode) or fast rise long duration step signals (STEP mode). The step mode is usually preferred for analytical work; the impulse mode is especially for operating in the presence of noise signals or power voltage on the line. Test pulses are generated within the 1501 and drive the cable under test through a type "F" connector on the side panel. Adapters are available to mate with other connector types. Reflected signals return to the same connector and are terminated by the source impedance, either 50 ohms or 75 ohms—selectable with an internal switch. The input circuits are automatically protected from voltage on the line up to ±100 volts for frequencies up to 440 Hz. Voltages over 5 volts automatically ac couple the input, blocking dc and low frequency voltages, and causing a front panel light to indicate the presence of voltage on the line.

The 1501 is designed to be a complete measurement package when the Chart Recorder (016-0506-00) is plugged in. A strip chart 4 cm wide by 32.5 cm long can be made in about 20 seconds for about 10 cents per chart. For convenience in previewing each chart or as a substitute for graphic records, a separate oscilloscope may be easily connected to the Vertical and Horizontal outputs of the 1501. The 323 SONY/TEKTRONIX Oscilloscope is recommended for a size and style match with the 1501. The TEKTRONIX 211 Oscilloscope is also recommended. Most any oscilloscope with dc coupled vertical and horizontal amplifiers having a vertical sensitivity of 0.2 volts per division and a horizontal sensitivity of 0.5 volts per division is suitable.

The recorded portion of each chart has ten major horizontal divisions spaced 2.5 cm apart (about 1 inch) and eight major vertical divisions spaced 0.5 cm apart. The long (25 cm) horizontal scale provides distance resolution down to an inch or two for the 500 foot range at 2 feet per division. A direct reading, ten turn, start point delay dial provides the means for precise distance measurements using an oscilloscope display. Each chart is 7.5 cm longer than the recorded portion to provide space for handwritten data.

The chart recorder when installed in the 1501 can be driven by the 1401A or 1401A-1 Spectrum Analyzer. It works especially well when coupled with a 323. The 1401A has a 50-Ω input and the 1401A-1 has a 75-Ω input especially suited for CATV.

CHARACTERISTICS

Test Signal Amplitudes—Step 1 V, Impulse 10 V.

Displayed Risetime—1.3 ns (from reflection).

Displayed Impulse Width—1.3 ns (at 50% amplitude).

Displayed Aberrations—+5%, —5%, total not to exceed 8% of test signal amplitude within first ten feet, much less thereafter.

Vertical Deflection Factors— 0.5, 1, 2, 5, 10, 20 and 50% (of test signal amplitude) per division. One division on scope is equal to one 0.5 centimeter division on chart. Accuracy is 3%.

Displayed Noise (Tangentially measured)—Less than 0.2% using noise filter mode, or recorded on chart.

Source Impedance— 75 ohms within 2% or 50 ohms within 2%. Selectable with internal slide switch.

Maximum Safe Input Voltage— ±100 volts (dc + peak ac) for ac frequencies to 440 Hz.

Horizontal Scale Factors—2, 5, 20, 50, 200, 500 feet per division. Accuracy within 3%.

Start Point (Delay) Ranges—500 feet and 5000 feet, continuously variable. Direct distance readout on dial. Accuracy within 2% of dial setting.

Distance Ranges—0-520 feet at 2 feet/div
0-550 feet at 5 feet/div
0-5200 feet at 20 feet/div
0-5500 feet at 50 feet/div
0-7000 feet at 200 feet/div
0-10,000 feet at 500 feet/div

Metric Calibration (Option 2)—The metric 1501 Options 2 and 3 have scale factors of 0.5, 2, 5, 20, 50 and 200 meters with delay ranges of 100 and 1000 meters. This allows measurements to be made out to 3000 meters.

Cable Dielectric—Three choices. Either solid polyethylene, foam polyethylene with propagation velocity of 0.81, or one other, adjustable to your choice.

Sweep Rate—Changes from about 40 per second (flicker free) to 4 per second when noise filter mode is selected. Approximately 20 seconds when a chart recording is made. Front panel pushbutton starts the recording. Paper automatically stops when record is complete.

Sweep Output—0 to +5 volt ramp within 2%.

Vertical Output—0.2 V per chart division. Range limited to +2 V to −2 V.

External Pen Drive Input— 0.2 V per chart division, 1.6 V p-p.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C; Nonoperating: −55° to +75°C (without batteries), −40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock (operating and nonoperating)—30 g's ½ sine, 11 ms duration. Two guillotine-type shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—Meets radiated interference requirements of MIL-I-6181D and MIL-I-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

POWER SOURCES

External DC Source—Operates from an external dc source of 6 V to 16 V, requires 5 W.

External AC Source—Operates from an external ac source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 15 W maximum at 115 Vac.

Battery Operation—Removable power pack contains a battery of 6 size C NiCd cells providing at least 8 hours of operation with 30 recordings at 20° to 25°C. Power packs may be removed and plugged into ac to recharge the cells or may be left in the 1501 for recharge. The cells completely recharge in 16 hours. The 1501 may be operated from ac while the cells recharge or turned off, except for recharge.

DIMENSIONS AND WEIGHTS

	in	cm
Height	≈4	8.9
Width with handle	≈9	21.6
Depth with panel cover	≈11	27.0
Depth with handle	13	33.0
	lb	kg
Weight with Recorder and Accessories	≈8	≈3.6
Net weight without Recorder and Accessories	≈7	≈3
Shipping weight with Recorder	≈15	≈6.8

TIME DOMAIN REFLECTOMETER MODULE

1501 Included Accessories—Cover front (200-0812-00); chart recorder (016-0506-00); two rolls chart paper (006-1658-00); "F" male to male adapter (103-0157-00); "F" female to female adapter (103-0159-00); "F" male to BNC female adapter (103-0158-00); 8-ft power cable assembly (161-0043-02); cover plate, chart recorder blank (016-0509-00); TDR slide rule (003-0700-00): TDR Application Note #1 (062-1538-00); cable interconnector (012-0214-00).

ORDERING INFORMATION

1501 (with recorder) **$2000**

Option 1 (without recorder) ..... **Subtract $475**

Option 2 (Metric version) ..... **No Charge**

Option 3 (Metric version without recorder) ..... **Subtract $475**

OPTIONAL ACCESSORIES

Chart Recorder, Order 016-0506-00 ..... **$525**

323 Oscilloscope with P7 Phosphor—The 323 with high persistance P7 phosphor is highly recommended.
Order 323 Option 76 ..... **$995**

1501 Convenience Accessory Group—Panel cover (200-0812-00); neck strap carrying assembly (346-0051-00); accessory pouch (016-0113-03); protective cover (016-0112-00);
Order 020-0053-00 ..... **$27.50**

Protective Cover—Waterproof blue vinyl,
Order 016-0112-00 ..... **$13.00**

Handle Conversion Kit (for two instruments)—For combining an existing 323 or 324 Oscilloscope with 1501 TDR.
Order 040-0563-00 ..... **$33.00**

Handle Conversion Kit (for three instruments)—For combining the 1501 with a 323 or 324/1401A or 1401A-1.
Order 040-0596-00 ..... **$100.00**

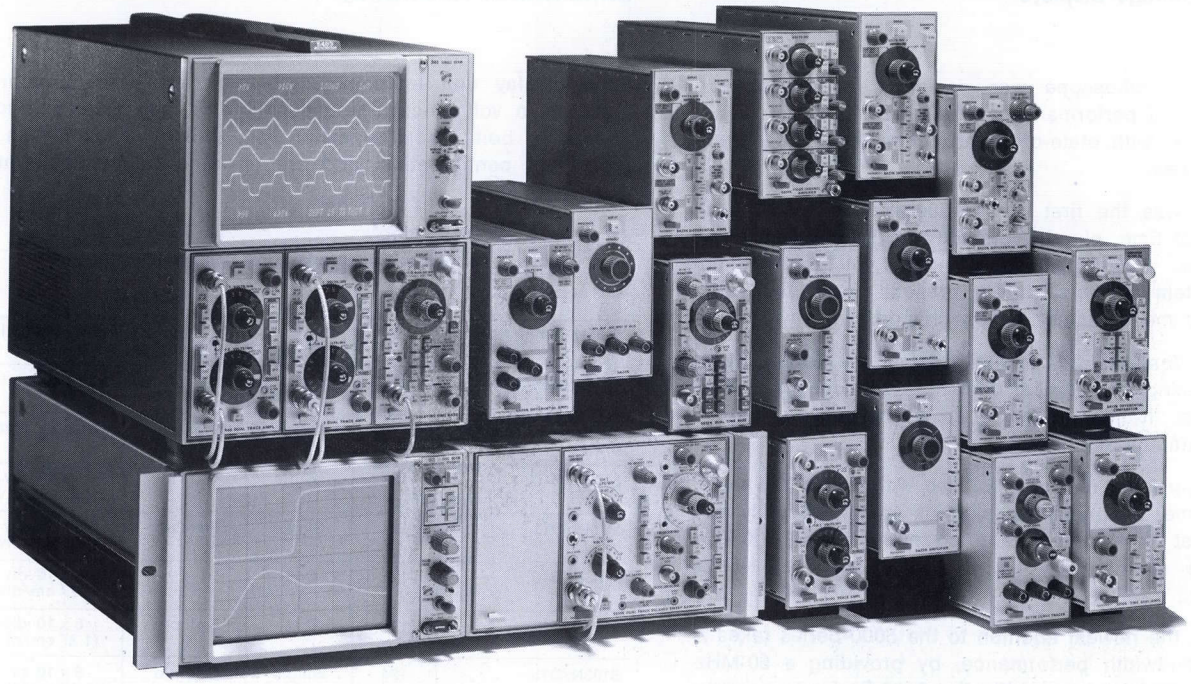
Chart Paper—One roll, **Order 006-1658-00** **$7.55**

Power Pack—Extra power pack, identical to the one supplied with the 1501, allows one power pack to charge while the other is powering the 1501. **Order 016-0119-02** **$125.00**

Battery Set—Set of 6 NiCd cells, **Order 146-0012-01** .. **$26.00**

Adapters
"F" male to BNC female, **Order 103-0158-00** **$7.00**
"F" female to BNC male, **Order 013-0126-00** **$7.00**
"F" female to GR 874, **Order 017-0089-00** **$14.00**

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; 21 diverse plug-ins and bench-mount/rackmount convertibility make the 5000-Series Oscilloscopes an excellent choice for your measurement needs from dc to 60 MHz. Thirteen versatile amplifiers, 5 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.

Dc to 60-MHz Oscilloscopes (5400 Series)	116
Dc to 2-MHz Oscilloscopes (5100 Series)	124
Amplifier Plug-ins (35 MHz and 60 MHz)	120
Amplifier Plug-ins (1 MHz and 2 MHz)	126
Time Base Plug-ins (Single Sweep)	122-131-133
Time Base Plug-ins (Delayed Sweep)	123-132
Other Plug-ins	133

Low Cost

Bandwidth 2 MHz or 60 MHz

Sampling to 1 GHz

0 - 100 kHz Spectrum Analysis

Seven Oscilloscope Models

Three-Plug-in Mainframes

Dual-Beam and Storage Displays

Crt Readout (5400-Series Only)

Large 6½-inch Crt (8 x 10 div)

10 μV/div High Gain Differential Amplifier

One to Eight Trace Capability

Delayed Sweep Time Bases

Y-T or X-Y Operation

Color Coded Front Panels

Bench-to-Rack Convertibility

The 5000-Series Oscilloscope was designed to provide optimum versatility and performance at the lowest possible price. This was achieved with state-of-the-art technology and manufacturing techniques.

The 5100-Series was the first of the 5000-Series family, providing for the first time, plug-in versatility to the low frequency oscilloscope user. Plug-in versatility means you can buy an oscilloscope system that meets your present needs, then add plug-ins as your measurement needs change.

The 5100-Series features 2-MHz mainframes, the 5103N, typically accommodating two vertical deflection and one horizontal deflection plug-in. It has the ability to easily convert from a bench to a rackmount configuration.

To date, 16 plug-ins are available for use with the 5100-Series, with more to come. Among these plug-ins are the recently announced low cost 5L4N Spectrum Analyzer for the 0 - 100 kHz frequency range and the 5S14N, a general-purpose, 1-GHz sampling plug-in.

The 5400-Series, the newest addition to the 5000-Series takes a giant step in bandwidth performance, by providing a 60-MHz bandwidth. With 60-MHz bandwidth, the 5400-Series is capable of satisfying a wide range of measurement needs. The 5400-Series features readout of plug-in scale factors on the crt except with plug-ins having an N suffix such as 5A22N, 5B10N, etc. This feature, previously available only on more sophisticated oscilloscopes, allows you to make measurements quicker and more conveniently. The CRT READOUT can also be externally accessed.

The 5400 Series provides the same three-plug-in compartment feature and benchmount/rackmount convertibility as the 5100 Series.

Whether it's the low frequency 5100-Series or the 60-MHz 5400-Series, the TEKTRONIX 5000-Series Oscilloscopes always give you the most versatility and performance for your dollar.

CRT DISPLAY UNITS

Five 5100-Series crt display units 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.

Two 5400-Series display units are presently available, a single-beam, non-storage display and a variable persistence storage display. Both displays feature crt readout of plug-in scale factors. Additional display units will become available.

Each display unit features a 6½-inch* crt with an internal graticule, a voltage-current-time calibrator, and a beam finder. The units bolt onto the mainframe, either in the bench or rackmount configuration, and are powered by the mainframe.

*The 5403/D41 uses a 5-inch crt.

Mainframe And Display Unit Configurations

Product	Page	Features		
5103N Mainframe	124	Power Supply/Amplifier Unit compatible with any of five display units		
5403 Mainframe	117 119	Power Supply/Amplifier Unit compatible with D40 and D41 Display Units		
Mainframe/Display Units		**Beams**	**Storage**	**Display Size**
5103N/D10	124	Single		8 x 10 div (1.27 cm/div)
5103N/D11	124	Single	Bistable	8 x 10 div (1.27 cm/div)
5103N/D12	125	Dual		8 x 10 div (1.27 cm/div)
5103N/D13	125	Dual	Bistable	8 x 10 div (1.27 cm/div)
5103N/D15	124	Single	Bistable	8 x 10 div (1.27 cm/div)
5403/D40	118	Single		8 x 10 div (1.22 cm/div)
5403/D41	116	Single	Variable Persistence	8 x 10 div (0.9 cm/div)

PLUG-IN VERSATILITY

Presently 21 plug-ins are available in the 5000-Series family. All these plug-ins are compatible with the 5400-Series, and all but five are compatible with the 5100-Series mainframes.

The amplifier plug-ins include single, dual, and four trace units, various differential amplifiers (including one with a current probe input), and a differential comparator amplifier. The time base plug-ins include single, dual and delayed sweep units. All 5000-Series time bases are compatible* with the 60-MHz 5403 mainframe.

Three special purpose plug-ins are also available. The new 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 sampler, extends the bandwidth of either the 5100 or the 5400-Series to 1 GHz @ 2 mV sensitivity.

*The 5B10N, 5B12N and 5B13N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400 Series.

More plug-ins are planned for the 5000-Series, so that even greater measurement capability will be available to you.

Back-lighted knob skirts on the plug-ins provide scale factor readout. The correct scale factor is automatically indicated when using the X10 magnifier and the recommended 1X and 10X probes.

Amplifier Plug-Ins

Product	Page	Traces	Minimum Deflection Factor	Bandwidth —3 dB	Cmrr
5A13N	126	Single	1 mV/div	2 MHz	10,000:1
5A14N	127	Four	1 mV/div	1 MHz	
5A15N	127	Single	1 mV/div	2 MHz	
5A18N	127	Dual	1 mV/div	2 MHz	
5A19N	128	Single	1 mV/div	2 MHz	1,000:1
5A20N	130	Single	50 μV/div	1 MHz	100,000:1
5A21N	128	Single (Voltage and Current)	50 μV/div 0.5 mA/div	1 MHz	100,000:1
5A22N	129	Single	10 μV	1 MHz	100,000:1
5A23N	130	Single	10 mV/div	1.5 MHz	
5A24N	130	Single	50 mV/div	2 MHz	
5A38	120	Dual	10 mV/div	35 MHz	
5A45	121	Single	1 mV/div	60 MHz	
5A48	120	Dual	1 mV/div	60 MHz	

Time Base Plug-Ins

Product	Page	Dual and Delaying Sweep	Sweep Rate	Mag	Single Sweep	Volts/Div Ext Mode
5B10N	131		1 μs to 5 s	X10	Yes	50 mV and 500 mV
5B12N	132	Dual	A 1 μs to 5 s B 2 μs to 0.5 s	X10 —	Yes —	50 mV and 500 mV
5B13N	133		1 μs to 100 ms			50 mV
5B40	122		0.1 μs to 5 s	X10	Yes	50 mV
5B42	123	Delaying	A 0.1 μs to 5 s B 0.1 μs to 0.5 s	X10 X10	Yes —	50 mV

Special Purpose Plug-Ins

Product	Page	Description
5CT1N	133	Semiconductor Curve Tracer
5L4N	126	Low Cost Spectrum Analyzer
5S14N	134	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		

5103N DIMENSIONS AND WEIGHTS*

Dimensions	Cabinet		Rackmount	
	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

5403 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	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	11.3
Shipping	34.0	15.4	45.0	20.4

5000-SERIES ACCESSORIES

Probes				
For	Voltage		Current	
5103N	P6060	10X	P6042	(Dc to 50 MHz)
			P6021	(Ac Probe)
5403	P6065A	10X	P6042	(Dc to 50 MHz)
	P6011	1X	P6021	(Ac Probe)
	P6022	1X/10X (switchable)		
	P6045	1X, 10X, 100X FET		

SCOPE-MOBILE® Cart
5103N, 5403 — 203 or 203 Option 1

Cameras**
5103N — C-5
5403/D40 — C-59-R or C-50-R†
5403/D41 — C-30A with 016-0248-00 adapter

Blank Panel
5103N, 5403 — 016-0195-00

Viewing Hoods
5103N, 5403 — 016-0260-00 (folding), 016-0154-00

Rain Cover
5103N, 5403 — 016-0544-00

See accessories section for complete information.

*Refer to page 324.

**For other camera choices, refer to camera/adapter chart on page 247.

†Battery Pack required for use with the 5000-Series.

Low Cost

Variable Persistence Storage

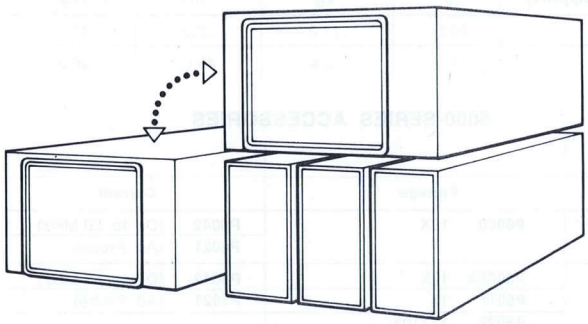
Crt Readout

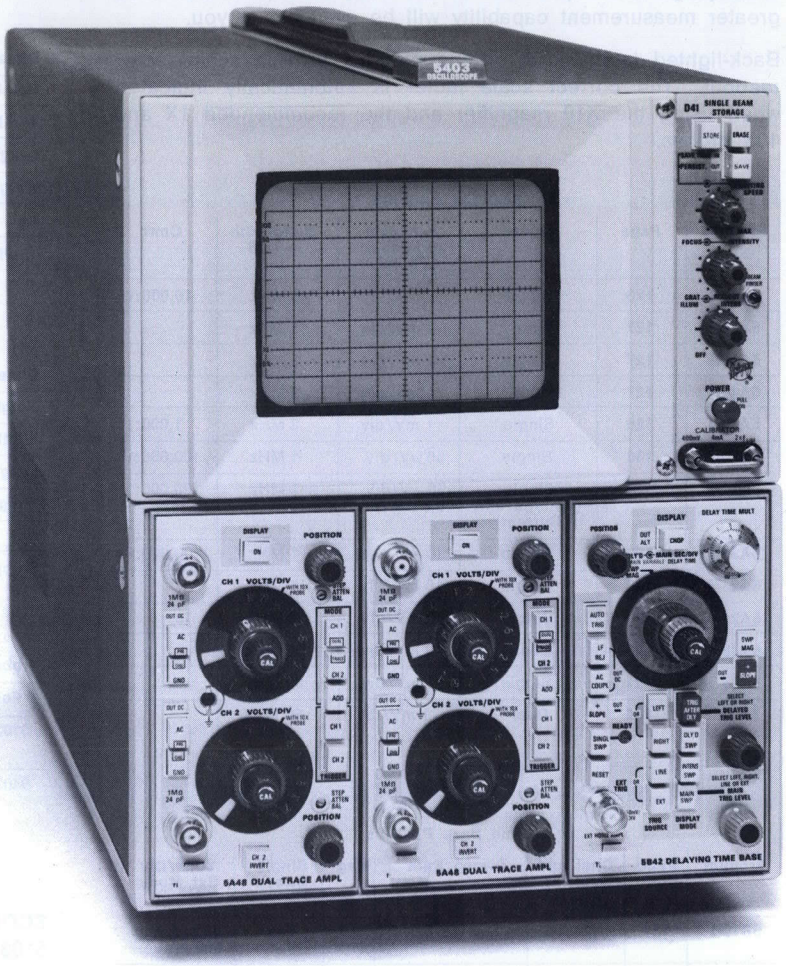
Dc to 60 MHz

Three-Plug-In Flexibility

21 Versatile Plug-ins

Bench to Rack Convertibility





With the new 5403/D41 Variable Persistence Storage Oscilloscope, the length of time a waveform persists on the crt is continuously variable simply by turning a dial. Viewing time at normal intensity can be varied from a small fraction of a second to greater than 5 minutes. In the save mode you can view signals for up to an hour at lower intensity.

High speed events that occur only once or at very low repetition rates are easily observed. You can make low frequency measurements easier and more accurately by eliminating flicker or by transforming a slow 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.

Capabilities of the 5000 Series Sampler and Spectrum Analyzer plug-ins are enhanced by the 5403/D41 Variable Persistence Storage Oscilloscope. The discrete dot traces produced in sampling applications 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 5403/D41 it is easy to display a full scan pattern simultaneously even when the scan rate yields full scale periods in excess of a second.

As part of the versatile 5400 Series the 5403/D41 offers crt readout of deflection factors for convenient, error-free measurements; user programmable crt readout of test information for ready identification and ease of photographic recording; and the increased flexibility of a 3-plug-in mainframe. With the 21 diverse plug-ins available for the 5403/D41 you can make virtually any measurement from dc to 60 MHz.

5403 MAINFRAME VERTICAL SYSTEM

Channels—Two plug-in compartments (left and center) compatible with all 21 plug-ins for the 5000 Series. Crt readout is not available with plug-ins having a suffix N (5A13N, 5B10N, etc.).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz maximum, determined by plug-in.

Chopped Mode—The 5403 will chop between channels at an approximate 25 kHz to 100-kHz rate, depending on plug-ins used and operating modes chosen.

Alternate Mode—In this mode each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5403 switches to the second amplifier.

HORIZONTAL SYSTEM

Channels—One plug-in compartment (right) compatible with all 21 plug-ins for 5000 Series. Crt readout is not available with plug-ins having a suffix N (5A13N, 5B10N, etc.).

Internal Trigger Mode—Left vertical, right vertical.

Fastest Calibrated Sweep Rate— 10 ns/div, determined by plug-in.

X-Y Mode—The phase shift is within 1° from dc to 20 kHz, checked with two amplifiers of the same type.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C, unless otherwise specified.

Power Requirements— 100, 110, 120, 200, 220 and 240 Vac ±10%; internally selected with quick change jumpers. Line frequency range: 48 to 440 Hz.

5403/D41 VARIABLE PERSISTENCE STORAGE OSCILLOSCOPE

The 5403/D41 offers variable persistence storage with a maximum stored writing speed greater than 5 div/μs or conventional (nonstorage) operation. In the "save" mode, stored traces can be viewed for up to an hour. The D41 crt with its 8 x 10-div (0.9-cm/div) viewing area is extremely burn resistant and does not require special operating precautions.

CRT READOUT labels the crt with: deflection factors; sweep rates; invert and uncalibrated symbols; and identifies the trace and its data. The readout is automatically corrected when magnified sweeps and recommended 10X or 100X probes are used.

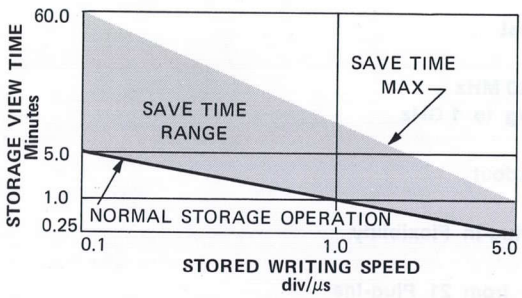
Accelerating Potential— 8.5 kV.

Phosphor—P31

Persistence—Continuously variable. May be turned off when not needed, thus producing high contrast stored displays without the characteristic fading of variable persistence.

Maximum Stored Writing Speed—Writing speed is greater than 5 div/μs for a viewing time of 15 seconds.

Storage View Time— 5 minutes with a writing speed of greater than 0.1 div/μs. This can be increased to 1 hour at reduced intensity by selecting the "save" mode.



Save—Prevents erasing and storing additional displays. Extends viewing time of stored displays for up to 1 hour.

Erase— 0.5 seconds ±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 approximately 10 kΩ paralleled by approximately 40 pF. Maximum input 50 V (dc and peak ac).

Beam Finder—Brings trace within graticule area and intensifies trace.

Calibrator—Voltage amplitude is 400 mV ±1%. Current amplitude is 4 mA ±1%. Frequency is 2X line frequency.

Option 1—The 5403 may be ordered without CRT READOUT. This feature can easily be added by installing a conversion kit.

Option 3—User Addressable CRT READOUT. An additional CRT READOUT access is available for the operator to program two 10-digit words such as: time; operator name or test number. The additional display is useful for photographic records and is accomplished by external resistors and switches.

Option 4—Protective Panel Cover (cabinet model only). The 5403 may be ordered with a protective front panel cover. The cover protects the front panel and knobs for transportation and storage.

Option 5—For users who do not require the 5-div/μs writing speed, a 1-div/μs option can be ordered at a significantly lower cost.

ORDERING INFORMATION

Cabinet (without plug-ins)—
5403/D41 Oscilloscope, order 5441 ..... **$2275**

Rackmount (without plug-ins)—
R5403/D41 Oscilloscope, order R5441 ..... **$2275**

OPTIONS

Option 1—Without crt readout ..... **Sub $350**

Option 3—User-addressable crt readout ..... **Add $ 60**

Option 4—Protective panel cover (cabinet model only) ..... **Add $ 15**

Option 5—Reduce writing speed to 1 div/μs ..... **Sub $300**

CONVERSION KITS

Cabinet-to-rackmount, Order 040-0583-01 ..... **$ 38**

Rackmount-to-cabinet, Order 040-0584-02 ..... **$38**

Crt Readout, Order 040-0691-00 ..... **$350**

Low Cost

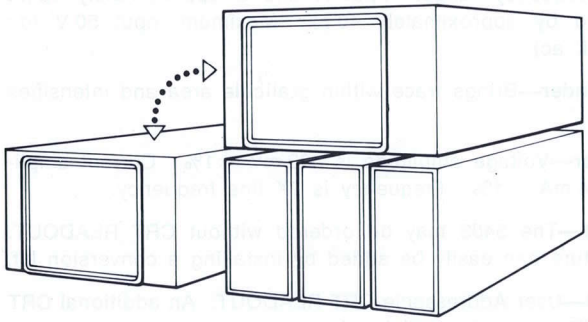
Dc to 60 MHz Sampling to 1 GHz

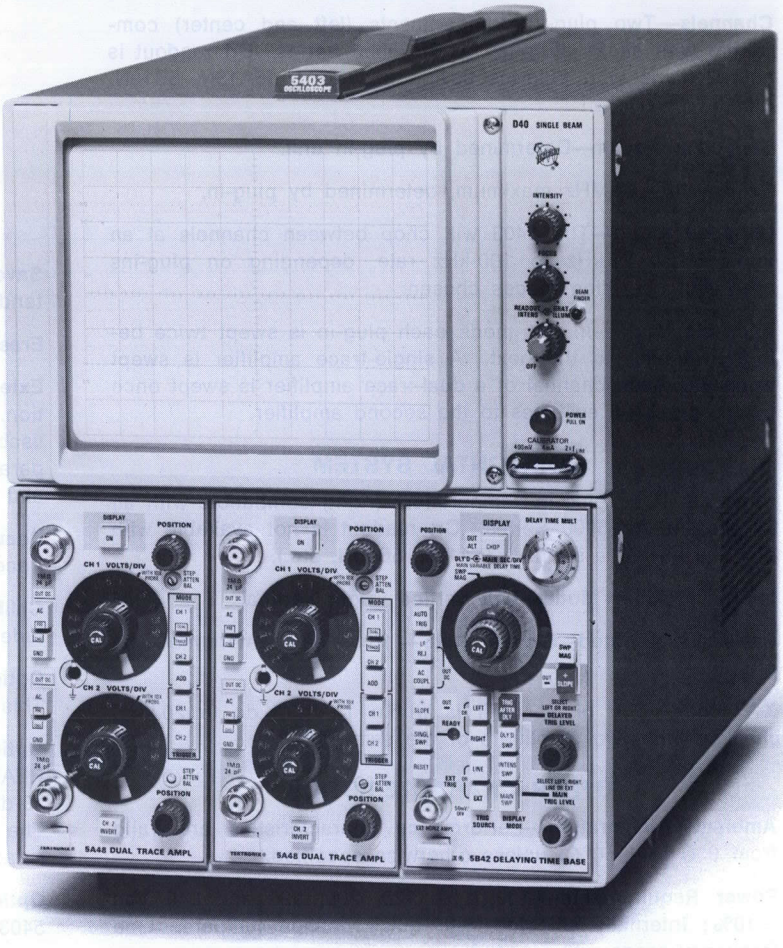
Crt Readout

Three-Plug-In Flexibility

Choose from 21 Plug-Ins

Bench-to-Rack Convertibility





The new 5400-Series combines outstanding versatility and low cost in a 60-MHz, general-purpose, plug-in oscilloscope system. It features CRT READOUT of plug-in scale factors, a three plug-in mainframe, a choice of *21 plug-ins, and easy bench-to-rackmount convertability.

CRT READOUT is a feature previously found only on more expensive oscilloscopes. With the plug-in scale factors displayed on the CRT, measurement time is reduced, because the operator can concentrate on the CRT display rather than having to look down at the plug-in knobs. The CRT READOUT reduces operator errors by taking into account magnifiers and probe attenuators. The CRT READOUT can also be accessed externally. This unique ability can be used to readout dates, picture numbers, digital clock times, etc.

*Plug-ins with an N suffix, such as 5A13N, 5B12N, etc., do not provide CRT READOUT.

All the plug-ins in the 5000-Series are compatible** with the 5400-Series mainframe. Thus, although the 5400-Series is new, it already has a wide range of measurement capability. The available plug-ins provide multi-trace (up to four) amplifiers, differential amplifiers, a differential comparator amplifier, transistor curve tracer, a 1-GHz sampler spectrum analyzer and delayed sweep time-bases. More plug-ins utilizing the additional mainframe bandwidth will be available soon.

The 5403/5A48/5B42 provides 5 mV/div sensitivity at 60 MHz and 1 mV/division sensitivity at 25 MHz. This 1 mV/division sensitivity for example, allows you to look at the heads of tape drive and disc drive units. Problems in these units are often the causes of computer system malfunctions.

If you're looking for a 60-MHz general-purpose oscilloscope, the 5400-Series provides you with the most versatility and performance at the lowest price.

**The 5B10N, 5B12N and 5B13N Time Bases do not permit viewing the leading edge of a triggered waveform when used in the 5400-Series.

5403 MAINFRAME

VERTICAL SYSTEM

Channels—Two plug-in compartments (left and center) compatible with all 5400-Series plug-ins and all 5000-Series plug-ins. CRT READOUT is not available with plug-ins having a suffix N (5A13N, 5B10N, etc.).

Deflection Factor—Determined by plug-in unit.

Bandwidth— 60 MHz maximum, determined by plug-in.

Chopped Mode—The 5403 will chop between channels at an approx 25-kHz to 100-kHz rate, depending on plug-ins used and operating modes chosen.

Alternate Mode—In this mode each plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5403 switches to the second amplifier.

HORIZONTAL SYSTEM

Channels—One plug-in compartment (right) compatible with all 5400 and 5000 Series plug-ins. CRT READOUT is not available with plug-ins having a suffix N (5A13N, 5B10N, etc.).

Internal Trigger Mode—LEFT VERT, RIGHT VERT.

Fastest Calibrated Sweep Rate— 10 ns/div, determined by plug-in.

X-Y Mode—The phase shift is within 1° from dc to 20 kHz, checked with two amplifiers of the same type.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C, unless otherwise specified.

Power Requirements—100, 110, 120, 200, 220 and 240 Vac ±10%; internally selected with quick change jumpers. Line frequency range: 48 to 440 Hz.

5403/D40 SINGLE-BEAM OSCILLOSCOPE

A combination of 5403 Mainframe and D40 Crt Display Unit. The crt has an 8 x 10 division (1.22 cm/div) display area with internal parallax-free edge-lit graticule. A bright display is provided by a 15-kV accelerating potential. P31 phosphor standard; P7 or P11 optional without extra charge.

CRT READOUT labels the crt with: deflection factors; sweep speeds; invert and uncalibrated symbols; and identifies the trace and its data. The readout is automatically corrected when magnified sweeps and recommended 10X or 100X probes are used.

Beam Finder—Brings trace within viewing area and intensifies trace.

External Intensity Input— +5 V will turn the beam on to full brightness from an off level. Frequency range is dc to 2 MHz. Input R and C is approx 10 kΩ, paralleled by approx 40 pF. Maximum input is ±50 V (dc + peak ac).

Calibrator—Voltage amplitude is 400 mV within 1%. Current is 4 mA within 1%. Frequency is twice the line frequency.

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

Mainframe	Writing Speed cm/μs				Camera	Lens
	P31		P11			
	10,000 ASA	3,000 ASA	10,000 ASA	3,000 ASA		
5403/D40	180	90	245	125	C-59R	f/2.8 0.67 mag
	330	160	450	230	* ** C-50R	f/1.9 0.7 mag

*Slight cropping of the graticule corners.

**Requires optional battery pack (016-0270-00) for operation with the 5403/D40.

Option 1—The 5403/D40 may be ordered without CRT READOUT. This feature can easily be added by installing a conversion kit.

Option 3—User Addressable CRT READOUT. An additional CRT READOUT access is available for the operator to program two 10-digit words such as: time; operator name or test number. The additional display is useful for photographic records and is accomplished by external resistors and switches.

Option 4—Protective Panel Cover (cabinet model only). The 5403/D40 may be ordered with a protective front panel cover. The cover protects the front panel and knobs for transportation and storage.

ORDERING INFORMATION

The 5403/D40 may be ordered as a cabinet model oscilloscope equipped with a tilt bail or it may be ordered as a 5¼-inch rackmount oscilloscope equipped with a slide-out assembly.

Cabinet (without plug-ins)—
5403/D40 Oscilloscope, order 5440 ..... $1175

Rackmount (without plug-ins)—
R5403/D40 Oscilloscope, order R5440 ..... $1175

OPTIONS

Option 1	**Without Crt Readout**	**Sub $350**
Option 3	**User addressable Crt Readout**	**Add $60**
Option 4	**Protective Panel Cover** ..... (cabinet model only)	**Add $15**
Option 76	**P7 Phosphor**	**No Charge**
Option 78	**P11 Phosphor**	**No Charge**

CONVERSION KITS

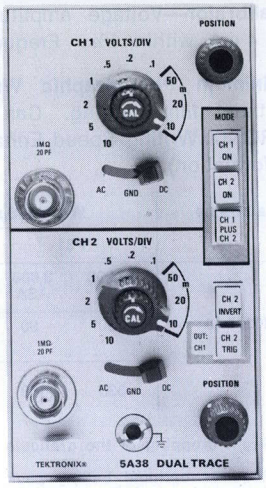
Cabinet-to-rackmount, Order 040-0583-01 ..... $38
Rackmount-to-cabinet, Order 040-0584-02 ..... $38
Crt Readout, Order 040-0691-00 ..... $350

NEW 5A38 Dual-Trace Amplifier

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 the 5400-Series Mainframe. It features 10 mV/div sensitivity and crt readout of deflection factor.

Bandwidth—Dc coupled, dc to ≥35 MHz in the 5403. Lower end response, ac coupled, ≤10 Hz.

Risetime— ≤10 ns.

Deflection Factor—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 approximately 20 pF.

Maximum Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V peak to peak maximum 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.

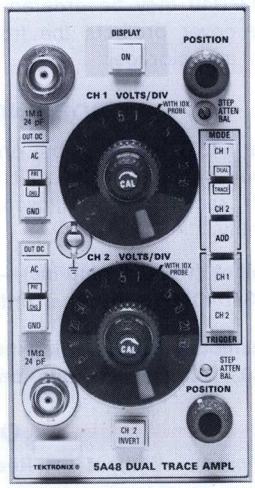
5A38 Dual-Trace Amplifier **$350**

5A48 Dual-Trace Amplifier

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).

Risetime— 5.8 ns or less (5 mV/div to 10 V/div), 14 ns or less (1 mV/div and 2 mV/div).

Deflection Factor—1 mV/div and 2 mV/div accurate within 5%, and 5 mV/div to 10 V/div, accurate within: 3% 15° to 35°C; 4% 0° to 50°C; (1-2-5 sequence). Uncalibrated, continuously variable between steps and to at least 25 V/div.

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 in horizontal compartment). Internal trigger source is selectable from channel one or channel two.

Input R & C— 1 MΩ within 1%, approx 24 pF.

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

Stability—Drift with Time (constant ambient temperature and line voltage) 0.3 mV or less over any 1 minute after 1 hour warmup. Drift with Ambient Temperature (constant line voltage) 0.2 mV/°C or less.

5A48 Dual-Trace Amplifier **$450**

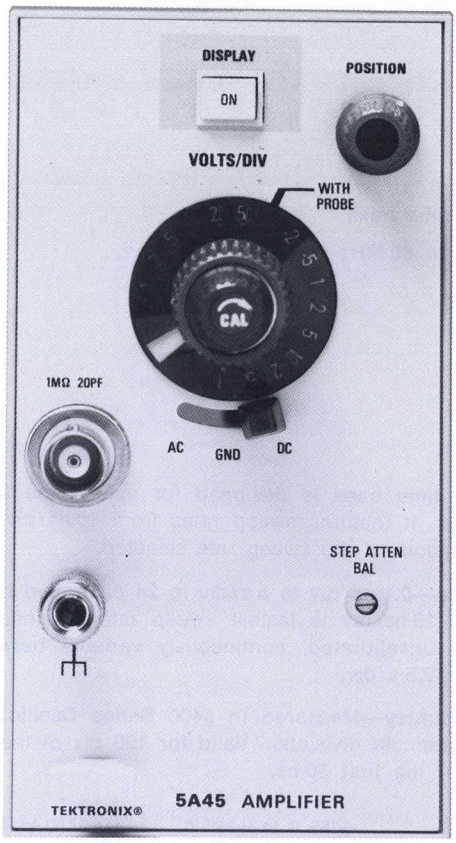
NEW

5A45 Single-Trace Amplifier

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 the 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

Risetime— ≤ 14 ns, 1 mV/div and 2 mV/div. ≤5.8 ns, 5 mV/div through 10 V/div.

Deflection Factor—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 approximately 20 pF.

Maximum Safe Input Voltage—Dc coupled, 250 V (dc + peak ac). Ac coupled, 500 V (dc + peak ac). Ac component 500 V peak-to-peak maximum, 1 kHz or less.

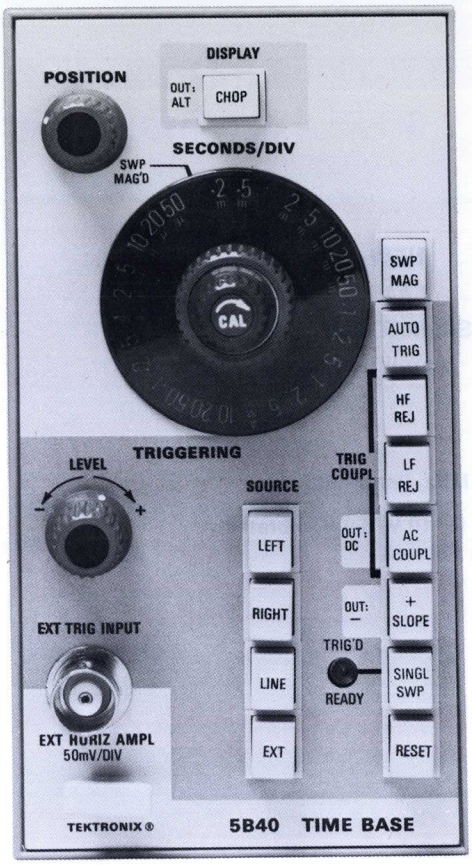
Stability— ≤0.3 mV vertical shift in any one minute after one hour warm-up, ambient temperature and line voltage held constant. ≤0.2 mV/°C vertical shift with line voltage held constant.

5A45 Single-Trace Amplifier **$250**

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 the 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 10X 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 the magnified sweep after the first 30 ns.

	+15° C to +35° C		0° C to +50° C	
Time/Div	**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 10 MHz to 60 MHz	0.4 div 1.0 div	60 mV 150 mV
Ac	Trigger requirements increase below 50 Hz.		
Lf Rej	Trigger requirements increase below 7.5 kHz.		
Hf Rej	Trigger requirements increase above 50 kHz.		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

External Trigger Input—Maximum 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 approximately 24 pF. Trigger level range is ≥ ± 1.5 V.

External Horizontal Input—Deflection factor is 50 mV/div ±3%. Input R and C is 1 MΩ paralleled by approximately 24 pF. Dc coupled bandwidth is dc to ≥2 MHz. The ac coupled lower response is ≤50 Hz. Maximum input voltage is 350 V (dc + peak ac) or 350 V p-p ac at ≤1 kHz.

5B40 Time Base **$275**

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	Minimum Signal Required	
	Frequency Range	Int	Ext
Dc 5400 ampl	Dc to 10 MHz	0.4 div	100 mV
5400 ampl	10 MHz to 60 MHz	1.0 div	400 mV
5100 ampl	Dc to 2 MHz	0.4 div	200 mV
Ac	Requirements increase below 50 Hz		
Ac Lf Rejection	Requirements increase below 7.5 kHz		

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep.

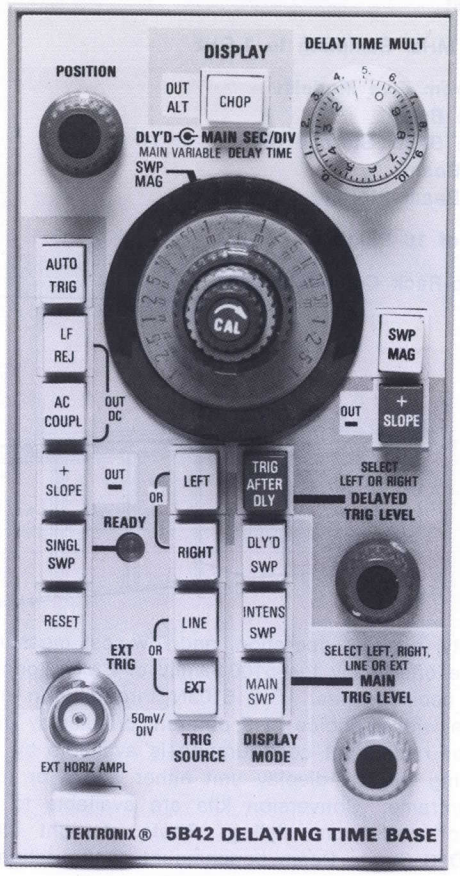
External Trigger Input—Max input voltage is 350 V (dc + peak ac), 350 V p-p ac at 1 kHz or less. Input R and C is 1 MΩ within 2%, approx 20 pF. Trigger level range is at least ±2.5 V.

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 division 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	Minimum Signal Required
	Frequency Range	Int
Dc 5400 ampl	Dc to 10 MHz	0.4 div
5400 ampl	10 MHz to 60 MHz	1.0 div
5100 ampl	Dc to 2 MHz	0.4 div

EXTERNAL HORIZONTAL INPUT

Deflection Factor— 50 mV/div within 3%.

Bandwidth—Dc coupled, dc to at least 2 MHz. Ac coupled, 50 Hz or less to at least 2 MHz.

5B42 Delaying Time Base **$575**

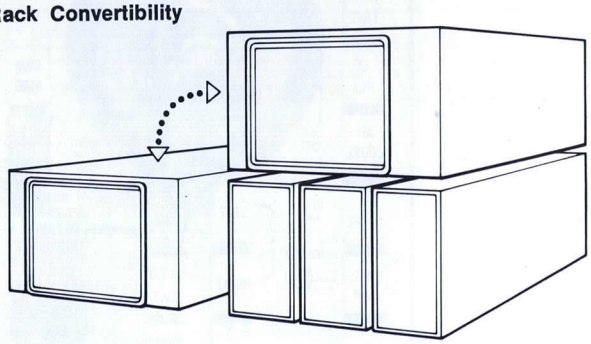
Low Cost

Dc to 2 MHz, Sampling to 1 GHz

Select from Five Models:
- **Single Beam**
- **Single Beam Storage (2)**
- **Dual Beam**
- **Dual Beam Storage**

Choice of 16 Plug-ins

Bench-to-Rack Convertibility



Reliability, ease of operation, and low-cost measurement flexibility are offered by the 5100 family of 2 MHz, general-purpose plug-in oscilloscopes. The 5103N three-plug-in mainframe is available with a choice of 5 different crt display units. Benchmount or rackmount configuration is available by order, or by positioning the crt display unit either above or to the left of the mainframe. Conversion kits are available to allow either bench or rackmount styling. Photo at right illustrates the 5103N/D10 Single Beam benchmount configuration.

5103N MAINFRAME

Vertical System

Channels—Two plug-in compartments (left and center) compatible with all 5100-Series Plug-ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth— 2 MHz maximum.

Chopped Mode—The 5103N will chop between two amplifiers, at an approx 25-kHz to 100-kHz rate, depending on plug-ins used and operating modes. The chop or alternate mode is selected at the time base unit.

Alternate Mode—In this mode each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5103N switches to the second amplifier.

Horizontal System

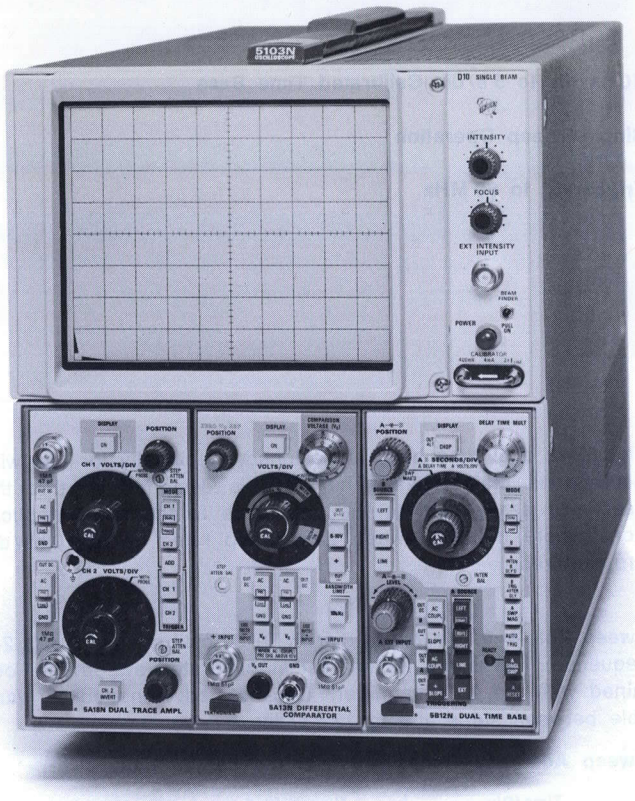
Channel—One right-hand plug-in compartment compatible with all 5100-Series Plug-ins.

Fastest Calibrated Sweep Rate— 0.1 μs/div (X10 mag) with 5B10N or 5B12N.

X-Y Mode—PHASE SHIFT is within 1° from dc to 100 kHz.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.



Power Requirements— 100, 110, 120, 200, 220 and 240 Vac ±10%; internally selected with quick change jumpers. Line frequency range: 48 to 440 Hz.

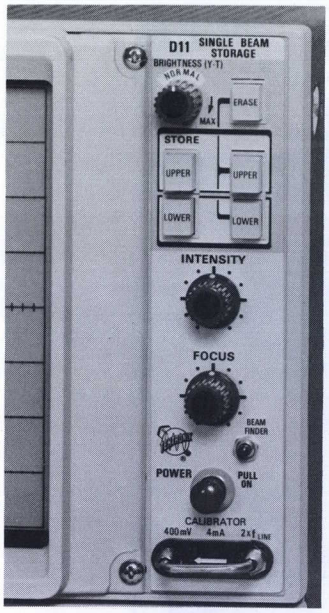
5103N/D10 SINGLE BEAM OSCILLOSCOPE

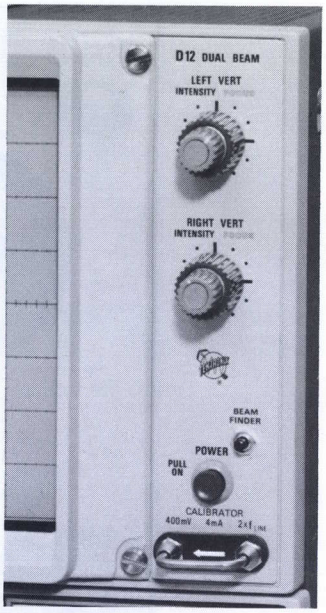
A combination of 5103N Mainframe and D10 Crt Display Unit. The electrostatic-deflection cathode-ray tube has an 8 x 10-division (½-in/div) display area with internal graticule. A bright display is provided by a 3.5-kV accelerating potential. P31 phosphor is standard; P7 or P11 optional without extra charge.

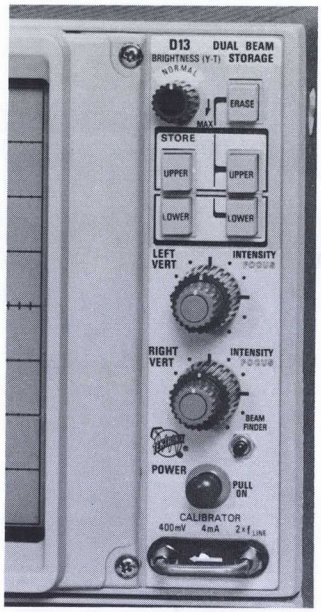
5103N/D11 and 5103N/D15 SINGLE BEAM STORAGE OSCILLOSCOPES

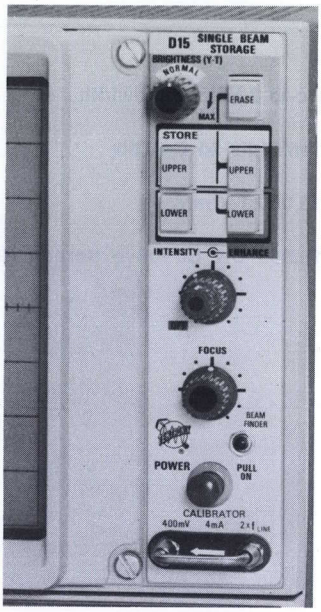
A combination of 5103N Mainframe and either D11 or D15 Crt Display Unit. Each unit features a single-beam, 6½-inch 8 x 10-div (½-in/div) crt with bistable, split-screen storage and an internal graticule. Accelerating potential is 3.5 kV and the phosphor is similar to P1. The 5103N/D11 has a brighter stored display. The 5103N/D15 has a higher stored writing speed (center 6 x 8 div).

5103N/D11 writing speed is at least 20 div/ms (Normal mode only). 5103N/D15 writing speed is at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage viewing time is at least one hour at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hours at reduced intensity, after which time the intensity may be increased to its original level. Variable brightness also permits optimum photographic results, and integration of multiple traces. Erase time is ≈250 ms.









Each Crt Display Unit shown above may be ordered with a 5103N Three-plug-in Mainframe to form a complete instrument. Photo on the opposite page shows the 5103N Mainframe and a D10 Crt Display Unit as the 5103N/D10 Single Beam Oscilloscope.

5103N/D12 DUAL BEAM OSCILLOSCOPE

A combination of 5103N Mainframe and D12 Crt Display Unit. Dual beam oscilloscopes are essential to the many applications where two transient events must be compared simultaneously. Application areas include stimulation and reaction events in areas such as medicine, biology, chemistry, engineering mechanics and many other electronic and scientific measurement areas. Both beams of the 5103N/D12 are driven by one set of horizontal deflection plates. When using a dual time base plug-in in the dual sweep mode, both beams will be deflected by both sweeps and with two single trace plug-ins four traces will be displayed. Other characteristics are the same as the 5103N/D10 Single Beam Unit.

5103N/D13 DUAL BEAM STORAGE OSCILLOSCOPE

A combination of 5103N Mainframe and D13 Crt Display Unit provides dual-beam, bistable, split-screen storage. The storage display characteristics and operation are the same as the 5103N/D11 Storage Unit. Other characteristics are the same as the 5103N/D12. New measurement problems are continuously developing which can only be solved with a dual beam storage oscilloscope. Experimenters and researchers in areas such as electronics, mechanics and bio-medicine recognize the expediency and thoroughness of dual beam storage for retaining two related transients.

Writing speed is at least 20 div/ms. (Option 3: 200 div/ms, center 6 x 8 div). Storage time is at least one hour at normal intensity increasing to 10 hours at reduced intensity. Erase time is ≈250 ms.

COMMON CHARACTERISTICS

External Intensity Input—+5 V will turn the beam on to full brightness from an off level. Frequency range is dc to 1 MHz. Input R and C is ≈10 kΩ paralleled by ≈40 pF. Maximum input is ±50 V (dc + peak ac).

Calibrator—Voltage output is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line frequency.

Beam Finder—When pressed, the beam is positioned on screen, regardless of vertical and horizontal position control settings.

Option 2—Protective Panel Cover. The 5103N may be ordered with a protective front panel cover. The cover protects the front panel and knobs for transportation and storage.

Option 3—(5103N/D13 Only) Fast writing speed crt. Increases stored writing speed to 200 div/ms (center 6 x 8 divisions).

ORDERING INFORMATION

Cabinet (without plug-ins)—

5103N/D10 Oscilloscope, order 5110	**$ 595**
5103N/D11 Storage Oscilloscope, order 5111	**$1095**
5103N/D12 Oscilloscope, order 5112	**$ 965**
5103N/D13 Storage Oscilloscope, order 5113	**$1435**
5103N/D15 Storage Oscilloscope, order 5115	**$1170**

Rackmount (without plug-ins)—

R5103N/D10 Oscilloscope, order R5110	**$ 595**
R5103N/D11 Storage Oscilloscope, order R5111	**$1095**
R5103N/D12 Oscilloscope, order R5112	**$ 965**
R5103N/D13 Storage Oscilloscope, order R5113	**$1435**
R5103N/D15 Storage Oscilloscope, order R5115	**$1170**

5103N OPTIONS

Option 2—Protective Panel Cover (cabinet models only)	**Add $15**
Option 3—(D13 only) Fast Writing Speed Crt	**Add $25**
Option 76—(D10 and D12 only) P7 Phosphor	**No Charge**
Option 78—(D10 and D12 only) P11 Phosphor	**No Charge**

CONVERSION KITS

These oscilloscopes may be converted from one configuration to the other as applications change.

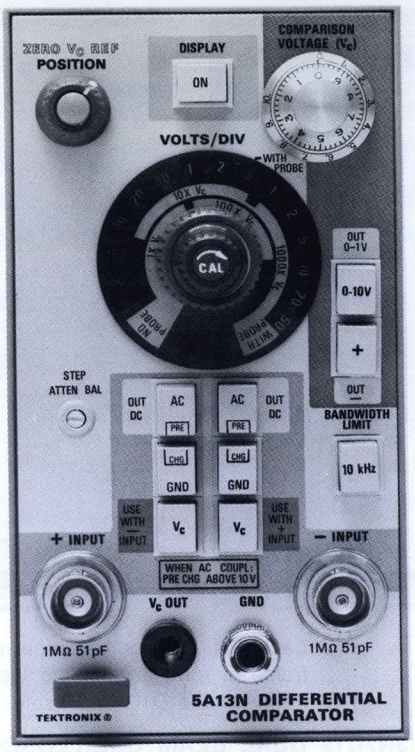
Cabinet-to-rackmount conversion kit order 040-0583-01	**$38**
Rackmount-to-cabinet conversion kit order 040-0584-02	**$38**

Dc-to-2 MHz Bandwidth

1 mV/div to 5 V/div

10,000:1 Cmrr

10,000 Div Effective Screen Height



The 5A13N is a differential comparator plug-in amplifier for the 5000-Series. It incorporates a number of performance features which make it particularly versatile, especially in multi-trace combination with other 5000-Series 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 utilizes its differential capabilities, but provides an accurate positive or negative internal offsetting voltage. A signal of up to ±10 V may be applied to an input (plus or minus) at a deflection factor setting of 1 mV/div and viewed in 10,000 divisions by offsetting the signal with the opposing comparison voltage. A ±1 V comparison voltage is also available for application requiring maximum resolution. The offset voltage may be externally monitored through a front panel output.

CHARACTERISTICS

Bandwidth—Dc to 2 MHz. Bandwidth Limit Mode, dc to 10 kHz. Ac Coupled, 2 Hz or less at the lower —3 dB point.

Deflection Factor— 1 mV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Input R and C— 1 MΩ, approx 51 pF.

Signal Range

Deflection Factor Settings	1 mV to 50 mV/div	0.1 V to 5 V/div
Common-Mode Signal Range	±15 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac at 1 kHz or less)	±350 V	±350 V
Max Ac Coupled Input (Dc Voltage)	±350 V	

Max Input Gate Current— 0.1 nA or less (equivalent to 100 μV or less, depending on external loading) at 25°C.

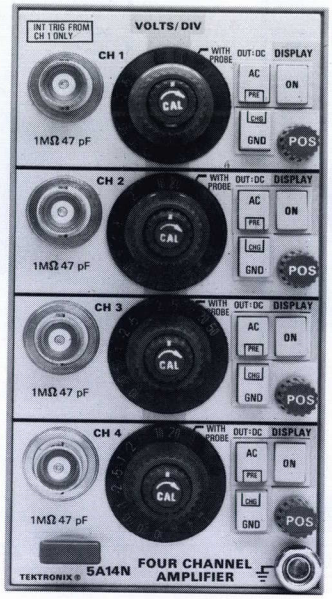
Overdrive Recovery— 1 μs to recover to within 3.0 mV and 0.1 ms to recover to within 1.5 mV after the removal of an overdrive signal between +15 V and —15 V, regardless of overdrive signal duration.

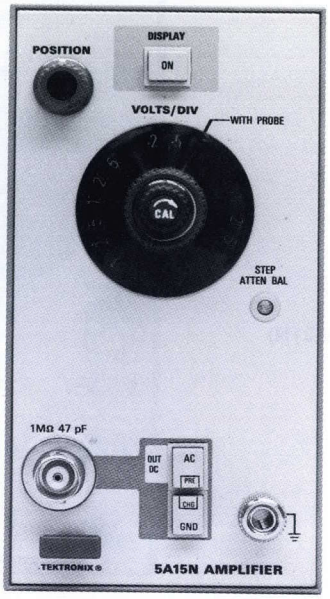
Internal Comparison Voltage—Ranges, 0 V to ±10 V, and 0 V to ±1 V. Accuracy, within 0.2% of dial setting plus 5 mV from ±1 V to ±10 V; within 0.2% of dial setting plus 1 mV from ±25 mV to ±1 V on the 0 V to ±1 V range. From 0 V to ±25 mV use the on-screen display for greater resolution. Vc output R, approx 15 kΩ.

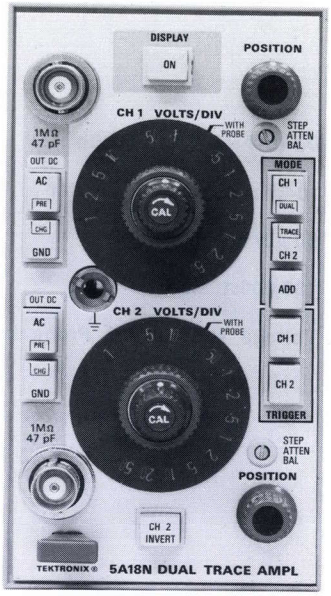
Common-Mode Rejection Ratio—At least 10,000:1, dc to 10 kHz at 1 mV/div to 50 mV/div dc coupled, with up to 20-volt peak-to-peak sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 V/div to 5 V/div dc coupled, with up to 100-volt peak-to-peak sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, cmrr is the same as stated for dc coupled. Below 5 kHz ac coupled, cmrr decreases to 400:1 at 10 Hz. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

5A13N Differential Comparator Amplifier **$565**

1 mV/Div to 5 V/Div







The 5A15N (single channel), 5A18N (two identical channels) and 5A14N (four identical channels) are amplifiers with solid-state circuits. Each features simplified front panel controls and can be used in the 5000-Series mainframes. These plug-ins may be used in combination for displaying up to eight traces. For instance, two 5A14N amplifiers provide eight traces; one each 5A14N and 5A15N amplifier provide five traces. Each amplifier may be used in the 5000-Series horizontal deflection plug-in compartment for X-Y operation.

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.

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 2 MHz (5A14N, 1 MHz) at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz (5A14N, 1 MHz) at all deflection factors.

Deflection Factor— 1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C— 1 MΩ within 1%, approx 47 pF.

Maximum Input—Dc coupled, 350 V (dc + peak ac). Ac coupled, 350 Vdc.

Chopping Rate (5A18N and 5A14N)— 25 kHz to 100 kHz depending upon plug-in combinations and number of traces displayed.

ORDERING INFORMATION

5A14N Four-Trace Amplifier **$595**
5A15N Single-Trace Amplifier **$130**
5A18N Dual-Trace Amplifier **$285**

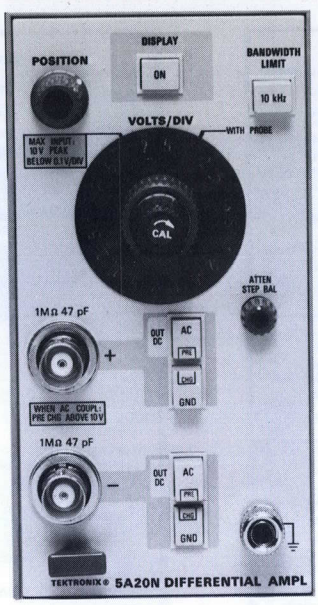
Dc-to-1 MHz Bandwidth

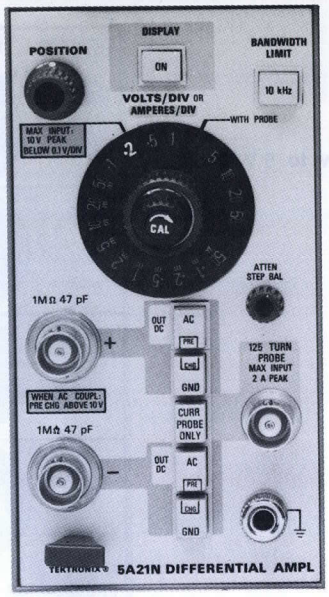
10-kHz Bandwidth Limiter

50 μV/div to 5 V/div

100,000:1 cmrr

Voltage and Current Probe Inputs (5A21N)





The 5A20N and 5A21N are 50 μV/div, dc coupled differential amplifiers for the 5000-Series. The units are identical except that the 5A21N has a current probe input. Each plug-in is compatible with each compartment of the 5000 Series Mainframes.

5A20N AND 5A21N VOLTAGE CHARACTERISTICS

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 2 Hz or less to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor— 50 μV/div to 5 V/div in 16 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C—Voltage mode, 1 MΩ within 0.15%, approx 47 pF.

Maximum Input Voltage

	Dc Coupled	Ac Coupled
50 μV/div to 50 mV/div	10 V (dc + peak ac)	350 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 sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sinewave. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

5A21N CURRENT PROBE INPUT CHARACTERISTICS (WITH P6021 CURRENT PROBE)

Bandwidth— 15 Hz or less, to at least 1 MHz. Bandwidth may be limited to 10 kHz.

Deflection Factor— 0.5 mA/div to 0.5 A/div in 10 calibrated steps (1-2-5 sequence). Accurate within 3%. Uncalibrated, continuously variable between steps and to 1.25 A/div.

Maximum Input Current— 4 A p-p (at probe loop) with 125-turn P6021 Current Probe.

Displayed Noise— 300 μA or less, tangentially measured. Performance characteristics are valid for the 5A20N and 5A21N from 0°C to +50°C.

ORDERING INFORMATION

5A20N Differential Amplifier **$185**
5A21N Differential Amplifier **$205**
P6021 5-FT Current Probe, order 010-0237-02 ..... **$100**
P6021 9-FT Current Probe, order 010-0244-02 ..... **$100**

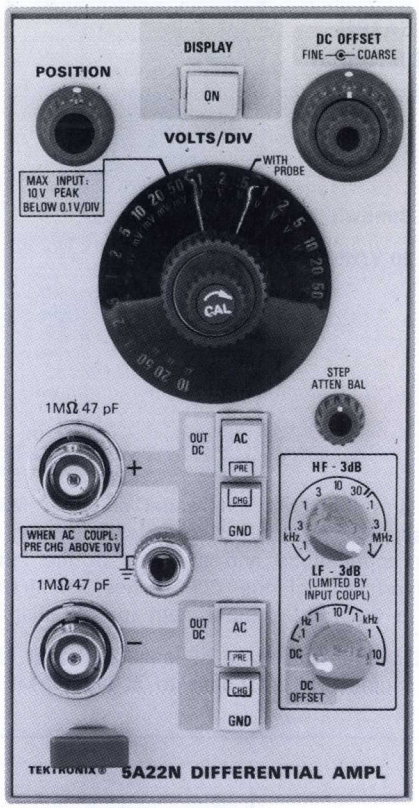
Dc-to-1-MHz Bandwidth

10 μV/div to 5 V/div

100,000:1 Cmrr

Selectable Upper and Lower —3 dB Points

Dc Offset



There are many factors which contribute to the usability and performance of this high-gain, wideband differential amplifier. Displayed noise (grounded inputs) is held to 20 μV or less at 10 μV/div, tangentially measured at full bandwidth. Since noise is related to bandwidth, the displayed noise can be greatly reduced with the HF —3 dB point selector. Low amplitude signals often ride a small dc component, perhaps a few millivolts, which would place a dc-coupled display 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 by using dc coupled inputs and low frequency limits selectable by a front panel switch. The same techniques are used to cancel a dc component from the signal being measured. Adding a dc voltage opposite in polarity to the polarity of the disturbing dc component is a third method. This is done by using the plug-in's variable dc offset. Full bandwidth is retained in this mode of operation. These and other factors make the 5A22N well suited for measurements in difficult, low-amplitude, low-frequency areas.

CHARACTERISTICS

Bandwidth—HF —3 dB point: selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz. 100 Hz to 0.3 MHz, accurate within 20% of selected frequency and at 1 MHz, bandwidth is down 3-dB or less. LF —3 dB point: selectable in 6 steps (1-10 sequence) from 0.1 Hz to 10 kHz, accurate within 20% of selected frequency. Ac coupled, 2 Hz or less.

Deflection Factor— 10 μV/div to 5 V/div in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Common-Mode Rejection Ratio—Ac coupled, 10 μV/div to 0.5 mV/div, at least 20,000:1 at 5 kHz and above, decreasing to 400:1 at 10 Hz. Dc coupled, at least 100,000:1, dc to 30 kHz from 10 μV/div to 100 μV/div with up to 20 V p-p sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, cmrr is at least 400:1 with up to 100 V p-p sinewave. Cmrr with two P6060 probes is at least 400:1 at any deflection factor.

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.

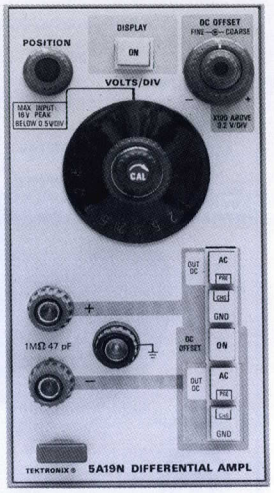
Max Input Gate Current— 200 pA or less.

Displayed Noise— 20 μV at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Drift With Temperature— 100 μV/°C or less.

5A22N Differential Amplifier **$450**

5A19N Differential Amplifier



Dc-to-2 MHz Bandwidth

1 mV/div to 20 V/div

Dc Offset

The 5A19N is a low cost differential amplifier featuring variable dc offset and simplicity of controls. It is ideal for monitor and systems applications and operates in the left or middle plug-in compartment of the 5000-Series mainframe for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth—Dc coupled, dc to at least 2 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 2 MHz at all deflection factors.

Deflection Factors—1 mV/div to 20 V/div in a 1-2-5 sequence. Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 50 V/div.

Input R and C— 1 MΩ within 0.3%, approx 47 pF.

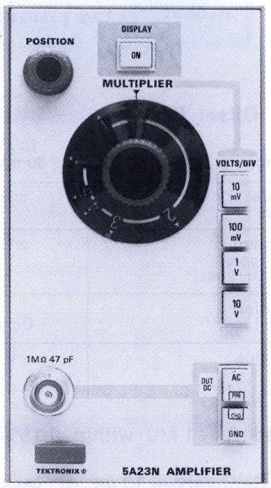
Signal and Offset Range

Deflection Factor Settings	1 mV/div to 200 mV/div	500 mV/div to 20 V/div
Common-Mode Signal Range	±16 V	±350 V
Max Dc Coupled Input (Dc + Peak Ac At 1 kHz Or Less)	±350 V	
Max Ac Coupled Input (Ac Voltage)	±350 V	
Dc Offset Range	+15 V to −15 V	+350 V to −350 V

Common-Mode Rejection Ratio—Dc coupled, 1 mV/div to 200 mV/div, at least 1000:1 from dc to 10 kHz; decreasing to 100:1 at 500 mV/div to 20 V/div.

5A19N Differential Amplifier **$170**

5A23N Amplifier



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

The 5A23N is a general-purpose amplifier for the 5000-Series Oscilloscopes. Featuring low cost and simplicity of controls, it is ideal for monitor and systems applications. It operates in the left or middle plug-in compartment of the 5000-Series mainframes for Y-T displays, or in the right compartment for X-Y displays.

Bandwidth—Dc coupled, dc to at least 1.5 MHz at all deflection factors. Ac coupled, 2 Hz or less to at least 1.5 MHz at all deflection factors.

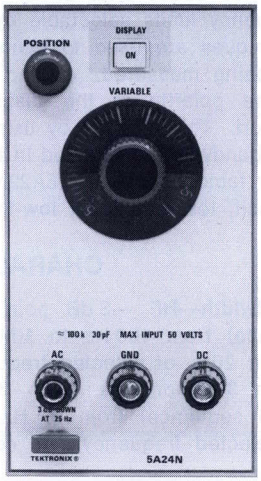
Deflection Factor— 10 mV/div to 10 V/div within 3% in 4 calibrated decade steps. A lighted multiplier control provides continuous variation between steps, and extends the deflection factor range to 100 V/div. Accuracy is within 5% at X2 and X5 multiplication.

Input R and C— 1 MΩ within 1%, approx 47 pF.

Maximum Input—350 volts (dc + peak ac).

5A23N Single-Trace Amplifier **$75**

5A24N Amplifier



50 mV/div to 1 V/div Deflection Factors

Easy to Customize

The 5A24N is a low-cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5000-Series mainframes. It contains mode switching, crt beam positioning, trigger pickoff for basic measurements, and a built-in 3⅜ x 2¾-inch soldering pad matrix for use by the customer who wishes to build his own input circuits for special applications. Customer-built circuits are powered through the circuit board which provides access to all mainframe power supplies.

Bandwidth—Dc coupled, dc to at least 2 MHz at 50 mV/div, decreasing to dc to 200 kHz at mid-attenutor range. Ac coupled, 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

Deflection Factor— 50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/div to at least 1 V/div.

Input R and C—Approx 100 kΩ, approx 30 pF.

Maximum Input— 50 volts (dc + peak ac).

5A24N Single-Trace Amplifier **$30**

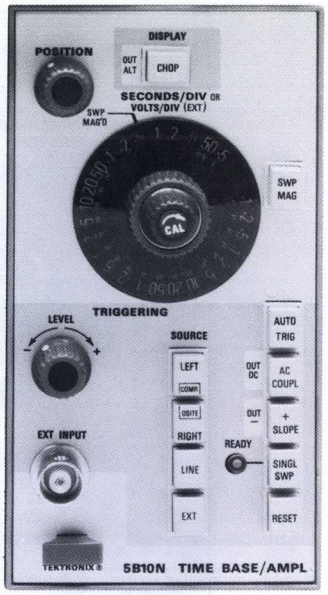
100 ns/div to 5 s/div Calibrated Time Base

Single Sweep

Direct Readout X10 Mag

Provides Alternate and Chopped Displays

50 mV/div and 500 mV/div Calibrated External Input



The 5B10N is a time base/amplifier plug-in unit for generating a sweep in the 5000-Series Oscilloscopes. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

Triggering the 5B10N is straightforward even with the many triggering modes which are push button selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

The 5B10N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartments as well.

CHARACTERISTICS

Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div, and within 4% at 2 s/div and 5 s/div. Magnified displays accurate within 1% in addition to specified time base sweep accuracy.

TRIGGERING

Coupling		To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External	200 mV	200 mV
Ac		Requirements increase below 50 Hz	

Auto Trig—Same as above except signal rate requirements are 15 Hz and above.

Single Sweep—Same as for ac and dc coupled.

External Trigger Input—Maximum input voltage is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div, accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

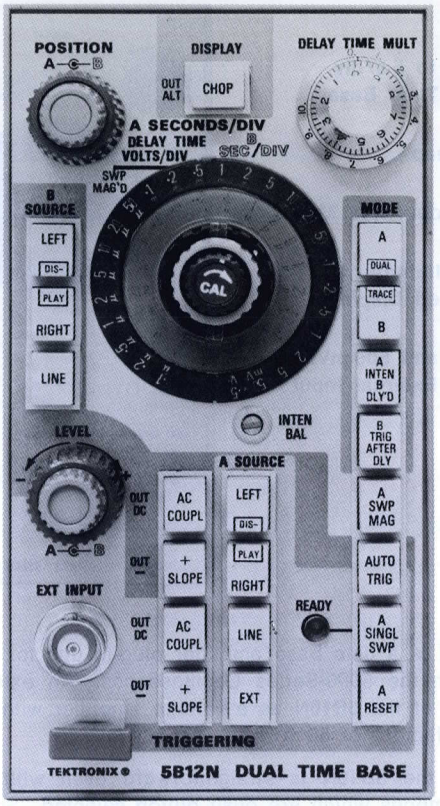
Maximum Input Voltage— 350 V (dc + peak ac).

5B10N Time Base/Amplifier **$195**

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

Dual and Delayed Sweep

Direct Readout X10 Mag



The 5B12N is a time base for generating single, dual or delayed sweeps in the 5000-Series Oscilloscopes. The 5B12N is normally used in the right hand plug-in compartment but is compatible with the vertical deflection compartments as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by push-button switches. Triggering sources for A and B sweep include left and right plug-in, line and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time.

When operated in the dual sweep mode in a dual-beam oscilloscope together with two amplifier plug-ins, first the A sweep and then the B sweep displays the signals from both amplifiers, therefore four traces will be displayed. Both sweeps are displayed simultaneously in Chop Mode.

When operated in the dual sweep mode in a single-beam oscilloscope together with two amplifier plug-ins, the A sweep is slaved to the left plug-in and the B sweep is slaved to the right plug-in.

The display mode push button selects Chop or Alternate time-share switching between vertical plug-ins and amplifier channels. Chop rate is 25 kHz to 100 kHz depending on plug-in combinations and number of traces displayed.

CHARACTERISTICS

A Sweep Rates— 1 μs/div to 5 s/div in 21 calibrated steps (1-2-5 sequence). X10 magnifier extends displayed sweep time/div to 100 ns. Uncalibrated, continuously variable between steps and to 12.5 s/div.

A Sweep Accuracy—Unmagnified, within 3% from 1 μs/div to 1 s/div and within 4% at 2 s/div and 5 s/div. Magnified, displays accurate within 1% in addition to specified time base sweep accuracy.

B Sweep Rates— 0.2 μs/div to 0.5 s/div in 20 calibrated steps.

B Sweep Accuracy—Within 3% from 1 μs/div to 0.1 s/div. Within 4% at 0.2 μs/div, 0.5 μs/div, 0.2 s/div and 0.5 s/div.

TRIGGERING

The following applies to the A and B trigger except as noted.

Coupling		To 1 MHz	At 2 MHz
Dc	Internal	0.4 div	0.6 div
	External*	200 mV	200 mV
Ac		Requirements increase below 50 Hz	

*A trigger only.

B sweep operates in triggered or free-run mode after delay time.

Auto Trig—Same as above on signal rates of 15 Hz and above.

The following characteristics apply to the A trigger only.

Single Sweep—Same as for ac and dc coupled.

External Trigger Input—Maximum input voltage is 350 V (dc + peak ac). Input R and C is 1 MΩ within 2% paralleled by ≈70 pF. Trigger level voltage range is +5 V to −5 V.

DELAYING SWEEP CHARACTERISTICS

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

Delay Time Multiplier Range—0.2 to 10.2 times the Time/Div setting.

Delay Time Multiplier Incremental Linearity—Within 0.2%.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% plus 2 minor dial divisions for 1 s to 5 s delay times.

Jitter—Less than 0.05% of the time represented by one division of the Delaying Sweep selected.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—Dc coupled, dc to at least 1 MHz. Ac coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 MΩ within 2%, approx 70 pF.

Maximum Input Voltage— 350 V (dc + peak ac).

5B12N Dual Time Base **$495**

1 μs/div to 100 ms/div Calibrated Time Base

External Horizontal Input

The 5B13N is a low-cost, general-purpose time base for the 5000-Series Oscilloscopes. Sweep rates are selected by push button. The 5B13N is for applications such as basic laboratory use by students, production testing, scientific research and other areas where 100 ms/div to 1 μs/div sweep rates are needed.

CHARACTERISTICS

Sweep Rates—1 μs/div to 100 ms/div within 5% in 6 calibrated decade steps. A lighted multiplier control provides continuous uncalibrated variation between steps, and extends the push-button selected rate to at least 1 s/div.

TRIGGERING

Coupling		Sensitivity and Frequency Range
Ac	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—Maximum input voltage is 200 V (dc + peak ac). Input R and C is approx 100 kΩ paralleled by approx 1000 pF. Trigger level voltage range is +1.5 V to −1.5 V.

EXTERNAL HORIZONTAL INPUT

Deflection Factor— 50 mV/div, accurate within 5%. A continuously variable deflection factor multiplier provides variation between 50 mV/div and 0.5 V/div.

Bandwidth—Dc to at least 100 kHz.

Input R and C—Approx 50 kΩ, approx 1000 pF.

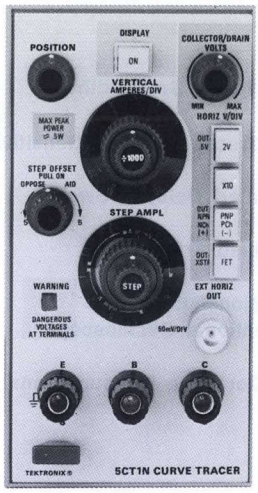
Maximum Input Voltage— 200 V (dc + peak ac).

5B13N Time Base **$95**

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 used in TEKTRONIX 5000-Series Oscilloscope systems for displaying characteristic curves of semiconductor devices to power levels up to 0.5 watts. The plug-in operates in either vertical deflection compartment of the mainframe. Horizontal deflection is achieved through a front panel source which drives the external input of either an amplifier or 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 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are 1 μA/step to 1 mA/step for current and 1 mV/step to 1 V/step for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.

5CT1N Curve Tracer **$375**

See complete description on page 226.

Dc-to-1 GHz Bandwidth

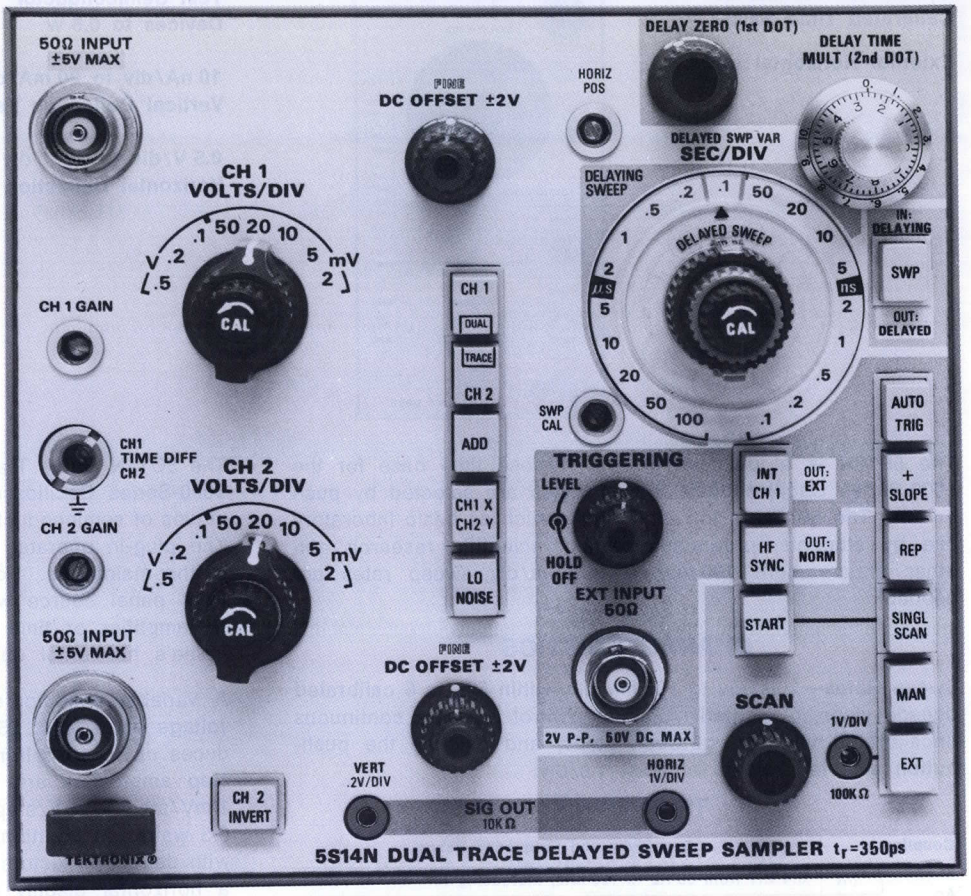
Dual Trace, 2 mV/div Sensitivity

Calibrated Delayed Sweep

Simplified Triggering

Operational Ease of a Conventional Oscilloscope

Two Dot Time Measurements



The 5S14N Sampling Unit combines amplifier and time-base functions in one double width plug-in unit designed to operate in all 5000-Series mainframes. Combining the Sampling amplifier and time-base functions in one plug-in enables the 5S14N to provide new economy and ease of operation.

Two identical amplifier channels provide dual trace sampling. A two-ramp time base introduces calibrated delayed sweep operation to sampling in an inexpensive package.

A new and unique feature is a system for making two-dot time-interval measurements. This feature provides an easy and accurate means for measuring the time between two points on a waveform. One bright dot on the trace is positioned with the Delay Zero control to the start of an event to be measured. Next a second bright dot is positioned by the Delay Time Multiplier Control to the end of the event. The time-interval between the selected points is then determined by multiplying the number read directly from the Delay Time Mult Dial by the selected time per division.

Front-panel control grouping is identified by different shades of color on the panel and the control nomenclature relates closely to that encountered in conventional oscilloscopes. Learning to operate the 5S14N requires a minimum effort for those familiar with conventional oscilloscope operation.

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.

Risetime—350 ps or less.

Step Aberrations—+2%, −3%, total of 5% p-p within first 5 ns, ±1% thereafter, tested with 284 Pulse Generator.

Deflection Factor—2 mV/div to 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%.

Maximum Input Voltage—±5 V.

Input Signal Range—2 V p-p maximum within a +2 V to −2 V window at any sensitivity.

Dc Offset Range—At least +2 V to −2 V.

Displayed Noise—2 mV or less unsmoothed (Tangentially measured). Low noise push button reduces random noise by factor of 4 to 1 or more.

Vertical Signal Output—0.2 V/div of vertical deflection; 10-kΩ source resistance.

Channel Delay Difference—Adjustable to zero or for any time difference up to at least 1 ns.

TIME BASE CHARACTERISTICS

Scan Modes—Repetitive, Single, Manual or External.

Delaying Sweep—May be used as the crt time base or as a delay generator for the Delayed Sweep. The sweep starts with minimum delay from the instant of trigger recognition. When the Delaying Sweep mode is selected for the time base, two bright dots in the trace are generated which may be positioned anywhere on the displayed waveform. The time between dots is equal to the reading on the Delay Time Multiplier dial multiplied by the time/div.

Delayed Sweep—This mode is used when the signal to be displayed occurs considerably later than the instant of trigger recognition or when the time must be 5 ns or less per division. The Delayed Sweep may be started with zero delay time with respect to the start of the Delaying Sweep. Or the start may be delayed by any time interval up to that represented by ten divisions of the Delaying Sweep selected.

Horizontal Signal Output— 1.0 V per div of horizontal deflection; 10-kΩ source resistance.

DELAYING SWEEP CHARACTERISTICS

Range—10 ns/div to 100 μs/div in 13 steps (1, 2, 5 sequence).

Accuracy—Within ±3%, excluding first ½ division of displayed sweep.

Delay Zero (1st Dot)—Adjustable to correspond to any instant within the time interval represented by the first nine divisions of the Delaying Sweep selected.

Delay Time (2nd Dot)—Adjustable to any portion of the time interval represented by ten divisions of the Delaying Sweep selected.

Delay Accuracy—Within ±1% of ten divisions when measurement is made within the last 9.5 divisions.

DELAYED SWEEP CHARACTERISTICS

Range—100 ps/div to 100 μs/div in 19 calibrated steps (1, 2, 5 sequence). Variable between steps by at least 2.5 to 1.

Accuracy—Within ±3% excluding first ½ division of displayed sweep.

Start Delay—Depends on the Delaying Sweep time selected and the setting of the Delay Time Mult dial. Adjustable from Zero to any time interval up to that represented by ten divisions of the Delaying Sweep selected. The Delaying Sweep start point corresponds to the second bright dot position.

Delay Jitter—Less than 0.05% of the time represented by one division of the Delaying Sweep selected.

TRIGGERING AND SYNC CHARACTERISTICS

Signal Sources—Internal from channel 1 vertical input or external through front-panel connector.

External Triggering—Nominal 50 Ω input, ac coupled, 2 V p-p, 50 V dc maximum. Trigger pulse amplitude 10 mV p-p or more with risetime of 1 μs or less, 10 Hz to 100 MHz. Sinewave amplitude 10 mV p-p or more from 150 kHz to 100 MHz.

Internal Triggering—Pulse amplitude 50 mV p-p or more with risetime of 1 μs or less. Sinewave amplitude 50 mV p-p or more from 150 kHz to 100 MHz.

Triggered Mode—Trigger recognition may be made to occur at any selected voltage level between +.5 V and —.5 V at instants when either a + slope or a — slope of the triggering signal crosses that level.

Auto Triggered Mode—For small signals or when there may be no triggering signal. Sampling pulses are automatically generated at a low rate in the absence of a triggering signal so a trace may always be generated and displayed. The trigger level range automatically adjusts to approximately the peak-to-peak voltage of the signal.

Holdoff—Varies the length of the time interval during which recognition is inhibited. Variation is at least 5 to 1. The control is particularly useful for displaying digital words when triggering on binary pulses.

HF SYNC Mode—For sinewaves from 100 MHz to 1 GHz, 10 mV p-p or more from external source, 50 mV p-p or more from internal pickoff.

Order 5S14N Dual Trace Delayed Sweep Sampler $1850
5103N/D10 Oscilloscope, Order 5110 ..... $ 595
5103N/D11 Storage Oscilloscope, Order 5111 ..... $1095

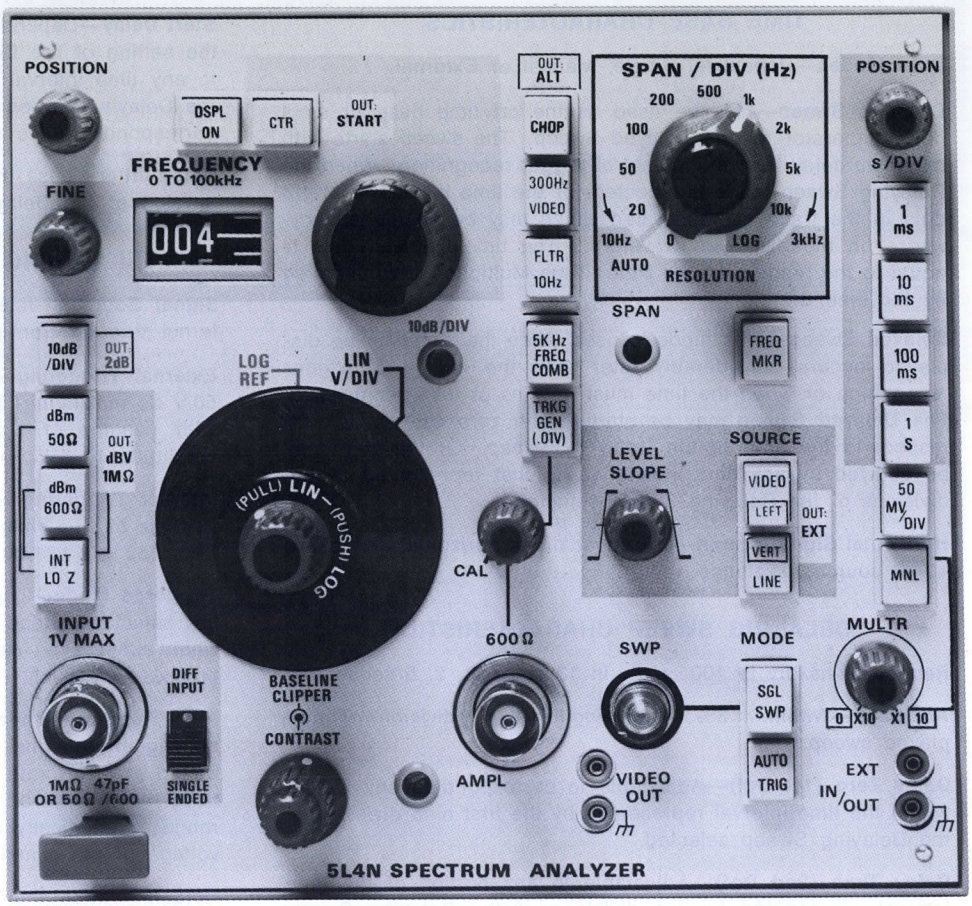
Low Cost

0-100 kHz Frequency Range

Resolution Bandwidth 10 Hz to 3 kHz

Log and Linear-Span Modes

Auto Resolution



The new 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 100 Hz over a 1 hour 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 can also be selected. At zero frequency span setting the 5L4N can be used for time domain displays.

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.

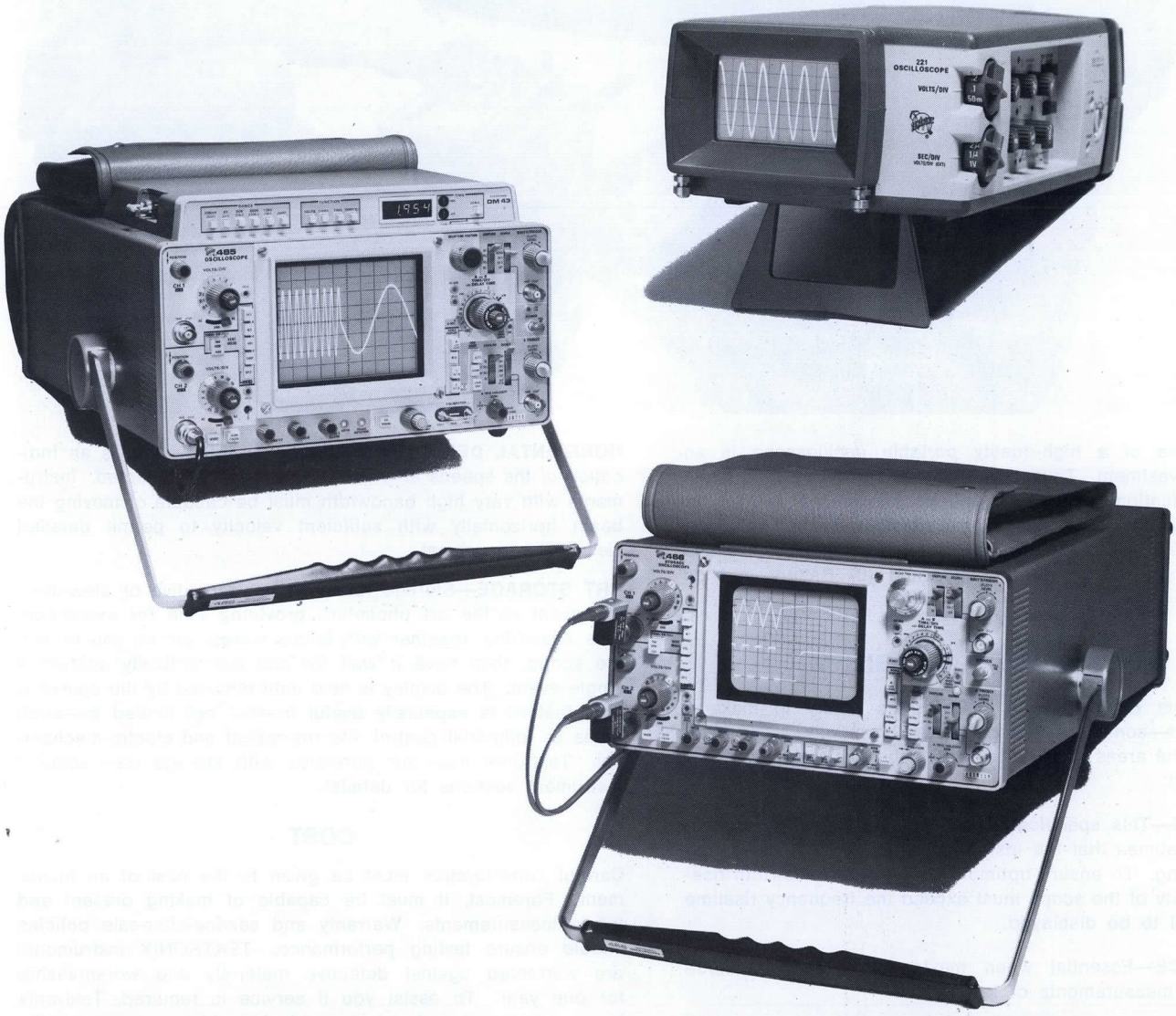
This low-frequency swept-front-end spectrum analyzer operates with any 5000-series oscilloscope, using two of the three mainframe compartments. A recommended combination consists of the 5L4N Spectrum Analyzer plug-in with the TEK 5103N/D11 Storage Oscilloscope. This high performance, attractively priced 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 on pages 202 and 203.

5L4N Spectrum Analyzer **$1950**

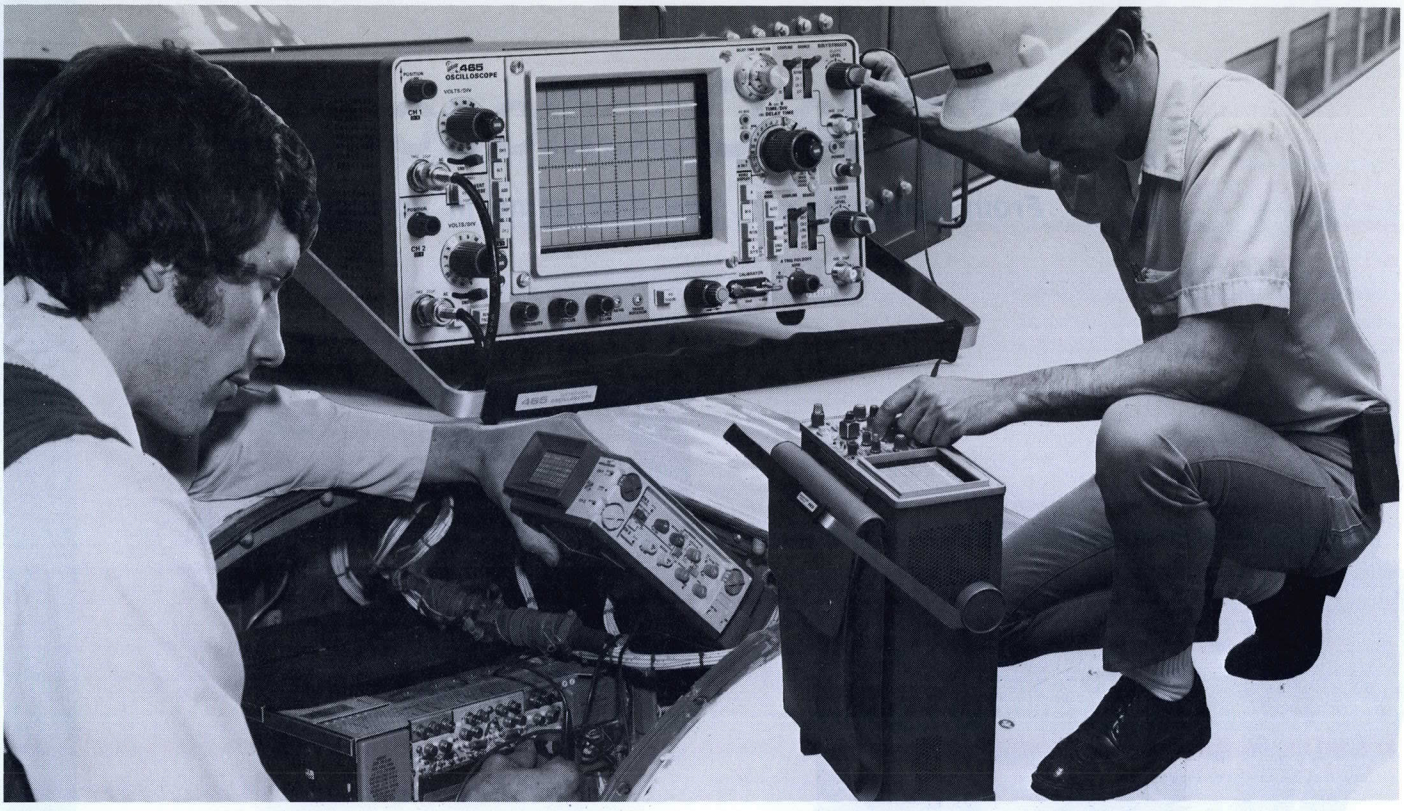
Portable Oscilloscopes

From Tektronix . . . the first name in portables



Portability . . . it's more than just a catch phrase at Tektronix, where for more than 20 years we've been perfecting the concept that laboratory-standard measurements can be made in the field as well as on the bench. TEKTRONIX portables are engineered to combine minimum weight with rugged durability, operator ease with measurement versatility, power-source selection with mobility — all with measurement standards equalling or surpassing the finest laboratory instruments.

The following pages describe three series of portable oscilloscopes. The 400-Series offers wide-bandwidth, laboratory-quality measurements from instruments weighing in the 20-pound range. The 300-Series from Sony/Tektronix Corporation offers mid-range measurement capability. And, the 200-Series miniscopes, weighing just 3.5 pounds including internal batteries, battery chargers, power cords and probes, introduces oscilloscope measurements into a broad range of application areas.



The purchase of a high-quality portable oscilloscope is an important investment. Thus, careful consideration must be given to your application or range of applications—present and future. The following are some areas to be considered when selecting a portable: (1) Measurement Capability; (2) Cost; (3) Size and Weight; (4) Durability; (5) Mobility; and (6) Battery and dc Operation.

MEASUREMENT CAPABILITY

Many aspects enter into an instrument's ability to make a measurement—some are more important than others. The following are the areas considered most important to making your measurement:

BANDWIDTH—This specification reflects the range of frequencies and risetimes that the instrument is capable of measuring and displaying. To ensure optimum fidelity, the bandwidth risetime capability of the scope must exceed the frequency risetime of the signal to be displayed.

DUAL TRACE—Essential when making time and amplitude comparison measurements of two 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 DEFLECTION SWEEP SPEEDS—This is an indication of the speeds at which the crt beam is deflected. Instruments with very high bandwidth must be capable of moving the beam horizontally with sufficient velocity to permit detailed viewing of the signal.

CRT STORAGE—Storage retains a non-repetitive or slow-moving event in the crt phosphor, providing time for inspection. This capability, together with single sweep, allows you to arm the scope, then have it wait for and automatically capture a single event. The display is held until removed by the operator. This feature is especially useful in—but not limited to—such areas as industrial control, electro-optical and electro-mechanical. Tektronix has four portables with storage (see specific instrument sections for details).

COST

Careful consideration must be given to the cost of an instrument. Foremost, it must be capable of making present and future measurements. Warranty and service-after-sale policies should ensure lasting performance. TEKTRONIX instruments are warranted against defective materials and workmanship for one year. To assist you if service is required, Tektronix has service centers located world-wide. Many years of satisfactory performance can be gained by conducting a thorough value analysis of the product prior to purchase.

DIGITAL MEASUREMENTS

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.

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 digital display of sweep delay times is needed to augment the basic oscilloscope.

Tektronix, this year, adds a new dimension to portable oscilloscopes—a digital multimeter installed within the portable cabinet of a 464, 465, 466 or 475 oscilloscope. The DM40 and DM43 display voltage, resistance or delay time on a 3½-character digital 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 of the oscilloscope.

A discussion of both portable oscilloscope-dmms and their operating characteristics begins on page 145.

SIZE & WEIGHT

The accessibility of the equipment to be repaired dictates size and weight requirements. Some applications require that the scope be used in and around heavy equipment; that it be carried on catwalks, cranes, trucks etc. Other situations require transport over great distances. The TEKTRONIX 200 and 300 series have convenient neck straps which free both hands. The 200 series are small, light-weight and easily fit into a toolkit, briefcase or glove compartment. At about 25 pounds, the 400 series offer unequalled performance for their size.

DURABILITY

Before an instrument can be considered portable, it must be designed and constructed to withstand the extremes associated with mobility—it must be rugged.

Vibration and shock tolerance are important parameters. TEKTRONIX portables withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles while operating. They also withstand shock of 30 g's, half sine, 11 ms duration, (200 series is 150 g's, half sine, 2 ms) two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Selectively, they are humidity tested using MIL-E-16400 F as a guide. The test consists of subjecting the instrument to relative humidities between 90 and 95% while varying the temperature over a 25°C to 60°C range. Five cycles of this rising and lowering temperature (each cycle covering 24 hours) are performed.

The following chart is provided as a quick reference to finding the instrument which best fits your needs.

TEKTRONIX PORTABLES SELECTION GUIDE

Product	Page	Storage	Bw	Deflection Factor	Dual Trace	Delayed Sweep	Sweep Rate (With Mag)	Mag	Battery Power	Display Size
211	163		500 kHz	10 mV/div @ BW 1 mV/div Min			1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
212	163		500 kHz	10 mV/div @ BW 1 mV/div Min	Yes		1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
214	163	Yes	500 kHz	10 mV/div @ BW 1 mV/div Min	Yes		1 μs/div	X5	Yes Int.	6 x 10 div 0.2 in/div
221	161		5 MHz	5 mV/div @ BW 1 mV/div Min			0.1 μs/div	X10	Yes Int.	6 x 10 div 0.2 in/div
323	159		4 MHz	10 mV/div @ BW 1 mV/div Min			0.5 μs/div	X10	Yes Int.	6 x 10 div ¼ in/div
326	157		10 MHz	10 mV/div @ BW 1 mV/div Min	Yes		0.1 μs/div	X10	Yes Int.	8 x 10 div ¼ in/div
434/ R434	155	Yes	25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50	Yes w/1105	8 x 10 div 0.98 cm/div
464	151	Yes	100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes w/1106	8 x 10 div 0.90 cm/div
465/ R465	147		100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes w/1106	8 x 10 div 1 cm/div
466	151	Yes	100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes w/1106	8 x 10 div 0.90 cm/div
475/ R475	147		200 MHz	2 mV/div @ BW 2 mV/div Min	Yes	Yes	1 ns/div	X10	Yes w/1106	8 x 10 div 1 cm/div
485/ R485	141		350 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	1 ns/div		Yes w/1105	8 x 10 div 0.8 cm/div
DM40	145	Digital Multimeter, for 464, 465, 466 and 475.								
DM43	145	Digital Multimeter, with temperature measurement capability, for 464, 465, 466 and 475.								
1105	150	Battery Power Supply								
1106	150	Battery Pack for 464, 465, 466 and 475								
821	166	Word Recognizer								
DD501	165	Digital Delay								

These instruments are tested to operate at an altitude up to 15,000 feet and they can be carried, non-operating to 50,000 feet.

TEKTRONIX portables operate over a temperature range of —15°C to +55°C and can be stored for long periods from —55°C to +75°C. For those instruments with internal batteries, the storage temperatures are —40°C to +60°C.

Some portables (400 Series) are available which comply with the electromagnetic interference specifications described in MIL-I-6181D. This specification limits the radiated interference between 150 kHz and 1 GHz, and it limits the interference conducted through the power cord between 150 kHz and 25 MHz.

Consistent with quality, TEKTRONIX portables are tested to meet all of these rigid physical and electrical requirements.

MOBILITY

Beyond size and weight, a portable oscilloscope should be equipped for convenient carrying and viewing. All TEKTRONIX portables are designed to be carried comfortably in a position that places the front panel in the horizontal plane. This allows the unit to be placed on the floor with the crt in a position for convenient viewing.

Many portables use their handles as tilt stands for bench-top use. These handles should have sufficient positions to permit convenient viewing and they should lock firmly into the desired position. The 300 Series, friction lock to the desired position. The 400 Series have 13 convenient self-locking positions; and in all cases, the handles swing out of the way when not in use. The 200 Series have a special flip stand to tilt the instruments upward.

BATTERY AND DC OPERATION

Whether battery operation is required depends upon the availability of commercial power, or whether operation while isolated from the line or ground is desired. All of TEKTRONIX portables can be battery powered. Some have internal batteries while others are operated from the free-standing 1105 Battery Power Supply. The 1105 offers the convenience of providing battery capability only when required.

In some applications only dc power is available. The 464, 465, 466, and 475 Option 7 can be operated from 12 or 24 Vdc in addition to operating from a detachable battery pack. All of the 300 Series have internal batteries and can be powered from external dc sources ranging from 6 to 32 Vdc (See specific instrument for details). The 432 and 434 operate from external dc sources ranging from 105 to 250 Vdc. All of these scopes operate from conventional ac sources of 115 and 230 Vac, 50 and 60 Hz (most will operate to 440 Hz).

Discussion of many innovative features has been deferred to specific instrument sections. Some are: trigger view, alternate sweep switching, delayed and mixed sweep, deflection factor readout, automatic deflection factor readout adjustment with attenuating probes, automatic focus, adjustable trigger hold-off and more. A broad range of flexibility equips these scopes for any portable application.

DIGITAL SERVICING

For those employing portable oscilloscopes in digital equipment servicing and design, Tektronix has added two digital servicing aids whereby "analog answers to digital problems" become simple operations. Digital Delay, DD501, provides a delayed trigger dependent upon the occurance of selectable number of digital events. The 821 Word Recognizer provides a trigger dependent upon the occurance of a selected 4-bit logic word. Furthermore the 821 can operate as a logic probe or logic driver.

Details on TEKTRONIX digital servicing aids begin on page 165.

350 MHz at 5 mV/Div

1 ns/Div Sweep Rate

6.0 Div/ns Writing Speed

Alternate Switching Between Intensified and Delayed Sweeps

1-MΩ and 50-Ω Input Impedances

Input Protection 50-Ω Internal

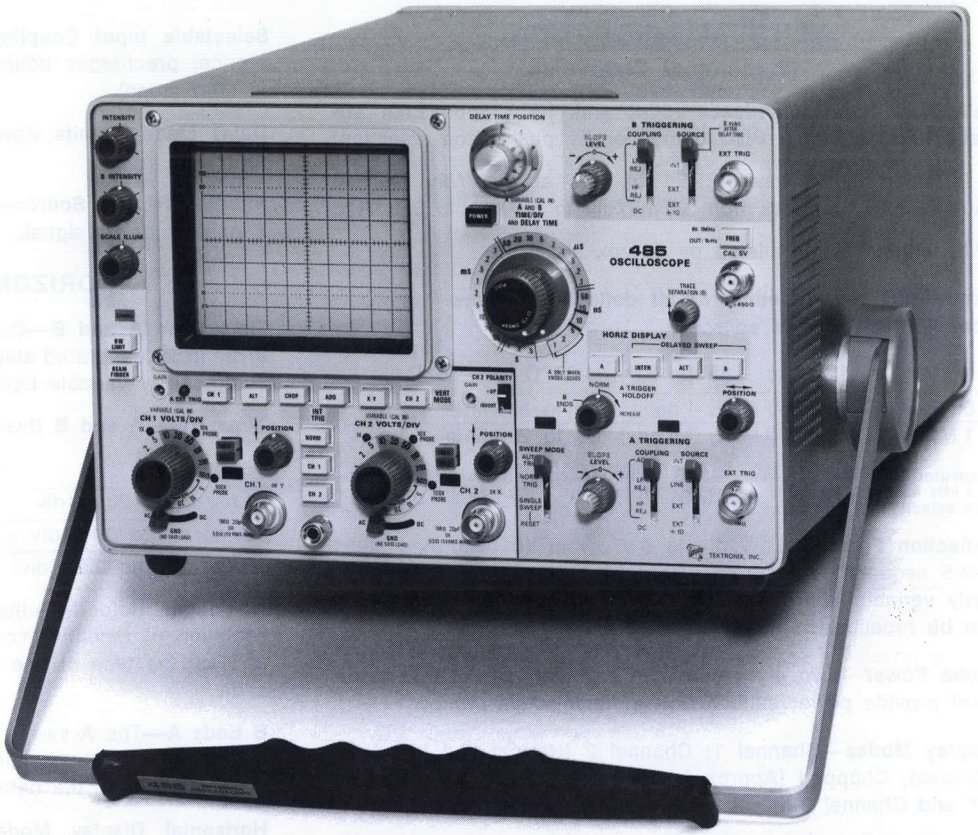
Automatic Deflection Factor Readout

Auto Focus

Variable Trigger Holdoff

Push Button Ext Trigger View

Weighs Only 21 Pounds



The 485 is a 350 MHz, 1 ns/div portable dual-trace oscilloscope weighing 21 lbs, the lightest weight wide-band portable oscilloscope on the market today. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, adjustable trigger holdoff, EXT TRIG display, alternate delayed sweep, with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control. Single-function 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 volts/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 auto-focus circuit makes it unnecessary to readjust the focus each time the intensity is changed. The focus will always be correct in single shot photography. A beam current limit circuit protects the crt phosphor from high intensity burns.

A new approach to battery operation is offered with the 1105 Battery Power Supply. The 485 can be powered for over 2 hours with this stand-alone power supply. Internal batteries add weight and are not required when commercial power is available. With the 1105, batteries are carried only when necessary.

VERTICAL DEFLECTION

(2 Identical Channels)

Selectable Input Impedance—50-Ω and 1-MΩ impedance are available at a single BNC connector by pushbutton selection.

50 Ω within 0.5%; vswr 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 5 V/div to 350 MHz.

1 MΩ within 1% paralleled by approx 20 pF.

Bandwidth* and Risetime at all deflection factors from 50-Ω terminated source

	−15°C to +35°C	+35°C to +55°C
50 Ω	Dc to 350 MHz, 1 ns	Dc to 300 MHz, 1.2 ns
1 MΩ	Dc to 250 MHz, 1.4 ns	Dc to 200 MHz, 1.8 ns

*Measured at −3 dB. Lower −3 dB point, ac coupled from 50 Ω source, is 1 kHz or less for 50 Ω and 10 Hz or less for 1 MΩ. 20 MHz bandwidth limit selection is provided.

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Probe Power—Two 4-pin connectors at the rear of the instrument provide power suitable for optional active probes.

Display Modes—Channel 1; Channel 2 (Normal and Inverted); Alternate; Chopped (Approx 1-MHz rate); Added; X-Y (Channel 1-Y and Channel 2-X).

Automatic Scale Factor—Probe tip deflection factors for 10X and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

50-Ω Protection—Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 volts. The "disconnected" condition is indicated, and has manual reset.

Maximum Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approximately: 5 V rms continuous. 0.1 watt-second for instantaneous voltages of 5 V to 50 V.	
	Ac Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
1 MΩ	Dc Coupled	250 V (dc + peak ac), 500 V p-p to 1 kHz.
	Ac Coupled	500 V (dc + peak ac), 500 V p-p to 1 kHz.

Selectable Input Coupling—Ac; dc; GND (provides zero reference, precharges coupling capacitor, disconnects 50-Ω load in 50-Ω mode).

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signals), Channel 1 or Channel 2 signal.

HORIZONTAL DEFLECTION

Time Base A and B—Calibrated sweep range; 1 ns/div to 0.5 s/div in 27 calibrated steps (1-2-5 sequence). Uncalibrated A is continuously variable between steps and to at least 1.25 s/div.

Time Base A and B Sweep Accuracy

Sweep Rate	+15°C to +35°C	−15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

A Trigger Holdoff—Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for sweeps faster than 0.2 s/div.

B Ends A—The A sweep is reset at the end of the B sweep to allow the fastest possible sweep repetition rate for increased trace intensity in the delayed sweep mode.

Horizontal Display Modes—A, Intensified, Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2 and 5 ns/div.

Alternate Display Modes—Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed) sweep approx 4 div from the A sweep.

CALIBRATED SWEEP DELAY

Delay Time Range—0 to 10 times Delay Time/Div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	±(1% of measurement +0.2% of full scale)
50 ns/div to 1 ms/div	±(0.5% of measurement +0.1% of full scale)
2 ms/div to 0.5 s/div	±(1% of measurement +0.1% of full scale)

Full scale is 10 times the Delay Time/Div setting.

Jitter— 1 part or less in 20,000 of 10X the Time/Div setting.

TRIGGERING A and B

A Trigger Modes—Normal, sweep runs when triggered. Automatic, sweep free-runs in the absence of a triggering signal and for signals below 20 Hz. Single Sweep, sweep runs one time on the first triggering event after the reset selector is pressed.

B Trigger Modes—B Runs After Delay Time, starts automatically at the end of the delay time. B Triggerable After Delay Time, runs when triggered. The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A & B Trigger Sensitivity

Trigger Mode		To 50 MHz	To 350 MHz
Dc	Internal	0.3 div deflection	1.5 div deflection
	External	20 mV	100 mV
Ac		Signals below 16 Hz are attenuated	
Ac Lf Reject		Signals below 16 kHz are attenuated	
Ac Hf Reject		Signals below 16 Hz and above 50 kHz are attenuated	

A External Trigger Display—A momentary push button selector overrides other vertical controls and displays the external signal being used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive and negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for EXT ÷ 10.

A Sources—Internal, line, external, external ÷ 10.

B Sources—B Runs After Delay Time, internal, external, external ÷ 10.

External Inputs— 1 MΩ paralleled by approx 20 pF. Maximum input voltage; 500 V (dc + peak ac), 500 v p-p to 1 kHz.

Jitter—0.1 ns or less at 350 MHz and 1 ns/div.

X-Y OPERATION

Full Sensitivity X-Y (CH 1-Y, CH 2-X)— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Y-axis bandwidth identical to Channel 1. X-axis bandwidth is dc to at least 4 MHz —3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

CRT

Crt— 4-inch rectangular tube; 8 x 10-div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P11 optional without extra charge; 21-kV accelerating potential.

Photographic Writing Speed—At least 3 div/ns with standard P31 phosphor and at least 6 div/ns with optional P11 phosphor using the TEKTRONIX C-31-R Camera and Polaroid type 410 film.

Auto Focus—Automatically maintains beam focus for all intensity settings.

Graticule—Internal, no parallax; variable edge lighting; markings for measurement of risetime. Graticule is dark with illumination off.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls.

External Z-Axis—Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (dc to 20 MHz) blanks trace of average intensity. +2 V (dc to 2 MHz) blanks maximum intensity trace.

Beam Current Limit—Automatically limits the average beam current to protect the crt phosphor.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: —15°C to +55°C. Filtered forced air ventilation is provided. Storage: —35°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator—Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω 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, approximately 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs—Open circuit, approximately 4 V positive-going rectangular pulse; into 50 Ω, approx 0.5 V.

Power Requirements—Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 watts maximum power consumption at 115 V. Line frequency 48 to 440 Hz.

485 350-MHz Portable Dual-Trace Oscilloscope

	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-inch 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 **$4200**

R485 Oscilloscope, 7-in rack model **$4240**

485-1 or R485-1 Oscilloscope, without A Ext Trig Display ..... **Sub $100**

485-2 or R485-2 Oscilloscope, without A Ext Trig Display and with 50-Ω input only instead of selectable input impedance ..... **Sub $350**

INSTRUMENT OPTIONS

Option 4, Emi Modification ..... **Add $20**
The 485 may be ordered to meet the interference specification of MIL-I-6181D over the following frequency ranges: Radiated from the instrument under test (with included crt mesh filter installed) —150 kHz to 1 GHz; conducted through the power cord —150 kHz to 25 MHz.

Emi modified instruments include the standard accessories plus the following: BNC covers and retainers (200-0678-00 and 346-0045-00); mesh filter (378-0648-00).

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

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability and provide added convenience.

Current Loop Adapter—The adapter provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is approximately 25 ns.
Order 012-0341-00 ..... **$20.00**

50-Ω 5X Pad—Provides reverse termination for the calibrator.
Order 011-0060-02 ..... **$20.00**

Folding Viewing Hoods—Improves viewing in high ambient light conditions.
Folds to 7/16 x 4-1/4 x 7-1/2 inches.
Order 016-0274-00 ..... **$ 7.00**

Folds to 9/16 x 6-3/4 x 13-3/4 inches.
Order 016-0082-00 ..... **$11.00**

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 Frame/Corrector Lens 016-0306-00).
Order C-30A-P Option 1 ..... **$560.00**

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 **$695.00**

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 **$750.00**

SCOPE-MOBILE Cart—Occupies less than 18 inches aisle space, has storage area in base.
Order 200 ..... **$125.00**

1105 Battery Power Supply—Provides 2.3 hours of battery operation. See Page 150 for complete description.
Order 1105 Battery Power Supply **$525.00**

PROBES

Probes are not supplied with the 485. Probes should be ordered separately according to the application.

	Probe Type	Attenuation	Input Impedance	Lower —3 dB Point Ac Coupled	Bandwidth with 485	Order		Price
50-Ω Input	P6056	10X	500 Ω 1 pF	200 Hz	350 MHz	Std Opt 2	010-6056-03 — 6 ft 010-6056-05 — 9 ft	$55 $55
	P6057	100X	5000 Ω 1 pF	20 Hz	350 MHz	Std Opt 2	010-6057-03 — 6 ft 010-6057-05 — 9 ft	$55 $55
	P6201 (FET Probe)	1X 10X } Plug-on 100X } Plug-on	100 kΩ 3 pF 1 MΩ <1.5 pF 1 MΩ <1.5 pF	10 Hz 1 Hz 10 Hz	330 MHz	Std	010-6201-01 — 6 ft	$395
1-MΩ Input	P6053B	10X	10 MΩ 9.5 pF 12 pF 13.5 pF	1 Hz	250 MHz 250 MHz 200 MHz	Opt 1 Std Opt 2	010-6053-11 — 3.5 ft 010-6053-13 — 6 ft 010-6053-15 — 9 ft	$65 $65 $65

Refer to probe section of catalog for more detailed specifications.

Digital Multimeter/with temperature

A DMM within a portable

NEW
DM40
DM43

Time Interval Measurement

Dc Volts, 200 mV to 1200 V

Ohms, 200 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 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 push buttons 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 needs to make no 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 (see page 147), or of the storage 466 or 464 (see page 151). 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 retrofitted packages.)

CHARACTERISTICS

All characteristics apply to both DM40 and DM43 except where indicated.

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.

Maximum 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, 200 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.

Maximum 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° to +125°C	+125° to +150°C
Accuracy	Within 2°C	Within 3°C	Within 3°C	Within 4°C

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.

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)
Weight (approx)		
Net (without panel cover)	26.5 lb (12.0 kg)	28.0 lb (12.7 kg)
Net (with panel cover accessories and accessories pouch)	29.5 lb (13.4 kg)	31.0 lb (14.0 kg)
Shipping	37.0 lb (16.7 kg)	38.9 lb (17.6 kg)

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 $2215
465 DM43 Oscilloscope/multimeter with temp. $2300
475 DM40 Oscilloscope/multimeter $3040
475 DM43 Oscilloscope/multimeter with temp. $3125
464 DM40 Storage oscilloscope/multimeter $3690
464 DM43 Storage oscilloscope/multimeter with temp. $3775
466 DM40 Storage oscilloscope/multimeter $4240
466 DM43 Storage oscilloscope/multimeter with temp. $4325

(See instrument discussions on following pages for additional instrument options)

OPTIONAL ACCESSORIES

Test leads (order 012-0427-00) $11

475 pictured above is identical in appearance to the 465 (not shown) except the 465 deletes the 0.01 and 0.02 μs TIME/DIV and 2 mV VOLTS/DIV switch positions.

200 MHz at 2 mV/div (475)	**8 x 10-cm Calibrated Display**	**Bandwidth Limiting**
1 ns/Div Sweep Rate (475)	**Easy-to-Operate**	**Versatile Trigger Selection**
100 MHz at 5 mV/Div (465)	**Trigger View**	**Battery Operation**
5 ns/Div Sweep Rate (465)	**Automatic Volts/Div Readout**	**Delayed Sweep**

The need to view and accurately measure complex nanosecond signals on customer locations or in a "field" environment is commonplace and expected. The new 465 and 475 have been specifically designed to be easy to use and meet the high performance and portable demands of these applications.

The exceptionally low cost of the 465 with 100 MHz at 5 mV/cm and the 475 with 200 MHz at 2 mV/cm represents a price/performance breakthrough for portables and insures top value for the future.

At less than 23 lb the 465 and 475 portables are light, short and easy to carry (25.3 lb with panel cover and accessories).

Although light weight, small and rugged, the 465 and 475 contain a big, bright, high-resolution crt. Even in adverse ambient light conditions low rep-rate pulses are easily viewed. With 8 cm vertically and 10 cm horizontally the crt display covers ⅓ of the entire front panel. Though the front panel is small in area and dominated by the larger crt, these versatile portables are easy to use. Operation has been simplified by single-function push buttons, control knob design, layout and color-coordinated front panels.

Troubleshooting circuits and equipment is often more effectively accomplished when using external trigger sources. It is essential that the timing, amplitude and other characteristics of the external trigger waveforms are known. By simply pressing a front panel push button on the 465 or 475, any waveform applied at the A trigger input is instantly displayed, thus eliminating resetting controls and disconnecting leads. This can be a real time saver and convenience when external trigger signals are frequently being used as timing references.

In the past, multi-trace applications or measurements requiring frequent attenuation or probe changes necessitated bothersome and error-prone deflection factor determination. With the 465 and 475, probe tip deflection factors for recommended 1X and 10X probes are automatically indicated by readout lights behind the knob skirts.

Measuring with respect to ground is important in many applications. This is easily accomplished at the probe when dc coupled by simply pressing the small ground reference push button on the probes recommended for 465 and 475 use.

The 465 and 475 can be operated from either a free-standing battery pack or one which attaches directly to the oscilloscope. Both are small and light weight, providing a handy solution for making accurate measurements in difficult environments such as conducted emi, ground loops, power line fluctuations, or in the absence of line power.

CHARACTERISTICS

All characteristics apply to both the 465 and 475 except where indicated.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth* and Risetime at all deflection factors from 50 Ω terminated source

	−15°C to +40°C	+40°C to +55°C
465	Dc to 100 MHz, 3.5 ns	85 MHz, 4.12 ns
475	Dc to 200 MHz, 1.75 ns	175 MHz, 2.0 ns

*Measured at −3 dB down. Bandwidth may be limited to approximately 20 MHz by bandwidth limit switch.

Lower −3 dB point, ac coupling from 50-Ω source

465/475	X1 Probe	10 Hz or less
	X10 Probe	1 Hz or less

Deflection Factor

465—5 mV/div to 5 V/div in 10 calibrated steps**

475—2 mV/div to 5 V/div in 11 calibrated steps**

**1, 2, 5 sequence, accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Display Modes—Channel 1; Channel 2 (normal and inverted); Alternate; Chopped (465—approx 250-kHz rate, 475—approx 1-MHz rate); Added; X-Y (selected by Time/div, CH 1-X, CH 2-Y)

Automatic Scale Factor Readout—Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when dc coupled).

Input R and C—1 megohm within 2% paralleled by approx 20 pF.

Maximum Input Voltage

Dc Coupled	250 V (dc + peak ac) 500 V (p-p ac at 1 kHz or less)
Ac Coupled	500 V (dc + peak ac) 500 V p-p (ac at 1 kHz or less)

Signal Output—(465) CH 1 vertical signal is dc to at least 50 MHz −3 dB and approx 25 mV/div terminated into 50 Ω, and approx 50 mV/div terminated into 1 MΩ. (475) CH 2 vertical signal is dc to at least 50 MHz −3 dB and approx 10 mV/div terminated into 50 Ω, and approx 20 mV/div terminated into 1 MΩ.

Delay Line—Permits viewing leading edge of displayed waveform.

Probe Power (for 475 only)—Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

465

Time Base A—0.05 μs/div to 0.5 s/div in 22 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

Time Base B—0.05 μs/div to 50 ms/div in 19 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

475

Time Base A and B—0.01 μs/div to 0.5 s/div in 24 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 1 ns/div.

Variable Time Control; Time Base A (465/475)—Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy, full 10 cm

	+20°C to +30°C		−15°C to +20°C +30°C to +55°C	
	465	475	465	475
Unmagnified	±2%	±1%	±3%	±2%
Magnified	±3%	±2%	±4%	±3%

Horizontal Display Modes—A only, Mixed Sweep, A Intensified, B Delayed.

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal), Normal Trigger, Single Sweep. Lights indicate when sweep is triggered and when single sweep is ready.

Time Base B Sweep Modes—B Starts After Delay Time; B Triggerable after Delay Time from selected source.

Calibrated Mixed Sweep—Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep. Mixed sweep measurements utilize portions of the A and B sweeps. The 465 is accurate to within 2% plus measured A sweep accuracy for the A portion of the display and to within the B accuracy for the B portion of the display. The 475 has a cumulative accuracy of within 3%.

CALIBRATED SWEEP DELAY

Delay Time Range

465—0.2 to 10X Delay Time/Div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

475—0 to 10X Delay Time/Div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15° to +35°C
over one or more major dial divisions	within 1%
less than one major dial division	within 0.01 major dial divisions

Jitter—1 part or less in 50,000 (0.002%) of 10X the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A and B

A Trigger Modes—Normal (sweep runs when triggered), Automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz), Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed).

B Trigger Modes—B Runs After Delay Time (starts automatically at the end of the delay time), B Triggerable After Delay Time (runs when triggered), the B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity

		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 push button selector overrides other vertical controls and displays the signal being used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform.

Time Base Trigger Sources—A: Norm, Channel 1, Channel 2, Line, External and External ÷ 10. B: Starts After Delay, Norm, CH 1, CH 2, and External. Level adjustment through at least ±2 Volts in External, through at least ±20 Volts in External ÷ 10.

External Inputs—R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (dc + peak ac) maximum input.

X-Y OPERATION

465

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—5 mV/div to 5 V/div in 10 calibrated steps, accurate within 4%. Bandwidth is dc to at least 4 MHz. Phase difference between amplifiers is 3° or less from dc to 50 kHz.

475

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—2 mV/div to 5 V/div in 11 calibrated steps, accurate within 3%. Bandwidth is dc to at least 1 MHz. Phase difference between amplifiers is 1° or less from dc to 1 MHz.

CRT

Crt— 5-inch rectangular tube; 8 x 10-cm display area. Horizontal and vertical centerlines further marked in 0.2-cm increments. P31 phosphor normally supplied; P11 optional without extra charge. 18-kV accelerating potential.

Z-axis input—dc-coupled to crt cathode; noticeable modulation at normal intensity with 5 V or more peak-to-peak signal; dc to 50 MHz useable frequency range.

Graticule—Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Storage: −55°C to +75°C. Filtered forced air ventilation is provided.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes. 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (OPTION 4 only)—Meets interference requirements of MIL-I-6181D, power line conducted, 150 kHz to 25 MHz. Radiated (with included mesh filter installed), 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-F-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 Volts	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Signal Outputs—Positive gates from both time bases (approx 5 V), and a vertical signal output from one channel.

Power Requirements—Quick-change line voltage selector provides six ranges: 110 V, 115 V, 120 V, 220 V, 230 V and 240 V, each ±10%. 48 to 440 Hz, 75 watts (465) or 100 watts (475) maximum at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 7.

	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 P6065A Probes with accessories (010-6065-03); accessory pouch (016-0535-02); blue crt light filter (337-1674-00); clear crt light filter (337-1674-01); ground post (134-0016-01).

475

Included Accessories—Two 6-ft P6075A Probes with accessories (010-6075-03); accessory pouch (016-0535-02); blue crt light filter (337-1674-00); clear crt light filter (337-1674-01); ground post (134-0016-01).

INSTRUMENT OPTIONS

EMI Environmentalized, Option 4—Includes the features of the 465 and 475; in addition meets electromagnetic interference requirements of MIL-I-6181D over the following frequencies. Power line conducted: 150 kHz to 25 MHz: Radiated (with included mesh filter installed): 150 kHz to 1 GHz.

Tv Sync Separator, Option 5 (465 only)—Option 5 adds a tv sync separator, providing stable sweep triggering from composite video waveforms. With sync separator mode selected, A sweep is automatically triggered at the field rate and tv line rate triggering is added to the signal source selection for sweep B. The sync separator accepts sync-positive or sync-negative video, from Channel 1, Channel 2 or external input. Video signal requirement is 2 divisions internal display or 100 mV external input. Recognition circuits are optimized for 405-525-625 line or 50 or 60 Hz field rate broadcast systems, and are compatible with closed circuit systems up to 1201 line 60 Hz field rate.

Included Accessories—Two 6-32 adapters (103-0051-01); interchangeable light filter/tv graticule (NTSC) (337-1674-02); interchangeable light filter/tv graticule (CCIR) (337-1674-03); OPTION 5 instruction book insert.

External Dc Operation, Option 7—In addition to the standard ac line operation, Option 7 permits the 465 and 475 to be powered from a 12 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 **$1825**
475 Oscilloscope **$2650**
R465 Oscilloscope **$1900**
R475 Oscilloscope **$2725**
465 DM40 Oscilloscope/multimeter **$2215**
465 DM43 Oscilloscope/multimeter with temp **$2300**
475 DM40 Oscilloscope/multimeter **$3040**
475 DM43 Oscilloscope/multimeter with temp **$3125**

(See pages 145 and 146 for details on DM40 and DM43)

INSTRUMENT OPTIONS

Option 4 Emi Environmental ..... **Add $ 75**
Option 5 TV Sync Separator (465 only) ..... **Add $100**
Option 7 Ext Dc Operation ..... **Add $ 75**
Option 78 P11 Phosphor ..... **No Charge**

Note: Option 7 cannot be ordered along with DM40 and DM43.

OPTIONAL ACCESSORIES

Probes: P6201 1X FET (475 only); P6042 dc to 50 MHz Current Probe; P6063A Switchable 1X-10X (475 only); P6062A Switchable 1X-10X (465 only). See accessories section for ordering information.

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 ..... **$570**

Camera Adapter and Corrector Lens—Adapts C-30A to 465 or 475,
order 016-0301-00 ..... **$ 42**

Option 7 Modification Kit—Converts existing 465 or 475's to the Option 7 version. For 465's with serial No. below B042244,
order 040-0650-00 ..... **$150**

For 475's with serial No. below B061174,
order 040-0665-00 ..... **$150**

For 465's or 475's with serial No. above those listed,
order 040-0666-00 ..... **$150**

Protective Cover—Waterproof, blue vinyl,
order 016-0554-00 ..... **$ 11**

Folding Polarized Viewing Hood—Order 016-0180-00 .... **$ 15**

Mesh Filter—Improves contrast and emi filtering,
order 378-0726-01 ..... **$ 16**

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base **order 200** **$125**

1105 BATTERY POWER SUPPLY

The 1105 is a rugged, portable power supply suitable for powering portable oscilloscopes or other instruments 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).

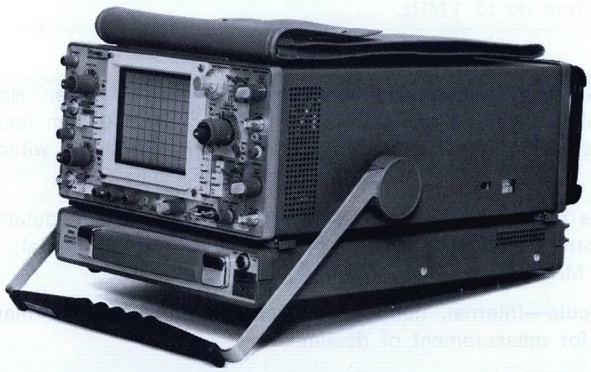
Battery Operating Time—Approx 140 watt-hours.

Recommended Max Output Current— 0.9 amp.

ORDERING INFORMATION

1105 Battery Power Supply **$525**
Option 1, 230 V Operation ..... **No Charge**

1106 BATTERY PACK



The 1106 is a convenient, snap-on battery power supply for TEKTRONIX 464, 465, 466, or 475 Option 7 Oscilloscopes.

Output Power—22 to 24 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.

Order 1106 Battery Pack **$275**

Portable Storage Oscilloscopes

The Fastest Storage . . . the Most Versatile Package

NEW
466
464

1350 cm/μsec Stored Writing Speed (466 only)

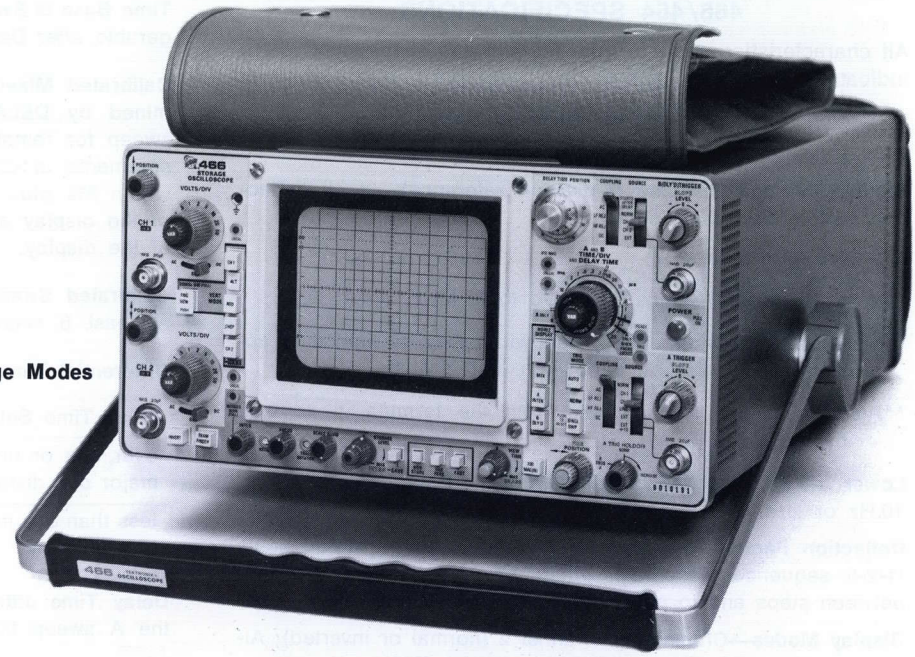
Dc to at Least 100 MHz Bandwidth

5 mV/div Vertical Sensitivity at Full Bandwidth

5 nsec/div Sweep Speed

Variable Persistence and FAST Transfer Storage Modes

Fully Portable—Just 26 Pounds



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 new 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/μsec 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 (ac/dc inverter), 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 push button 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 of 0.90 cm/division. A reduced scan graticule is superimposed over the center of the main graticule, measuring 8 by 10 divisions of 0.45 cm/division. And 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, 464 at lower cost offers all other features of the 466.

466/464 SPECIFICATIONS

All characteristics apply to both the 466 and 464, except where indicated.

VERTICAL DEFLECTION

(2 Identical Channels)

Bandwidth* and Risetime (5-division 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 approximately 20 MHz by bandwidth limit switch.

**Risetime 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 approximately 12.5 volts/div.

Display Modes—Channel 1; Channel 2 (normal or inverted); Alternate; Chopped (approx 250 kHz); Added; X-Y.

Input R and C— 1 Megohm within 2% paralleled by approx 20 pF.

Maximum Input Voltage—

Dc Coupling	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 DEFLECTION

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.

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 divisions	±1%	±2.5%
less than one major dial division	±0.01 major dial divisions	±0.025 major dial divisions

Delay Time Jitter— 1 part or less in 50,000 (0.002%) of 10X 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	Internal	0.3 div deflection	1.5 div deflection
	External	50 mV	150 mV
	External ÷ 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 Volts in External, through at least ± 20 Volts in External ÷ 10.

External Inputs—R approx 1 MΩ; 250 V (dc + peak ac) maximum 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)			
Fast	3,000 div/μs	Reduced Scan not 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 Volts	1% 0°C to +40°C
Output Current	30 mA	2% +20°C to +30°C
Frequency	Approx 1 kHz	

Signal Outputs—Positive gates from both time bases (approx 5.5 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 watts maximum 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 (337-1674-01), adapter, ground wire (134-0016-01).

INSTRUMENT OPTIONS

EMI Environmentalized, Option 4—Meets electromagnetic interference requirements of MIL-I-6181D over the following frequencies. Power line conducted: 150 kHz to 25 MHz: Radiated (with included mesh filter installed): 150 kHz to 1 GHz.

External Dc Operation, Option 7—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. Storage: −55° to +75°C. Forced air ventilation is provided.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes. 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (OPTION 4 only)—Meets interference requirements of MIL-I-6181D, power line conducted, 150 kHz to 25 MHz. Radiated (with included mesh filter installed), 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-F-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

ORDERING INFORMATION

466 Oscilloscope **$3850**
464 Oscilloscope **$3300**
464 DM40 Storage oscilloscope/multimeter **$3690**
464 DM43 Storage oscilloscope/multimeter with temp . **$3775**
466 DM40 Storage oscilloscope/multimeter **$4240**
466 DM43 Storage oscilloscope/multimeter with temp . **$4325**
(See pages 145 and 146 for details on DM40/DM43)

INSTRUMENT OPTIONS

Option 4 Emi Environmental ..... **Add $75**
Option 7 Ext Dc Operation ..... **Add $75**

Note: Option 7 cannot be ordered along with DM40 and DM43.

OPTIONAL ACCESSORIES

1106, Battery Pack (used with option 7) **$275**

C-30-A-P Option 1—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..... **$570**

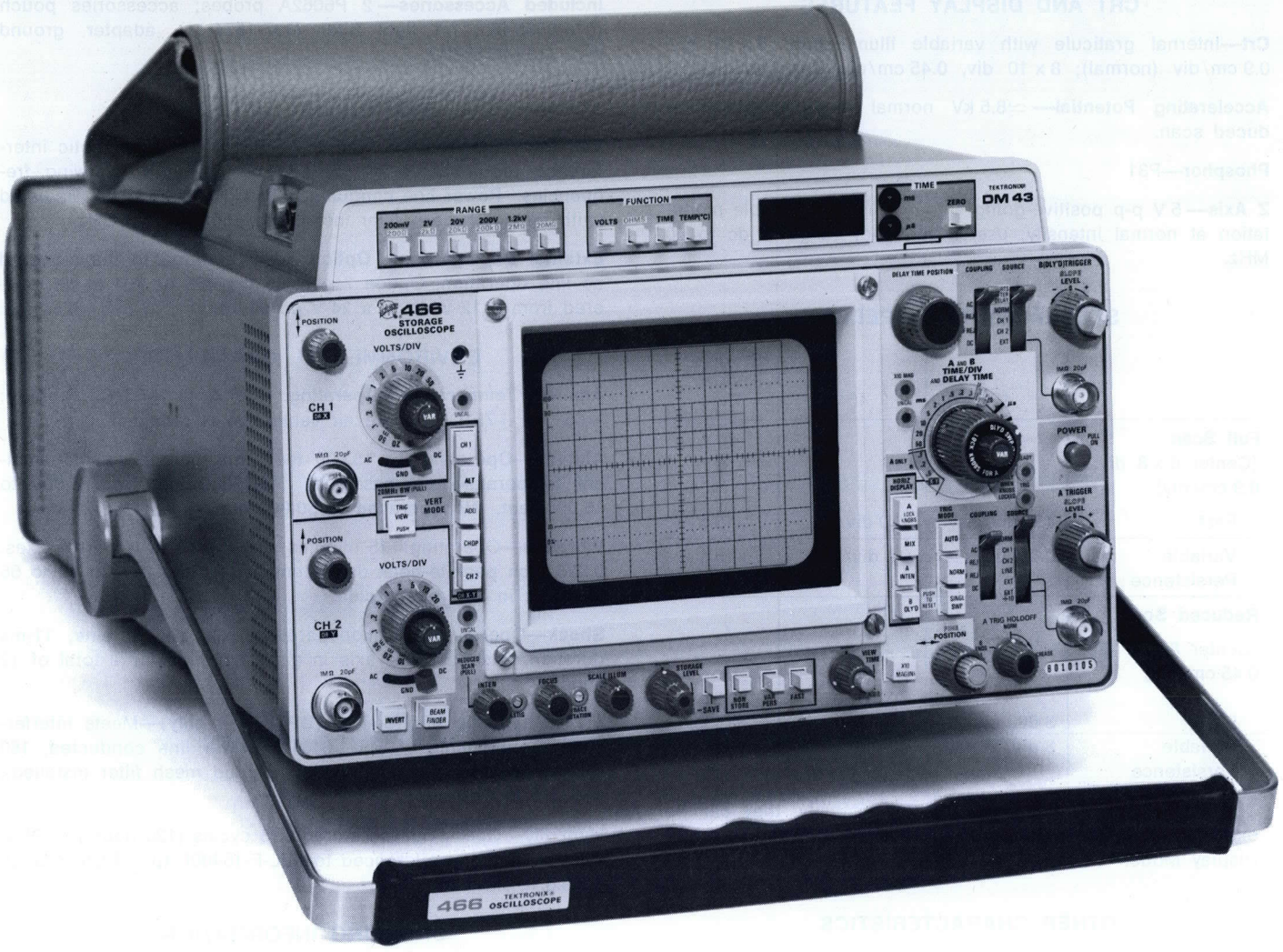
P6042, dc to 50 MHz Current Probe, **Order 010-0207-00** .. **$835**

P6045, FET Probe and Power Supply, **Order 010-0205-00** **$500**

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base. **Order 200** **$125**

Storage Portables with Multimeter

The Fastest Storage . . . the Most Versatile Package



The Fastest Stored Writing Speed — 1350 cm/μsec in 466

Digital Differential Time

Digital Dc Volts

Digital Resistance

Digital Temperature in DM43

100 MHz Bandwidth

A Self-contained, Fully Portable Measurement System

An unprecedented combination of measurement instruments within a single portable package, the 466/464 DM40/DM43 joins together the newest concepts in TEKTRONIX portable instrumentation.

At 100 MHz bandwidth, the 466 and 464 each offer variable persistence and FAST transfer modes of storage. For a detailed description of storage mainframe characteristics, see the discussion beginning on page 151.

The DM40 and DM43 mount integrally with the storage portable mainframe to provide digital measurements of differential delay time, dc voltage and resistance. Additionally, the DM43 (with P6430 probe) provides digital temperature measurements. Detailed multimeter characteristics begin on page 145.

ORDERING INFORMATION

466 DM40 Storage oscilloscope/multimeter $4240
466 DM43 Storage oscilloscope/multimeter with temp. $4325
464 DM40 Storage oscilloscope/multimeter $3690
464 DM43 Storage oscilloscope/multimeter with temp. $3775

(For additional mainframe options, see pages 151-153).

Note: Option 7 cannot be ordered along with DM40 and DM43.

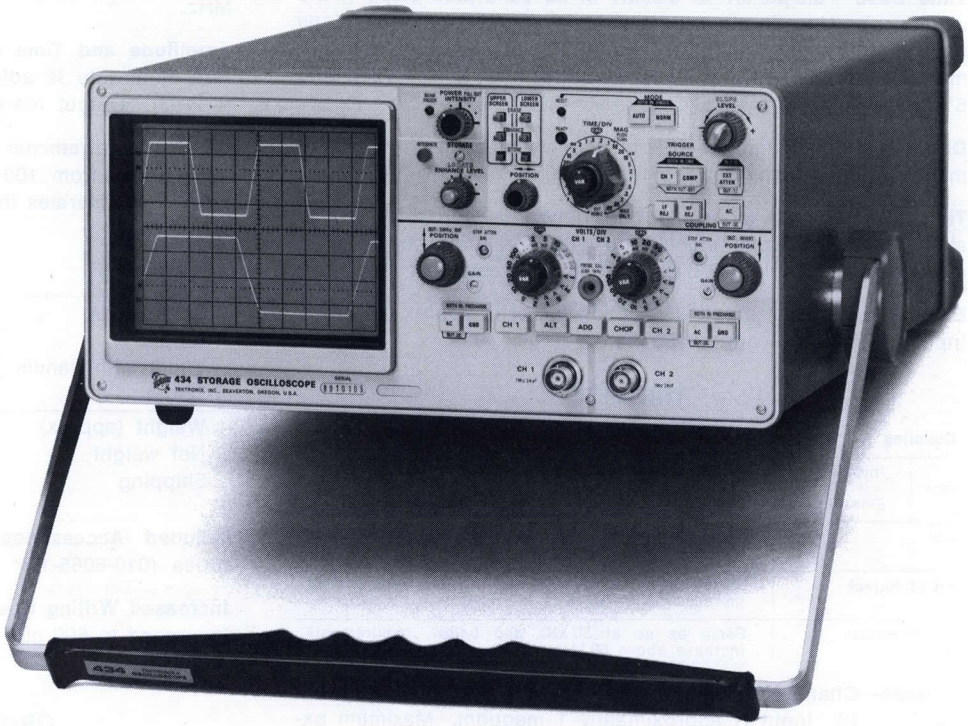
Deflection Factors to 1 mV/div

Automatic Volts/div Readout

Direct-Reading Wide-Range Magnifier

20¾ lb

5¼-inch 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-inch rectangular tube, 8 x 10 div (1 div = 0.98 cm) display area. Phosphor is similar to P1. 4-kV accelerating potential.

Graticule—Internal, parallax-free, nonilluminated.

Split-Screen Storage— 3 Display Modes: Storage on either upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display on entire screen. Independent operation of both halves.

Writing Speed (Center 8 div)—Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 1, 500 div/ms, normal; to 5000 div/ms, enhanced).

Storage Viewing Time—Up to four hours.

Erase Time— 300 ms or less.

VERTICAL DEFLECTION
(2 Identical Channels)

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 3%. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Bandwidth and Risetime—(from 50-Ω terminated source, with or without 10X probe) Dc to at least 25 MHz at 3-dB down*, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low-frequency 3 dB down point with ac coupling is 14 Hz or less (less than 1 Hz with 10X probe).

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approximately 100 kHz); Added.

Input R and C— 1 megohm ±2% paralleled by approx 24 pF.

Maximum Input Voltage—dc coupled: 250 V (dc plus peak ac), ac coupled: 500 V (dc plus peak ac). In either mode the maximum ac is 500 V p-p at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

Internal Trigger Source—Composite (displayed signals) or Channel 1 signal only.

*Bandwidth derating to 22 MHz at temperatures above +30°C.

HORIZONTAL DEFLECTION

Time Base— 0.2 μs/div to 5 s/div in 23 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to 12.5 s/div. Accurate within 3% unmagnified and 4% magnified from +20°C to +30°C, within 4% unmagnified and 5% magnified from −15°C to +55°C.

Direct Reading Magnifier—Six-position, push-to-turn, 50X maximum. Extends fastest sweep rate to 20 ns/div.

Time Base Sweep Modes—Auto Trigger, (sweep free runs in absence of triggering signal and provides bright baseline at all sweep rates), Normal Trigger, Single Sweep.

External Horizontal Input—Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

Coupling		To 5 MHz	At 25 MHz
Dc	Internal	0.3 div deflection	1 div deflection
	External	50 mV	175 mV
Ac		Same as dc at 20 Hz and above, requirements increase below 20 Hz	
Ac Lf Reject		Same as ac at 50 kHz and above, requirements increase below 50 kHz	
Ac Hf Reject		Same as ac at 50 kHz and below, requirements increase above 50 kHz	

Sources—Channel 1 only, composite, line, external and external ÷ 10. Input R approximately 1 megohm. Maximum external input, 250 Volts (dc + peak ac). External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating, −15°C to +55°C. Storage, −55°C to +75°C.

Altitude—Operating, 15,000 feet. Maximum allowable operating temperature decreases 1°C/1000 feet from 5,000 to 15,000 feet.

Vibration—Operating and non-operating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating. 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—With the optional mesh filter (378-0682-00) installed the 434 meets interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Locate—When the 434 is operated in the stored mode, the beam can be positioned to the left of the graticule area to determine the vertical position of the next sweep without disturbing a stored display.

Z Axis—Input dc coupled to crt, noticeable modulation at normal intensity with 5 volts or more p-p, dc to at least 20 MHz.

Amplitude and Time Calibrator— 0.6 V adjustable within 1.0% Repetition rate is adjustable to 1 kHz within 1.0% (+20°C to +30°C). Output resistance is 575 ohms.

Power Requirements—Operates without range switching on all voltages from 100 V to 240 V, 50 to 400 Hz, 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 6065A 6-ft probes with accessories (010-6065-13); accessory pouch (016-0165-00).

Increased Writing Speed, Option 1—Increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation.

ORDERING INFORMATION

434 Storage Oscilloscope **$2350**

R434 Storage Oscilloscope (Rackmount model) **$2390**

Option 1 Increased Writing Speed (434/R434) ..... **Add $25**

OPTIONAL ACCESSORIES

1105 Battery Power Supply—Provides 2.5 hours (432) or 1.8 hour (434) of battery operation. See Page 162 for complete description.
Order 1105 Battery Power Supply **$525**

Mesh Filter—Improves contrast and EMI filtering.
Order 378-0682-00 ..... **$16.50**

Portable to Rackmount Assembly—Includes hardware for converting standard 432 and 434 to 19-inch rack installation.
Order 016-0272-00 ..... **$75**

Folding Polarized Viewing Hood—Order 016-0180-00 ..... **$15**

Clear Plastic Crt Filter—Order 378-0677-00 ..... **$1.75**

C-30A-P Option 1 Compact Camera—f/1.9 lens, 0.8 magnification, Polaroid Land Pack Film back for 3000-speed film (includes Adapter Frame/Corrector Lens 016-0301-00).
Order C-30A-P Option 1 ..... **$570**

Camera Adapter—Mounts C-30A Series Camera to the 432 & 434 Oscilloscope. **Order 016-0301-00** **$42**

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base. **Order 200** **$125**

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

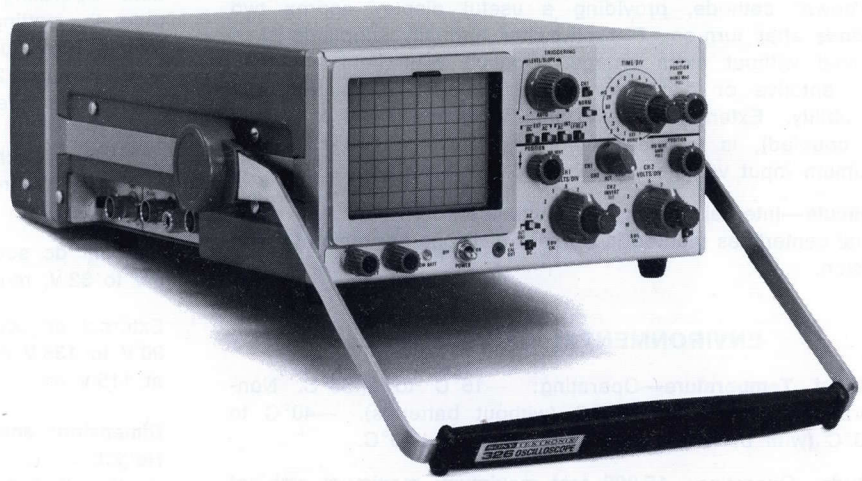
Ac, Dc or Battery Powered

Compact Size—Weight <13 lb

5-MHz Bandwidth at 1 mV/div

Designed for Severe Environments

Convenient Accessory Storage



The 326 is an all solid-state, dual channel, 10-MHz portable oscilloscope providing the operator the convenience of using ac, dc or internal rechargeable batteries for powering the instrument. The 326 features small size and light weight, together with low power consumption. Depth is 15 inches, width is 8.7 inches, height is 4.0 inches, and weight is less than 13 pounds. Power consumption is only 12 watts from an external dc source and 35 watts when powered from the ac line. Internal rechargeable batteries will provide up to 4 hours continuous operation. The portability/performance provided by the 326 Oscilloscope makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—Dc to at least 10 MHz at 3-dB down. Dc to at least 5 MHz at 3-dB down using X10 gain. Low-frequency 3-dB-down point with ac coupling is 10 Hz or less, extending to 1 Hz or less with the included 10X probes.

Risetime— 36 ns or less; 72 ns or less using X10 gain.

Deflection Factor— 10 mV/div to 10 V/div in 10 calibrated steps (1-2-5 sequence), 1 mV/div to 1 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 110-kHz rate); Added.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage— 500 V (dc + peak ac).

Delay Line— Permits viewing leading edge of displayed waveform.

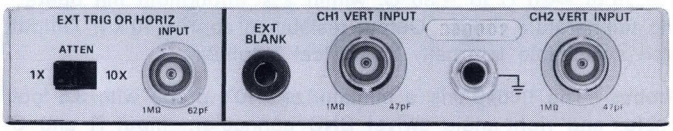
Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base— 1 μs/div to 1 s/div in 19 calibrated steps (1-2-5 sequence); accurate within 3% over the center 8 divisions from 1 μs/div to 0.2 s/div; accurate within 4% at 0.5 s/div and 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.1 μs/div. Accuracy of magnified display is within 4% over the center 8 divisions from 0.5 μs/div to 20 ms/div, within 5% at 0.1 μs/div, 0.2 μs/div, 50 ms/div and 0.1 s/div.

External Input—Continuously variable from approx 25 mV/div to approx 1.5 V/div. Ac or dc coupled. Dc to at least 200 kHz at 3-dB down.



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—Ac and Ac Lf Rej for internal triggering, ac and dc for external triggering. 300-V maximum input voltage (combined dc + peak ac).

Amplitude Requirements—0.3-div deflection or 150 mV external to 1 MHz, increasing to 1.0-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external ac coupling and below 50 kHz with Ac Lf Rej coupling.

CRT

Crt— 8 x 10-div display area; each div is ¼ inch. Crt uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your field engineer, representative or distributor for application information and availability. External blanking input requires +5 V to +20 V (dc coupled), is usable from dc to at least 100 kHz. 50 V maximum input voltage (combined dc + peak ac).

Graticule—Internal, black, nonilluminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum; maximum ambient temperature must be decreased by 1°C/1000 feet from 5,000 feet to 15,000 feet. Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Nonoperating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probes—The P6049A is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal dc source: Removable power pack contains 9 size "C" NiCd cells providing 1.5 to 4 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Charger provides for charging the internal batteries when connected to the ac line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External dc source: Operates from an external dc source of 9 V to 32 V, requires up to 12 W.

External ac source: Operates from an external ac source of 90 V to 136 V or 180 V to 272 V. 48 to 440 Hz, 35 W maximum at 115 V ac.

Dimensions and Weights

Height	4.0 in	10.2 cm
Width with handle	8.7 in	22.2 cm
Depth, handle not extended		
With charger	15.0 in	38.1 cm
Without charger	12.2 in	31.0 cm
Depth, handle extended		
With charger	18.2 in	46.2 cm
Without charger	15.8 in	40.1 cm
Net weight without accessories		
With charger	≈13 lb	≈5.9 kg
Without charger	≈10 lb	≈4.5 kg
Shipping weight	≈19 lb	≈8.6 kg

Included Accessories—Two P6049A 10X probes (010-6049-01); carrying case (016-0532-00); strap assembly (346-0098-00); viewing hood (016-0297-00); blue light filter (426-0871-00); external dc cable assembly (012-0406-00).

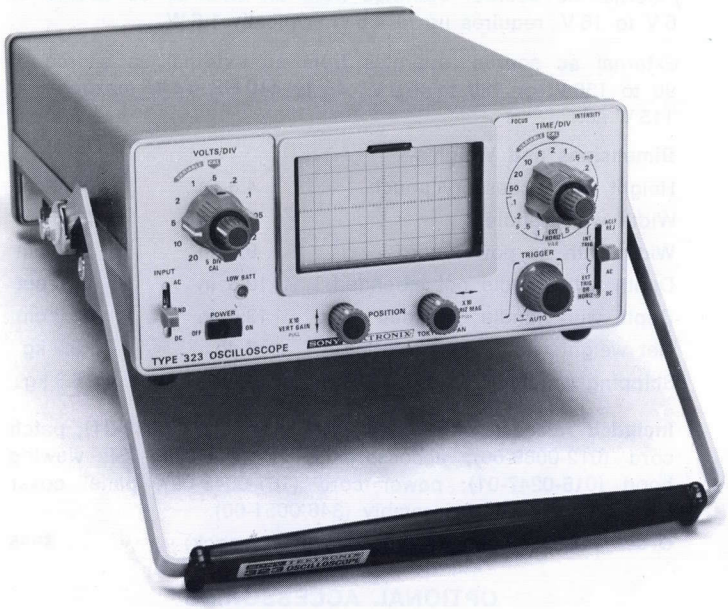
Order 326 Oscilloscope, including power pack **$1725**

The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Battery Set—Set of 9 NiCd cells, **order 146-0018-00** **$50**

Battery Pack—Includes 146-0018-00 in battery housing, **order 016-0296-00** **$60**



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

Ac, Dc or Battery Powered

Compact Size—Weight ≈7 lb

Up to 7 Hours Operation from Internal Battery Pack

Designed for Severe Environments

Convenient Accessory Storage

The 323 is an all solid-state, single-channel, 4-MHz portable oscilloscope providing the operator the convenience of using ac, dc or internal rechargeable batteries for powering the instrument. The 323 features small size and light weight, together with extremely low power consumption. Depth is 10.6 inches, width— 8.5 inches, height— 4.3 inches, weight— ≈7 pounds. Power consumption is up to 4.5 watts (typically 1.6 watts) from an external dc source, and 14 watts when powered from the ac line. Internal rechargeable batteries will provide up to 7 hours continuous operation, sufficient for a full working day. The portability/performance provided by the 323 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications; for example, industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

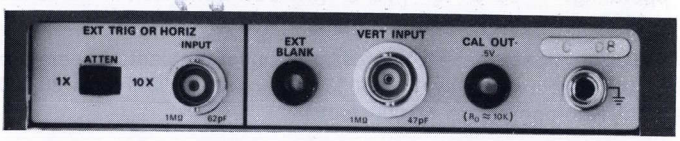
Bandwidth—Dc to at least 4 MHz at 3-dB down. Dc to at least 2.75 MHz at 3-dB down using X10 gain. Low-frequency 3-dB down point with ac coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime—90 ns or less; 130 ns or less using X10 gain.

Deflection Factor—10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 1 mV/div to 2 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/div.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage—500 V (dc + peak ac).



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

HORIZONTAL DEFLECTION

Time Base—5 μs/div to 1 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.2 s/div; accurate within 4% from 0.5 s/div to 1 s/div. Uncalibrated, continuously variable between steps and to at least 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.5 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/div, 50 ms/div, and 0.1 s/div.

External Input—Continuously variable from approx 20 mV/div to approx 30 V/div, ac or dc coupled. Dc to at least 10 kHz at 3-dB down.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—Ac and Ac Lf Rej for internal triggering, ac and dc for external triggering. 300 V maximum input voltage (combined dc + peak ac).

Amplitude Requirements—0.3-div deflection or 75 mV external to 400 kHz, increasing to 0.75-div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external ac coupling and below 30 kHz with Ac Lf Rej coupling.

The SONY®/TEKTRONIX® 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

CRT

Crt— 6 x 10 div display area; each div is ¼ inch. Crt uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (dc coupled), is usable from dc to at least 100 kHz. 150 V maximum input voltage (combined dc + peak ac).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of Mil-Std-202C. Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The 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. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the ac line, operating or non-operating. Front-panel light indicates when internal batteries are low, or when external dc source is low. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External dc source: operates from an external dc source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.

External ac source: operates from an external ac source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 V ac.

Dimensions and Weights—

Height with accessory pouch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with ac power cord	9.3 in	23.5 cm
Depth with handle not extended	10.6 in	27.0 cm
Depth with handle extended	13.0 in	33.0 cm
Net weight without accessories	7 lb	3.2 kg
Shipping weight	≈14 lb	≈6.3 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-02); panel cover (200-0812-00); strap assembly (346-0051-00).

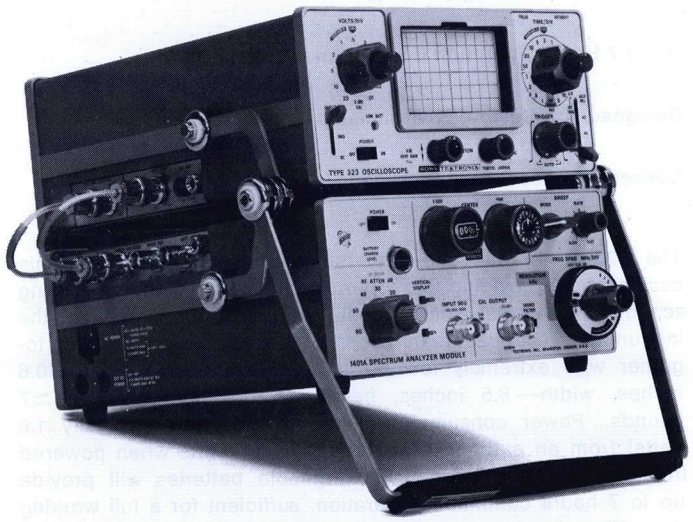
Order 323 Oscilloscope (includes power pack) **$995**

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, **order 016-0112-00** **$13**

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** **$125**

Battery Set—Set of 6 NiCd cells, **order 146-0012-01** **$26**



PORTABLE SPECTRUM ANALYZER SYSTEM

The 323 Oscilloscope becomes a frequency domain measurement tool when used with the TEKTRONIX 1401A 1-to-500 MHz Spectrum Analyzer Module. Ac, dc, or battery power may be used for this 15-pound system. A complete description of the 1401A and the 1401A/323 System is found in the Spectrum Analyzer section.

5 MHz Bandwidth

3.5 lb, 3 x 5¼ x 9½ Inches

Internal Battery Pack

5 mV/div to 100 V/div

Integral 1 MΩ Probe

The 221 has all 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 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″ 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 volts dc + peak ac. The 1 μs/div to 200 ms/div timebase 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 or synchronize the sweep to difficult signals.

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 volts (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

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.

Maximum Input Voltage— 600 volts (dc + peak ac), 600 volts peak-to-peak 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 maximum 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.

Maximum External Horizontal Input Voltage— 200 V (dc + peak ac), 200 V p-p ac to 500 kHz, referenced to probe common.

TRIGGER

Internal—Triggers on at least 0.5 division from 2 Hz to 5 MHz.

External— 0.5 volt from dc to 5 MHz.

CRT

Crt— 6 x10-div display area, each division is approx 0.2 inch. 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 feet, maximum operating temperature decreased by 1°C/1,000 feet above 15,000 feet. Nonoperating, 50,000 feet.

Vibration—Operating and nonoperating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one minute 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. Maximum operating time is achieved at +20°C to +30°C charge and operating temperature. Internal charger provides for charging the batteries when connected to an external power line with instrument turned on or off. Battery operation is automatically interrupted when battery charge drops to approx 10 volts 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 volts ac (48 to 62 Hz) or 80 to 250 volts dc, watts or less.

Dimensions and Weights

Height	3.0 in	7.6 cm
Width	5.2 in	13.3 cm
Depth	9.0 in	22.8 cm
Net Weight without Accessories	3.5 lb	1.6 kg
Shipping	≃8.0 lb	≃3.6 kg

Included Accessories—Viewing hood (016-0199-00); 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 $775

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") conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

Order 015-0231-00 ..... $4.50

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... $5.85

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... $5.85

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 ..... $2.80

211
212
214

Portable Oscilloscopes

500-kHz Miniscopes

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 (212 & 214)

Storage (214)

The growing 200 series of miniscopes represent a breakthrough in portable oscilloscope design. Fully self-contained, these miniature size, ultra light-weight portables are double-insulated, permitting 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 volts (dc + peak ac) above ground when operated from batteries. Although insulated, normal caution should be observed when connecting the oscilloscope probe to the test point.

With the 214, storage is introduced in a miniscope. Storage retains a nonrepetitive or slow moving signal. This allows closer inspection of these signals. In the single sweep mode, the 214 waits for, then records a single event. With this feature, the scope's sweep circuit is armed and will wait for the signal to arrive before it runs. When the signal occurs, the sweep runs once and then waits for a manual reset. When combined with storage, this provides the unique capability of automatically waiting for an event and then storing it for subsequent viewing. The 214 is especially suited for such applications as telephone line signals, electromechanical information, industrial controls and more.

CHARACTERISTICS

Except where indicated, all characteristics apply to all three scopes.

VERTICAL DEFLECTION

Deflection Factor— 1 mV/div to 50 V/div in 15 calibrated steps (1-2-5 sequence), accurate within 5%. Uncalibrated, continuously variable between steps to at least 125 V/div.

Bandwidth—dc to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower 3-dB down point ac coupled is less than 2 Hz.

Input R and C—Approx 1 MΩ paralleled by approx 160 pF from 1 mV/div to 50 mV/div; and 140 pF from 100 mV/div to 50 V/div, via attached signal acquisition probes. With optional X10 attenuator adapter, input R is 4.4 MΩ and input C is approx 20 pF.

Insulation Voltage— 500 V rms or 700 V (dc + peak ac) when operated from internal batteries, with the line cord and plug stored. When operated from ac, line voltage plus floating voltage not to exceed 250 V rms; or 1.4X line + (dc + peak ac) not to exceed 350 V.

Display Modes (212 and 214)—Channel 1 only, Channel 2 only, or Channel 1 and Channel 2 chopped from 500 ms/div to 2 ms/div of time base, (chopped frequency approx 50 kHz for the 212 and approx 40 kHz for the 214) and alternate from 1 ms/div to 5 μs/div of time base.

Maximum Input Voltage (X1 probe only)— 1 mV/div to 50 mV/div, 600 V (dc + peak ac), ac not over 2 kHz. 0.1 V/div to 50 V/div, 600 volts (dc + peak ac), 600 volts p-p ac, 5 MHz or less.

Maximum Input Voltage Using Optional 10X Attenuator—1000 volts (dc + peak ac).

Channel 1-Channel 2 Isolation (212 and 214)— 1000:1 (Signals less than 6 divisions).

HORIZONTAL DEFLECTION

Time Base (212 and 214)— 5 μs/div to 500 ms/div in 16 calibrated steps (1-2-5 sequence); accurate to within 5%.

Time Base (211)— 5 μs/div to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate to within 5%.

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable between settings. Extends maximum sweep rate to at least 1 μs/div.

External Horizontal Input (212 and 214) (Channel 1)— 1 mV/div to 50 V/div within 10%; dc to 50 kHz; X-Y phasing to 5 kHz less than 3°. Input characteristics same as Channel 1.

External Horizontal Input (211) (at side panel)— 1 V and 10 V/div within 10%; dc to 75 kHz. Approx 0.5 MΩ paralleled by approx 30 pF. Maximum external horizontal input voltage is 200 V (dc + peak ac) or 200 V p-p ac, referenced to probe common.

TRIGGER

Internal (212 and 214 with composite trigger source)—Triggers on at least 0.2 divisions, dc to 500 kHz.

Internal (212 and 214 with channel 2 trigger source)—Triggers on 0.2 division from 2 Hz (3-dB down) to 500 kHz.

External— 1 V to 16 V p-p to 500 kHz. Input R and C, 1 MΩ paralleled by approx 30 pF.

Single Sweep (214)—Sweep generator produces one sweep when trigger is received.

CRT

Crt (211 and 212)— 6 x 10-division display area, each division is approx 0.2 inch. P31 phosphor normally supplied; P7 optional without extra charge. 1 kV accelerating potential.

Crt (214)—Bistable storage. 6 x 10-division display area, each division is approx 0.2 inch.

Graticule—Internal, black line, nonilluminated.

Stored Luminance (214)—At least 8 foot lamberts.

Writing Speed (214)—Normal, at least 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°; nonoperating −40°C to +60°C.

Altitude—Operating, 25,000 feet, maximum operating temperature decreased by 1°C/1000 feet above 15,000 feet. Nonoperating, 50,000 feet.

Vibration—Operating and nonoperating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inch p-p (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in one-minute sweeps. Held for three minutes at 55 Hz. All major resonances must be above 55 Hz.

Shock—Operating and nonoperating; 150 g's; ½ sine, 2 ms duration in each direction along each major axis. Total of 12 shocks.

Humidity—Operating and nonoperating; 5 cycles (120 hours) to 95% relative humidity, referenced to MIL-E-16400F.

OTHER CHARACTERISTICS

Power Sources—An internal dc source provides up to 5 hours operation (214 stored mode, up to 3.5 hours). Operating time depends on trace intensity, operating temperature and temperature during previous battery charge. Maximum operating time is achieved at +20°C to +30°C charge and operating temperature. Internal charger provides for charging the batteries when connected to an ac line with instruments turned off. Dc operation is automatically interrupted when battery charge drops to approximately 10 volts to protect batteries against deep discharge. Full recharge requires approximately 16 hours (214, 8 hours). Extended charge times will not damage the batteries.

Power Sources (212 and 214)—A pilot light battery-charge indicator light will extinguish when approximately 10 minutes (5 minutes for the 214) of scope operating time remains in the batteries.

Power Source (211)—A battery meter indicates full charge at 15 volts and discharged at 10 volts.

External Ac Source— 110 to 126 volts, 58 to 62 Hz, (212 and 214, 3 W; 211, 2 W or less at 126 volts). Can be operated at 104 to 110 volts with resulting slow discharge of internal batteries. Power options are shown below.

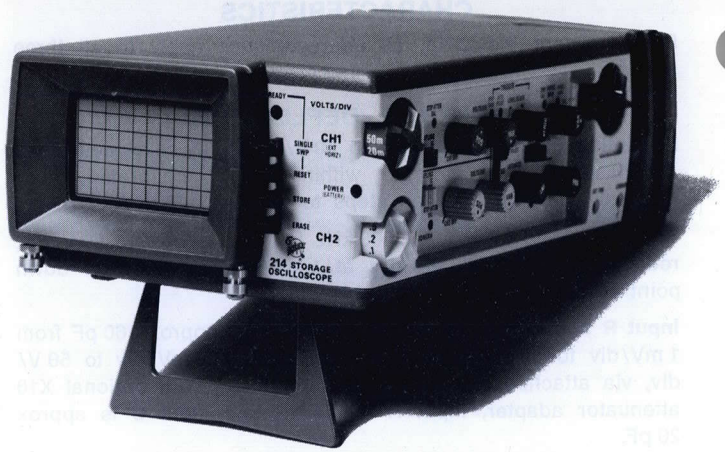
	212 and 214		211	
Dimensions	**in**	**cm**	**in**	**cm**
Height	3.0	7.6	3.0	7.6
Width	5.3	13.3	5.3	13.3
Depth	9.5	24.1	8.9	22.6
Weight (approx)	**lb**	**kg**	**lb**	**kg**
Without Accessories	3.5	1.6	3.0	1.4
Shipping	7.0	3.2	7.0	3.2

Included Accessories—Viewing hood (016-0199-01); carrying case (016-0512-00); neck strap (346-0104-00); (212 and 214) 2 fuses (159-0121-00).

ORDERING INFORMATION

211 Oscilloscope, including batteries **$595**
212 Dual-Trace Oscilloscope, including batteries **$755**
214 Dual-Trace Storage Oscilloscope, including batteries **$985**

Batteries 146-0026-00 = 1 set of 5
need 2 sets of 5



48-52 Hz POWER OPTIONS

Option 1 for 220 to 250 V, includes batteries ..... **No Charge**
Option 2 for 90 to 110 V, includes batteries ..... **No Charge**

OPTIONAL ACCESSORIES

10X Attenuator Package—A slip-on tip to provide lower circuit loading (4.4 MΩ, approximately 20 pF) and higher maximum 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 ..... **$27**

Alligator Clip Kit—A pair of alligator clips that allow connecting the probe (or optional 10X attenuator) and ground lead to large (up to ⅜") conductors. Includes: red clip (015-0229-00); yellow clip (015-0230-00); 6-32 to probe adapter (103-0051-01).

Order 015-0231-00 ..... **$4.50**

Probe-tip to BNC Panel Connector Adapter
Order 013-0084-01 ..... **$5.85**

Probe-tip to BNC Cable Adapter
Order 103-0096-00 ..... **$5.85**

Power Cable Adapter Assembly—A short length of two-wire power cord. One end has a femals 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 ..... **$2.80**

Digital Delay

Analog answers to digital problems

NEW

DD 501

Delay by Events Trigger Output

Separate "START" and "EVENTS" Channels

Up to 80 MHz Count Rate

Compatible with TTL, ECL, MOS

Delays up to 99,999 Events

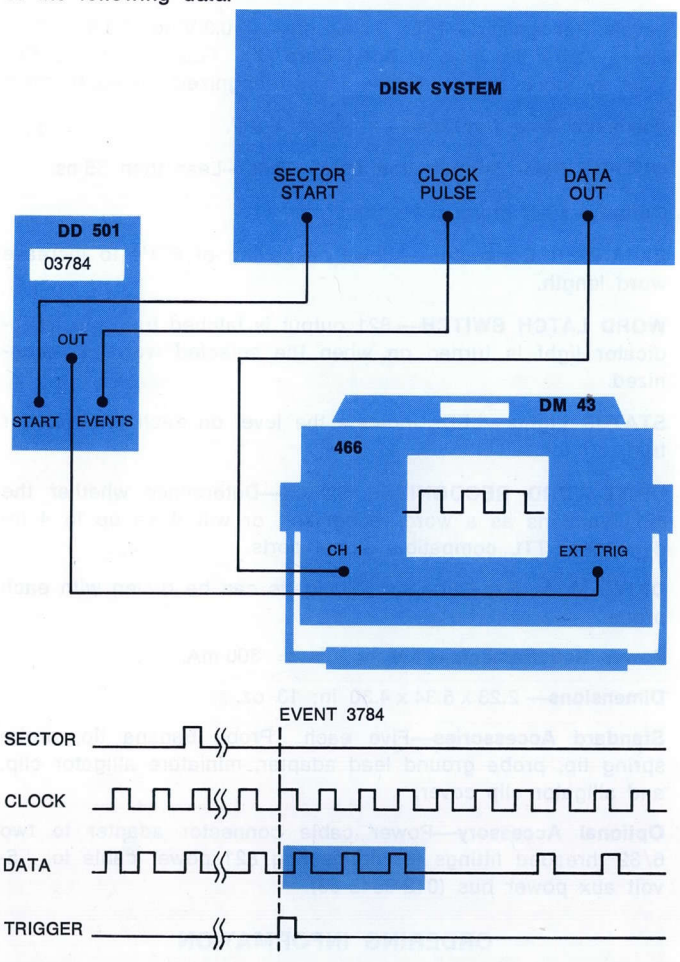
Trigger View and Level Out

Compatible with Most Voltage Probes

This TM 500-compatible unit provides "delay by events" triggering for oscilloscopes, counters, etc. The trigger out is initiated after the occurrence of a selectable number of events, or digital bits.

Sweep delaying by event, rather than by time, removes display jitter caused by mechanical speed variance in rotating memories. Furthermore, delay by events can allow the operator to easily spread out his displayed train of pulses for detailed examination. He does not have to march the pulses through the display and count the events to know where he is. The number set on the thumbwheel switches always tells him exactly where he is looking on the pulse train.

Below is a typical setup for looking at a logic train, in this case 3,784 clock pulses after the disk sector pulse. The 466 oscilloscope is triggered on the 3,784th pulse for a stable view of the following data.



CHARACTERISTICS

EVENTS DELAY

Count— 0 to 99,999 events.

Max. Count Rate— 80 MHz.

Insertion Delay— 30 ns or less.

Recycle Time— 25 ns or less.

Reset—Permits counter reset.

TRIGGER

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

Input Impedance— 1 MΩ, 20 pF.

Slope—Either + or —, selectable.

Sensitivity— 85 mV peak-to-peak.

Trigger Level Range—From —1.0 V to +1.0 V.

Frequency Response—Up to 80 MHz at 85 mV sensitivity.

Minimum Detectable Pulse Width— 5 ns.

Trigger View Out—At least 0.5 V (200 Ω or less source impedance).

Triggered Light—Visual indication of events. Visual indication of start gate open.

OUTPUT

Width—Events pulse width plus 6 ns or less.

Voltage— +0.8 V or less to at least +2.0 V into three TTL loads (approximately 5 mA).

Light—Indicates output trigger.

Timing between EVENTS START and EVENTS—Lead time needed for EVENTS START to ensure recognition of next EVENTS pulse: 0 ns.

ENVIRONMENTAL

Temperature—Operating: 0°C to +50°C.

ORDERING INFORMATION

DD501 Digital Delay **$495**

(See page 252 for descriptions of required TM 500 power modules and other plug-in instrumentation).

NEW

821

Word Recognizer

Analog Answers to Digital Problems

3

Digital Counters and Generators, Logical "AND" Trigger for Scopes

Four-input Logic Probe

Babysitter Latch

Word Length Expansion

Word Recognition

TTL Logic Driver

Interchangeable Probe Tips

This four-bit parallel word recognizer provides an oscilloscope with an external trigger signal upon recognition of a selected parallel digital word. Your portable oscilloscope's analog waveform display can thereby be used to analyze digitally-dependent signals.

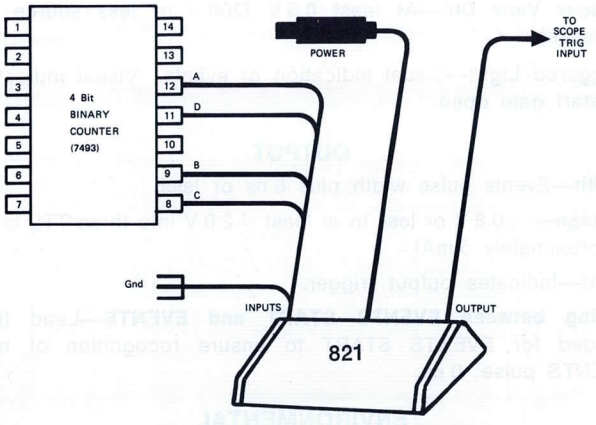
The 821 fits into your pocket, or into the accessories pouch of a TEKTRONIX portable oscilloscope.

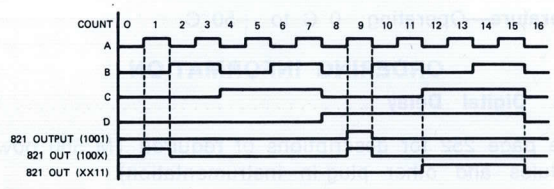
It's versatile! It functions as a word recognizer, logic babysitter, a four-bit strobed logic probe or a TTL logic driver. It will also inform the operator when a selected word pattern does NOT occur. Channels 1, 2 and 3 are dc coupled. Channel 4 may be either edge-gated or dc coupled.

The 821 is expandable! Additional 821's may be linked together for 8-, 12- or 16-bit word recognition.

The application example illustrated, lower left, shows an 821 connected to the outputs of a 4-bit counter. The 821 is set to construct a unique trigger at the count of nine (1001). The ladder diagram below shows the resulting output for this selected word, plus output waveforms for alternate words (100X, XX11) using the same inputs.

Other applications include driving the EVENTS START of the 7D11 Digital Delay or DD 501 Digital Delay plug-ins; deriving the START (A) or STOP (A, B) signal for universal counter measurements using the 7D15, DC 503, or DC 505 Universal Counter plug-ins.





CHARACTERISTICS

Number of Inputs—Four. Input cables are permanently attached. The probe of each cable has an interchangeable probe tip.

Levels Recognized—TTL: False (0)— −0.3 V to +0.8 V; True (1)— +2.0 V to +5.5 V; Don't Care (X). Four WORD SELECTOR switches determine the level recognized on each input.

Maximum Safe Overload— −4 V to +9 V.

OUTPUT Pulse Propagation Delay Time—Less than 35 ns.

Output— 50-Ω driver.

EXPANDER Connector—Allows cascading of 821's to increase word length.

WORD LATCH SWITCH— 821 output is latched true and an indicator light is turned on when the selected word is recognized.

STATUS Lights—LEDs indicate the level on each line—on for true, off for false.

DRIVE-WORD RECOGNIZER Switch—Determines whether the 821 functions as a word recognizer, or will drive up to 4 independent TTL compatible signal ports.

DRIVE Mode Fan-Out—Six TTL loads can be driven with each probe.

Power Requirements— 5 V dc, @ ≃ 300 mA.

Dimensions— 2.23 x 5.34 x 4.30 in; 13 oz.

Standard Accessories—Five each: Probe banana tip, probe spring tip, probe ground lead adapter, miniature alligator clip, and alligator clip cover.

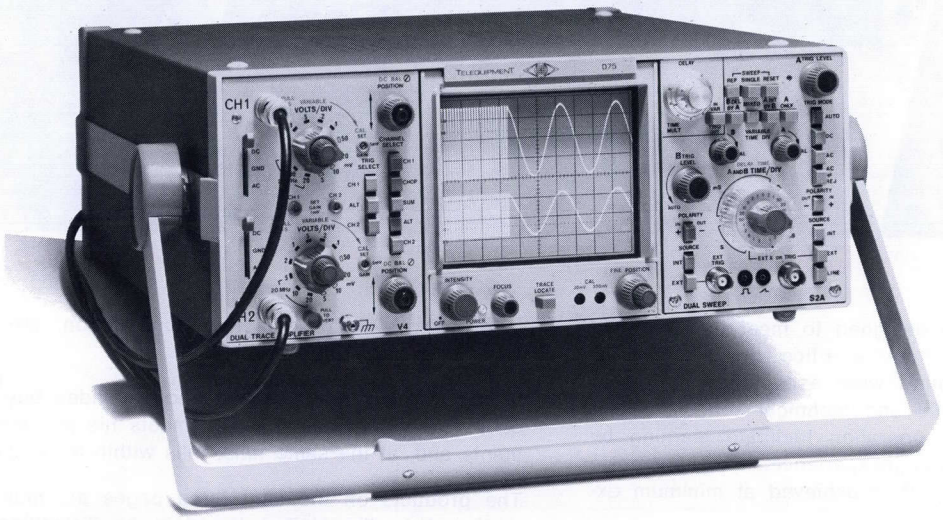
Optional Accessory—Power cable connector adapter to two 6/32 threaded fittings for connecting 821 power cable to +5-volt aux power bus (012-0545-00).

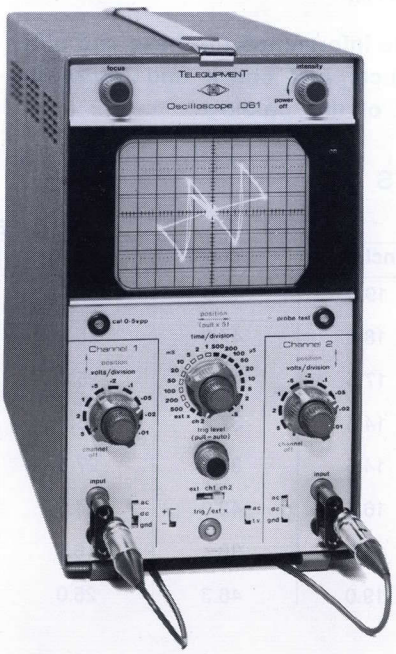
ORDERING INFORMATION

821 Word Recognizer **$200**

Optional Power Cable Adapter (012-0545-00) **$12.50**

TELEQUIPMENT Oscilloscopes





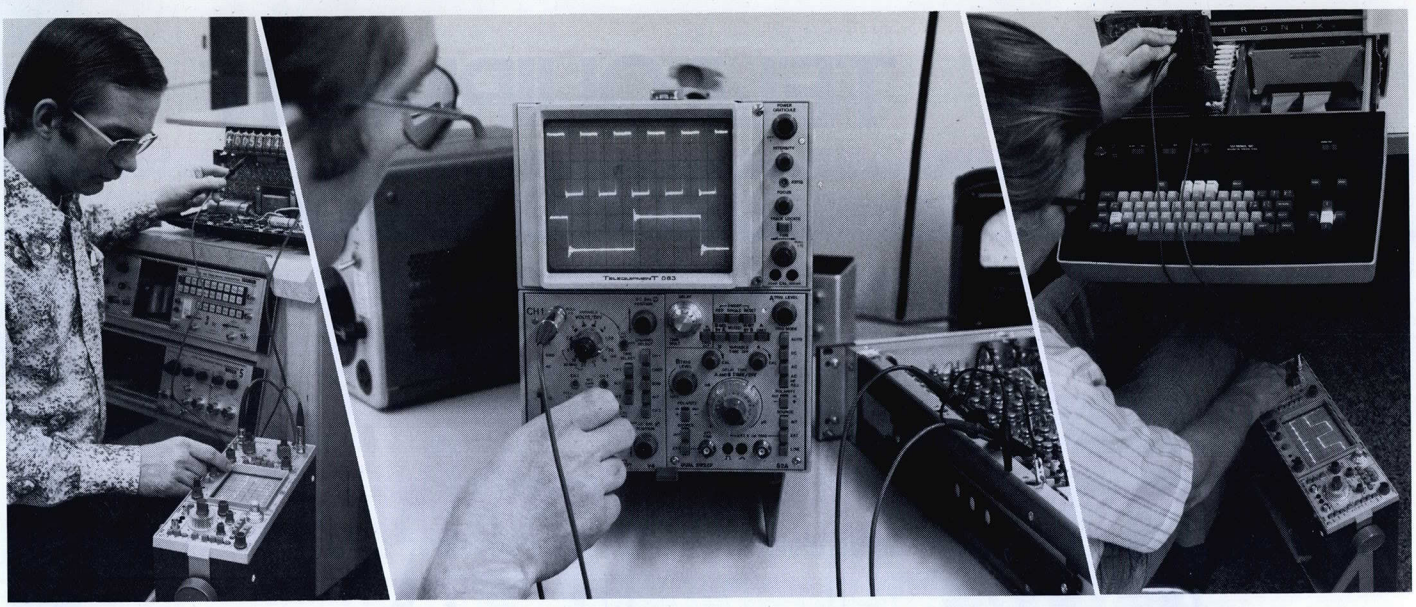
TELEQUIPMENT oscilloscopes combine low price with a number of features not usually found in other oscilloscopes of the same price range. Features such as calibrated sweep rate and vertical step attenuators, variable controls, triggered sweep, probe-calibration outputs, illuminated graticule and TV-field or line triggering, make the instrument versatile and easier to use.

Warranty, sales and service are the same as for other TEKTRONIX products.

Telequipment is a division of Tektronix U.K. Ltd., a wholly-owned subsidiary of Tektronix, Inc.

TELEQUIPMENT Products

Reliability and simplicity at low cost



TELEQUIPMENT products are designed to meet the needs of the cost-conscious buyer without sacrifice of reliability or general utility. They have found wide acceptance as teaching aids in vocational-industrial and technical schools. Their simple controls and ease of operation facilitate learning by minimizing error caused by user inexperience. Excellent basic training in oscilloscope use is thus achieved at minimum expense.

Electronics service organizations, whether company associated or independently owned, constitute another major area where TELEQUIPMENT has become an established name. Models are available for applications ranging from the troubleshooting and repair of simple audio devices to the installation and maintenance of computer peripherals, medical instruments, and related digital equipment. Ruggedized portable models are available for field work although even the bench models, with their solid-state construction, are light enough for easy transportation.

In the following pages the economy-minded buyer should find at least one instrument which meets his performance requirements and, at the same time, falls within his budget limitations.

The products on the next three pages are manufactured and marketed in the United Kingdom by Telequipment, London, England. Outside the United Kingdom they are available from Tektronix, Inc., its marketing subsidiaries and distributors. Warranty, sales and service are the same as for other TEKTRONIX products.

For complete information on these and other TELEQUIPMENT products just check and return the reply card at the back of this catalog.

DIMENSIONS AND WEIGHTS

INSTRUMENT	HEIGHT		WIDTH		DEPTH		NET WEIGHT	
	Inches	cm	Inches	cm	Inches	cm	lb	kg
D83 Oscilloscope	11.3	28.6	8.5	21.6	19.0	48.3	31.4*	14.3*
D75 Oscilloscope	5.4	13.6	15.0	38.0	18.6	47.0	25.5	11.5
D67 Oscilloscope	9.8	24.7	8.3	21.0	17.5	44.5	25.0	11.5
D66 Oscilloscope	9.5	24.0	8.3	21.0	14.5	37.0	25.5	11.5
DM64 Oscilloscope	9.5	24.0	8.3	21.0	14.5	37.0	27.5	12.5
D61 Oscilloscope	11.0	28.0	6.3	16.0	16.5	42.0	14.3	6.5
S51B Oscilloscope	8.0	20.3	7.0	17.8	15.0	38.1	16.0	7.3
CT71 Curve Tracer	9.6	24.5	9.3	23.5	19.0	48.3	25.0	11.7

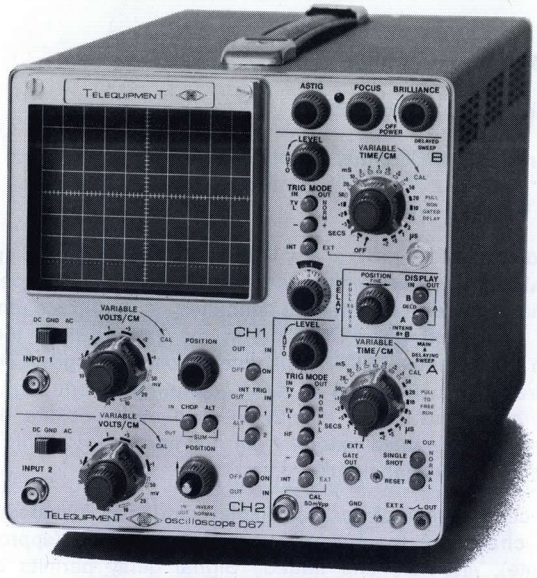
*Combined weight of mainframe and 2 plug-ins.

D67

25-MHz Bandwidth at 10 mV/cm
3% Measuring Accuracy
Delayed Sweep Time Base
All Solid-State Design
Large, Bright 8 x 10-cm Display

The D67 offers an impressive array of specifications normally found only in high-priced oscilloscopes. Features include, 25-MHz bandwidth, delaying sweep, 3% accuracy, 10 mV sensitivity, sweep rates from 200 ns/cm to 2 s/cm, dual trace with signal delay line, FET inputs, all solid-state design.

D67 Oscilloscope **$1025**



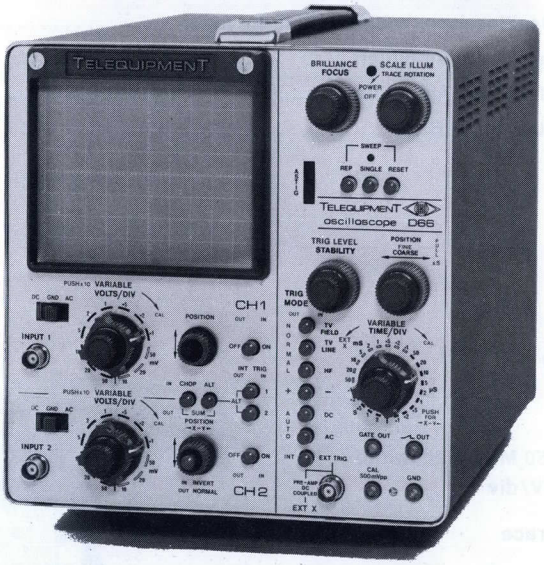
D66

25-MHz Bandwidth at 10 mV/cm
Minimum Deflection Factor 1 mV/cm
Switched X-Y Operation
Large, Bright 8 x 10-cm Display

The D66 provides 25 MHz bandwidth at 10 mV/cm. X10 gain expands the sensitivity to 1 mV/cm at 15 MHz bandwidth. Sweep rates extend from 2 sec/cm to 100 ns/cm (to 20 ns/cm with X5 Magnifier).

An X-Y function on the D66 projects the TELEQUIPMENT product line into areas recently held only by higher-priced oscilloscopes. Bandwidth is dc to 1 MHz and phase error is less than 1° at 25 kHz. A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 80-kHz rate), alternate and added. Signal delay allows viewing the leading edge of the display.

D66 Oscilloscope **$875**



NEW

D61

10 MHz Bandwidth at 10 mV/cm
Automatic Tv Frame and Line Triggering
Switched X-Y Operation
8 x 10-cm Viewing Area
Weighs under 15 lb

No other oscilloscope in its price range offers as many benefits to the user. Among its more outstanding features are: fully transistorized design, easily operated controls, bright 8 x 10-cm display, automatic circuits select tv line or frame triggering and alternate or chopped sweep modes for optimum displays. Identical input channels can be used for dual-trace displays or connected to X-Y operation at the turn of a switch.

D61 Oscilloscope **$475**

TELEQUIPMENT Oscilloscopes

Laboratory quality, plug-ins or portable

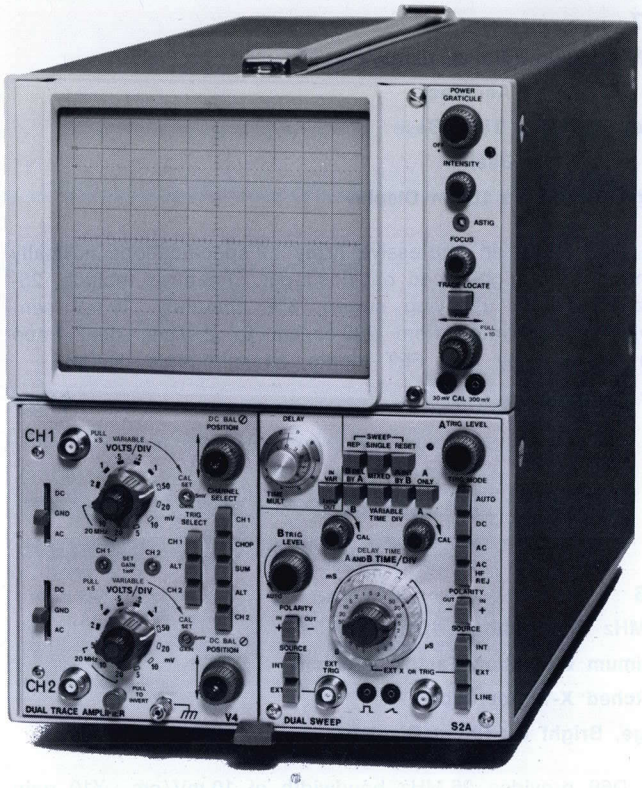
D83

Dc-to-50 MHz Bandwidth at 5 mV/div

Delayed Sweep Time Base

Dual-Trace or Differential Amplifier

Bright 6½-inch Displays



A bandwidth of 50 MHz at 5 mV/div and the concept of plug-in selectability are the main features of this oscilloscope. The plug-ins include a differential amplifier, a dual-trace amplifier and a dual time base. The crt in the D83 is from the field proven 7000-Series TEKTRONIX line of oscilloscopes. The display area is 8 x 10 div. A 15-kV accelerating potential gives the D83 a clear and bright display to view and measure delayed sweeps. Sweep rates extend from 100 ns/div to 2 s/div (to 10 ns/div with X10 magnifier).

A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 350-kHz rate), alternate and added. Signal delay permits viewing the leading edge of the waveform.

D83 Oscilloscope, without plug-in units **$800**
V4 Dual-Trace Amplifier **$295**
V3 Differential Amplifier **$295**
S2A Dual Time Base **$400**

NEW

D75

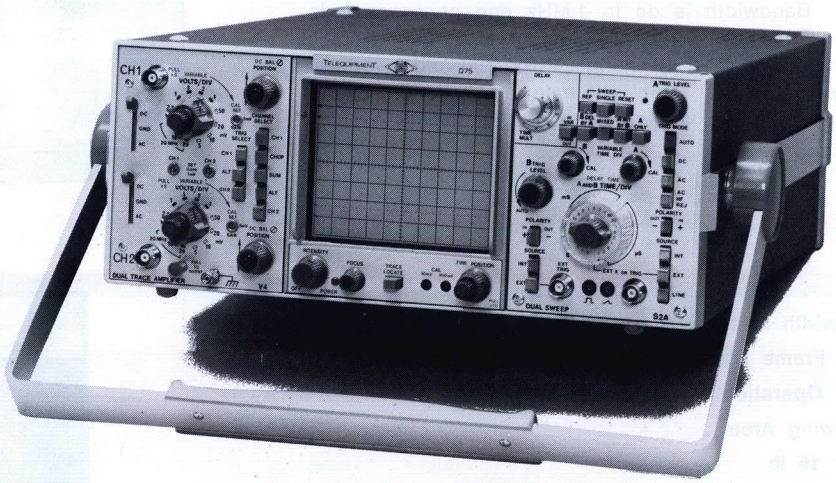
Dc-to-50 MHz bandwidth at 5 mV/div

Dual trace

Delayed/mixed sweep to 10 ms/div

15 kV accelerating potential

Compact, portable with protective panel cover



Portability and laboratory quality are combined in this 50-MHz Dual-Trace Oscilloscope for maximum utility in field service applications. Essentially a portable version of the D83, the D75 offers the same delayed and mixed sweep capability, 100 ns/div sweep rate (with X10 magnifier) and dual time base.

The twin vertical amplifiers have deflection factors from 5 mV/div to 20 V/div in 12 calibrated steps (1-2-5 sequence), 1 mV/div to 4 V/div using X5 gain, all steps accurate within 3%. Display modes are channel 1 only; channel 2 (normal and invert); alternate; chopped; added.

An accelerating potential of 15 kV and a parallax-free internal graticule (8 x 10 cm) provide bright, easy-to-read displays. A Trace Locate control positions the beam on screen regardless of vertical and horizontal position settings. A Z-axis input permits intensity modulation of the writing beam.

D75 Oscilloscope **$1,375**

DM64

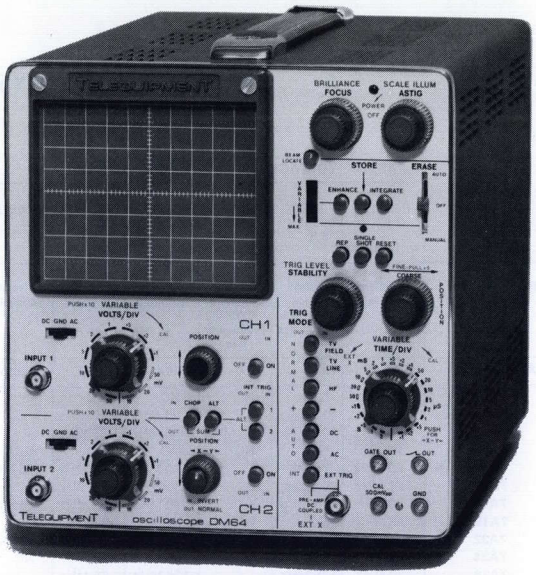
Dc-to-10 MHz Bandwidth at 1 mV/cm

Bistable Storage and Conventional Displays

Convenient X-Y Operation

Dual Trace

8 x 10-cm Viewing Area



The world's least expensive bistable storage oscilloscope is now here in the TELEQUIPMENT product line. The heart of this oscilloscope is the proven crt from the TEKTRONIX 560-Series Oscilloscope storage line. The crt is the single screen version of the 564 and utilizes an 8 x 10-cm display area.

The normal stored writing speed is at least 25 cm/ms but the writing speed can be increased to at least 250 cm/ms by implementing the Enhanced Mode. The storage view time is one hour or less. Coupled with this storage crt is the ability to measure X-Y relationships with the same ease as measuring Y-T.

The bandwidth of the DM64 is 10 MHz with a deflection factor of 10 mV/cm, using the X10 gain will extend the sensitivity to 1 mV/cm. Sweep rates extend from 100 ns/div to 2 sec/div. A full complement of vertical-display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 150 kHz rate), alternate and added.

DM64 Oscilloscope **$1095**

S51B

3-MHz Bandwidth

Tv Field Triggering

The low cost and easy to operate, S51B features a 3 MHz bandwidth and 100 mV/div to 50 v/div calibrated deflection factors. The calibrated horizontal time base provides 1 μs/div to 100 ms/div sweep rates, and a x2 magnifier.

Triggering modes include automatic, normal and tv field. The crt has an 8 x 10-cm display area and a Z-axis input.

S51B Oscilloscope **$280**

CT71

Displays Dynamic Characteristic Curves of Transistors, Diodes and FETs

Direct Comparison of Similar Devices

Dc Collector Supply to 1 kV

Leakage Measurements to 5 nA

Step Generator Range to 200 mA or 20 V

The TELEQUIPMENT CT71 Curve Tracer is a dynamic semiconductor tester which displays characteristic curves of transistors, FETs and diodes. The CT71 is easy to operate and is well suited for student lab use and industrial applications.

CT71 Curve Tracer **$845**

7000-SERIES OSCILLOSCOPE SYSTEMS/PROBE SELECTION CHART

		PASSIVE VOLTAGE 1 MΩ INPUT COMPATIBLE							PASS. VOLTAGE 50 Ω INPUT COMP.		FET PROBES 50 Ω/1 MHΩ INPUT COMPATIBLE			CURRENT PROBES		
PROBE		P6011 3.5′	P6063A P6053B 3.5′	P6055 3.5′	P6009	P6015 10′	P6062A	P6065A	P6056	P6057	P6045	P6046	P6201	w/passive term P6021 5′ 10 mV/ma	w/passive term P6022 5′ 10 mV/ma	P6042
FEATURES		Miniature Probe	Fastest Probes Compatible with 1-MHz Input	Adj. Attenuation for Differential Use	1.5 kV Compatibility	40 kV Compatibility	Selectable Attenuation	Miniature Probe	Fastest 10X Passive Probe low C	Fastest 100X Passive Probe low C	10-MΩ Input Impedance	Differential probe high cmrr	Low capacitive loading ac coupling dc offset	AC high current	AC high frequency	DC high current
ATTENUATION		1X	10X	10X	100X	1000X	Selectable	10X	10X	100X	Selectable	Selectable	Selectable	Selectable	Selectable	Selectable
	7A11*	NC	NC	NC	NC	NC		NC						55 MHz	150 MHz	45 MHz
	7A12	20 MHz	115 MHz		95 MHz	70 MHz					105 MHz	75 MHz	115 MHz	50 MHz	100 MHz	45 MHz
	7A13	20 MHz	105 MHz	65 MHz	85 MHz	65 MHz					90 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A14	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	55 MHz	120 MHz	NC
7900 FAMILY	7A15A/AN	20 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A16A	20 MHz	200 MHz		130 MHz	80 MHz					160 MHz	90 MHz	215 MHz	55 MHz	150 MHz	45 MHz
	7A18/N	20 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	500 MHz	480 MHz	200 MHz	95 MHz	430 MHz	NC	NC	50 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz	NC						1 MHz	1 MHz	1 MHz
	7A24	NC	NC		NC	NC	NC	NC	350 MHz	350 MHz	180 MHz	90 MHz	310 MHz	NC	NC	45 MHz
	7A26	20 MHz	175 MHz		125 MHz	75 MHz					145 MHz	85 MHz	180 MHz	55 MHz	140 MHz	45 MHz
	7A11	NC	NC	NC	NC	NC	NC	NC						55 MHz	130 MHz	45 MHz
	7A12	20 MHz	100 MHz		85 MHz	65 MHz					95 MHz	70 MHz	105 MHz	50 MHz	90 MHz	45 MHz
	7A13	20 MHz	95 MHz	65 MHz	85 MHz	60 MHz					90 MHz	70 MHz	100 MHz	50 MHz	85 MHz	45 MHz
	7A15A/AN	20 MHz	75 MHz		70 MHz	55 MHz	75 MHz	75 MHz			75 MHz	60 MHz	80 MHz	45 MHz	70 MHz	40 MHz
7800 FAMILY	7A16A	20 MHz	160 MHz		110 MHz	75 MHz					135 MHz	85 MHz	165 MHz	55 MHz	130 MHz	45 MHz
	7A18	20 MHz	85 MHz		80 MHz	60 MHz	85 MHz	85 MHz			85 MHz	65 MHz	90 MHz	45 MHz	70 MHz	40 MHz
	7A19	NC	NC	NC	NC	NC	NC	NC	400 MHz	400 MHz	205 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	185 MHz	90 MHz	280 MHz	NC	NC	45 MHz
	7A26	20 MHz	145 MHz		105 MHz	75 MHz					130 MHz	85 MHz	155 MHz	55 MHz	125 MHz	45 MHz
	7A11	NC	NC	NC	NC	NC	NC	NC						55 MHz	125 MHz	45 MHz
	7A12	20 MHz	100 MHz		85 MHz	65 MHz					90 MHz	70 MHz	100 MHz	50 MHz	90 MHz	45 MHz
	7A13	20 MHz	100 MHz	65 MHz	85 MHz	65 MHz					85 MHz	70 MHz	100 MHz	50 MHz	85 MHz	40 MHz
	7A14	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	50 MHz	105 MHz	NC
	7A15A/AN	20 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			70 MHz	55 MHz	70 MHz	45 MHz	70 MHz	40 MHz
7704A	7A16A	20 MHz	145 MHz		115 MHz	75 MHz					125 MHz	80 MHz	150 MHz	55 MHz	125 MHz	45 MHz
	7A18/N	20 MHz	75 MHz		70 MHz	60 MHz	75 MHz	75 MHz			70 MHz	60 MHz	75 MHz	45 MHz	70 MHz	40 MHz
	7A19**	NC	NC	NC	NC	NC	NC	NC	250 MHz	250 MHz	155 MHz	85 MHz	215 MHz	NC	NC	45 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz	NC						1 MHz	1 MHz	1 MHz
	7A24	NC	NC		NC	NC	NC	NC	200 MHz	200 MHz	145 MHz	80 MHz	180 MHz	NC	NC	45 MHz
	7A26	20 MHz	140 MHz		105 MHz	75 MHz					120 MHz	80 MHz	140 MHz	55 MHz	115 MHz	45 MHz
	7A11	NC	NC	NC	NC	NC	NC	NC						50 MHz	85 MHz	40 MHz
	7A12	20 MHz	75 MHz		70 MHz	60 MHz	70 MHz	70 MHz			70 MHz	60 MHz		45 MHz	70 MHz	40 MHz
	7A13	20 MHz	75 MHz	55 MHz	60 MHz	55 MHz	70 MHz	70 MHz			70 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A14	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	50 MHz	80 MHz	NC
7600 FAMILY	7A15A/AN	20 MHz	60 MHz		55 MHz	50 MHz	60 MHz	60 MHz			60 MHz	50 MHz		40 MHz	60 MHz	35 MHz
	7A16A	20 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			85 MHz	70 MHz		50 MHz	85 MHz	40 MHz
	7A18/N	20 MHz	70 MHz		65 MHz	55 MHz	70 MHz	70 MHz			70 MHz	55 MHz		45 MHz	70 MHz	40 MHz
	7A22	1 MHz	NC	1 MHz			1 MHz	NC						1 MHz	1 MHz	1 MHz
	7A26	20 MHz	95 MHz		85 MHz	65 MHz	95 MHz	95 MHz			85 MHz	70 MHz		50 MHz	85 MHz	40 MHz

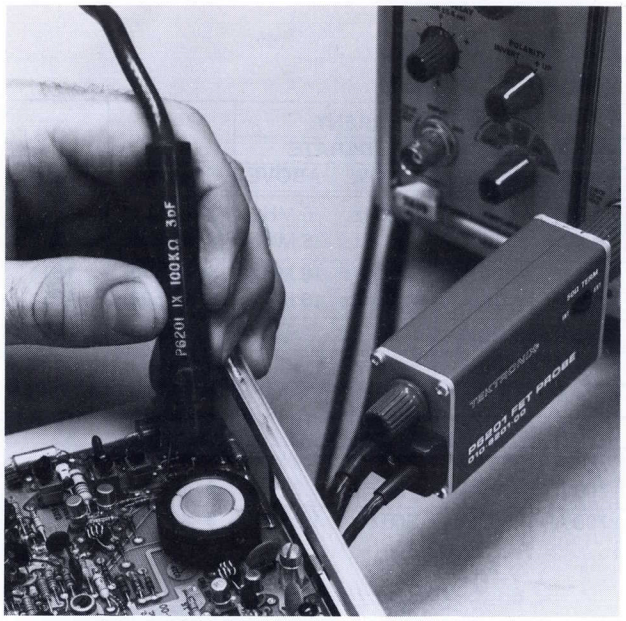
***NOTE: The values in the above table represent the approximate useful frequency response for the measurement systems at the probe tip.**

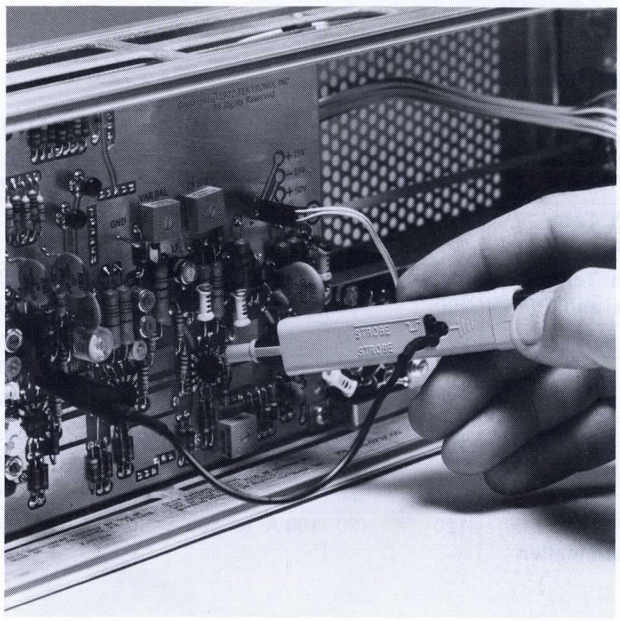
**** = Option 9 Mainframe**

NC = Not Compatible

Probes and Accessories

5





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.

For amplitude measurements, the capacitance and resistance of the probe form a voltage divider with the circuit under test. For low frequency (about 5 MHz and below) the resistive component is of primary importance in most probes and should be two orders of magnitude greater than the circuit source impedance. For higher frequencies, the importance of the capacitance increases drastically and will eventually be the prime consideration.

For risetime measurements, the interaction of the probe capacitance with the source impedance is of importance (RC time constant). For best results, the capacitance should be kept minimal. Typical probe specifications represent their response to a 25-ohm source environment.

For many circuits, the loading of the circuit by the probe may cause unnatural performance. For this consideration, probe capacitance is of prime importance at high frequencies (greater than about 30 MHz) and resistance at low frequencies (less than 5 MHz).

The best general-purpose probe is the active probe which contains the best obtainable combination of high probe resistance and low capacitance.

Logic Probe	176
FET & 50-Ω Probes	178
Current Probes	181
Voltage Probes	185
Accessories	189
Scope Carts	198

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.

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3. For many circuits, the loading of the circuit by the probe may cause unnatural performance. For this consideration, probe capacitance is of prime importance at high frequencies (greater than about 30 MHz) and resistance at low frequencies (less than 5 MHz).
4. The best general-purpose probe is the active probe which contains the best obtainable combination of high probe resistance and low capacitance.

CURRENT PROBES

TYPE	USEFUL BANDWIDTH Hz to MHz	CURRENT/DIV SCOPE AT 50 mV/DIV	SATURATION DC	SATURATION AMP ms PRODUCT	MAXIMUM CURRENT MAX RMS	MAXIMUM CURRENT PEAK PULSE	MAXIMUM CURRENT DERATE BELOW	MAXIMUM CURRENT DERATE ABOVE	PRICE	PAGE
P6021 with Term	120 50	.1 A to .5 A	.5 A	.5	5.3 A	250 A	300 Hz	5 MHz	**$ 140.00**	181
with 134 and PS	12 35	1 mA to 1 A	.5 A	.5	5.3 A	15 A	230 Hz	5 MHz	**$ 410.00**	181
P6022 with Term	8.5 k 100	50 mA or .5 A	.2 A	.009	2.1 A	100 A	3 kHz	10 MHz	**$ 185.00**	181
with 134 and PS	100 60	1 mA to 1 A	.2 A	.009	2.1 A	15 A	1.3 kHz	10 MHz	**$ 450.00**	181
P6042	Dc 50	1 mA to 1 A	10 A	—	10 A	10 A	—	1 MHz	**$ 835.00**	182
CT-1	30 k 1000	10 mA	.2 A	.001	.5 A	100 A			**$ 60.00**	183
CT-2	1.2 k 85	50 mA	.2 A	.05	2.5 A	100 A			**$ 70.00**	184
CT-3	30 k 1000	10 mA	.2 A	.001	.5 A	100 A			**$ 50.00**	184
CT-5 with P6021/134	12 k 20	20 mA to 1 kA	20 A	500	700 A	15 kA	230 Hz	1.2 kHz	**$1035.00**	184
with P6042	.5 k 20	20 mA to 10 kA	20 A	8000	700 A	10 kA	20 Hz	1.2 kHz	**$1460.00**	184
CT-5 with P6021 Passive Termination	120 20	100 A to 500 A	20 A	500	700 A	50 kA	300 Hz	1.2 kHz	**$ 765.00**	184

VOLTAGE PROBES for 50 Ω inputs, or 1 MΩ inputs

TYPE	ATTEN	LENGTH IN FEET	PACKAGE NUMBER	LOADING		RISETIME IN NS	INPUT LIMITS MAX. DC + PK. AC	INPUT LIMITS LINEAR DYNAMIC RANGE	INPUT LIMITS DC OFFSET RANGE	READ-OUT	PRICE	PAGE
P6045 FET	1X	6.0	010-0204-00 Std	10 M	5.5 pF	1.5	±12 V	±.5 V	±1 V	NO	**$365.00**	178
	10X				2.5 pF		±100 V	±5 V	±10 V			
	100X				1.8 pF		±100 V	±50 V	±100 V			
P6046 DIFF/AMP	1X	6.0	010-0213-00 Std	1 M	10 pF	3.5	±25 V	±5 V		NO	**$470.00**	178
	10X			10 M	3 pF		±250 V	±5 V				
P6056[1]	10X	6.0	010-6056-03 Std	500 Ω	1 pF	0.1	±16 V	±16 V		YES	**$ 55.00**	179
		9.0	010-6056-05 Opt 2								**$ 55.00**	
P6057[1]	100X	6.0	010-6057-03 Std	5 KΩ	1 pF	0.25	±50 V	±50 V		YES	**$ 55.00**	179
		9.0	010-6057-05 Opt 2								**$ 55.00**	
P6201 FET	1X	6.0	010-6201-01 Std	100 K	3.0 pF	0.4	±100 V	±.6 V	±5.6 V	YES	**$395.00**	180
	10X			1 M	1.5 pF		±200 V	±6 V	±56 V			
	100X						±200 V	±60 V	±200 V			

[1]Must be shunted by 50 Ω (011-0049-01) on a 1-MΩ system.

TYPE	ATTEN	LENGTH IN FEET	PACKAGE NUMBER	LOADING		USEFUL BW MHz	DC MAX	SCOPE C IN pF	READ OUT	PRICE	PAGE
P6006[1]	10X	3.5	010-0127-00 Opt 1	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	NO	**$ 33.00**	185
		6	010-0160-00 Std		8.5	25				**33.00**	
		9	010-0146-00 Opt 2		11	25				**33.00**	
		12	010-0148-00 Opt 3		13	12				**33.00**	
P6007	100X	3.5	010-0150-00 Opt 1	10 MΩ	2 pF[2]	25	1.5 kV	15 to 55	NO	**$ 42.00**	185
		6	010-0165-00 Std		2.2	20				**42.00**	
		9	010-0152-00 Opt 2		2.4	15				**42.00**	
		12	010-0154-00 Opt 3		2.6	13				**42.00**	
P6008	10X	6	010-0129-01 Std	Environmentalized —50°C to +150°C					NO	**$100.00**	
P6009	100X	9	010-0170-00 Opt 4	10 MΩ	2.5 pF[2]	120	1.5 kV	12 to 47	NO	**$ 75.00**	185
		9	010-0264-01 Std		2.5 pF	100			YES	**75.00**	
P6010	10X	3.5		Furnished with S-5 (Page 106) For other uses see P6054A or P6065							
P6011	1X	3.5	010-0193-00 Opt 1	1 MΩ	48 pF[2]	17	500 V	ANY	NO	**$ 25.00**	185
		6	010-0190-00 Std		68	10				**25.00**	
		9	010-0229-00 Opt 2		95	7				**25.00**	
P6012	10X	3.5	010-0203-00 Opt 1	10 MΩ	11.5 pF	35	500 V	15 to 47	NO	**$ 47.00**	
		6	010-0209-00 Std		14.5	30				**47.00**	
		9	010-0231-00 Opt 2		17.5	22				**47.00**	
P6013A	1000X	10	010-0177-01 Std	100 MΩ	3 pF	80	12 kV	15 to 55	NO	**$250.00**	186
		25	010-0175-01 Opt 3		3.5	13				**250.00**	
P6015	1000X	10	010-0172-00 Std	100 MΩ	3 pF	75	20 kV	12 to 47	NO	**$295.00**	186
P6027	1X			Same As P6028 But With UHF Connectors						**$ 24.00**	186
P6028	1X	3.5	010-0074-00 Opt 1	1 MΩ	50 pF[2]	17	600 V	ANY	NO	**$ 22.00**	186
		6	010-0075-00 Std		67	10				**22.00**	
		9	010-0076-00 Opt 2		90	7				**22.00**	
		12	010-0077-00 Opt 3		112	4				**22.00**	
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	**$ 80.00**	
P6049A	10X	3.5	010-6049-01	10 MΩ	13.5 pF	20	500 V	43 to 66	NO	**$ 40.00**	
P6052	10X or 1X			Obsolete, replaced by P6062A							
P6053B	10X	3.5	010-6053-11 Opt 1	10 MΩ	9.5 pF	250	500 V	15 to 24	YES	**$ 65.00**	186
		6	010-6053-13 Std		12.5	250				**65.00**	
		9	010-6053-15 Opt 2		13.5	88				**65.00**	
P6054A	10X	3.5	010-6054-11 Opt 1	10 MΩ	9.5 pF	250	500 V	15 to 24	NO	**$ 60.00**	187
		6	010-6054-13 Std		12.5	250				**60.00**	
		9	010-6054-15 Opt 2		13.5	88				**60.00**	
P6055[3]	10X	3.5	010-6055-01 Std	1 MΩ	10 pF[2]	60	500 V	20 to 47	YES	**$ 95.00**	187
P6058			010-0259-00	For use with DM 501 Plug-in Unit						**$ 70.00**	
			010-0260-00	For use with 7D13 Plug-in Unit						**$ 75.00**	
P6060[3]	10X	3.5	010-6060-01 Opt 1	10 MΩ	7.5 pF[2]	35	600 V	15 to 55	YES[4]	**$ 37.00**	187
		6	010-6060-03 Std		8.5	25				**37.00**	
P6061	10X			Obsolete, replaced by P6065A							
P6062A	10X or 1X	3.5	010-6062-01 Opt 1	10 MΩ	13.5 pF	100				**$ 65.00**	188
				1 MΩ	100 pF	8					
	10X or 1X	6	010-6062-03 Std	10 MΩ	14 pF	100				**$ 65.00**	
				1 MΩ	105 pF	6.7	500 V	15 to 47	YES		
	10X or 1X	9	010-6062-05 Opt 2	10 MΩ	17 pF	100				**$ 65.00**	
				1 MΩ	135 pF	4.5					
P6063A	10X or 1X	3.5	010-6063-01 Opt 1	10 MΩ	11 pF	200				**$ 80.00**	188
				1 MΩ	80 pF	12	500 V	15 to 24	YES		
	10X or 1X	6	010-6063-03 Std	10 MΩ	14 pF	200				**$ 80.00**	
				1 MΩ	105 pF	6					
P6065A	10X	6	010-6065-13 Std	10 MΩ	12.5	100[5]	500 V	20 to 24	YES	**$ 49.00**	188
		9	010-6065-15 Opt 2		13.5						
P6075A	10X	6	010-6075-13 Std	10 MΩ	12.5	200	500 V	Designed for 475 only	YES	**$ 54.00**	

[1]Available with UHF connectors.
[2]Rating varies with scopes having other than 20 pF inputs.
[3]Designed for use with scopes having differential inputs.
[4]Not compatible with crt readout.
[5]100 MHz with 465, 75 MHz.

Logic Probe

TTL/DTL Compatible

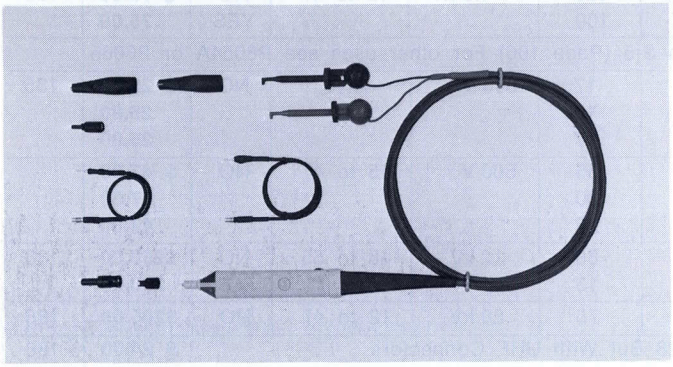
Detects Steady Logic Levels

Detects Trains of Logic Pulses

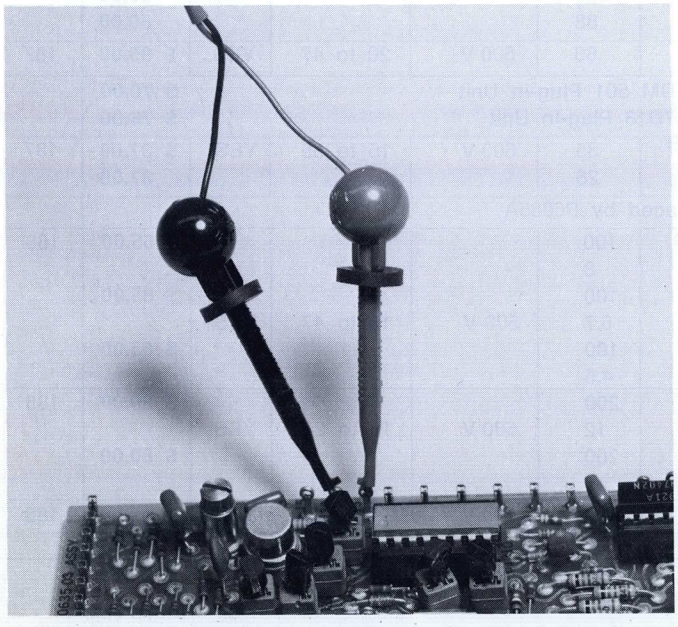
Detects Abnormal Conditions

Strobed Detection of Logic Pulses

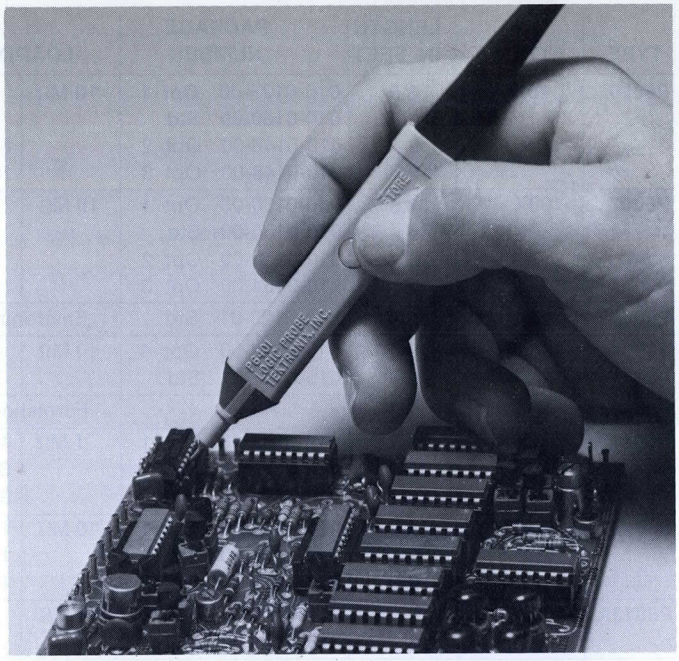
Protected Against Overvoltage



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 mechanical design embodies the experience gained in building more than a million oscilloscope probes. It's light, small and uses the same wide group of probe accessories that extend the usefulness of TEKTRONIX oscilloscope probes.

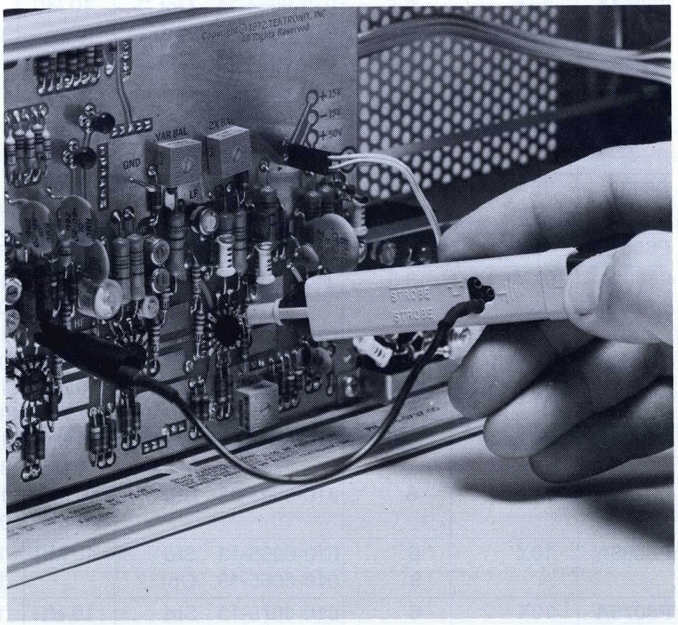


Probe power clips clip to any convenient 5-volt power source.



The occurrence or nonoccurrence of single pulse or very low repetition-rate pulses are clearly indicated by the P6401.

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.



In the "strobe" mode the P6401 detects the occurrence of a logic state at probe tip in time coincidence with a logic state at a second point.

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 ≈0.8 V

High State— ≈2.1 V to 6 V

Abnormal State— ≈0.8 V to 2.1 V or High Source Z (open test point)

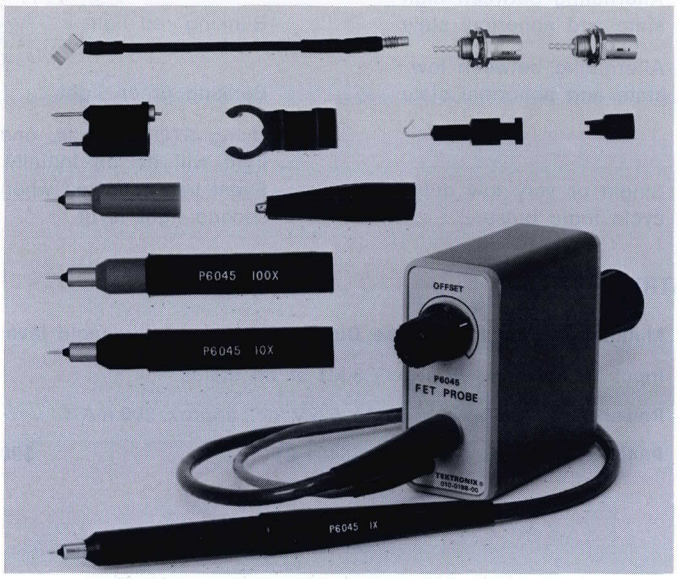
Minimal Recognizable Pulse Duration— 10 ns at threshold level

Input Resistance—Approx 7.5 kΩ at all states

Power Required— 4.5 V dc to 5.5 V dc, approx 200 mA

P6401 5-Ft Probe, order 010-6401-01 ..... **$90**

P6045 DC to 230 MHz 1X



The P6045 is an active (FET) probe providing unity gain and dc to 230-MHz bandwidth. The low input-capacitance of the probe permits coupling of high-frequency signals to an oscilloscope input with minimum loading on the circuit under test. Plug-on attenuator heads provide higher input resistance, reduced input capacitance, and attenuation of the signal. Effective dc offset range is also increased when using an attenuator head.

The P6045 is designed primarily for use with conventional oscilloscopes (with 1-MΩ input resistance). The internal 50-Ω termination may be switched in or out to adapt the probe output to either 1-MΩ or 50-Ω inputs.

ACCESSORY POWER SUPPLY

The P6045 may be powered from the probe power of an oscilloscope, +12 V and −12 V, or by the Accessory Power Supply. The P6045 power requirements are not compatible with the 7000-Series, 485, and 475 probe power outputs.

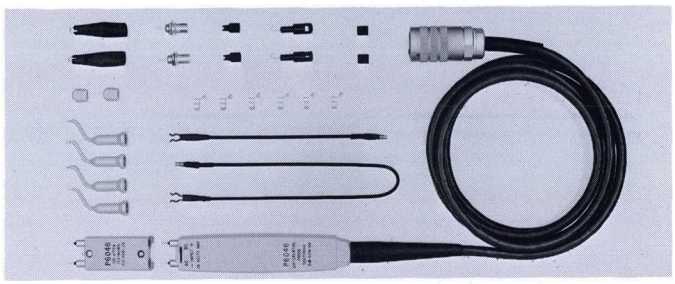
Bandwidth (−3 dB) dc to 230 MHz. **Risetime** is 1.5 ns or less. **Probe Gain** is 1X, 10X to 100X. **Input Impedance** is 10 MΩ shunted by 5.5 pF. **Attenuator Input C** is 10X 2.5 pF, 100X 1.8 pF. **Dynamic (Signal) Range** is at least −1 V to +1 V (with respect to tip of probe without attenuator head). **Effective Offset** is extended 10X and 100X by attenuator heads. **Noise** (Tangential) is 600 μV or less at output. **Maximum Input Voltage** (probe only) is 12 V, derated with frequency. **LF Response** (−3 dB) (ac coupled) is 16 Hz or lower.

P6045 FET Probe & Power Supply, Order 010-0205-00 . . . $500
Includes: 10X attenuator head (010-0357-02); 100X attenuator head (010-0358-01); ac-coupling capacitor head (010-0360-00); 2.5-inch ground lead (175-0249-00); bayonet ground adapter (013-0085-00); hook tip (206-0114-00); alligator clip (344-0046-00); two test jacks (131-0258-00); probe holder (352-0090-00); carrying case (016-0090-01); power cord (161-0025-01).

Opt 5 w/o Power Supply, Order 010-0204-00 . . . . . $365

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 18 MHz. Maximum input voltage at 230 MHz is 20 V.

P6046 DC to 100 MHz with 1000:1 CMRR AT 50 MHz



The P6046 Differential Probe and P6046 Amplifier Unit provide new measurement capabilities when used with all TEKTRONIX oscilloscopes. With this probe system, the differential-signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 Probe and Amplifier provides dc-to-100 MHz single-ended and differential measurements. The cmrr of the P6046 and amplifier is 1000:1 at 50 MHz.

A switch on the probe selects ac or dc input coupling. Accessories include a plug-on 10X attenuator for extending the differential input voltage range, and a ground tip for applications requiring single-ended input. Unique swivel tips provide variable spacing to accommodate varying distance between test points.

The P6046 Amplifier mounts conveniently on the side of the oscilloscope and features a calibrated 1-mV/div to 200-mV/div (2 V/div with 10X attenuator) deflection factor (oscilloscope deflection factor set at 10 mV/div). The output impedance of the amplifier is 50 Ω. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems.

The P6046 Differential Probe may be used with the 1A5 Differential Amplifier with TEKTRONIX 540 and 550 Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the 1A5 to 45 MHz. The 1A5 supplies both probe power and amplification.

CHARACTERISTICS

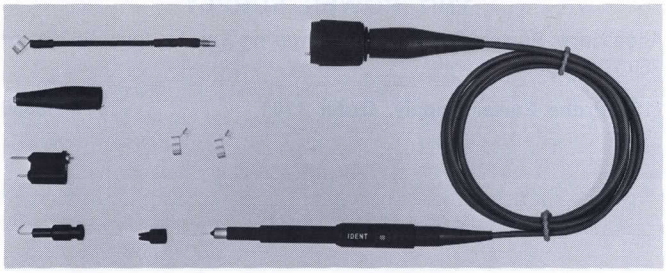
Probe and Amplifier

Deflection Factor is 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). **Bandwidth** is dc-to-100 MHz at 3-dB down. **Risetime** is 3.5 ns or less. **Common-Mode Rejection Ratios** with deflection factors of 1 mV/div to 20 mV/div are at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, 1,000:1 from 10 MHz to 20 MHz, and 500:1 at 50 MHz. **Common-Mode Linear Dynamic Range** is ±5 V, ±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). **Maximum Input Voltage** is ±25 V (dc + peak ac), ±250 V with 10X attenuator. **Output Impedance** is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems. **Probe Cable** is 6 feet long, terminated with a special nine-pin connector. **Amplifier Power Requirements** are 10 watts maximum, 48 to 400 Hz. Factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V-to-250 V (234 V nominal).

P6046 FET Differential Probe & Amplifier & Power Supply, Order 010-0232-00 ..... **$890**
Includes: Accessories as shown; power supply hanger assembly (014-0029-00); 50-Ω cable (012-0076-00); 50-Ω termination (011-0049-01); carrying case (016-0111-01).

Opt 5 w/o Amplifier & Power Supply, Order 010-0213-00 .. **$470**

P6056 DC to 3.5 GHz 10X



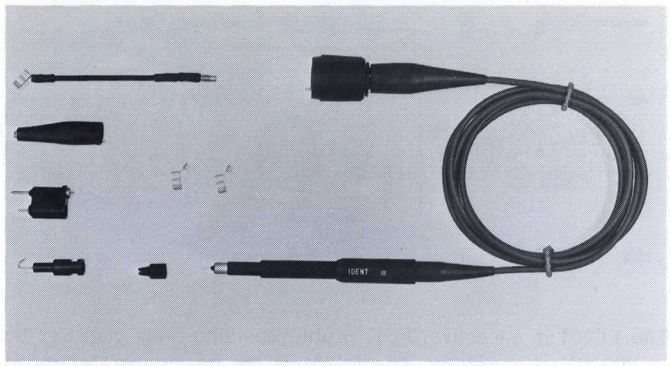
The P6056 is a miniature low-capacitance probe for use with 50 Ω, wide-band oscilloscopes. Bandwidth dc to 3.5 GHz. This probe can also be used with 50-Ω sampling systems, with an appropriate BNC adapter.

The P6056 is equipped with a special BNC connector that provides trace identification and crt READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

Attenuation is 10X. **Input Resistance** is 500 Ω at dc and approx 300 Ω at 1 GHz. **Input Capacitance** is 1.0 pF. **Risetime** is less than 100 ps, Probe only. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. **Bandwidth** is 3.5 GHz probe only dc to 500 MHz with 7A19 and 7904. **Maximum Input Voltage** RF (CW) 22 volts dc 16 volts. **Maximum Power Dissipation** is 0.5 watt. **Transit Time Variation** from probe to probe is less than 70 ps.

P6056 10X 50-Ω Probe, 6 ft, **Order 010-6056-03** **$55**
Opt 2, 9-ft, **Order 010-6056-05** **$55**
Included accessories as shown.

P6057 DC to 1.4 GHz 100X



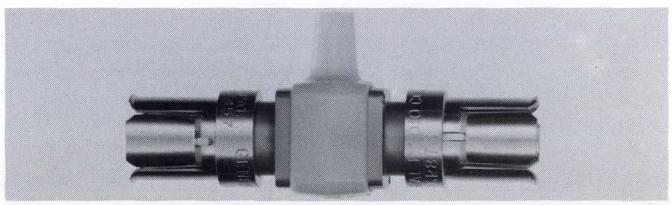
The P6057 is a miniature low-capacitance probe for use with 50 Ω, wide-band oscilloscopes. Bandwidth dc to 1.7 GHz. This probe can also be used with 50-Ω sampling systems, with an appropriate BNC male adapter (017-0063-00).

The P6057 is equipped with a special BNC connector that provides trace identification and crt READOUT information when used with plug-in units and mainframes that have these features. A convenient button on the probe activates the trace identification function.

Attenuation is 100X. **Input Resistance** is 5000 Ω at dc and approx 1500 Ω at 1 GHz. **Input Capacitance** is 1.0 pF. **Risetime** is less than 250 ps probe only. **Typical Risetime** with 7904 Oscilloscope and 7A19 Amplifier is 0.8 ns. **Bandwidth** is 1.4 GHz probe only dc to 480 MHz with 7A19 and 7904. **Maximum Input Voltage** 50 V dc or rms to 500 MHz decreasing to 21 volts at 1 GHz. **Transit Time variation** from probe to probe is less than 70 ps.

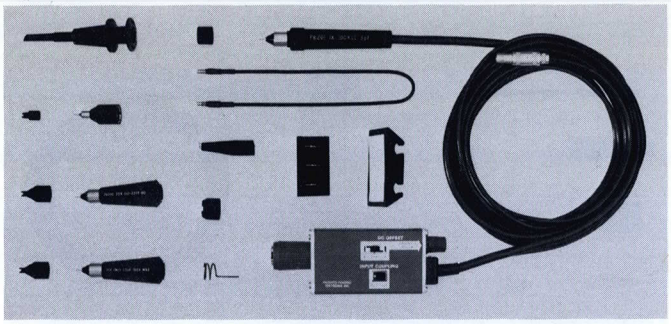
P6057 100X 50-Ω Probe, 6-ft, **Order 010-6057-03** **$55**
Opt 2, 9-ft, **Order 010-6057-05** **$55**
Included accessories as shown.

OPTIONAL ACCESSORY



The VP-1 50-Ω "T" pickoff allows signal pickoff from a closed 50-Ω system with minimum disturbance of the system's characteristics. The VP-1 is used with the P6056 and P6057 probes in a closed, 50-Ω coaxial system with minimum disturbance.
Order 017-0073-01 ..... **$38**

P6201 DC to 900 MHz 1X



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 risetime and pulse fidelity in higher source impedance circuits, due to low input capacitance when compared to other general-purpose probes.

The P6201 provides a dc offset feature to bias out a voltage level and allow observation of signals riding atop a carrier. This allows the signal to be brought within the linear input window of the probe. Ac or dc coupling selection is also available. When ac coupled, the dc voltage component, which could otherwise saturate an active probe, is blocked, allowing viewing of the superimposed signal.

The P6201 is designed primarily for use with TEKTRONIX 7900, 7800 and 7700 Series, 475 and 485 Oscilloscope, due to its direct compatibility with the probe power available on these instruments. The P6201 is valuable for use in the 50 Ω and 1 MΩ input real-time oscilloscope systems and also with sampling systems, spectrum analyzers and counters where high performance and minimum signal source loading is desired.

The probe includes a locking-type BNC connector which provides scale-factor readout information to instruments having readout capability, while maintaining compatibility with those instruments without readout. The 10X and 100X attenuator heads couple readout information to the instrument via the output connector.

The 1101 Accessory Power Supply is available to power the P6201 for use with instrumentation not supplying probe power.

Bandwidth (—3 dB) dc to 900 MHz, **Risetime** is 0.4 ns or less. **Probe Gain** is 1X within 3%. **Attenuator Accuracy** ≤4% with probe (10X or 100X). **Input Impedance** (probe only) is 100 kΩ (within 1%) shunted by 3.0 pF. Attenuator Heads are 1 MΩ (within 1%) shunted by 1.5 pF or less. **Dynamic (Signal) Range** is at least ±600 mV; extends to ±6 V with 10X attenuator; ±60 V with 100X attenuator. **Dc Offset Range** is at least —5.6 V to +5.6 V (with respect to tip of probe without attenuator head). Effective offset is extended by 10X and 100X attenuation heads to ±56 V and ±200 V respectively. **Noise** (Tangential) is 300 μV or less at output. **Maximum Input Voltage** is ±100 V, probe only and ±200 V with attenuation heads, derating with frequency. **Lf Response** (—3-dB) (ac coupled) is 10 Hz or lower; 10X attenuator extends lf response to ≤1 Hz; with 100X attenuator, lf response is ≤10 Hz.

P6201 FET Probe, Order 010-6201-01 ..... **$395**

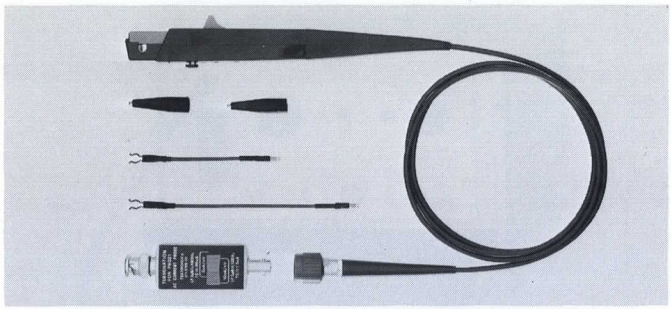
Included accessories as shown.

1101 POWER SUPPLY

Accessory Power Supply, for powering up to four P6201 or P6051 Probes.

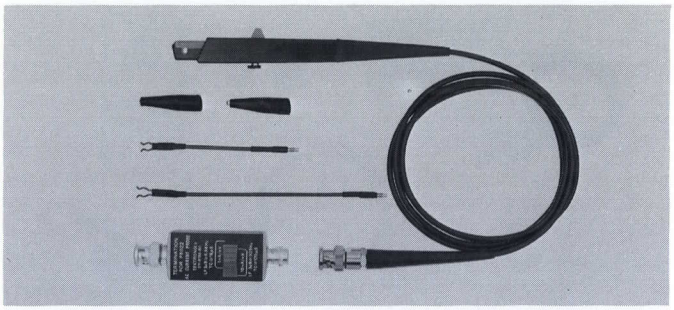
1101 Probe Power Supply, Order 1101 ..... **$330**

P6021 120 Hz to 60 MHz—Ac Current Probes



The P6021 and P6022 are ac current probes, the P6021 has 125 turns and the P6022 has 50 turns. The probes are designed for use with real-time oscilloscopes. Neither the termination nor the amplifier is required to use the probes with the TEKTRONIX 5A21N and 7A14 Plug-in Amplifiers. Both probes provide the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Just open the spring-loaded slide, place the conductor (up to 0.150 inches with P6021 and 0.100 inches with P6022) in the probe slot and release the slide. No electrical connection is required.

P6022 935 Hz to 150 MHz—Ac Current Probes



The shielded probe head is not grounded when the slide is in the open position, eliminating accidental grounding of the circuit under test. For general-purpose applications, the P6021 offers wide-band performance with excellent low-frequency characteristics. The extra-small size of the P6022 makes it ideally suited for measuring current in compact semiconductor circuits. Both probes, low-frequency capabilities and sensitivity can be expanded using the 134 Current Probe Amplifier. Either probe, with passive termination or with the amplifier, can be used with oscilloscopes having input resistance of 1 MΩ or greater.

PERFORMANCE CHARACTERISTICS

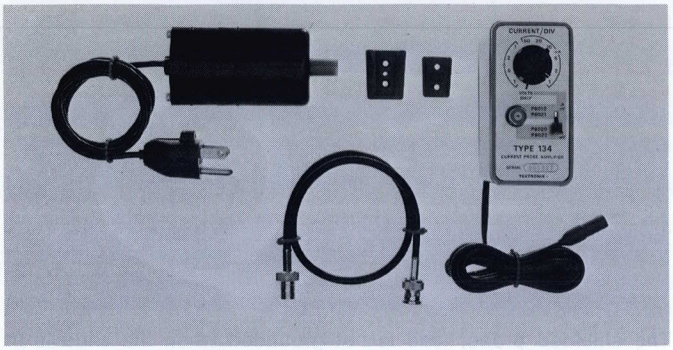
		P6021 & P6022 PROBE WITH PASSIVE TERMINATION				P6021 & P6022 PROBE WITH 134 AMPLIFIER	
SENSITIVITY	P6021	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy ±3%.				Switched current amplifier steps from 1 mA/div to 1 A/div (with 50 mV/div oscilloscope setting). Accuracy ±3%.	
	P6022	1 mA/mV or 10 mA/mV, selected by termination switch. Accuracy ±3%.					
SYSTEM BANDWIDTH†/RISETIME Oscilloscope Bandwidth		Bandwidth		Risetime		Bandwidth	Risetime
P6021	50 MHz	39 MHz		9.0 ns		30 MHz	11.6 ns
	75 MHz	48 MHz		7.3 ns		35 MHz	10.0 ns
	100 MHz	52 MHz		6.7 ns		36 MHz	9.6 ns
P6022		1 mA/mV	10 mA/mV	1 mA/mV	10 mA/mV	Bandwidth	Risetime
	50 MHz	47 MHz	48 MHz	7.45 ns	7.2 ns	40 MHz	8.8 ns
	75 MHz	65 MHz	70 MHz	5.35 ns	5.0 ns	50 MHz	7.0 ns
	100 MHz	80 MHz	90 MHz	4.36 ns	3.9 ns	54 MHz	6.4 ns
	150 MHz	100 MHz	120 MHz	3.50 ns	2.9 ns	59 MHz	5.9 ns
LOW FREQUENCY RESPONSE		P6021 ≤450 Hz at 2 mA/mV ≤120 Hz at 10 mA/mV		P6022 ≤8.5 kHz at 1 mA/mV ≤935 Hz at 10 mA/mV		P6021 ≤12 Hz	P6022 ≤100 Hz
NOISE P6021 & P6022						≤150 μA	
MAXIMUM CURRENT (CW)	P6021	15 A peak-to-peak sinewave between 1.2 kHz and 5 MHz at 2 mA/mV; between 300 Hz and 5 MHz at 10 mA/mV				15 A peak-to-peak sinewave between 230 Hz and 5 MHz	
	P6022	6 A peak-to-peak sinewave between 10 kHz and 10 MHz at 1 mA/mV; between 3 kHz and 10 MHz at 10 mA/mV				6 A peak-to-peak sinewave between 1.3 kHz and 10 MHz	
MAXIMUM CURRENT (PULSE)	P6021	250 A peak, not to exceed 500 A-μs or 5 A rms				15 A peak, not to exceed 500 A-μs or 5 A rms	
	P6022	100 A peak, not to exceed 9 A-μs or 2 A rms				15 A peak, not to exceed 9 A-μs or 2 A rms	
MAXIMUM VOLTAGE		600 V (dc + peak ac)				600 V (dc + peak ac)	
NET WEIGHT		≈1 lb				≈5 lb	

†All bandwidths stated are —3 dB.

P6021 Current Probe & Term, 5-ft, **Order 015-0140-02** **$140**
Opt 2, 9-ft & Term, **Order 015-0140-03** **$140**
Opt 6, 5-ft w/o Term, **Order 010-0237-02** **$100**
Opt 2 & 6, 9-ft w/o Term, **Order 010-0244-02** **$100**

P6022 Current Probe & Term, 5-ft, **Order 015-0135-00** **$185**
Opt 2, 9-ft & Term, **Order 015-0135-01** **$185**
Opt 6, 5-ft w/o Term, **Order 010-0238-00** **$140**
Opt 2 & 6, 9-ft w/o Term, **Order 010-0238-02** **$140**

134 AC Current Probe Amplifier



The 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div). 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.

Linear Deflection: ±15 A peak at 1 A/div. **Impedance:** (input) approx 50 Ω, ac coupled. **Bandwidth:** 8 Hz to 50 MHz at a gain of 50; 10 Hz to 30 MHz at a gain of 125 (3-dB down). **Net Weight:** approx 4 lb.

134 Current Probe Amplifier, Order 015-0057-02 ..... $310
Includes: Hanger assembly (014-0029-00), cable assembly (012-0104-00).

Opt 4, 230 Vac, Order 015-0057-03 ..... $310

ORDERING INFORMATION

P6021

P6021 Current Probe & Term, 5-ft, Order 015-0140-02 .... $140
Opt 2, 9-ft & Term, Order 015-0140-03 ..... $140
Opt 6, 5-ft w/o Term, Order 010-0237-02 ..... $100
Opt 2 & 6, 9-ft w/o Term, Order 010-0244-02 ..... $100
134 Current Probe Amplifier, Order 015-0057-02 ..... $310
Opt 4, 230 Vac, Order 015-0057-03 ..... $310

P6022

P6022 Current Probe & Term, 5-ft, Order 015-0135-00 .... $185
Opt 2, 9-ft & Term, Order 015-0135-01 ..... $185
Opt 6, 5-ft w/o Term, Order 010-0238-00 ..... $140
Opt 2 & 6, 9-ft w/o Term, Order 010-0238-02 ..... $140
134 Current Probe Amplifier, Order 015-0057-02 ..... $310
Opt 4, 230 Vac, Order 015-0057-03 ..... $310

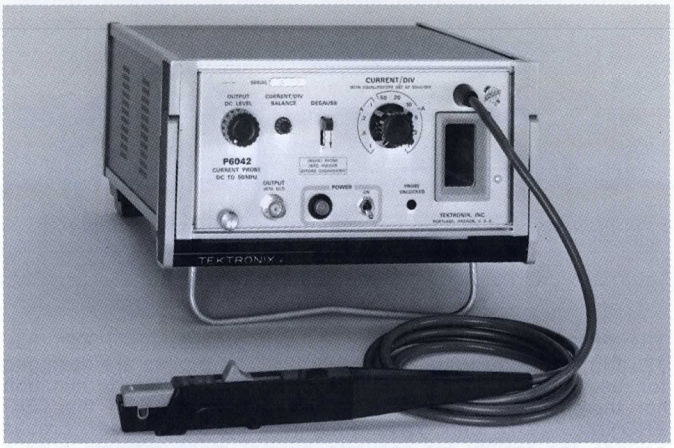
OPTIONAL ACCESSORIES for P6021 and P6022

Calibrator Adapter, BNC order 013-0092-00 ..... $10
Adapter, BNC to UHF order 103-0015-00 ..... $3

Carrying Case for P6021 or P6022 and a 134 amplifier.
Order 016-0087-01 ..... $7

Passive Termination
For P6021, Order 011-0105-00 ..... $45
For P6022, Order 011-0106-00 ..... $54

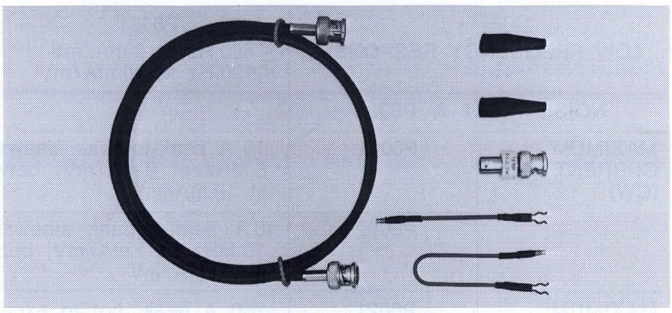
P6042 DC to 50 MHz CURRENT PROBE



The P6042 is a dc-to-50 MHz current probe designed for use with all TEKTRONIX Oscilloscopes. Utilizing a variation of the Hall effect, the P6042 offers new capabilities for making both high-frequency and dc current measurements. Ac signals with dc components can be displayed on the oscilloscope with true waveform presentation. The probe is particularly useful for evaluating the performance of semiconductor circuits where a wide range of parameters exist. Fast switching transients low-frequency response, and dc level can all be displayed simultaneously.

The probe can also be used to measure the sums or differences of currents in separate wires. When the probe is clipped around two wires carrying current in the same direction, the sum is displayed. By reversing one of the wires, the difference is displayed. For increasing sensitivity, several loops can be placed through the probe, increasing the sensitivity by the number of loops.

The P6042 consists of an amplifier with built-in power supply, 6-foot probe cable, and probe head. The probe is easy to use. Simply place the conductor (Up to 0.150-inch diameter) in the slot of the probe head and close the spring-loaded slide . . . no need to break the circuit under test. A warning light on the front panel of the amplifier indicates when the slide is in the unlocked position. A compartment is provided in the front panel for use in degaussing, and for convenient storage of the probe head when the system is not in use.



CHARACTERISTICS

Sensitivity is 1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 50 mV/div). **Bandwidth** is dc to 50 MHz at 3-dB down. **Risetime** is 7 ns or less. **Dynamic Range** is + and — 10 divisions of display. **Noise** (periodic and random deviation) is 0.5 mA or less, plus 0.2 or less major divisions of display. Random trace shift is 1.5 mA or less. **Thermal Drift** is 2 mA/°C or less, plus 0.2 or less major division of display per °C. **Maximum Input Current** is 10 A (dc plus peak ac).* **Maximum Voltage of Circuit Under Test** is 600 V (dc plus peak ac). **Output Impedance** is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the probe for use with 1-MΩ systems.

*Peak-to-peak current derating is necessary for cw frequencies higher than 1 MHz. At 50 MHz, the maximum allowable current is 2 A.

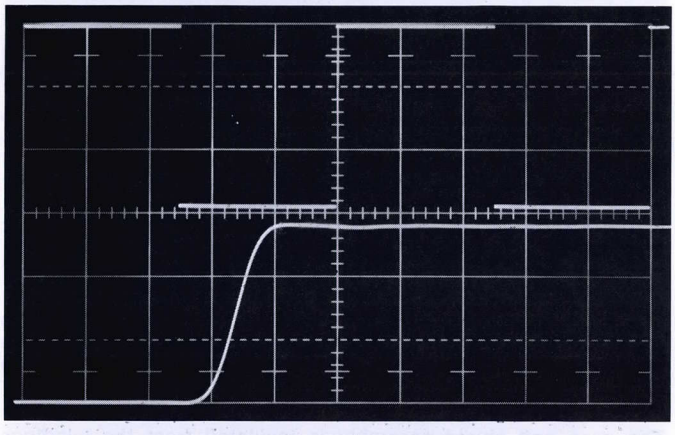
Amplifier Power Requirement is approximately 20 W, 50 Hz to 400 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V. **Dimensions And Weight** of the amplifier are 4½ inches (11.4 cm) high by 7½ inches (19.2 cm) wide by 9¾ inches (24.8 cm) deep; 6½ lbs. (3.1 kg). **Probe Cable** is 6 feet long, permanently connected between the probe head and amplifier.

P6042 dc to 50 MHz Current Probe, Order 010-0207-00 .. $835
Included accessories as shown.

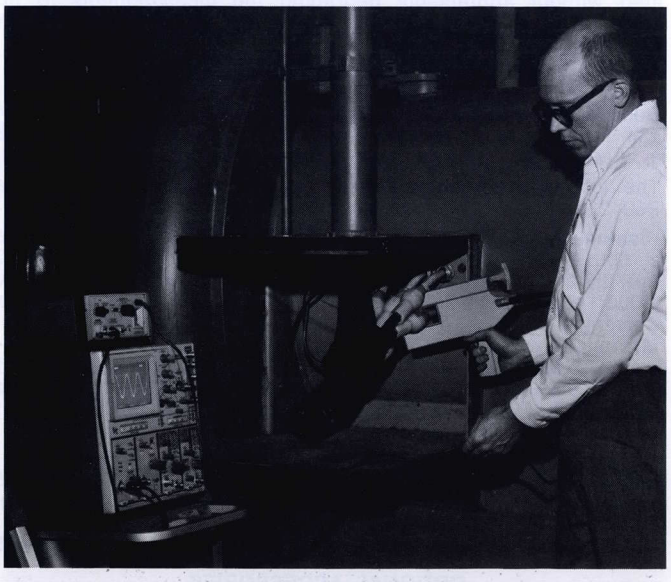
OPTIONAL ACCESSORIES

The CT-5 High-Current Transformer extends the maximum measurement capability of the P6042 at bandwidths from 1 Hz to 20 MHz.

CT5 Current Probe (includes dc Bucking Coil)
Order 015-0189-01 ..... $625
Opt 5 w/o dc Bucking Coil, Order 015-0189-00 ..... $475

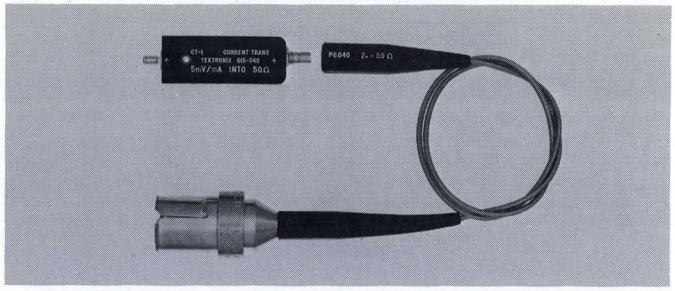


Upper display is a 60-Hz squarewave demonstrating the dc response of the P6042. The lower display is the same waveform at 10 ns/div. Double exposure photograph.



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.

CT-1 1-GHz AC CURRENT PROBE



The CT-1 Current Probe is designed for use with TEKTRONIX 50-Ω sampling units. With the use of a 50-Ω termination the CT-1 can be used with wideband, nonsampling oscilloscopes for making fast-risetime current measurements.

Several CT-1 current transformers may be placed throughout the circuit and monitored by one or more probe cables. For a longer length probe, additional 50-Ω cable can be used in series with the probe. Conductor sizes up to 0.065 inches in diameter can be monitored. (Note the CT-1 permanently inserted into a 50-Ω circuit will not change the 50-Ω environment.)

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.

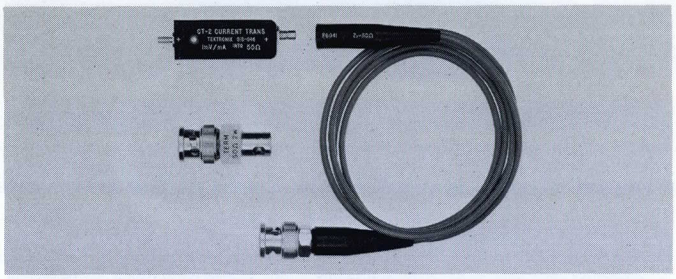
Impedance is 50 Ω. **Attenuation** is 1X. **Output Connector** is a GR type. **Cable Length** is 18 inches. Additional 50-Ω cable can be used in series with the probe. RG213/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

CT-1 CURRENT TRANSFORMER

Sensitivity is 5 mV/mA into a 50-Ω load. Accuracy is ±3%. **Decay Time Constant** is 5 μs, approximated by 1% per 50 ns; limit, 1 μs. **Risetime** is less than 350 ps. **Frequency Response** is 35 kHz to 1 GHz (3 dB down). **Insertion Impedance** with a 50-Ω termination is 1 Ω shunted by approximately 5 μH; 2 Ω shunted by approximately 5 μH without a 50-Ω termination. **Capacitance Loading** to a bare wire passing through the CT-1 transformer is typically 1.5 pF for #14 gauge, 0.6 pF for #20 gauge. **Maximum Voltage of Circuit Under Test** is 1000 V dc. **Direct Current** reduces the L/R time constant by a factor of 2 at 0.6 A. **Pulse Current Rating** is 100 A peak, with a max amp-second product of 1 A-μs. **Rms Current Rating** is 500 mA maximum. **Temperature Rating** is −25°C to +65°C. **Physical Dimensions** are 3/8 x 9/16 x 1-13/16 inches plus #6-32 x 1/4-inch mounting stud.

CT-1 Current Probe, Order 015-0041-00 ..... $60
Opt 5 without Probe Cable, Order 015-0040-00 ..... $33
Probe Cable, Order 010-0133-00 ..... $30

CT-2 AC CURRENT PROBE



The CT-2 Current Probe is designed for use with TEKTRONIX dc-to-100 MHz Oscilloscopes. A 50-Ω termination is used in conjunction with the CT-2 for terminating the probe at the input of the oscilloscope.

The insulated case of the CT-2 Current Transformer is convenient to use in applications where limited circuit space exists. Several CT-2 Transformers may be placed throughout the circuit and monitored by one or more 010-0164-00 Cables. Conductor sizes up to 0.050 inches in diameter can be monitored.

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.

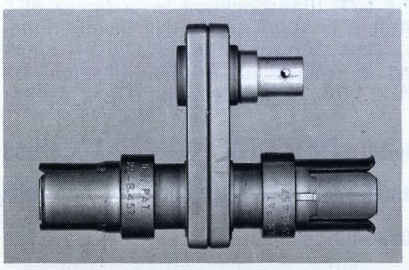
Impedance is 50 Ω. **Attenuation** is 1X. **Output Connector** is BNC type. **Cable Length** is 42 inches. Additional 50-Ω cable can be used in series with the probe. RG213/U or RG58A/U cable is recommended to preserve the high-frequency response.

CT-2 AC CURRENT PROBE

Sensitivity is 1 mV/mA into a 50-Ω load. Accuracy is ±3%. **Decay Time Constant** is 125 μs, approximately by 1% per 1.25 μs; limit, 25 μs. **Risetime** is approx 0.5 ns. **Frequency Response** is 30% down at 1.2 kHz, 7% down at 200 MHz. **Insertion impedance** with a 50-Ω termination is 0.04 Ω shunted approx 5 μH; 0.08 Ω shunted by approx 5 μH without a 50-Ω termination. **Capacitive Loading** to a bare wire passing through the CT-2 Transformer is typically 2.1 pF for #16 gauge, 0.7 pF for #22 gauge. **Maximum Voltage of Circuit Under Test** is 1000 V dc. **Direct Current** reduces the L/R time constant by a factor of 2 at 0.5 A. **Pulse Current Rating** is 100 A peak, with a max amp-second product of 50 μs. **Rms Current Rating** is 2.5 A maximum. **Temperature Rating** is −25°C to +65°C.

CT-2 & Cable & Term, Order 015-0047-00 ..... **$70**
Includes: Probe cable (010-0164-00); 50-Ω term. 011-0049-01.
Opt 5 w/o Cable or Term, Order 015-0046-00 ..... **$35**
Probe Cable, Order (010-0164-00) **$22**
50 Ω Termination; Order (011-0049-01) **$15**

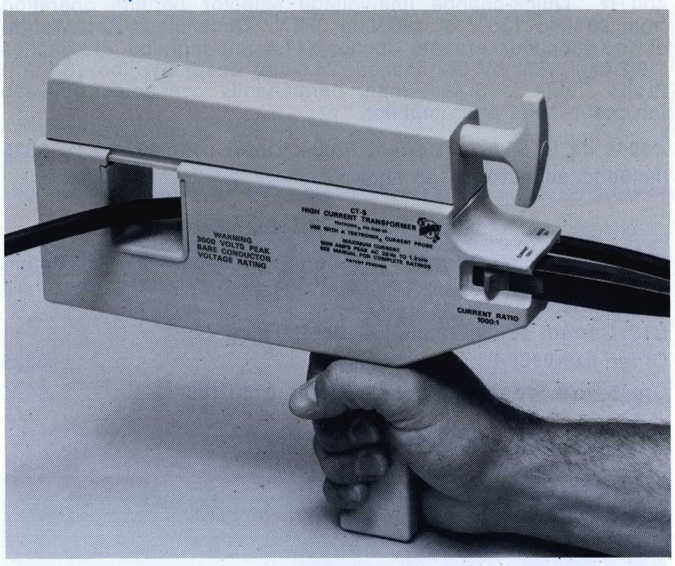
CT-3 SIGNAL PICKOFF



Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50-ohm system. Used with any of the TEKTRONIX sampling instruments, the CT-3 provides the link for use as a trigger source.

Sensitivity is 10% of the voltage under test, into a 50-ohm load. **Decay Time Constant** is 4.5 μs at 0 dc current. **Risetime** is less than 0.4 ns. **Frequency Response** is 50 kHz to 875 MHz at 0 dc current. **Insertion Impedance** with a 50-ohm termination is 1 ohm shunted by 4.5 μH; 2 ohms shunted by 4.5 μH without a 50-ohm termination. **Vswr** is less than 1.2 at 1.5 GHz. **Voltage Rating** at 0 V dc is 25 V rms, 1-kv pulse peak. The volts-second product is 100 Vμs. If exceeded, the L/R decay will decay rapidly toward zero.
CT-3 Signal Pickoff, Order 017-0061-00 ..... **$50.00**

CT-5 50,000 A PULSED CURRENT PROBE



The CT-5 is a clip-on High-Current Transformer designed to extend the measurement capability of TEKTRONIX clip-on current probes. Maximum low-frequency performance is obtained using the P6042 dc Current Probe. Maximum pulse current up to 50,000 A may be measured provided the 8 A-sec rating is not exceeded. It may also be used with the P6021 (not compatible with P6022) in conjunction with a current probe amplifier for measurements at normal power line frequency and above.

The CT-5 has receptacles for insertion of a current probe in either 20:1 or 1000:1 step-down ratios. The 1.5-inch square opening makes it possible to clip onto large conductors to make current measurements without breaking the circuit under test.

The core and shield assembly is insulated from the windings and the handle. This allows measurements to be made on bare conductors to 3000 volts, and to 10 kV rms on insulated conductors or by use of a high-voltage bushing.

Use of an optional dc bucking coil assembly, which slips over the front of the CT-5, allows up to 300 amps of dc to be tolerated without appreciably degrading the measurements to be made. This is very useful for measuring ac signals riding on top of dc.

CHARACTERISTICS

Bandwidth—with CT-5/P6042 is 0.5 Hz to 20 MHz; CT-5/P6021/134 is 12 Hz to 20 MHz; CT-5/P6042/dc Bucking Coil is 1 Hz to 1 MHz. See previous two pages for additional information.

The following are characteristics of the CT-5 using either the P6042 or P6021/134 combination.

Risetime is 17.5 ns or less. **Insertion Impedance** is 20 μΩ or less at 60 Hz, increasing to 20 mΩ at 1 MHz. **Current Range** is 20 mA/div to 20 A/div (20:1 step-down ratio); 1 A/div to 1000 A/div (1000:1 step-down ratio). Accuracy is within 4%. **Maximum Current** is 1000 A peak cw.* **Amp-Second Product** is 8 A-s. **Maximum Voltage** of circuit under test is 3000 V (bare conductor). **Maximum dc Bucking Current** is 300 mA to buck out 300 A dc (using optional dc bucking coil). **Dimensions and Weight**—the length is 10½ inches, width is 2¼ inches, height is 9½ inches, net weight is approx 4 lb.

CT5 Current Probe (includes dc Bucking Coil).
Order 015-0189-01 ..... **$625**
Includes carrying case (016-0191-00); high-voltage bushing, 10 inches (015-0194-00).
Opt 5 w/o dc Bucking Coil, Order 015-0189-00 ..... **$475**

OPTIONAL ACCESSORIES

Dc Bucking Coil, Order 015-0190-00 ..... **$150**
High-Voltage Bushing, 4 ft long, inside diameter is 1 inch, **order 015-0194-01** **$15**

*Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.

P6006 DC to 35 MHz 10X

The P6006 is a general-purpose probe designed for use with TEKTRONIX dc-to-33 MHz oscilloscopes. The probe can be compensated to match all TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ. This probe is more rugged and has a higher voltage rating than the miniature probes.

Attenuation is 10X; **Input Resistance** is 10 MΩ; **Input Capacitance** for standard length probe is approximately 7.5 pF when used with an instrument having a 20-pF input capacitance; 8.5 pF for the 6-ft version, 11 pF for the 9-ft version, 13 pF for the 12-ft version; **Probe Risetime** is approximately 5 ns; **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 12 ns; **Voltage Rating** is 600 V dc, ac peak, or dc and ac peak combined.*

P6006 10X Probe, 6-ft BNC, Order 010-0160-00 ..... **$33**
Opt 4, 6-ft UHF, Order 010-0158-00 ..... **$35**
Opt 1, 3.5-ft BNC, Order 010-0127-00 ..... **$33**
Opt 1 & 4, 3.5-ft UHF, Order 010-0125-00 ..... **$35**
Opt 2, 9-ft BNC, Order 010-0146-00 ..... **$33**
Opt 2 & 4, 9-ft UHF, Order 010-0142-00 ..... **$35**
Opt 3, 12-ft BNC, Order 010-0148-00 ..... **$33**

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 5.7 MHz when working into a 20-pF input, or higher than 3.6 MHz when working into a 47-pF Input.

P6007 DC to 25 MHz 100X

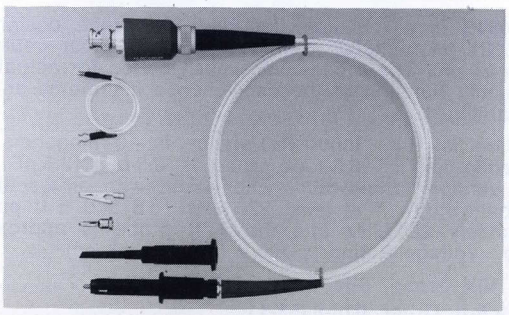
The P6007 low input-capacitance, high-voltage (1.5-kV) probe is designed for use with TEKTRONIX dc-to-33-MHz oscilloscopes. The probe can be compensated to match all TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 MΩ.

Attenuation is 100X; **Input Resistance** is 10 MΩ; **Input Capacitance** for 3.5-ft probe is approximately 2.0 pF when used with an instrument having a 20-pF input capacitance; 2.2 pF for the 6-ft version, 2.4 pF for the 9-ft version, 2.6 pF for the 12-ft version; **Probe Risetime** is approximately 7 ns; **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is approx 12.5 ns; **Voltage Rating** is 1.5 kV dc or ac rms, 4.2 kV ac peak to peak.*

P6007 100X Probe, 6-ft, Order 010-0165-00 ..... **$42**
Opt 1, 3.5-ft, Order 010-0150-00 ..... **$42**
Opt 2, 9-ft, Order 010-0152-00 ..... **$42**
Opt 3, 12-ft, Order 010-0154-00 ..... **$42**

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 200 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

P6008 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°C to +55°C. Input capacitance is 9.0 pF when used with an instrument having a 15 pF input capacitance. Probe 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 approximately 7.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Risetime** is less than 4 ns; **Typical Risetime** of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.6 ns; **Voltage Rating** is 600 V dc, ac peak, or dc and ac peak combined.*

P6008 10X Probe, 6-ft Envir., Order 010-0129-01 ..... **$100**

Includes: banana plug (134-0013-00); miniature alligator clip (344-0045-00); 12.5-inch ground lead (175-0925-00); probe holder (352-0090-00); retractable hook tip (013-0071-01).

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 20 MHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 300 V.

P6009 DC to 120 MHz 100X

The P6009 low input capacitance, high-voltage (1.5-kV) probe is designed for use with TEKTRONIX dc-to-150 MHz oscilloscopes. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 12 pF to 47 pF and input resistance of 1 MΩ.

A version of the P6009 is equipped with a special BNC connector that provides †CRT READOUT information when used with plug-in units and mainframes that have these features. The readout connector is not compatible with most standard non-readout BNC connectors.

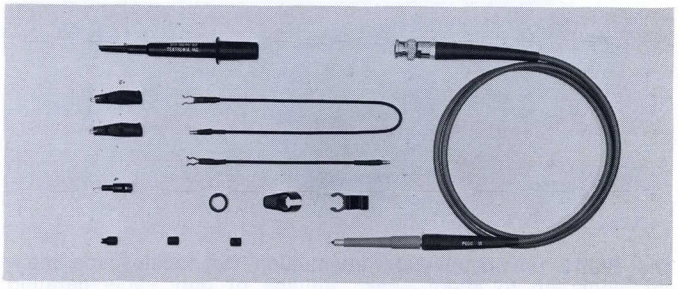
Attenuation is 100X. **Input Resistance** is 10 MΩ. **Input Capacitance** is approximately 2.5 pF when used with an instrument having a 20 pF input capacitance; **Probe Risetime** is approximately 2 ns; **Typical Risetime** of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.1 ns. **Voltage Rating** is 1.5 kV dc or ac rms, 4 kV AC peak to peak*. **Cable** is 9 ft long, terminated with a BNC connector; **Net Weight** is approx 16 oz.

P6009 100X Probe, 9-ft w/Readout, Order 010-0264-01 .. **$ 75**
Opt 4 w/o Readout, Order 010-0170-00 ..... **$ 75**

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 200 kHz. At 40 MHz, the maximum allowable peak-to-peak voltage is 425 V.

†Readout coding inoperative with 7A15A and 7A22.

P6011 DC to 17 MHz 1X



The P6011 1X Passive Probe can be used with all TEKTRONIX general-purpose oscilloscopes. The small size of the probe body makes it ideal for working on compact circuitry.

Attenuation is 1X. **Input Resistance** is 1 MΩ, instrument input R included. **Input Capacitance** for the 3.5-ft probe is approx 28 pF; 48 pF for the 6-ft version, instrument excluded. For total input capacitance of the system add input C of the instruments. **Probe Risetime** for the 3.5-ft length is less than 12 ns into 15 pF or less than 15 ns into 20 pF. The probe risetime of the 6-ft version is less than 15 ns into 15 pF or less than 17 ns into 20 pF. The probe risetime of the 9-ft version is less than 23 ns into 15 pF or less than 25 ns into 20 pF. **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 16 ns. **Voltage Rating** is 500 V dc, ac peak, or dc and ac peak combined.

P6011 1X Probe, 6-ft, Order 010-0190-00 ..... **$25**
Opt 1, 3-5-ft, Order 010-0193-00 ..... **$25**
Opt 2, 9-ft, Order 010-0229-00 ..... **$25**

Included accessories as shown.

*Peak voltage derating is necessary for cw frequencies higher than 0.5 MHz. When the probe is used with a plug-in having an input C of 20 pF, the maximum allowable peak voltage at 1 MHz is 510 V. At 5 MHz, the maximum is 100 V; 46 V at 10 MHz.

P6013A 12 kV 1000X

The P6013A provides 1000X attenuation for oscilloscope measurements of high amplitude waveforms or dc potentials up to 12 kV. The probe can be compensated for oscilloscope input capacitance up to 60 pF and input resistance of 1 MΩ. The P6013A is similar to the P6015 shown in photo.

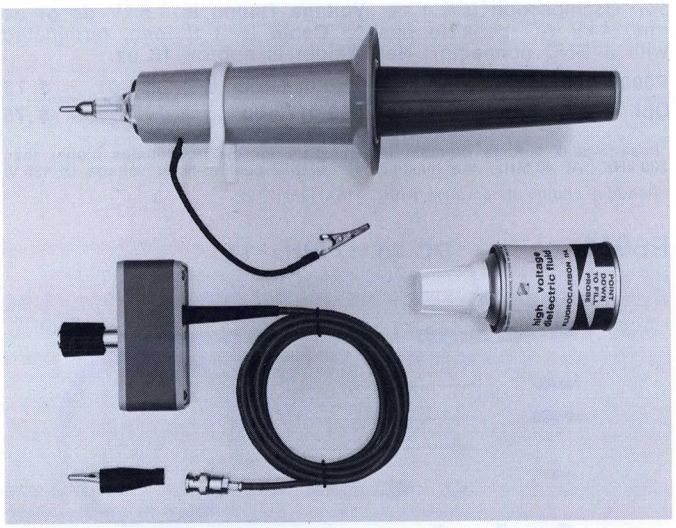
Attenuation is 1000X. **Input Resistance** is 100 MΩ. **Input Capacitance** of probe with 10-ft cable is 3 pF; 3.5 pF with 25-ft cable. **Probe Risetime** is 7 ns or less with 10-ft cable, 13.5 ns or less with 25-ft cable. **Typical Risetime** of 10-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 13 ns. **Voltage Rating** is 12 kV, peak pulse, or peak ac.* **Net Weight** is approx 5½ lb.

P6013A 1000X Probe, 10-ft, **Order 010-0177-01** **$250**
Includes: compensating box (015-0083-00 BNC); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00).

Opt 3, 25-ft, **Order 010-0175-01** **$250**
Includes: compensating box (015-0084-00 BNC) alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-01).

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 100 kHz. At 1 MHz, the maximum allowable peak-to-peak voltage is 5.5 kV.

P6015 40 kV 1000X



The P6015 provides 1000X attenuation for oscilloscope measurements up to 40-kV peak. Voltage or duty cycle derating is necessary for RF voltages at frequencies over 100 kHz, or in temperatures above 25°C.

The probe can be compensated for instruments with nominal input capacitance of 12 pF to 47 pF.

Attenuation is 1000X. **Input Resistance** is 100 MΩ. **Input Capacitance** is approximately 3 pF. **Probe Risetime** is approximately 4 ns. **Typical Risetime** of the probe, 1A1 Plug-In Unit and 547 Oscilloscope is 8 ns. **Temperature Range** is 10°C to 55°C **Voltage Rating** is 40 kV peak ac or pulse, 20 kV dc or rms continuous at 25°C*.

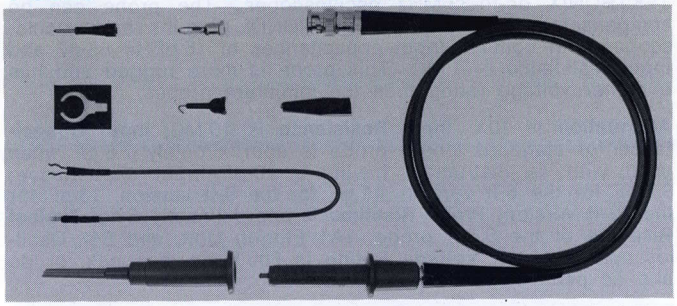
P6015 1000X Probe, 10-ft, **Order 010-0172-00** **$295**
Includes: compensating box (015-0049-00 BNC) or (015-0039-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); can of high-voltage dielectric fluid (252-0120-00); carrying case† (016-0128-01).

†not shown.

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 100 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 13 kV.

P6027 DC to 17 MHz 1X

P6028 DC to 17 MHz 1X



The P6028 is a general-purpose 1X voltage probe designed for use with TEKTRONIX oscilloscopes that have BNC input connectors. **The P6027** is identical to the P6028 except for the UHF connector.

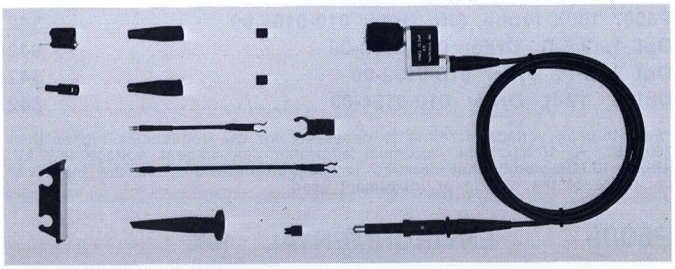
Attenuation is 1X. **Input Resistance** is 1 MΩ, instrument input R included. **Input Capacitance** for 3.5-ft version is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument. **Probe Risetime** is approximately 10 ns. **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 15 ns. **Voltage Rating** is 600V dc or ac peak to peak*.

P6028 1X Probe, 6-ft, **Order 010-0075-00** **$22**
Opt 1, 3.5-ft, **Order 010-0074-00** **$22**
Opt 2, 9-ft, **Order 010-0076-00** **$22**
Opt 3, 12-ft, **Order 010-0077-00** **$22**
Included accessories as shown.

P6027 1X Probe, 6-ft, **Order 010-0071-00** **$24**
Opt 1, 3.5-ft, **Order 010-0070-00** **$24**
Included accessories as shown.

*Peak-to-peak voltage derating is necessary for cw frequencies sigher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak 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 push button for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

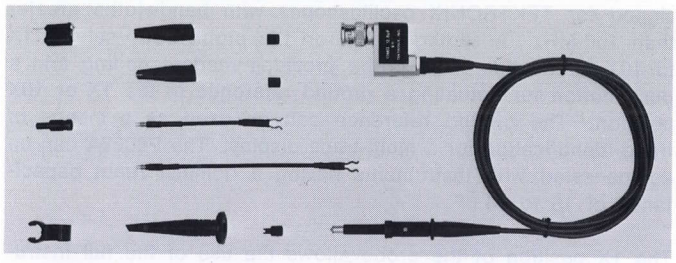
Attenuation is 10X. **Input Resistance** is 10 megohms. **Input Capacitance** for the 3.5-foot probe is 9.5 pF; 12.5 pF for the six-foot version. **Bandwidth,** when used with an oscilloscope with a bandwidth of at least 225 MHz: 3.5 and 6 ft probes is approximately 200 MHz and the 9 ft probe is approximately 115 MHz. **Voltage Rating** is 500 V (dc + peak ac).*

P6053B 10X Probe, 6-ft, Order 010-6053-13 ..... **$65**
Opt 1, 3.5-ft Order 010-6053-11 ..... **$65**
Opt 2, 9-ft, Order 010-6053-15 ..... **$65**

Included accessories as shown.

*Peak voltage derating is necessary for cw frequencies higher than 5.5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.

P6054A DC to 250 MHz 10X



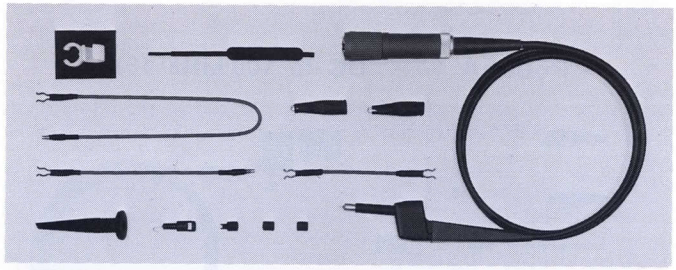
The P6054A is a miniature, fast-rise, 10X probe designed for use in conjunction with TEKTRONIX oscilloscopes having a nominal input capacitance of 15 to 24 pF. The probe does not incorporate CRT READOUT/trace-identify functions but does have a ground reference button.

Attenuation is 10X. **Input Resistance** is 10 megohms. **Input Capacitance** for the 3.5-ft probe is 9.5 pF; for the 6-foot version 12.5 pF; for the 9-foot version 13.5 pF. **Bandwidth with 454A Oscilloscope—** 3.5-ft and 6-ft probe is at least 150 MHz and the 9-ft probe is at least 115 MHz. **Voltage Rating** is 500 V (dc + peak ac).†

P6054A 10X Probe, 6-ft, **Order 010-6054-13** **$60**
Opt 1, 3.5-ft, **Order 010-6054-11** **$60**
Opt 2, 9-ft, **Order 010-6054-15** **$60**
Included accessories as shown.

†Peak voltage derating is necessary for cw frequencies higher than 6 MHz. At 10 MHz the maximum allowable peak voltage is 300 V; 25 V at 100 MHz, 22 V at 150 MHz. Values for 3.5-ft probe only.

P6055 20,000:1 CMRR 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.

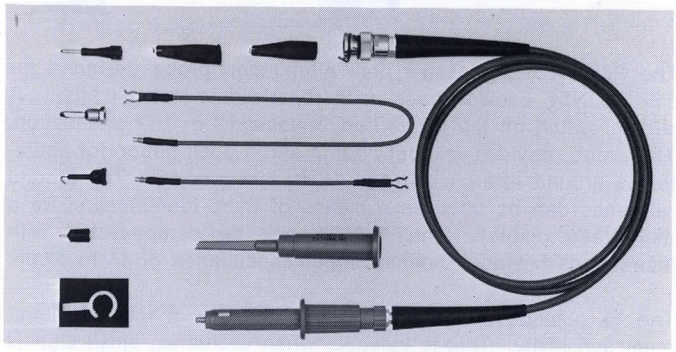
When two P6055 Probes are used to drive the two inputs of a differential amplifier, the ability to change the attenuation ratio of one probe versus the other is helpful in maintaining the cmrr of the system.

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 or 1A5. **Attenuation** is adjustable to 10X. **Input Resistance** is 1 MΩ ±0.5%. **Input Capacitance** is approx 10 pF when used with an instrument having 20 pF input capacitance; 12.5 pF when used with an instrument having 47 pF input capacitance. **Typical Risetime** of the probe with 7A13 and 7704 Oscilloscope is 5.4 ns. **Voltage Rating** is 500 V (dc + peak ac).*

P6055 10X Differential Probe, 3.5-ft, **Order 010-6055-01** .. **$95**
Included accessories as shown.

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 12 MHz. At 70 MHz, the maximum allowable peak-to-peak voltage is 100 V.

P6060 DC to 35 MHz 10X



The P6060 is a precision passive probe with 10X attenuation, for use with TEKTRONIX low- and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 MΩ.

The BNC-type connector utilizes a special grounding clip to shift the deflection factor indicator to 10X normal reading in 5000-Series Oscilloscopes.

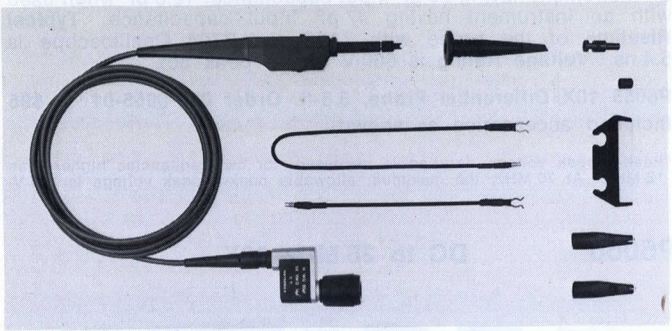
Attenuation is 10X. Accuracy when used with a 1 MΩ ±0.15% instrument input will be within ±0.4%. When used with a 1 MΩ ±2% instrument input the accuracy will be within ±2%. **Input Resistance** is 10 MΩ within ±0.25% with a 1 MΩ ±0.15% instrument input; 10 MΩ within ±0.4% when used with a 1 MΩ ±2% instrument input. **Input Capacitance** for 15 pF instruments is ≈6.0 pF with 3.5-ft probe and ≈7.7 pF with 6 ft. On 55 pF we have ≈9.5 pF with the 3.5 ft ≈11.5 pF for the 6 ft. **Cmrr (Probe Pair)—**At least 400:1 (with 5A20N or 5A21N) dc to 30 kHz. **Bandwidth—** 3.5-foot probe at least 40 MHz (with 453A; 20 mV/div to 10 V/div). 6-foot probe at least 30 MHz (with 453A; 20 mV/div to 10 V/div. **Maximum Input Voltage—** 600 V (dc + peak ac).*

P6060 10X Probe, 6-ft, Order 010-6060-03 ..... **$37**
Opt 1, 3.5-ft, Order 010-6060-01 ..... **$37**
Included accessories as shown.

*Peak-to-peak voltage derating is necessary for cw frequencies higher than 3 MHz. Maximum 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 push button 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.

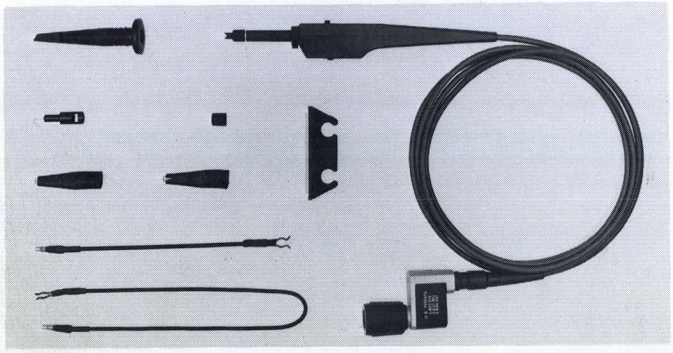
The 1X position of the probe allows the use of the full instrument sensitivity. This is valuable when evaluating small signals of 10 MHz or less. The 1X - 10X switch allows the user to switch in and out a decade of sensitivity without returning to the oscilloscope. The user may also arbitrarily switch from 1X to 10X in order to evaluate the effects of loading by the oscilloscope.

Attenuation, 10X and 1X. **Input resistance:** 1X position, 1 megohm; 10X position, 10 megohms within 0.5%, oscilloscope input resistance must be 1 MΩ within 2%. **Input capacitance** for the 3.5 foot probe is 100 pF in the 1X position, and 13.5 pF in the 10X position; for the 6 foot version, 105 pF in the 1X position, and 14 pF in the 10X position. For the 9 foot probe 135 pF in the 1X position and 17 pF in the 10X position. **Bandwidth** of the 10X probe (all lengths) is at least 100 MHz when used with a 466 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).

P6062A Switchable Attenuation Probe, 6-ft,
Order 010-6062-03 ..... **$65**
Opt 1, 3.5-ft, Order 010-6062-01 ..... **$65**
Opt 2, 9-ft, Order 010-6062-05 ..... **$65**

P6063A DC to 200 MHz

1X, 10X Selectable Attenuation



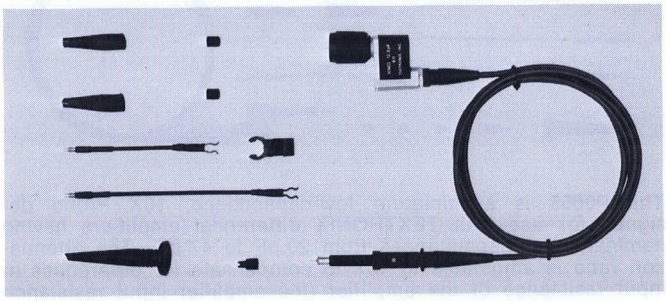
The P6063A is a fast-rise dual attenuation, passive probe designed for TEKTRONIX oscilloscopes with bandwidths greater than 100 MHz. A sliding switch on the probe body selects 1X to 10X attenuation. The probe provides readout coding and a push button for actuating a ground reference in the 1X or 10X 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 megohm; 10X position, 10 megohms 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 1 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 as 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).

P6063A Switchable Attenuation Probe, 6-ft,
Order 010-6063-03 ..... **$80**
Opt 1, 3.5-ft, Order 010-6063-01 ..... **$80**

P6065A DC to 100 MHz 10X



The P6065A is a miniature passive probe with precise 10X attenuation for use with the TEKTRONIX 465 Oscilloscope. When used with the 465 Oscilloscope, the bandwidth will be 100 MHz. When compensated to other 20-24 pF input capacitance instruments the bandwidth will be at least 75 MHz.

The probe provides both ground reference and readout features. The ground reference push button, on the probe body, when depressed provides a ground reference signal which can also be used to identify which probe is in use on a multi-channel instrument.

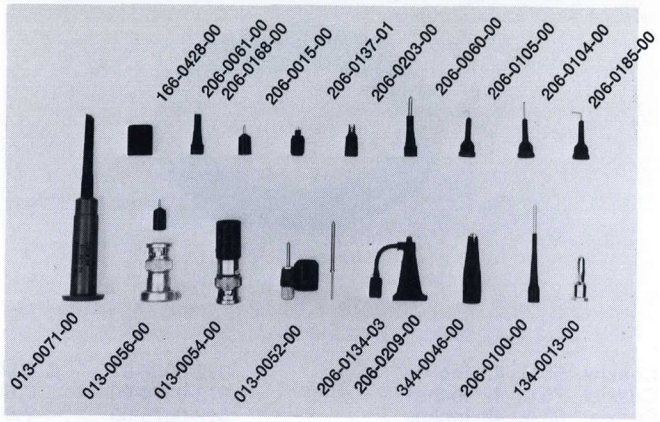
Attenuation is 10X within 0.4% when used with a 1 MΩ ±0.15% instrument input and within ±2% when used with a 1 MΩ ±2% instrument input. **Input Resistance** is 10 MΩ within ±0.25% with a 1 MΩ ±2% instrument input. **Input Capacitance** is 12.5 pF. **Bandwidth** is 100 MHz when used on the 465 Oscilloscope. **Maximum Input Voltage** is 500 V (dc + peak ac) to 3.5 MHz derated to 35 V at 100 MHz.

P6065A 10X Probe, 6-ft, Order 010-6065-13 ..... **$49**
Opt 2, 9-ft, Order 010-6065-15 ..... **$49**

Included accessories as shown.

#6-32 PROBE TIPS AND ACCESSORIES

The following tips and adapters can be used on all TEKTRONIX Probes that accept a #6-32 screw-on tip including the P6006, P6007, P6008, P6009, P6027, P6028 and P6060 Probes.



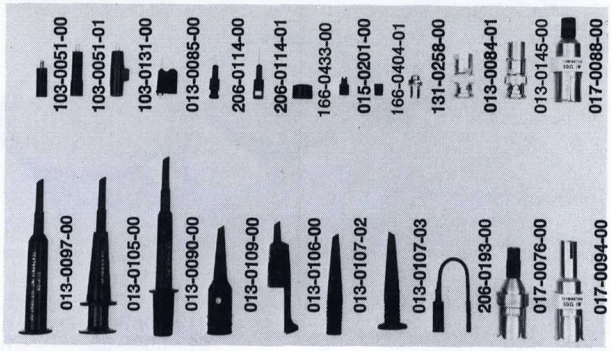
DESCRIPTION	PART NUMBER	PRICE
Bayonet ground assembly (for P6006, P6007, P6008, P6009)	013-0052-00	$2.75
Probe tip to BNC adapter (for P6006, P6007, P6008, P6009)	013-0054-00	4.70
Probe tip to BNC adapter (for P6027, P6028)	013-0056-00	7.00
Probe retractable hook tip (for P6006, P6007, P6008, P6009, P6027, P6028)	013-0071-00	2.20
Probe ground cover (for P6009)	166-0428-00	.40
Probe banana tip	134-0013-00	.25
Probe straight tip (0.055 inch dia)	206-0015-00	.35
Probe spring tip (0.080 inch dia)	206-0060-00	.70
Probe spring tip (accepts 0.065 inch dia pin)	206-0061-00	.55
Probe calibration tip (0.063 inch dia)	206-0100-00	2.50
Probe long straight tip (0.032 inch dia)	206-0104-00	.35
Probe hook tip	206-0105-00	.35
Probe pin tip (accepts 0.025 inch, IBM SLT pin) See adjacent column for slip-on tip version (206-0209-00)	206-0134-03	2.15
Probe ground lead adapter (#6-32 to 0.025 inch x 0.025 inch square pin)	206-0137-01	1.20
Probe spring tip (accepts 0.068 inch dia pin)	206-0168-00	.55
Probe right angle hook tip	206-0185-00	.35
IC test tip (for P6009, P6022, P6028)	206-0203-00	.55
Miniature alligator clip	344-0046-00	.30

IDENTIFICATION TAGS

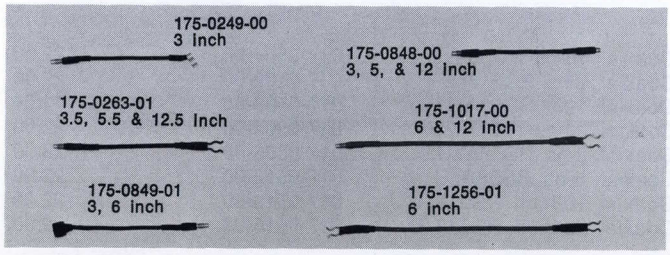
DESCRIPTION	PART NUMBER	PRICE
For 1/8 inch dia cable	016-0130-00	$1.50
For 3/16 inch dia cable	016-0127-00	1.50

SLIP-ON PROBE TIPS AND ADAPTERS

The following tips and adapters are designed for use with TEKTRONIX Miniature Probes that accept a slip-on tip.



DESCRIPTION	PART NUMBER	PRICE
Probe tip to BNC adapter	013-0084-01	$ 5.85
Bayonet ground assembly	013-0085-00	3.05
Retractable hook tip (for P6010, P6011, P6012, P6048, P6049)	013-0090-00	2.40
Retractable hook tip (for S-3A, P6045)	013-0097-00	2.50
Retractable hook tip (for P6052)	013-0105-00	2.75
Retractable hook tip (for 7A11)	013-0106-00	4.00
Retractable hook tip	013-0107-02	2.20
Retractable hook tip (for P6053B, P6054A, P6055, P6061, P6065A, P6075A, P6049A)	013-0107-03	2.20
Retractable hook tip (for P6051)	013-0109-00	4.95
P6201 Probe tip to BNC adapter	013-0145-00	6.50
Miniature probe tip cover, IC tester, package of 10	015-0201-01	1.00
package of 100	015-0201-02	6.00
Miniature Probe tip to GR adapter	017-0076-00	14.00
Miniature Probe tip to GR 50-Ω termination adapter	017-0088-00	27.50
P6201 probe tip to GR 50-Ω termination adapter	017-0094-00	25.85
Miniature Probe to #6-32 adapter (for P6045, P6046, 7A11, S-3A)	103-0051-00	1.30
Miniature Probe to #6-32 adapter (for all miniature probes except P6045, P6044)	103-0051-01	1.30
Miniature Probe to #6-32 adapter	103-0131-00	3.25
Chassis mount test jack, miniature probe	131-0258-00	1.75
Miniature probe tip ground cover, insulating sleeve	166-0404-01	.15
Ground lead, insulating sleeve	166-0433-00	.35
Probe tip hook	206-0114-00	1.00
Probe tip straight	206-0114-01	1.00
Probe tip flexible for .025 sq. pin	206-0193-00	2.40
Probe pin tip (accepts 0.025 inch, IBM SLT pin) similar to 206-0134-03 in adjacent column	206-0209-00	2.15

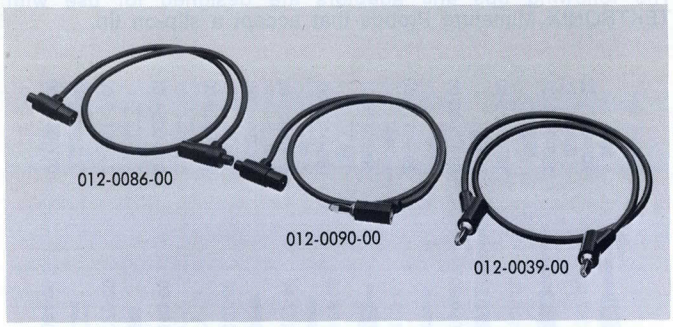


PROBE GROUND LEADS

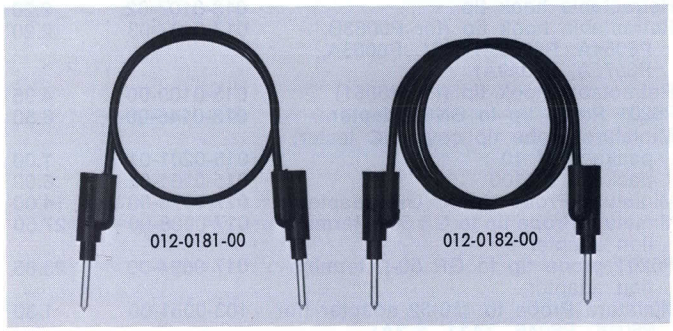
DESCRIPTION		PART NUMBER	PRICE
Ground lead†	3.5-inch	175-0263-01	$ .70
Ground lead†	5.5-inch	175-0124-01	.70
Ground lead†	12.5-inch	175-0125-01	.70
Ground lead for P6045, S-3A, P6056, P6057:	3-inch	175-0249-00	1.40
Ground leads for P6051,	3-inch	175-0848-00	.65
P6052, P6053, P6054:	5-inch	175-0848-01	.65
P6065, P6075, 7A11, P6201:	12-inch	175-0848-02	.65
Ground leads for P6051:	3-inch	175-0849-00	2.00
	5-inch	175-0849-01	2.00
Ground lead for P6055:	6-inch	175-1256-00	1.00
Ground lead for S-3A:	6-inch	175-1017-00	.80
	12-inch	175-1018-00	.80

†For the P6053B, P6054A, P6064A, P6075A and other probes requiring clip on ground leads.

PATCH CORDS

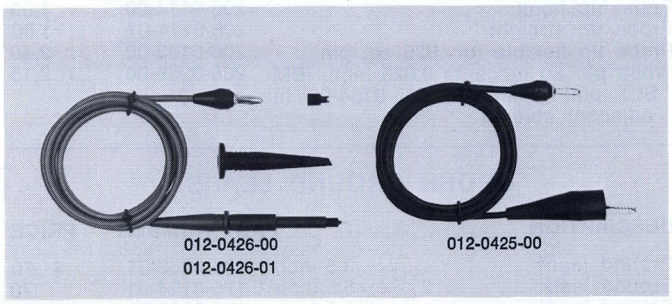


BNC to BNC, 18 inches		
Red	012-0087-00	$1.80
Black	012-0086-00	1.80
BNC to banana plug-jack, 18 inches		
Red	012-0091-00	2.00
Black	012-0090-00	2.00
Banana plug-jack to banana plug-jack, 18 inches		
Red	012-0031-00	1.80
Black	012-0039-00	1.80



Pin-jack to pin-jack, 0.08 inches dia pin		
Red, 8 inches	012-0179-00	$2.50
Red, 18 inches	012-0180-00	2.50
Black, 8 inches	012-0181-00	2.50
Black, 18 inches	012-0182-00	2.50

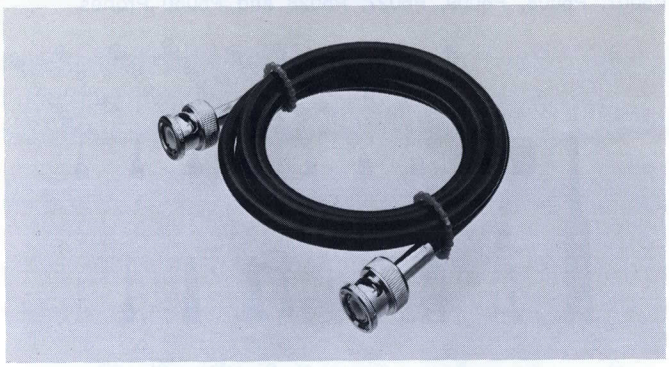
TEST LEADS



Test Lead, Black, 4-Ft	012-0425-00	$4.00
Test Lead, Red, 4-Ft	012-0426-00	6.25
Test Lead, Black, 4-Ft	012-0426-01	6.25
Test Lead set of 012-0426-00 and 012-0426-01	012-0427-00	$11.00

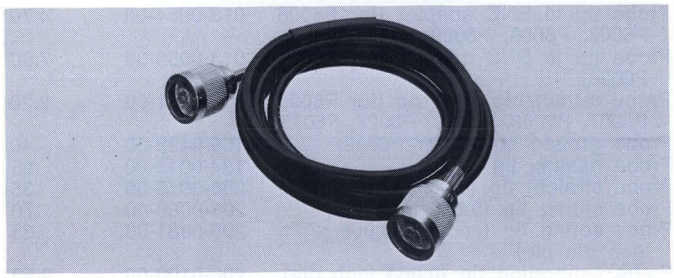
COAXIAL CABLES

BNC Connectors



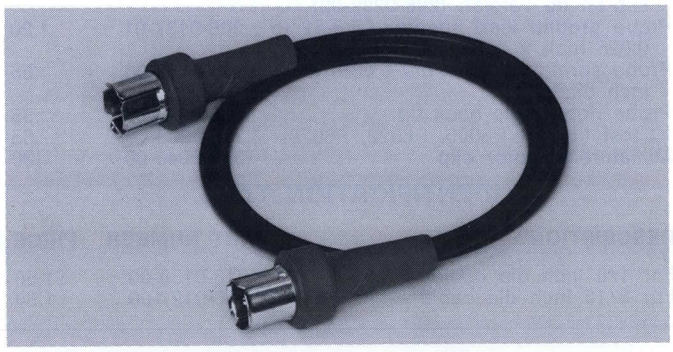
Coaxial, 50 Ω, 42 inches	012-0057-01	$ 7.00
Coaxial, 75 Ω, 42 inches	012-0074-00	7.60
Coaxial, 93 Ω, 42 inches	012-0075-00	7.60
Coaxial, 50 Ω, 18 inches	012-0076-00	7.00
Coaxial, 50-Ω Precision, 36 inches	012-0482-00	13.25

N Connectors 50 Ω



Coaxial N connectors, 6 feet	012-0114-00	$13.00

GR Connectors 50 Ω

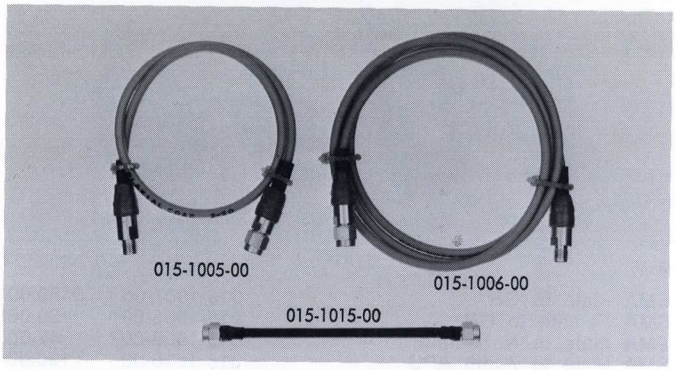


Coaxial 10-ns RG58A/U	017-0501-00	$22.00
Coaxial 5-ns RG213/U	017-0502-00	22.00
Coaxial 1-ns RG58A/U*	017-0503-00	11.00
Coaxial 20-ns RG213/U	017-0504-00	22.00
Coaxial 2-ns RG58A/U	017-0505-00	22.00
Coaxial 5-ns RG58A/U	017-0512-00	22.00
Coaxial 10-inch RG213/U	017-0513-00	22.00
Coaxial 20-inch RG213/U	017-0515-00	22.00

*Connector on one end only.

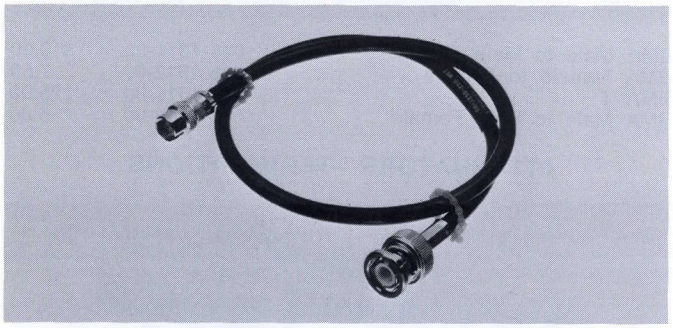
50-Ω CABLES

SMA (3 MM) Connectors 50 Ω



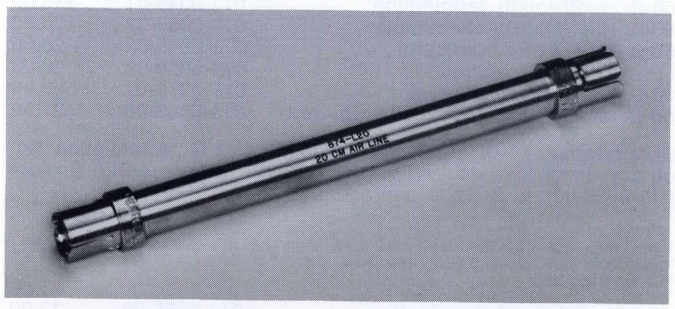
Coaxial 2 ns	015-1005-00	$44.00
Coaxial 5 ns	015-1006-00	55.00
Coaxial semirigid 500 ps	015-1015-00	26.40
Coaxial semirigid 750 ps	015-1017-00	26.40
Coaxial 1 ns	015-1019-00	32.00

BNC to BSM Connectors 50 Ω



Coaxial, 10 inches, RG58 BSM Female to BNC Male	012-0128-00	$9.00
Coaxial, 18 inches, RG58 BSM Female to BNC Male	012-0127-00	9.00

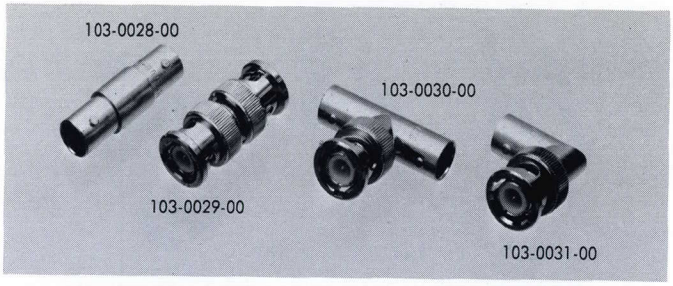
50-Ω AIR LINE



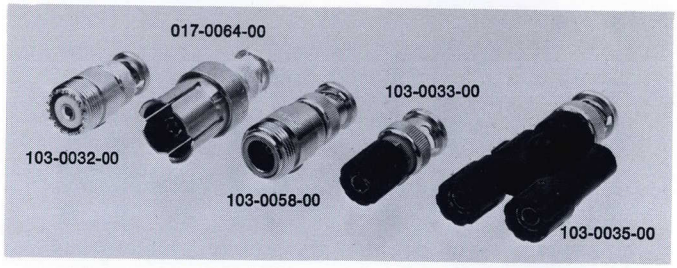
The 20-cm 50-Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω ±0.4%. Time delay is 0.6698 ns ±0.4%.

50-Ω Air Line	017-0084-00	$26.00

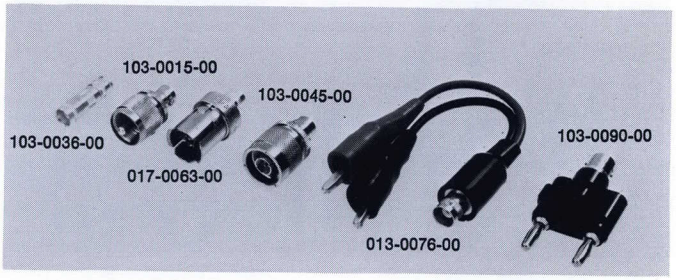
ADAPTERS



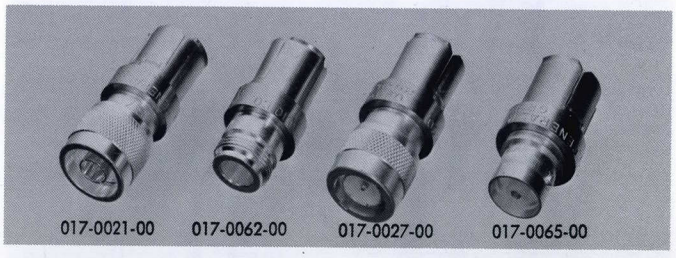
BNC Female to BNC Female	103-0028-00	$2.80
BNC Male to BNC Male	103-0029-00	4.40
BNC T	103-0030-00	4.70
BNC Elbow Male to Female	103-0031-00	4.00



BNC Male to GR	017-0064-00	$13.50
BNC Male to UHF Female	103-0032-00	3.00
BNC Male to Binding Post	103-0033-00	2.50
BNC Male to Dual Binding Post	103-0035-00	7.50
BNC Male to N Female	103-0058-00	5.00

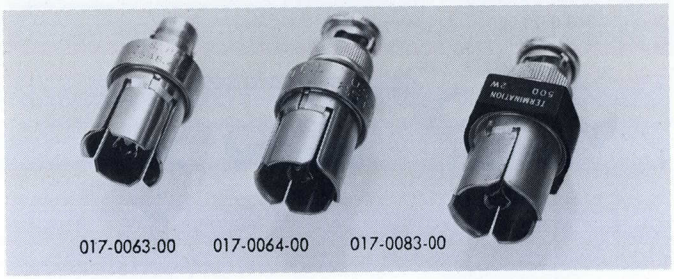


BNC Female to clip leads	013-0076-00	$ 6.25
BNC Female to GR	017-0063-00	10.00
BNC Female to UHF Male	103-0015-00	3.00
BNC Female to BSM Male	103-0036-00	6.30
BNC Female to N Male	103-0045-00	5.00
BNC Female to Dual Banana	103-0090-00	4.50



GR to N Male	017-0021-00	$11.00
GR to C Male	017-0027-00	15.00
GR to N Female	017-0062-00	12.00
GR to C Female	017-0065-00	15.00

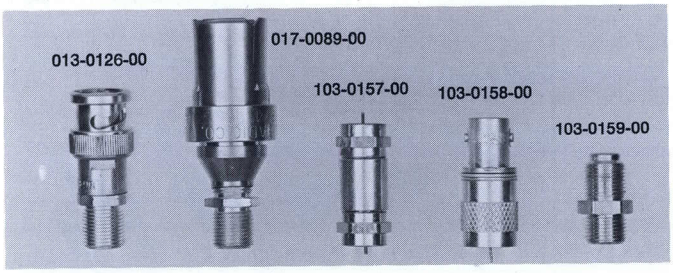
ADAPTERS



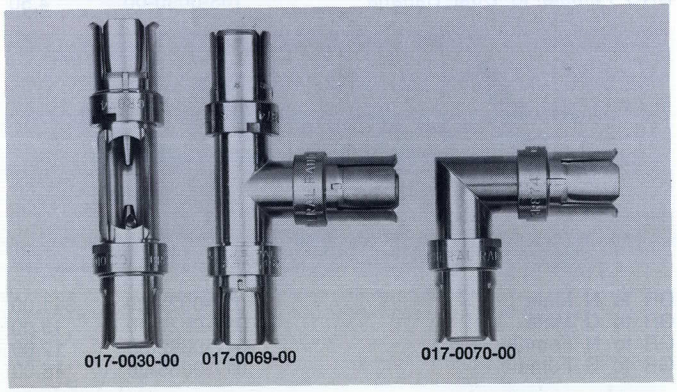
GR to BNC Female	017-0063-00	$10.00
GR to BNC Male	017-0064-00	13.50
50-Ω termination, thru-line *(GR to BNC Male)	017-0083-00	37.00

*Upper frequency limit VSWR not specified

N Male to GR	017-0021-00	$11.00
N Female to GR	017-0062-00	12.00
N Male to BNC Female	103-0045-00	5.00
N Female to BNC Male	103-0058-00	5.00

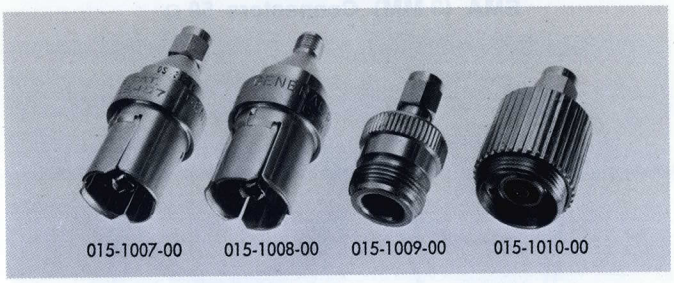


"F" Female to BNC Male	013-0126-00	$ 7.00
"F" Female to GR874	017-0089-00	14.00
"F" Male to "F" Male	103-0157-00	7.00
"F" Male to BNC Female	103-0158-00	7.00
"F" Female to "F" Female	103-0159-00	7.00

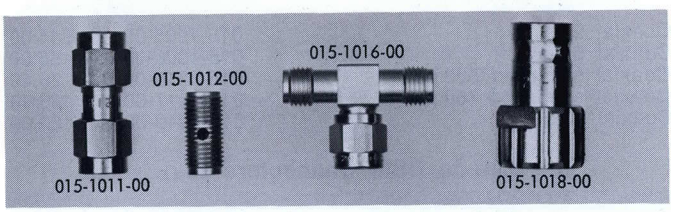


GR Insertion Unit	017-0030-00	$26.00
GR T	017-0069-00	28.00
GR Elbow	017-0070-00	26.00

ADAPTERS



SMA Male to GR	015-1007-00	$ 38.00
SMA Female to GR	015-1008-00	30.00
SMA Male to N Female	015-1009-00	47.00
SMA Male to 7-mm APC	015-1010-00	130.00



SMA Male to Male	015-1011-00	$10.00
SMA Female to Female	015-1012-00	7.50
SMA T	015-1016-00	25.00
SMA Male to BNC Female	015-1018-00	5.00

ATTENUATORS—TERMINATIONS

50-Ω feedthrough termination[1]	011-0049-01	$15.00
50-Ω 10X (20 dB) attenuator[2]	011-0059-02	20.00
50-Ω 5X (14 dB) attenuator[2]	011-0060-02	20.00
50-Ω 2X (6 dB) attenuator[2]	011-0069-02	20.00
50-Ω 2.5X (8 dB) attenuator[2]	011-0076-02	20.00
50-Ω feedthrough termination (5 watt)[3]	011-0099-00	21.00

Characteristics—dc Resistance is 50 Ω ± 1 Ω. Attenuation Accuracy is ±2% dc, ±5% at 2 GHz. Power rating (except 011-0099-00) is 2 watts average.

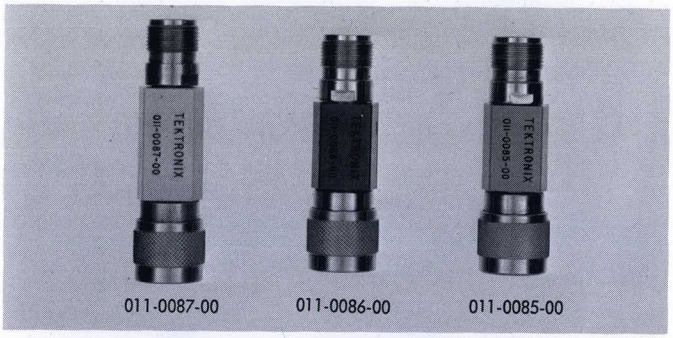
VSWR
[1]Less than 1.1 dc—250 MHz and less than 1.2 dc—500 MHz.
[2]Less than 1.1 dc—1.0 GHz and less than 1.2 dc—2.0 GHz.
[3]1.1 dc 100 MHz.

75-Ω feedthrough termination	011-0055-00	13.00
93-Ω feedthrough termination	011-0056-00	13.00
50-Ω to 75-Ω min loss attenuator	011-0057-00	15.00
50-Ω to 93-Ω min loss attenuator	011-0058-00	15.00
75-Ω 10X attenuator	011-0061-00	15.00
93-Ω 10X attenuator	011-0062-00	15.00
600-Ω feedthrough termination (1 watt, dc to 1 MHz)	011-0092-00	20.00
75-Ω to 50-Ω min loss attenuator (ac coupled)	011-0112-00	28.00

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.

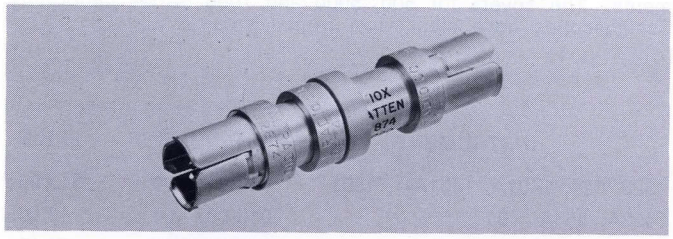
ATTENUATORS and TERMINATORS
N 50 Ω



Frequency range is dc to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 Ω.

DESCRIPTION	PART NUMBER	PRICE
10-dB attenuator	011-0085-00	$55.00
20-dB attenuator	011-0086-00	55.00
40-dB attenuator	011-0087-00	65.00

GR

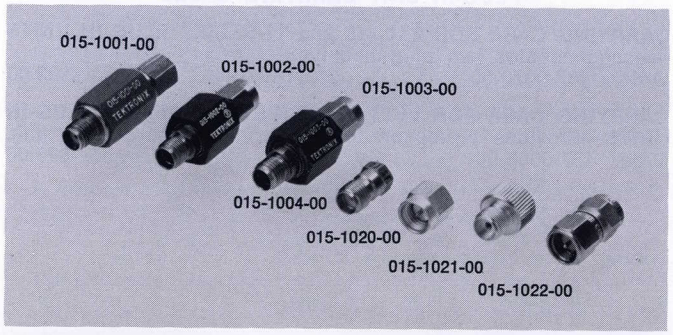


125-Ω min loss	017-0052-00	$52.00
50-Ω 10X attenuator	017-0078-00	52.00
50-Ω 5X attenuator	017-0079-00	52.00
50-Ω 2X attenuator	017-0080-00	52.00
50-Ω termination, end-line	017-0081-00	41.00

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

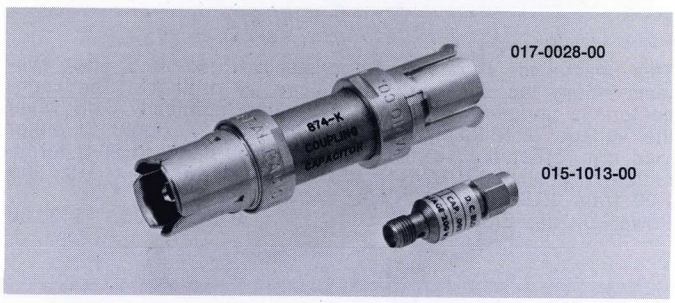


50-Ω 2X attenuator	015-1001-00	$ 90.00
50-Ω 5X attenuator	015-1002-00	120.00
50-Ω 10X attenuator	015-1003-00	120.00
50-Ω termination Female	015-1004-00	44.00
Short-Circuit termination Male	015-1020-00	8.30
Short-Circuit termination Female	015-1021-00	8.00
50-Ω termination Male	015-1022-00	32.00

CHARACTERISTICS

	Dc — 12.40 GHz		12.41 — 18.00 GHz		Power
	Attenuation Accuracy	Vswr	Attenuation Accuracy	Vswr	Continuous
Termination	±1 Ω	1.15	±1 Ω	1.15	0.5 W
2X (6 dB)	± .75 dB	1.40	±1.00 dB	2.00	1.0 W
5X (14 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W
10X (20 dB)	± .75 dB	1.40	±1.00 dB	1.60	1.0 W

50-Ω COUPLING CAPACITOR



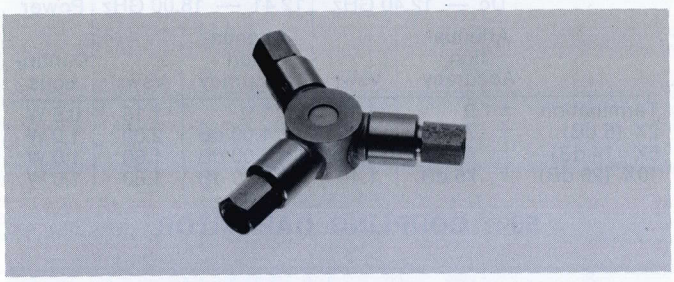
The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, ±20%) in series with the inner conductor. Reflection ratio (in 150-ps TDR system), maximum is 0.03. Voltage rating is 200 Volts.

Coupling Capacitor SMA (3 mm) **015-1013-00** **$90.00**

The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but dc and low frequencies are blocked. Voltage rating is 500 V.

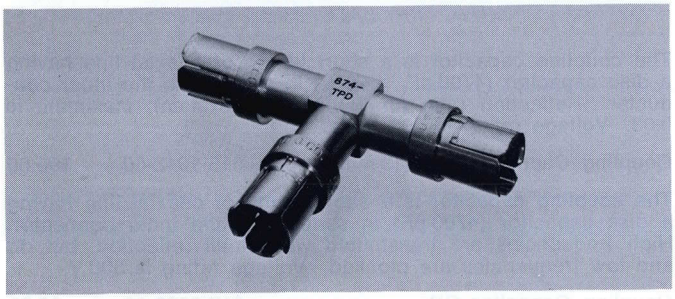
Coupling Capacitor GR **017-0028-00** **23.00**

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). Maximum VSWR is 1.50 from dc to 12.00 GHz and 1.90 from 12.01 to 18.00 GHz.

Power Divider SMA (3 MM) 015-1014-00 $130.00



This coaxial tee has a 16.67-ohm resistor in each leg, connected so that the tee looks like 50 ohm if two legs are terminated in 50 ohm. It is designed for use in broad-band 50-Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

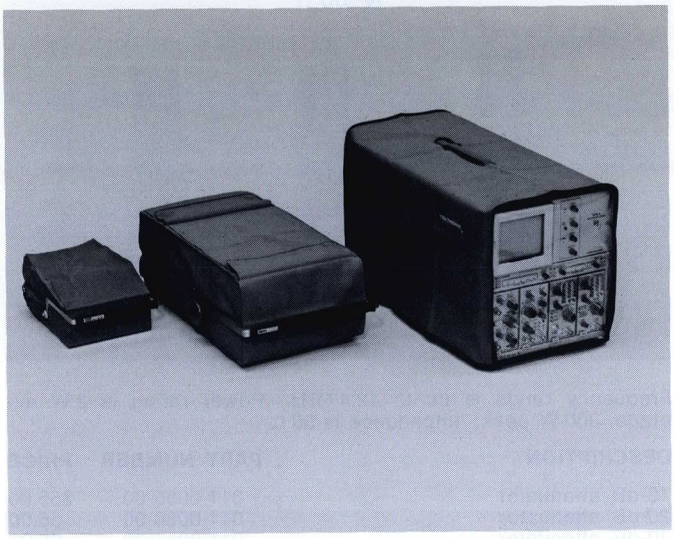
Power Divider GR 017-0082-00 $121.00

ACCESSORY HOUSING

Accessory housing without electrical components is useful for applications requiring special circuitry.

Accessory Housing 011-0081-00 $10.00

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.

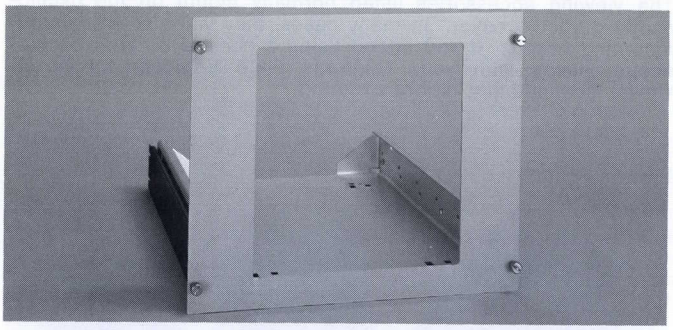
INSTRUMENT	PART NUMBER	PRICE
323, 324, 1401A, 1401A-1, 1501	016-0112-00	$13.00
453A, 454A, 491	016-0074-01	13.00
465, 475	016-0554-00	11.00
529 (with field case)	016-0085-00	11.00
560 Series (except 565, 567, 568)	016-0067-00	11.00
565, 567, 568	016-0069-00	11.00
540 Series	016-0068-00	11.00
5000 Series	016-0544-00	11.00
7300, 7400 Series	016-0192-00	11.00
7600 Series	016-0192-01	11.00
7704A, 7900	016-0531-00	11.00

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 ..... $33.00

CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit.
Order 437-0065-00 ..... $27.00

RACK ADAPTERS

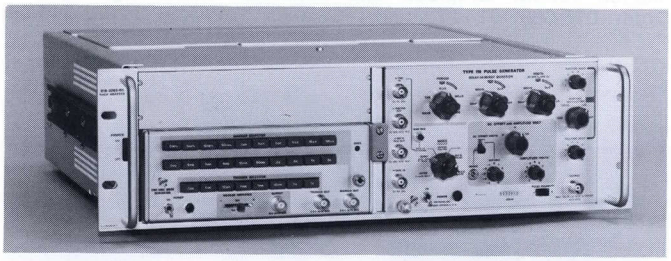


For rackmounting the 7700-Series Oscilloscopes and 611 in a standard 19-inch wide rack. Rack adapter includes slide-out assemblies. 7700-Series mask finish is light gray, 611 mask finish is black.

For 7704 and 7904, rack height is 15¾ inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0554-00 ..... **$120.00**

For 611, rack height is 14 inches, rack depth is 21¾ inches, shipping weight is approx 41 lb.
Order 040-0551-00 ..... **$120.00**

RACK ADAPTERS



For rackmounting most TEKTRONIX generators in a standard 19-inch wide rack. The rack height is 5¼ inches, rack depth is 19¾ inches. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and blank panels are provided to cover the unused openings. Mounting kits must be ordered separately for each instrument to be mounted.

Rack Adapter includes half-rack width blank panel (333-1384-00).
Order 016-0268-00 ..... **$275.00**

284 Mounting Kit includes quarter-rack width blank panel (016-0109-00).
Order 016-0187-00 ..... **$32.00**

106, 114, 115, and 191 Mounting Kits.
Order 016-0186-00 ..... **$18.00**

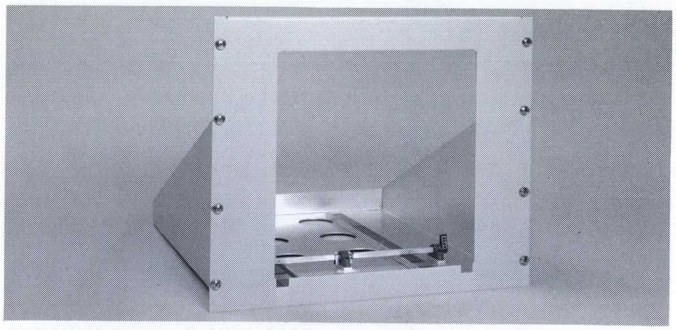
2101 and 2901 Mounting Kits.
Order 016-0188-00 ..... **$9.50**

286 Mounting Kit.
Order 016-0190-00 ..... **$15.00**

For rackmounting two TM 503s
Order 040-0616-01 ..... **$51.00**

For rackmounting one TM 503
Order 040-0617-01 ..... **$69.00**

CRADLE MOUNTS



For rackmounting 500 and 7700-Series cabinet-type oscilloscopes in a standard 19-inch wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, and 7700-Series mask finish is light gray.

For 7704A, rack height is 15¾ inches, rack depth is 22 inches, shipping weight is approx 16 lb.
Order 040-0560-00 ..... **$42.00**

For 540 Series and 575, rack height is 17½ inches, rack depth is 21-9/16 inches, shipping weight is approx 16 lb.
Order 040-0281-00 ..... **$42.00**

For 561B and 564B, rack height is 15¾ inches, rack depth is 21-9/16 inches, shipping weight is approx 17 lb.
Order 040-0321-01 ..... **$42.00**

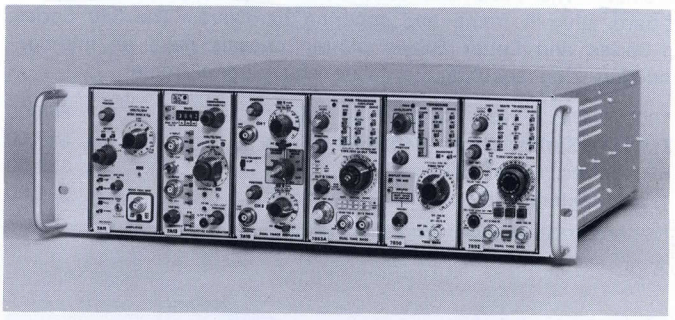
REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19-inch backless rack. Shipping weight is approx 3 lb.

For R561B, R564B, and R647A.
Order 040-0344-00 ..... **$11.00**

For RM565 and R567.
Order 040-0346-00 ..... **$12.00**

STORAGE CABINETS

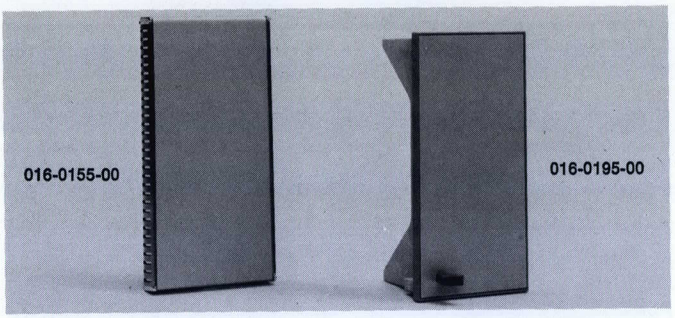


For 7000-Series Plug-in Units—Holds 6 plug-in units, for mounting in a 19-inch rack, 5¼ inches high.
Order 437-0126-01 ..... **$140.00**

For 1-Series and Letter-Series Plug-in Units—Holds 3 plug-in units. Measures 19 inches wide, 8¾ inches high, 9⅜ inches deep. Net weight is approx 9 lb.
Order 437-0031-00 ..... **$35.00**

For 2 and 3-Series Plug-in Units—holds 4 plug-in units. Measures 19 inches wide, 7 inches high, 13-5/16 inches deep. Net weight is approx 10 lb.
Order 437-0071-00 ..... **$38.00**

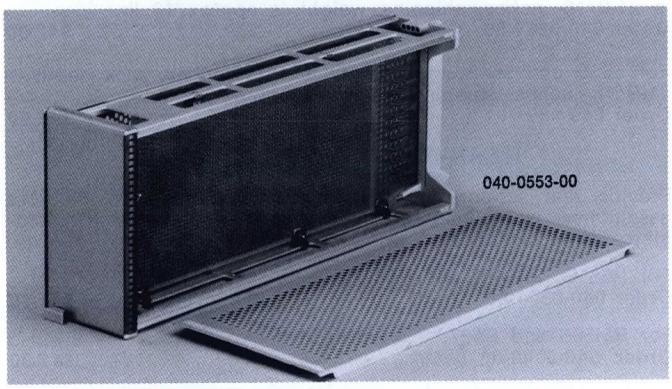
BLANK PANEL



Blank Panel—When operating the 5000/7000-Series mainframes or the TM 500 or 2600 Series generators with less than a full complement of plug-ins, the blank panel may be used to cover unused compartment. The panel for the 7000 Series is also good for EMI shielding.

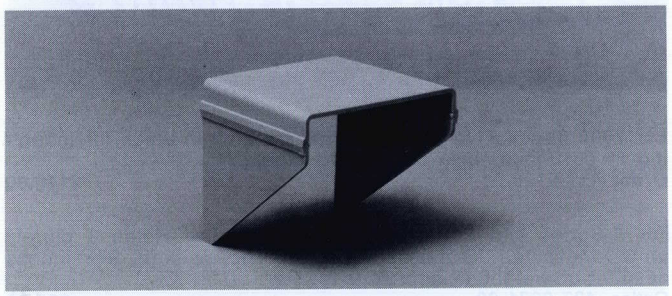
7000 Series, 2600 Series, Order 016-0155-00 ..... $10.00
5000 Series, Order 016-0195-00 ..... $ 4.70
TM 500 Series, Order 016-0195-01 ..... $ 4.70

BLANK PLUG-IN CHASSIS



Blank Plug-in Chassis—are available for all TEKTRONIX mainframes. The 7000 and 5000 Series provide a printed circuit board, plug-in frame and securing hardware. The 560 Series, 1-Series and Letter Series plug-in chassis have an interconnecting plug securing hardware and plug-in frame.

7000 Series, Order 040-0553-00 ..... $55.00
TM 500 Series, Order 040-0652-01 ..... $17.00
560 Series, Order 040-0245-00 ..... $32.00
1 and Letter Series, Order 040-0065-00 ..... $32.00



View Hood (folding)—for 211, 212, 214, 323, 324, 326, 576, 577, 5000 and 7000-Series Oscilloscopes.

For 576, order 016-0259-00 ..... $9.40
For 577, 5000 and 7000 Series, order 016-0260-00 ..... $9.40
For 211 and 212 (not pictured), order 016-0199-01 ..... $2.50
For 323 and 324 (not pictured), order 016-0247-01 ..... $3.30
For 326 (not pictured), order 016-0297-00 ..... $2.50

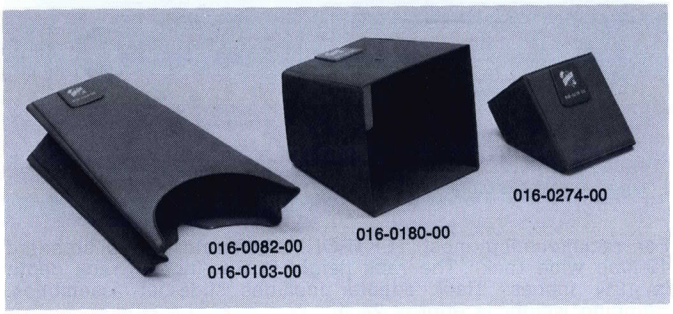
VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit camera-mounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezel-viewer compatibility before ordering.

Polarized Viewers—For TEKTRONIX 5-inch Oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.

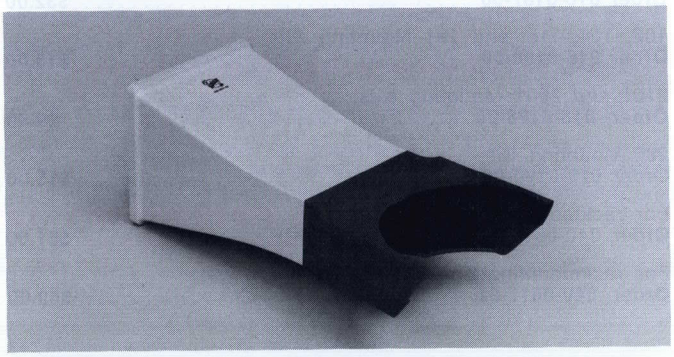
Rectangular Viewer, order 016-0039-00 ..... $15.00
Plastic Round Viewer, order 016-0053-00 ..... $15.00

Viewing Hood—For TEKTRONIX 5-inch Oscilloscopes. Includes molded rubber eyepiece and separate tubular light shield. Order 016-0001-01 ..... $11.00



Collapsible Viewing Hood—For Oscilloscopes with rectangular CRT's. Blue vinyl material, folds flat for convenient storage.
For 422, 453A, 454A, 485, 491, order 016-0082-00 ..... $11.00
For 422, 453A, 454A, 485, 491, order 016-0274-00 ..... $ 7.00
For 561B, 564B, 565, 568, order 016-0103-00 ..... $11.00

Polarized Collapsible Viewing Hood—To reduce reflections and glare under high ambient light conditions for 432, 434, 465, 475, order 016-0180-00 ..... $15.00



Viewing Hood—for 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

For 576, order 016-0153-00 ..... $11.50
For 5000 and 7000 Series, 601, 602, 603, 604, 528 and 577, order 016-0154-00 ..... $11.50

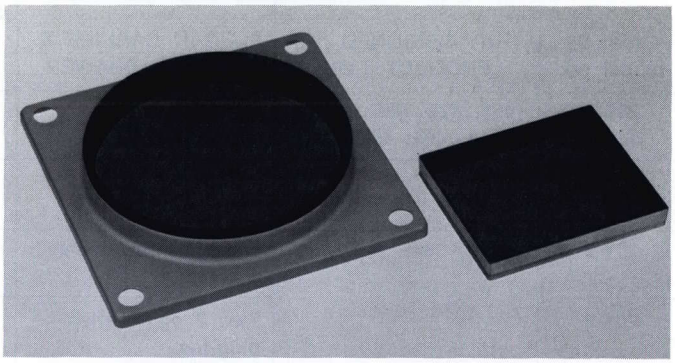
CATHODE-RAY TUBE LIGHT FILTERS

INSTRUMENT*	COLOR	PART NUMBER	PRICE
323, 324	Smoke-gray	426-0403-00	$2.30
	Blue†	426-0811-00	2.30
	Amber	426-0513-00	2.30
326	Blue†	426-0871-00	2.30
422, 491, 453A, 454A	Smoke-gray	378-0549-00	1.00
	Green	378-0557-00	1.00
	Blue†	378-0664-00	1.00
	Amber	378-0559-00	1.00
465, 475	Blue	337-1674-00	1.75
	Clear	337-1674-01	1.75
540-, 550-Series, 565, 575	Smoke-gray†	378-0567-00	1.75
	Green	378-0568-00	1.75
	Blue	378-0569-00	1.75
	Amber	378-0570-00	1.75
529, 561B, 567, 568	Smoke-gray†	378-0560-00	1.75
	Green	378-0561-00	1.75
	Blue	378-0562-00	1.75
	Amber	378-0563-00	1.75
520A, 521A, 522A	Smoke-gray†	378-0581-00	1.75
576	Blue†	378-0616-00	1.75
	Amber	378-0616-01	1.75
602	Smoke-gray†	378-0586-00	1.75
	Amber	378-0595-00	5.00
7904, 7844, 7313, 7700-Series, 7613 7623	Blue†	378-0625-00	1.75
	Amber	378-0625-01	1.75
	Gray	378-0625-02	1.75
	Green	378-0625-03	1.75
	Gray TV Graticule CCIR	378-0625-05	3.30
	Gray TV Graticule NTSC	378-0625-06	3.30
	Clear Implosion Shield With Spectrum Analyzer Graticule	337-1159-02	1.80
7613, 7623, 7623A, 7633	Spectrum Analyzer	378-0625-07	3.30
	Green (UV)	378-0625-08	1.75
	TV Graticule CCIR	378-0625-09	3.30
	TV Graticule NTSC	378-0625-10	3.30
7403N, 7603	Blue	378-0684-00	2.10
	Amber	378-0684-01	2.10
	Gray	378-0684-02	2.10
	Green	378-0684-03	2.10
	Gray TV Graticule CCIR	378-0684-04	3.85
	Gray TV Graticule NTSC	378-0684-05	3.85
	Clear Implosion Shield With Spectrum Analyzer Graticule	337-1439-01	1.65
	Blue Implosion Shield†	337-1700-01	1.75
	Clear Implosion Shield	337-1700-04	1.75
5100 and 5400 Series	Clear	337-1440-00	1.20
	Green	337-1440-01	1.20
	Amber	337-1440-02	1.50
	Blue	337-1440-03	1.20
	Gray	337-1440-04	1.50
5100, 5400, 603, 604	Green	378-0705-00	1.75
	Amber	378-0704-00	1.75
432, 434	Clear	378-0677-00	1.75

*For both cabinet and rackmount instruments unless rackmount version is listed.

†Standard filter supplied with instrument.

CRT MESH FILTERS



The mesh filter improves display contrast for oscilloscope viewing under high ambient light conditions. The filter is a direct replacement for the existing graticule cover on most TEKTRONIX instruments, or, in the case of the new portable oscilloscopes, snaps in the crt opening on the front panel.

A fine metal screen with a matte black surface is utilized to reduce light reflections. Although light transmission from the crt is reduced to approximately 28%, the high attenuation of external reflections allows viewing low-intensity displays in room light or other bright surroundings.

The mesh filter also serves as an emi filter. Installed on the instrument, the metal frame of the filter is grounded, providing effective filtering of the emi spectrum.

INSTRUMENT*	PART NUMBER	PRICE
323, 324	378-0596-00	$20.00
432, 434	378-0682-00	16.50
422, 491, 453A, 454A	378-0648-00	16.50
465, 475	378-0726-01	16.00
540-Series, 565	378-0572-00	20.00
529, 561B, 564B, 568	378-0575-00	20.00
7400	378-0696-00	20.00
7500, 7700-Series	378-0603-00	20.00

*For both cabinet and rackmount instruments.

SCOPE-MOBILE Usage Chart

Order by model no.	TRAY DESIGNED FOR PRODUCT TYPE	PLUG-IN CARRIER & STORAGE DRAWER	SCOPE LOCK-DOWN	TOP TRAY DIMENSIONS*	BOTTOM SHELF DIMENSIONS**	NET WEIGHT APPROX	PRICE
200	465, 475, 485, 453A, 454A, 491, 432, 434	None	No	11½ x 16½ in	12 x 12 x ¾ in deep	19 lb	**$125**
200-2	422	None	No	9¼ x 15 in	12 x 12 ¾ in deep	19 lb	**$120**
201-1	561B, 564B & 577	Storage drawer only	No	10½ x 18½ in	15½ x 25 in	37 lb	**$165**
201-2		Two 2 or 3 series plug-ins	No	10½ x 18½ in	15½ x 25 in	39 lb	**$185**
203	7403N, 7313, 7613, 7623, 7623A, 7633, 7603, 5100 & 5400 Series	Holds four 5 or 7 series plug-ins	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	**$215**
203 Opt. 1		Holds four 5 or 7 series plug-ins and TM-503	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	**$215**
204	7704A, 7844, 7904	Holds five 7 series plug-ins	Yes	14 x 21 in	17½ x 26⅞ in	48 lb	**$225**
204 Opt. 1		Holds five 7 series plug-ins and TM-503	Yes	14 x 21 in	17½ x 26⅞ in	48 lb	**$225**
204 Opt. 2	7704A, 7904, 576, 507	No storage drawer or plug-in carrier	No	14 x 21 in	17½ x 26⅞ in	45 lb	**$195**
205	520A, 521A, 522A, 556, 565, 568 & rack-mount instruments	Storage drawer only	No	17¾ x 22⅜ in	18½ x 25 in	46 lb	**$190**
206	Computer Terminals and portable instruments	Two flat shelves	No	16 x 27 in	16 x 27 in	34 lb	**$ 90**

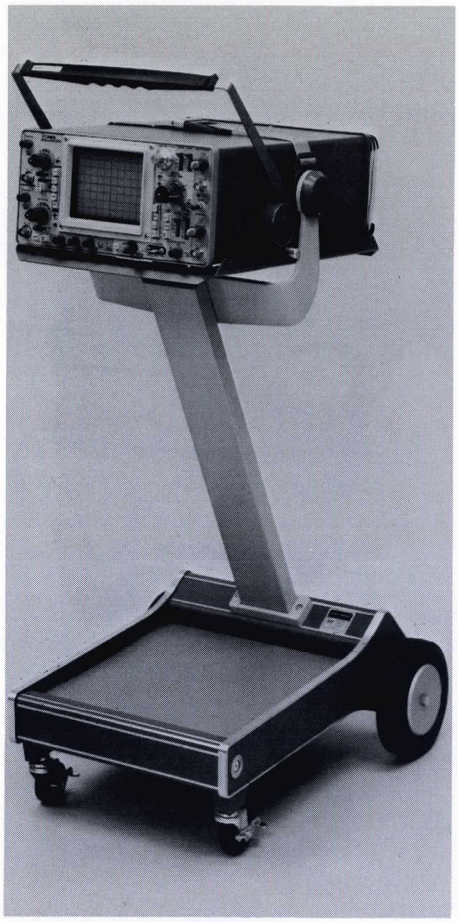
*Overall length bottom of tray, includes rear radius bend and front stops.
**Usable dimensions may be limited by height required.

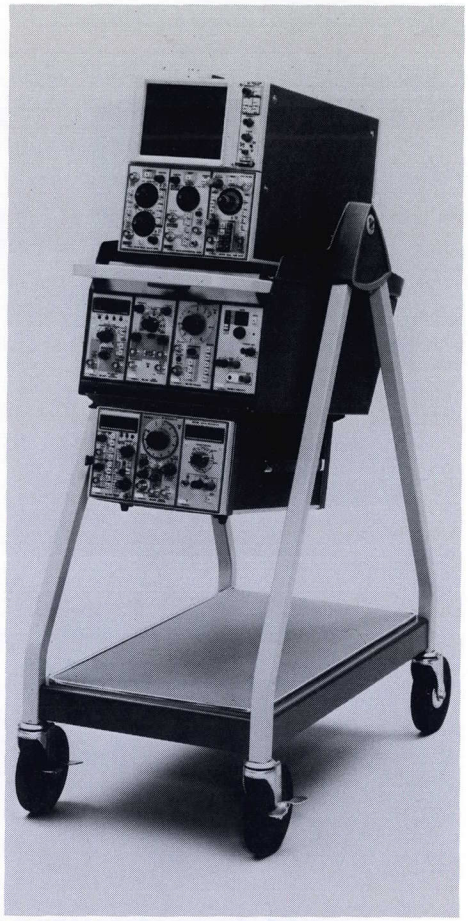
A SCOPE-MOBILE® Cart for Every Oscilloscope

There is a SCOPE-MOBILE Cart for every TEKTRONIX Oscilloscope that needs one. The cart is designed for "ease of use", tilting the oscilloscope to various degrees. The top tray on the models 200 and 200-2 has friction locks which will adjust from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting. The top tray on the other SCOPE-MOBILE Cart models 201 through 205 has tilt locks in 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

All SCOPE-MOBILE Carts feature sturdy aluminum construction, and a linoleum-covered steel plate for the bottom shelf. The 206 has two flat trays. The carts are equipped with rubber wheels and locking brakes on the front wheels.

The carts, with the exception of the 200 and 206, have three ac receptacles located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.





The 200 SCOPE-MOBILE® Cart is especially designed for the 432, 434, 453A, 454A, 465, 475 and 485 Portable Oscilloscopes and the 491 Spectrum Analyzer. A separate version, the 200-2, is designed for use with the 422 Portable Oscilloscope.

These oscilloscope carts occupy less than 18 inches of aisle space. With their large wheels and unique design, they can easily be moved up and down stairs. Friction locks on the oscilloscope tray permit the instrument to be positioned at any angle for convenient viewing. Storage space is provided at the base of the cart for accessories or associated instruments.

Adjustable tray friction-locks in any position from 0° to 60°. A finger-tip latch on the pedestal locks the tray for transporting.

Mechanical features include cast-aluminum construction with six-inch rubber wheels in the rear and two-inch swivel castors in front.

Pricing information is on page 198.

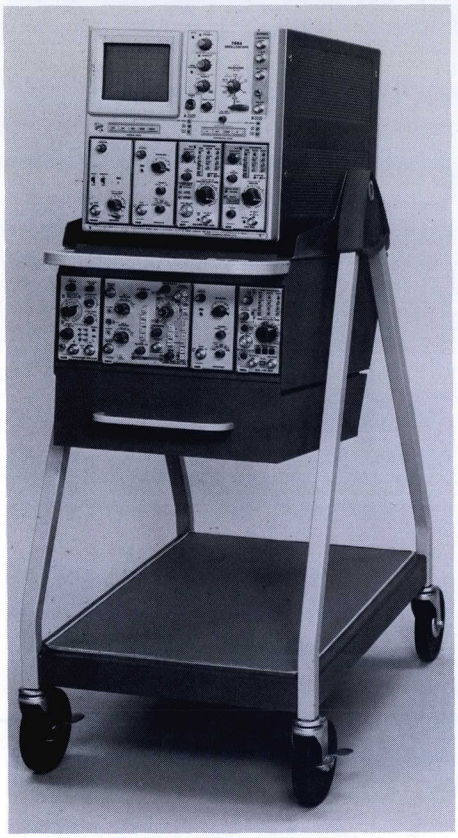
The 203 and 203 Option 1 SCOPE-MOBILE Carts hold any of the TEKTRONIX 5000 or 7000 Series three plug-in oscilloscopes. The SCOPE-MOBILE carts have storage space for four plug-ins. Three ac receptacles located at the rear of the cart supply power to an oscilloscope and associated instruments.

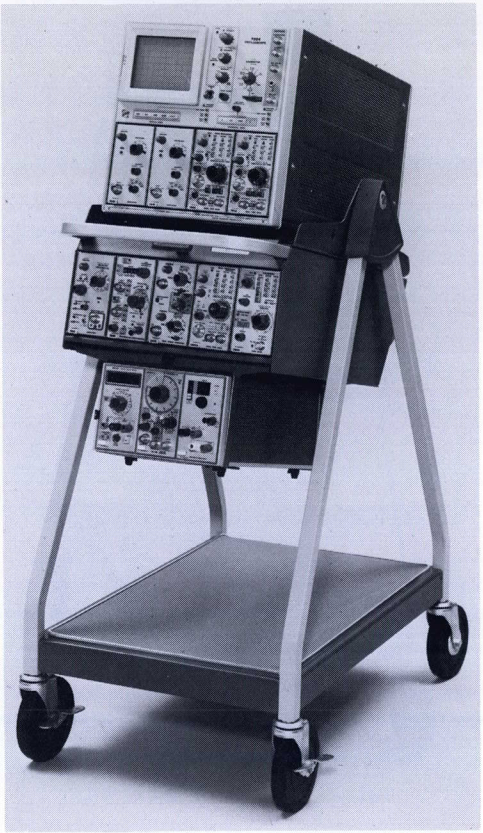
The 203 SCOPE-MOBILE includes a storage drawer.

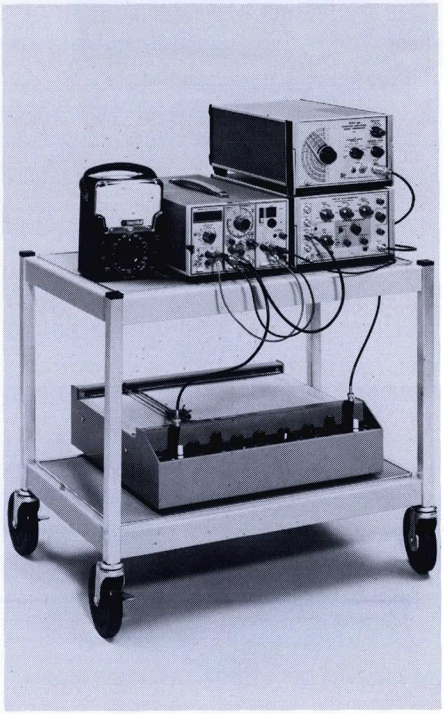
The 203 Option 1 storage drawer is replaced with a bracket that accepts a TM 503 Power Module. When the 203 Option 1 is combined with an oscilloscope, TM 503 Power Module and plug-ins, the combination becomes a versatile test station.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis. Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and linoleum-topped steel shelf at the bottom.

Pricing information is on page 198.







The 204 and 204 Option 1 SCOPE-MOBILE Carts hold any of the TEKTRONIX 7000 Series four plug-in oscilloscopes. The SCOPE-MOBILE carts have storage space for five plug-ins. Three ac receptacles located at the rear of the cart supply power to an oscilloscope and associated instruments.

The 204 SCOPE-MOBILE cart includes a storage drawer.

The 204 Option 1 storage drawer is replaced with a bracket that accepts a TM 503 Power Module. When the 204 Option 1 is combined with an oscilloscope, TM 503 Power Module and plug-ins, the combination becomes a versatile test station.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis. Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and linoleum-topped steel shelf at the bottom.

Pricing information is on page 198

The 206 Instrument Cart is a versatile mobile table. The 206 Cart provides a base for a portable test instrumentation setup. It may be used as added table space or for transport.

Portability may also be given to the computer terminal with the lower shelf being used for a hard-copy unit. The 5-inch rubber wheels (two wheels lock) allow easy pushing over carpeted areas and entrance ways. The low profile cart has two linoleum covered steel shelves attached to a sturdy aluminum frame. The shelves are 16 x 27 inches with an overall height of 25 inches.

OPTIONAL ACCESSORIES

A strap is available to secure the oscilloscope to the top tray of the SCOPE-MOBILE Cart that does not have a scope lock-down. See SCOPE-MOBILE Cart usage chart for instruments that do not have scope lock-down.

Strap assembly, **Order 346-0070-01** **$10.00**

SCOPE-MOBILE ADAPTER KITS

TM 503 Power Module Adapter Kit—Includes hardware to attach a TM 503 to 203 or 204 SCOPE-MOBILE.

For 203, **Order 016-0583-00** **$20.00**
For 204, **Order 016-0584-00** **$20.00**

SCOPE-MOBILE DRAWER

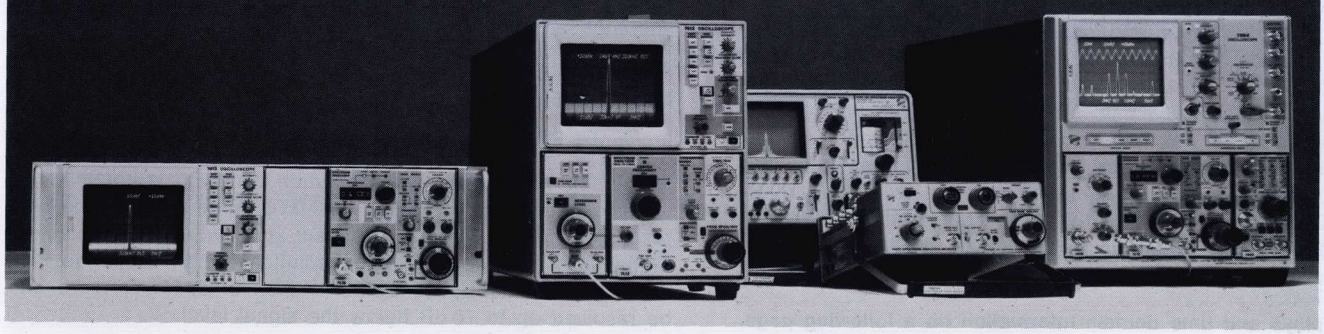
Drawer may be ordered separately for 203 or 204 SCOPE-MOBILE.

For 203, **Order 436-0120-01** **$20.00**
For 204, **Order 436-0121-01** **$20.00**

Spectrum Analyzers

6

This catalog section includes information about advances in spectrum analyzer performance: 30 Hertz Resolution at 1800 MHz, crt readout, and simultaneous time and frequency based displays. With TEKTRONIX products you receive more value in the form of high performance analyzers at lower costs. Additional value is received because TEKTRONIX mainframes are full-performance oscilloscopes when used with time domain plug-ins. Your Tektronix Field Engineer or Representative can show you how to add Tektronix Analysis to your capabilities.



New 5L4N

Spectrum Analyzer

0 to 100 kHz

Frequency Range
0 to 100 kHz
High-performance at low cost

Front Panel Selectable Impedance
50 ohm, 600 ohm, one megohm

Maximum Sensitivity
—134 dBm (50 Ω)
—145 dBm (600 Ω)
—147 dBV (Hi Z)
45 nV (Linear Mode)

Calibrated Appropriate To Impedance Selected

Input Modes
Single Ended
Differential (Balanced)

Dynamic Range
80 dB (Full 8 div)

Intermod
>70 dB down

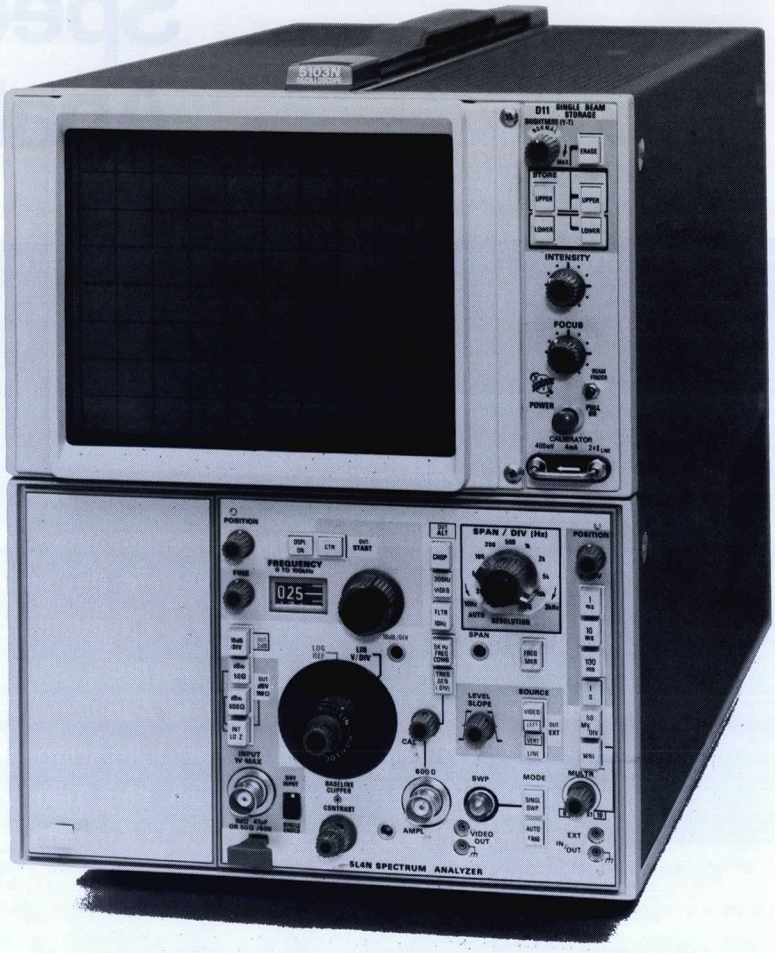
Frequency Span
20 Hz/div to 10 kHz/div

Span Modes
Log
Linear

Resolution Bandwidth
10 Hz to 3 kHz

Auto Resolution
All spans including LOG

Tracking Generator
(Included)



This analyzer consists of the 5103N/D11 Storage Oscilloscope and the 5L4N Spectrum Analyzer. A blank plug-in panel 016-0195-00 is shown installed in the left compartment.

The new 5L4N is a 0-to-100 kHz spectrum analyzer that offers both high performance and economy. This analyzer's unique features include 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 System, using two of the three compartments. We recommend the 5L4N Spectrum Analyzer with a 5103N/D11 Storage Oscilloscope as the optimum system for all applications.

See displays and time domain information on a following page.

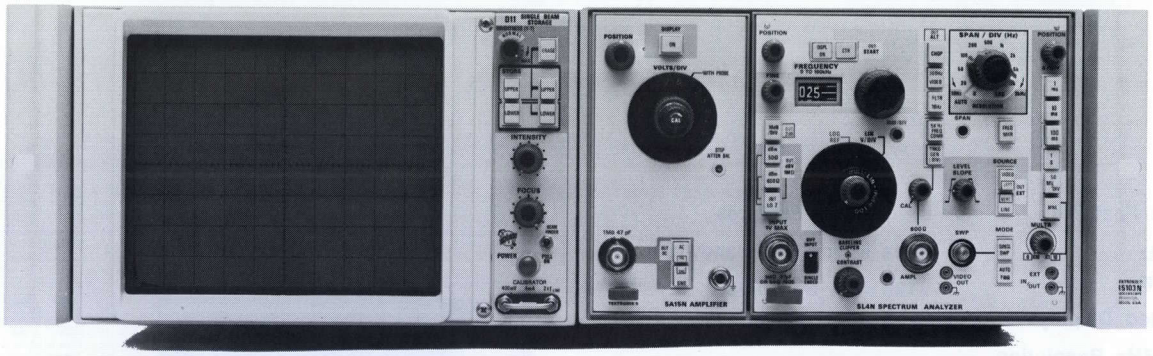
FREQUENCY CHARACTERISTICS

Range— 0 to 100 kHz. Accuracy ±3 kHz (fine tune control midrange and span/div calibrated for 10 kHz).

Stability—Within 100 Hz over a 1-hour period, at a fixed ambient temperature.

Incidental FM— 2 Hz (p-p) or less.

Resolution Bandwidth—The resolution bandwith 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.



The R5103N/D11 with 5L4N requires only 5¼" of rack height in a standard 19" rack. The left compartment holds one of the many optional 5000-Series plug-ins.

AMPLITUDE CHARACTERISTICS

Reference Level Range—Log 10 dB/div: from —10 dBm/dBV to —70 dBm/dBV, within .05 dB/dB to maximum of 2 dB over an 80 dB dynamic window. Log 2 dB/div: from —10 dBm/dBV to —130 dBm/dBV within 0.1 dB/dB to max. 1.0 dB. Linear: from 50 mV/div to 20 nV/div within 3%.

Display 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.

Dynamic Range— 80 dB (8 divisions).

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 3 kHz	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

Intermodulation Distortion—with the input signal level equal to or less than the reference level. Third order products down 70 dB or more from two —10 dBm/dBV signals, within any frequency span and down 75 dB or more from two —20 dBm/dBV signals, within any frequency span.

Spurious Signals from Internal Sources (Residual Response)—(with TRKG GEN and 5-kHz FREQ COMB Off and the input terminated in 600 Ω or less impedance). Equal to or less than —130 dBm/dBV referred to in the input; line related spurii less than —120 dBm/dBV.

INPUT CHARACTERISTICS

The Input Connector of the 5L4N is a floating three-conductor BNC connector that provides either a differential or single-ended input. A switch grounds the outer conductor for single-ended operation. An accessory "Y" adapter provides full shielding of the input signal leads. High Z is 1 MΩ, low Z is 600 Ω or 50 Ω.

Selectable Impedance— 1 megohm/47 pF or 600 Ω or 50 Ω (single-ended or differential).

Differential Input Characteristics—Common-mode signal range ±10 V; Maximum signal input, Low impedance 5 volt (dc + peak ac), (250 mW at 50 Ω, 125 mW at 600 Ω); High impedance 100 volt (dc + peak ac). A fast-rise pulse of 30 V or more, may open a 0.1 A fuse. Common-mode rejection ratio ≥70 dB.

Single-Ended Input Characteristics—Maximum signal input: —10 dBm/dBV (or 0.316 V) for linear operation. NOTE: Useful measurements can be made with the input overloaded up to 10 dB above the reference level. The overload will increase spurious responses but will not damage the input circuit.

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.

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—Requires 0 Volt to 500 mV ±50 mV; from a 1 kΩ or less source to sweep the full span.

OUTPUT CHARACTERISTICS

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.

5 kHz Freq Comb— 600 Ω source of 5 kHz ±.005% frequency markers for span calibration.

Video Out—Provides 250 mV ±3% 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 division of span, from 0 to 5 volts when using internal or manual sweep.

ORDERING INFORMATION

5L4N Spectrum Analyzer **$1950**
We recommend that the plug-in 5L4N be ordered with a cabinet style or rackmount storage mainframe.

5103N/D11 Storage Oscilloscope, order 5111 (cabinet) .. **$1095**

R5103N/D11 Storage Oscilloscope, order R5111 (rackmount) **$1095**

For mainframe specifications and option selections refer to the 5000-Series Section of this catalog, page 124.

OPTIONAL PLUG-INS FOR TIME DOMAIN USE

5A15N Single Trace Amplifier **$130**

5B10N Time Base Amplifier **$195**

OPTIONAL ACCESSORIES

175-1178-00 BNC to Pin Jack Adapter Cable **$12.00**

010-0160-00 10X Probe P6006 (6 foot) **$33.00**

016-0195-00 Blank Plug-in Panel ..... **$ 4.70**

7L12 Features

0 to 1800 MHz In One Display

Fully Calibrated Displays

300 Hz to 3 MHz Resolution

70 dB Dynamic Range

Intermodulation Distortion 70 dB Below Full Screen

Spurious Free Operation

Automatic Phase Lock

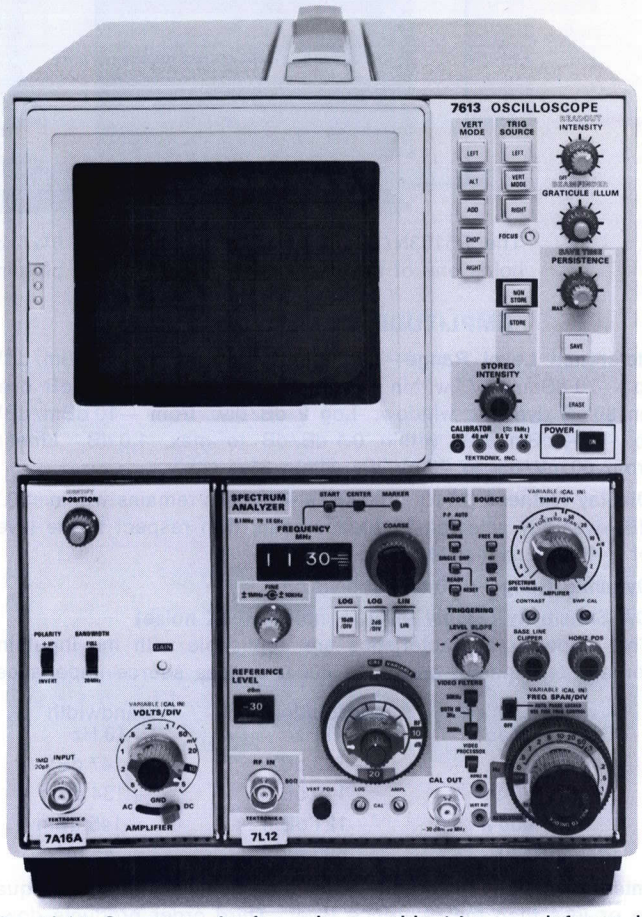
—115 dBm Sensitivity

7L13 Features

30 Hz Resolution Bandwidth

—128 dBm Sensitivity

All 7L12 Features



The 7L12 Spectrum Analyzer in a cabinet-type mainframe is easily carried. The left compartment holds one of the many optional 7000 series plug-ins.

The increasingly crowded spectrum requires the resolution, stability and spurious-free performance of the 7000-Series Analyzers. These analyzers are superior in their frequency range, giving you the added dimensions of the 7000 Series, providing you with more information from your simplest, or most complex applications. 7000-Series Analyzers are also easier to use. Simply stated, we believe they're a good buy. The TEKTRONIX 7L12 and 7L13 Spectrum Analyzers are both built to make exacting measurements of signals ranging up to 1800 MHz, using swept front-end techniques. The units are similar in function and application, except that the 7L13 has the additional features of 30-Hz resolution bandwidth and less than 10 Hz of internal FM'ing (phase locked). The units provide both frequency domain and time domain functions. Because they are part of the 7000 Series, 7L12 and 7L13 users are offered all the benefits of a growing, innovative group of TEKTRONIX products including CRT READOUT. In the description and specifications, statements refer to either analyzer, except where noted.

7000-Series mainframes with CRT READOUT will display Reference Level, dB/div, Frequency Span, Resolution and Time/div on screen when used with either analyzer. In addition, Center Frequency and Video Filter Bandwidth will be displayed when used with the 7L13. All display parameters are calibrated and quantitative information is displayed on both front panel and CRT READOUT.

Noise-level measurements are easy to make on both units and interfering noise, on other displays, is minimized by a selection of video filtering. Each of these units feature horizontal amplifier, time base and trigger functions for time domain displays. The Tektronix-introduced 3-MHz resolution mode enhances narrow-pulse spectrum analysis and provides demodulation of your signal for time-domain waveform measurements.

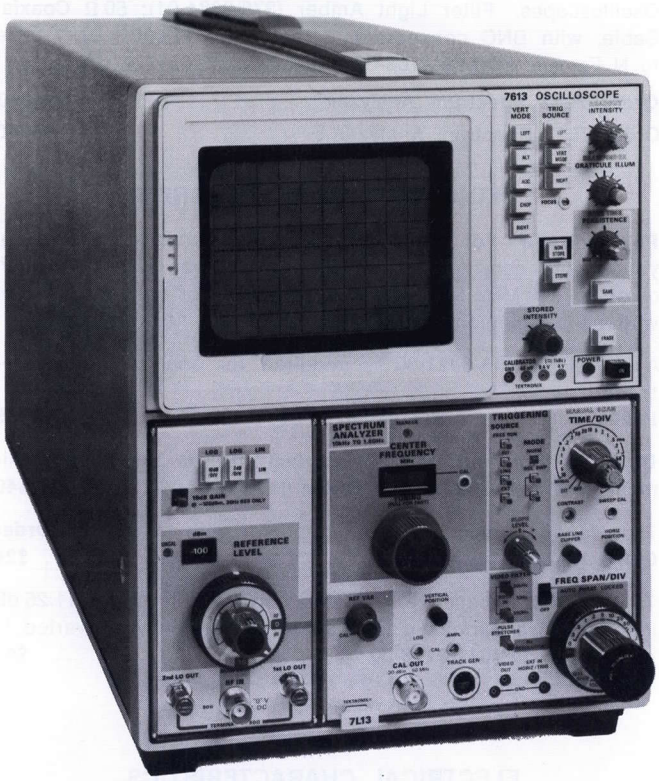
The 7L12 is a two-wide plug-in and the 7L13 is a three-wide plug-in unit. These swept front-end analyzers, when used with any 7000-Series Oscilloscopes, display a spectrum of signal energy within any frequency span to 1.8 GHz. If your work requires separation of signals with very small frequency differences, we suggest consideration of a storage mainframe for increased usefulness at the sweep rates required to achieve accurate displays at narrowest resolution and video filter settings. Be sure to read "Note about Phosphors and Graticules" before making a mainframe selection. Full mainframe specifications are located elsewhere in this catalog.

CHARACTERISTICS

Applies to both 7L12 and 7L13 when operating at frequencies between 100 kHz and 1800 MHz except where noted.

Frequency Tuning Range— 7L13 range is 1 kHz to 1.8 GHz. Resolution is within 1 MHz. Accuracy is ± (5 MHz + 20% of frequency span/div). 7L12 range is 100 kHz to 1.8 GHz continuously variable; accuracy ± (10 MHz + 1% of dial indication).

Frequency Span—Calibrated steps, in 1-2-5 sequence from 200 Hz/div to 100 MHz/div (7L13). 500 Hz/div to 100 MHz/div (7L12). Accuracy is within 5% of the span selected and linearity is within 5%, over the center 8 divisions of a 10-division display. A MAX SPAN position provides approximately 1.8 GHz (1800 MHz/div of span), and a 0 position provides fixed frequency operation for time domain display.



The 7L13 features 30 Hz resolution with less than 10 Hz of incidental FM (phase locked). The 7L13 is installed here in a 7613 variable persistence mainframe.

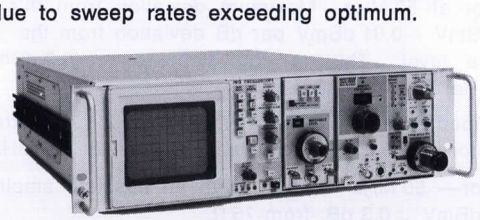
Display Flatness— 7L12, ± 1.5 dB over any selected frequency span, with respect to the display level at 50 MHz. 7L13 + 1 dB, — 2 dB over any selected frequency span, with respect to 50 MHz.

LOG 10 dB/div Mode—Provides a calibrated 70-dB dynamic range. Accuracy within ±0.1 dB/dB to a maximum of 1.5 dB over the 70-dB dynamic range.

LOG 2 dB/div Mode—Provides a calibrated 14-dB dynamic range. Accuracy within ±0.4 dB/2 dB to a maximum of 1.0 dB over the 14-dB range.

Linear Mode—Provides a linear display, within 10% over the graticule height.

Reference Level—Calibrated levels in decade steps, from —100 dBm to +30 dBm, within ±2 dB extended to —110 dBm to +30 dBm in the 7L13. (Includes attenuator and gain switching effects when the two are not offsetting each other). In the 7L13, a UNCAL indicator signifies when the display is not calibrated, due to sweep rates exceeding optimum.



The R7613 with 7000 series spectrum analyzer requires only 5¼″ of rack height in a standard 19″ rack. It is fan-cooled and comes complete with slide-out chassis tracks.

See displays and time domain information on a following page.

Calibrator— 50 MHz ±0.01% with an absolute amplitude level of —30 dBm to ±0.3 dB.

RF Attenuator—Calibrated 10 dB steps. Accuracy, ±0.2 dB or 1% of dB reading, whichever is greater.

Gain—Range is 70 dB with a gain selector extended to 80 dB in the 7L13, when operating with 30-Hz resolution bandwidth. The selector is an eight-position switch that changes the IF gain in 10-dB steps. Four positions (blue sector) provide three 10-dB steps, for a total of 30-dB gain change in the 10-dB/div display mode. All eight positions of the selector provide 70 dB of gain change in the 2 dB/div and LIN display modes. In the 7L13 the additional 10 dB, for 30-Hz resolution, is selected with a push button. Accuracy is within ±1 dB/10 dB step to a total of ±1.5 dB when the VARIABLE control is in its CAL detent. The VARIABLE control with approximately 10-dB range, provides continuous gain adjustment between each calibrated step.

Resolution—Resolution bandwidth selections from 30 Hz to 3 MHz (7L13), and 300 Hz to 3 MHz (7L12) in decade steps are provided. Bandwidth accuracy, at the 6-dB down level, is within 20% of the resolution selected. Shape factor over the 60 dB to 6 dB level is 12:1 or better for 30-Hz resolution and 4:1 or better for 300-Hz to 3-MHz resolution settings. Signal level change over all bandwidths is less than 0.5 dB.

Sensitivity for a CW Signal (Signal + noise = twice noise)— in LIN vertical Mode. —128 dBm at 30 Hz, —120 dBm at 300 Hz (7L13 only), —115 dBm at 300 Hz, —108 dBm at 3 kHz, —100 dBm at 30 kHz, —90 dBm at .3 MHz, —80 dBm at 3 MHz. Sensitivity may decrease 2dB at 1.7 GHz and 4 dB at 1.8 GHz. Below 100 kHz, the sensitivity degrades no more than 0.3 dB/kHz in the 7L13.

Intermodulation Distortion—(100 kHz to 1800 MHz) The third order is down 70 dB or more from two —30 dBm signals within any frequency span. Second order is down 70 dB or more from two —40 dBm signals.

Spurious Signals from Internal Sources (Residual Response)— Equal to or less than —100 dBm, referred to the first mixer input when terminated in 50 Ω.

Incidental FM'ing (7L13)— 10 Hz (p-p) when phase locked. 20 kHz (p-p) for 5 seconds when not phase locked.

Incidental FM'ing (7L12)— 200 Hz (p-p) maximum when phase locked. 20 kHz (p-p) maximum when not phase locked.

Stability (7L13)— Within 2 kHz, over a one hour period at a fixed temperature, when phase locked. Within 100 kHz when not phase locked over a one hour period, at a fixed temperature.

Maximum Input Power Level— —30 dBm with the rf attenuator at 0 dB, for linear operation. +30 dBm with the rf attenuator at 60 dB. (+30 dBm is also the power rating of the rf attenuator.) NOTE: The maximum input power level to the rf attenuator is 1 watt average and 200 watts peak. Maximum safe input is +30 dBm.

Sweep Modes and Rate— 7L13: Selection of an external sweep source, manual sweep, or calibrated time base 10 s/div to 1 μs/div, in a 1-2-5 sequence. 7L12: external sweep or calibrated time base 10 ms/div to 1 μs/div. Time base accuracy within 2%.

Triggering—The trigger signal source can be external, internal, or the line voltage. The signal is ac coupled from the line or internal source and dc coupled from the external source. Frequency range is approximately 15 Hz to 1 MHz.

7L13-Operating Characteristics

(between 1 kHz and 100 kHz.)

Intermodulation Distortion—at least 50 dB down from two signals (—30 dBm for 2nd order and —40 dBm for 3rd order) compared to 70 dB down at 100 kHz and above.

Minimum Reference Level—(without gain compression) —50 dBm compared to —60 dBm above 100 kHz in 10 dB/div and —110 dBm above 100 kHz in 2 dB/div.

Note about Phosphor and Graticules—Internal spectrum analyzer graticules are available at no cost in some mainframes. Check for availability of this option identified as OPTION 6. 7000-Series mainframes, except storage versions, are normally shipped with P31 phosphor. Slow swept displays sometimes are more easily viewed with P7 phosphor (an option with most mainframes). Check mainframe specification before ordering. External spectrum analyzer graticules for 7000-Series mainframes come with the analyzer (see included accessories). See mainframe specification for availability of internal spectrum analyzer graticules, (Option 6).

Included Accessories—Spectrum Analyzer Graticule: Clear plastic implosion shield with LOG, LIN, REF and f (frequency) direction markings. TEKTRONIX Part No. 337-1439-00 for 7403N Oscilloscope and 337-1159-02 for other 7000-Series Oscilloscopes. Filter Light Amber (378-0684-01); 50 Ω Coaxial Cable, with BNC connectors, 6 foot (012-0113-00); BNC Male to N Female Adapter (103-0058-00).

Order 7L12 Spectrum Analyzer **$4850**

Order 7L13 Spectrum Analyzer **$6750**

RECOMMENDED ACCESSORIES

P6201 Probe—For those measurements sensitive to loading, you should consider the P6201 Active Probe with bandwidth of dc to 900 MHz and with loading effects of only 100 kΩ, 3 pf with no attenuation, and 1 meg/1.5 pf with 10X attenuation.

A dc block 015-0221-00 is required for analyzer input protection.

P6201 6-ft Probe order 010-6201-01 ..... **$395**

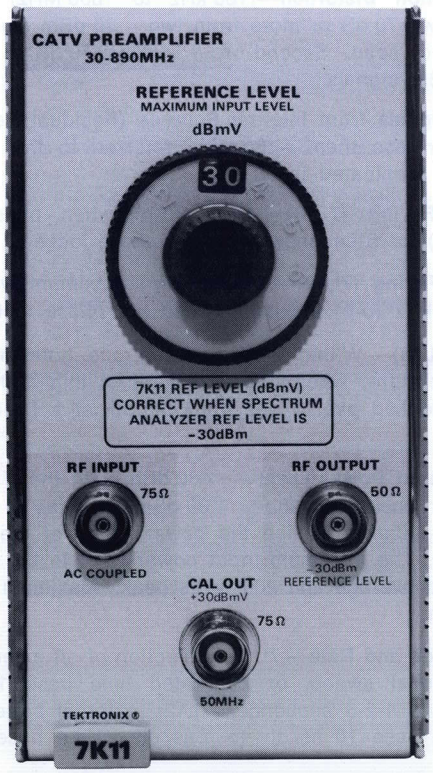
Dc Block (For applying signals riding on a dc potential). Maximum potential is 50 V dc. **Order 015-0221-00** **$40**

75 Ω to 50 Ω minimum loss attenuator with dc block. **Order 011-0112-00** **$28**

75 Ω to 50 Ω impedance matching network with direct 11.25 dB insertion loss permits display to be conveniently converted to dB/mV. **Order 011-0118-00** **$40**

7K11 CATV Preamplifier

Complements 7L12 and 7L13



The 7K11 is a plug-in accessory for the 7L12 and 7L13 Spectrum Analyzers. In combination with these analyzers, CATV system performance can be measured and compared to FCC and industry standards.

ELECTRICAL CHARACTERISTICS

(With 7L12 and 7L13)

Frequency Range— 30 MHz to 890 MHz.

Display Flatness (with 7L12)— ±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.

Display Flatness (with 7L13)— +0.5 dB, —1.5 dB, with respect to the level at 50 MHz, over the frequency range 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 for the 7K11 is no greater than 5 dB.

Intermodulation Distortion (with 7L12 or 7L13)—IM products and harmonics from two signals within the frequency span of the 7K11, 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. Maximum deviation from this reference is; 0.2 dBmV +0.01 dBmV per dB deviation from the +30 dBmV reference level. This is equivalent to: ±(0.2 dBmV ±0.01 [dBmV Ref Lvl —30 dB]).

Input Impedance— 75 Ω with a VSWR of 2:1 or better with 10 dB or more attenulation (between 50 MHz to 300 MHz).

Calibrator— 50 MHz ±0.01% with an absolute amplitude level of +30 dBmV ±0.3 dB. from 75 Ω.

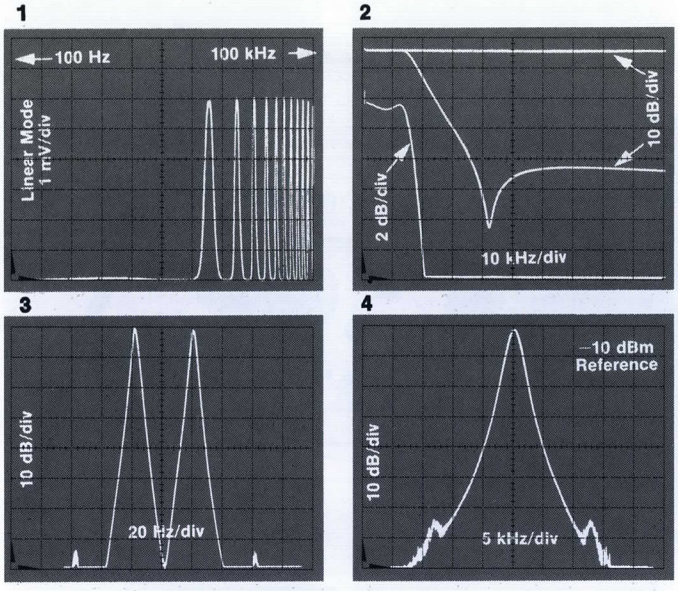
Included Accessories—BNC to BNC, 50 Ω Cable, 5½ inch, 012-0214-00; BNC to F Adapter, 013-0126-00; BNC to BNC, 75 Ω Cable, 42 inch, 012-0074-00.

7K11 CATV Preamplifier **$575.00**

New
5L4N

Spectrum Analyzer

0 to 100 kHz



(1) 10-kHz signal and its harmonics with the 5L4N operating in the LOG span mode.

(2) The internal tracking generator is "flat" as shown by the straight line display (10 dB/div). The second plot is the response (10 dB/div) of a 15-kHz filter using the tracking generator as a test source. At 2 dB/div, the third plot of the same filter, shows pass band ripple of less than 1 dB.

(3) Two —10 dBm signals with 10 kHz frequency separation. Third order intermodulation components are well below the 70-dB down line.

(4) 50-Hz modulation sidebands, more than 60 dB below carrier level, are easily observed.

OPERATING IN THE TIME DOMAIN

There are two ways to use the 5L4N for Time Domain measurements: (1) Select **Zero Span** for manually tuned receiver operation with **Time Domain** (Time Base) plots of information within the resolution bandwidth of the analyzer. (2) Add a low-cost plug-in amplifier such as the 5A15N. Again you use the built-in Time Base of the 5L4N. 5A15N Performance: 1 mV/div to 5 V/div, dc to 2 MHz. 5L4N Time Base Performance: 1 second to 1 millisecond per division in decade steps with a continuously variable 10-time multiplier.

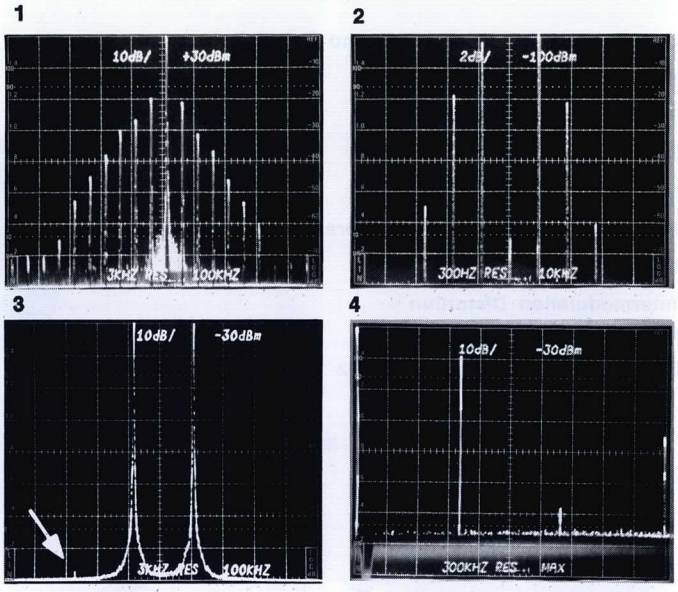
A third approach is useful when events of shorter duration than a millisecond are to be displayed. Insert a 5A15N, or other amplifier, remove the 5L4N and insert a low-cost Time Base, such as the 5B10N. 5B10N Performance: 1 μs/div to 5 s/div in 1-2-5 sequence.

When considering Frequency Domain measurement needs in the 0 to 100 kHz region, remember that just a few dollars more will give you Time Domain measurements too.

7L12
7L13

Spectrum Analyzers

0 to 1800 MHz

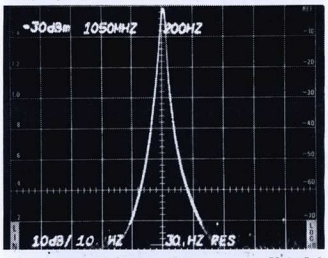


(1) Measure signals all the way from one watt down to 5 x 10^{-15} watt. This is a display of a +30 dBm level carrier and sidebands. Sideband levels in the display range down to 70 dBm below the reference level of +30 dBm.

(2) You can accurately measure small amplitude difference, even at the maximum sensitivities. The frequency modulated carrier of —113 dBm (center screen) is clearly displayed free of noise.

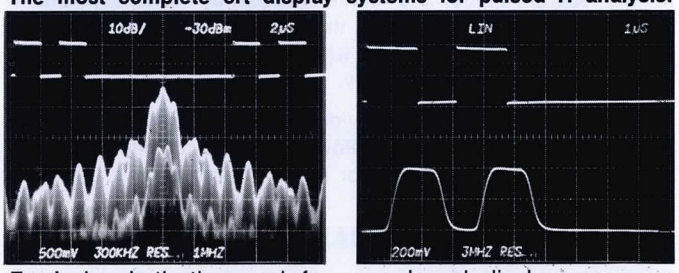
(3) Spurious-free measurements—Here two full-screen signals, at —30 dBm separated by about 200 kHz, result in a very small intermodulated distortion product (arrow) of approximately —110 dBm, 10 dB outside the specified 70-dB dynamic range.

(4) Display and measure more signals without changing plug-ins. You can display a full 0-1800 MHz spread of signals. The fundamental and the second and third harmonic of a 600-MHz signal are all seen together in this display.



A signal at 1050 MHz showing the exceptional 30-Hz resolution bandwidth capability of the 7L13. Note the CRT READOUT of center frequency. (Mainframe 7904)

The most complete crt display systems for pulsed rf analysis.



Employing both time and frequency-based displays, you can simultaneously examine the modulating signal, such as the double pulse (upper trace left), while analyzing the resulting spectral distribution (lower trace left). And, you can even use the 7L12 to display the modulation envelope (lower trace right) and compare it simultaneously with the original modulating pulses (upper trace right). Pulse modulation envelopes can be displayed because the 7L12 has a unique 3-MHz resolution bandwidth mode for time-based displays. Sensitivity to pulsed RF is substantially better than units with lesser resolution bandwidths.

(Mainframe 7904 with 7A19, 7L12 and 7B92).

Gated Mode for Pulsed R.F. and Television

50-ohm Input (1401A)

75-ohm Input (1401A-1)

Ac, dc or Battery Powered

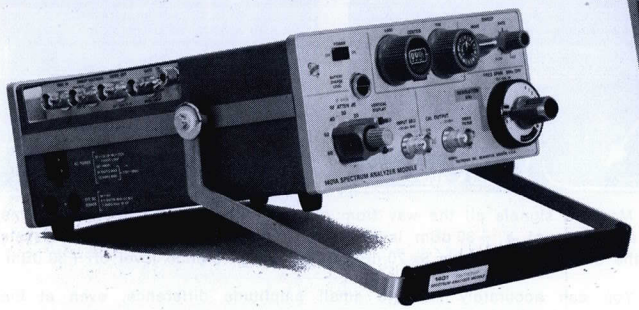
Up to 500 MHz in One Display

Frequency and Amplitude Calibrator

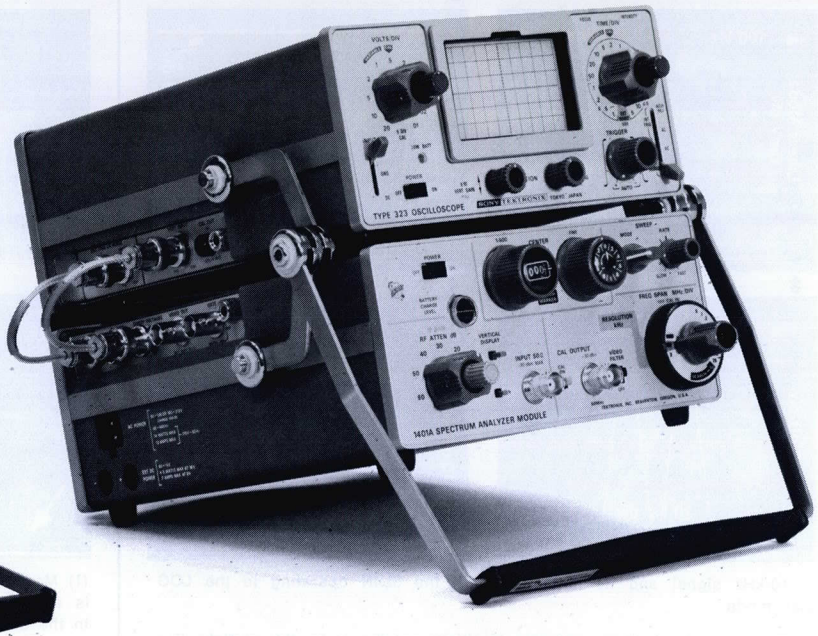
60-dB Log Dynamic Range

Intermodulation Distortion more than 60-dB down

Flat Within 1.5 dB over 200 MHz



1401A Spectrum Analyzer Module



1401A/323 Spectrum Analyzer System

The 1401A and 1401A-1 Spectrum Analyzer Modules are an expansion of the plug-in concept of using an oscilloscope for spectrum analysis. These modules, used with the SONY/TEKTRONIX 323 or other oscilloscopes, provide measurement facilities in the 1-MHz to 500-MHz frequency range. The 1401A is designed for 50-Ω systems, the 1401A-1 is for use with 75-Ω systems. Statements about the 1401A apply also to the 1401A-1 unless otherwise indicated.

The 1401A and 1401A-1 are compatible with any oscilloscope having 0.5 V/div horizontal deflection factor (adjustable ±10%) and 1.2 V full-screen vertical deflection.

One of the unique features of the 1401A is automatic center frequency positioning in the search mode. At 50-MHz/div frequency span (dispersion), the center frequency automatically becomes 250 MHz, preventing a possible erroneous display. In the search mode, the center frequency control positions a negative marker to indicate that part of the spectrum which will appear at center screen when the frequency span is reduced to less than 50 MHz/div.

Design of the 1401A/323 provides for easy carrying and convenient viewing and access. Power may be obtained from the normal ac line, 6 to 16 V dc, or internal rechargeable batteries.

ANALYZER CHARACTERISTICS

Center Frequency—Continuously selectable with 10-turn digital frequency readout control over the range of 1 to 500 MHz. Absolute accuracy within ± (5 MHz +5% of dial reading). Fine control provides a calibrated variation of up to plus or minus 1 MHz, within 10%.

CW Sensitivity	1401A	1401A-1
3 kHz Resolution	at least −100 dBm	at least −45 dBmV
100 kHz Resolution	at least −85 dBm	at least −30 dBmV
1000 kHz Resolution	at least −78 dBm	at least −23 dBmV

Frequency Span (dispersion)— 50 MHz/div to 100 kHz/div in 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.

Resolution Bandwidth— 3, 100, and 1000 kHz.

Display Flatness—Amplitude variations are within 1.5 dB to 200 MHz and 3 dB to 500 MHz.

Incidental FM— 20 kHz or less.

Intermodulation Distortion— 1401A at least 55 dB down with two signals at −30 dBm (+25 dBm 1401A-1), one MHz apart; 60 dB down with signals at −40 dBm (+15 dBm 1401A-1).

Frequency Stability—Within 50 kHz over any 5 minute interval after 20 minute warm-up and measurement at +20°C to +30°C ambient. Temperature coefficient = 0.5 MHz/°C or less.

Input Power	1401A	1401A-1
Maximum with RF attenuation	+30 dBm	+80 dBmV
Without attenuation	−30 dBm	+25 dBmV

RF Attenuator— 0 to 60 dB in 10 dB steps (accurate within +0.2 dB + 1% of dB reading).

IF Gain Control—At least 30-dB range.

Vertical Display—Linear and log.

Dynamic Range—At least 60 dB in log mode at 10 dB/div.

SWEEP CHARACTERISTICS

Free Run—Sweep rate continuously variable from one sweep per second or less to at least 100 sweeps per second.

External Trigger—Accepts an external positive pulse of 1 to 10 V, at least 100 ns width, 1 MHz or less.

External Horizontal—Input accepts signal of 0 to +5 V. 0 V corresponds to approximately 0 frequency and +5 V corresponds to approximately 500 MHz in search mode. 10 V maximum input.

CALIBRATOR

Frequency— 50 MHz within 0.01%.

Amplitude of the Fundamental—1401A, —30 dBm; 1401A-1, +25 dBmV. Accuracy, within 0.3 dB at 25°C and within 0.5 dB from —15°C to +55°C.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: —15°C to +55°C; Nonoperating: —55°C to +75°C (without batteries), —40°C to +60°C (with batteries); Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; Nonoperating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025-inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Electromagnetic Interference—Meets radiated interference requirements of MIL-I-6181D and MIL-I-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

OTHER CHARACTERISTICS

Power Sources—Battery operation: removable power pack contains 6 size "C" NiCd cells providing at least 3½ hours of operation. Maximum time is achieved at 20°C to 25°C charge and 20°C operating temperature. Internal charger provides for charging the internal batteries when connected to the ac line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge position prevents battery self-discharge when not in use. Battery charge level is indicated on an expanded scale dc voltmeter. External dc source: operates from an external dc source of 6 V to 16 V, requires 4.8 W. External ac source: operates from an external ac source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 14 W maximum 115 V ac.

Dimensions and Weights

	1401A 1401A-1		323		1401A/323	1401A-1/323
	in	cm	in	cm	in	cm
Height	3.5	8.9	3.5	8.9	7	17.8
Width w/handle	8.5	21.6	8.5	21.6	9.5	23.8
Depth w/panel cover	10.5	27.0	10.5	27.0	10.5	27.0
Depth w/handle	13	33.0	13	33.0	14.5	37.2
	lb	kg	lb	kg	lb	kg
Net weight w/o accessories	7.5	3.4	≈ 8	≈ 3.6	≈15	≈ 6.8
Shipping weight	12	5.4	≈14	≈ 6	≈23	≈10.4

SPECTRUM ANALYZER MODULE

1401A Included Accessories— 8-ft power cable assembly (161-0043-02); panel cover (200-0812-00); blue filter (378-0670-01); amber filter (378-0670-02); three 5½-inch, 50-Ω BNC to BNC cable assemblies (012-0214-00); 6-ft 50-Ω BNC to BNC cable assembly (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00); operator's handbook (1401A); instruction manual (1401A).

Order 1401A **$2500**

SPECTRUM ANALYZER MODULE

1401A-1 Included Accessories—Same as for 1401A except: Insert for instruction manual; two BNC to F adapters (013-0126-00); change 6-ft, 50-Ω BNC to BNC cable assembly to 6-ft 75-Ω BNC to BNC cable assembly (012-0113-01).

Order 1401A-1 ..... **$2600**

SPECTRUM ANALYZER SYSTEM

1401A/323 (P7 Phosphor) Included Accessories—Includes accessories for both the 1401A, 323 and a two-instrument handle conversion kit (040-0563-00).

1401A/323P7, Order 1401A-3 ..... **$3495**

1401A-1/323P7, Order 1401A-1-3 ..... **$3595**

323 OSCILLOSCOPE SUMMARY

Bandwidth	dc to 4 MHz
Risetime	90 ns
Deflection Factor	10 mV/div to 20 V/div at full bandwidth 1 mV/div at 2.75 MHz
Input R and C	1 megohm paralleled by approx 47 pF
Time Base	5 μs/div to 1 s/div
Magnifier	X10
Crt Display Area	6 x 10 divisions (¼-inch divisions)
Phosphor	P7 supplied when ordered with 1401A or 1401A-1
Amplitude Calibrator	Internal, 0.5 V at external jack
Power Sources	Internal batteries External 6 to 16 V dc 90 to 136 V ac 180 to 272 V ac 48 to 440 Hz 14 W at 115 V ac
Price with batteries	$995

The SONY/TEKTRONIX 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, it is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Protective Cover—Waterproof blue vinyl, **Order 016-0112-00 $13**

Handle Conversion Kit (for two instruments)—For combining an existing 323 Oscilloscope with 1401A or 1401A-1, for a system as shown, **Order 040-0563-00** **$33**

Handle Conversion Kit (for three instruments)—For combining an existing 323/1401A or 1401A-1 and 1501 TDR.
Order 040-0596-00 ..... **$100**

Power Pack—Extra power pack, in addition to the one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power pack is used in the 323.
Order 016-0119-00 ..... **$125**

Adapter—BNC 75 Ω to 50 Ω impedance matching network.
Order 011-0112-00 ..... **$28**

Battery Set—Set of 6 NiCd cells, **Order 146-0012-01** **$26**

Compact, Light Weight

Internal Phase Lock

Calibrated Dispersion to 100 MHz

Coupled Resolution

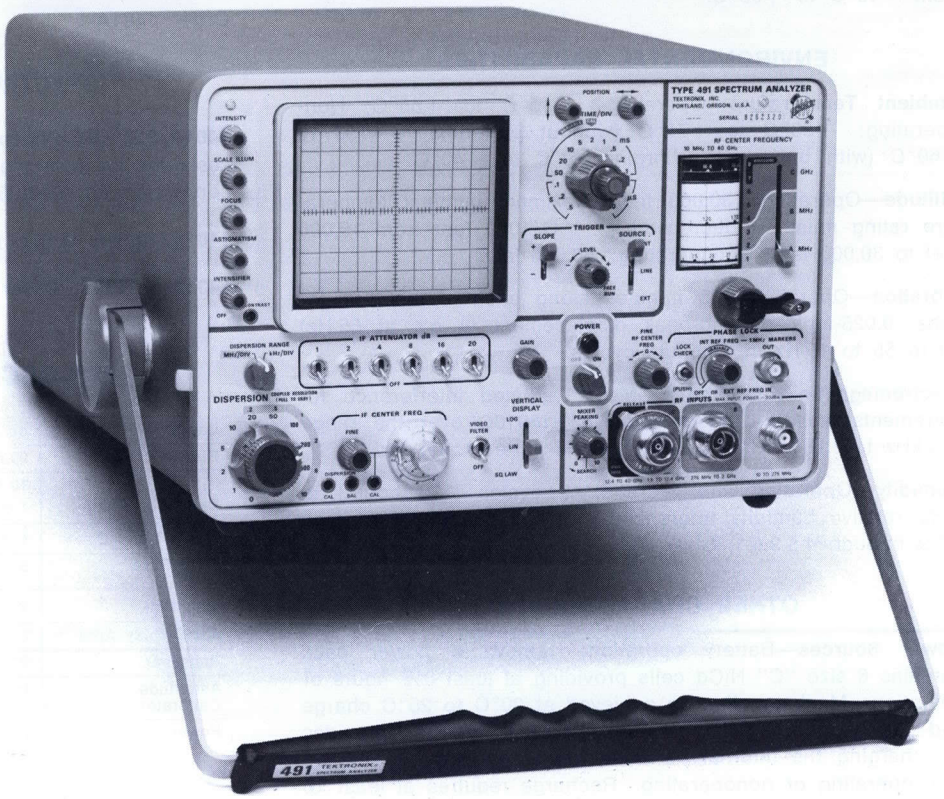
Wide-Range Time Base

Low Power Consumption

Environmentalized

All Solid-State

Battery Power Supply Available



The 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is an easy-to-carry package weighing less than 40 pounds complete with accessories. The R491 is electrically identical, requires only 7 inches of rack height.

Operation is simple. Resolution and calibrated dispersion controls are coupled, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Since dispersion is calibrated, frequency differences can be read directly from the crt. Internal phase lock provides stable displays even at 1 kHz/div dispersion.

Two modified instruments are available for applications which do not require the full center frequency range (10 MHz to 40 GHz) of the 491. These are the Option 1, (10 MHz to 2000 MHz) and the Option 2 (1.5 GHz to 40 GHz). Specifications for the Option 1 and Option 2 are the same as for the 491 except where noted.

Each instrument is completely self-contained, has oscilloscope-type time base and trigger circuits, 8 x 10-div crt with P7 phosphor and internal graticule. They operate over a wide range of ac voltages, require only 55 W, maximum.

Operation, independent of ac power source, is made possible by the new 1105 Battery Power Supply.

BAND	FREQUENCY RANGE	MINIMUM CW SENSITIVITY* 1-kHz RESOLUTION	100-kHz RESOLUTION
1	10 MHz to 275 MHz	≥ —100 dBm	≥ —80 dBm
2	275 MHz to 900 MHz	≥ —110 dBm	≥ —90 dBm
3	800 MHz to 2000 MHz	≥ —105 dBm	≥ —85 dBm
4	1.5 GHz to 4.0 GHz	≥ —110 dBm	≥ —90 dBm
5	3.8 GHz to 8.2 GHz	≥ —100 dBm	≥ —80 dBm
6	8.2 GHz to 12.4 GHz	≥ —95 dBm	≥ —75 dBm
7	12.4 GHz to 18.0 GHz	≥ —90 dBm	≥ —70 dBm
8	18.0 GHz to 40 GHz	≥ —80 dBm to 26.5 GHz ≥ —70 dBm to 40 GHz	≥ —60 dBm ≥ —50 dBm

*Signal + noise = 2X noise

Bands 1-8 are covered in the 491.

Bands 1-3 are available in Option 1.

Bands 4-8 only are available in Option 2, bands 4-6 directly, bands 7-8 using optional accessories.

CHARACTERISTICS

Dial Accuracy— ±(2 MHz + 1% of dial reading).

Calibrated Dispersion— 1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div and MHz/div). Accuracy throughout full range of rf-center frequency control, within ±3% except at 2 MHz/div (±5%) and 1 MHz/div (±7%). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within ±3%. Zero dispersion useful for prf measurements.

Coupled Resolution— 1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

Display Flatness—Maximum amplitude variation over 100-MHz dispersions up to 12.4 GHz is 3-dB or less, except over 50-MHz dispersion in Band 1. Above 12.4 GHz the maximum amplitude variation (100-MHz dispersion) is 6-dB or less.

Incidental FM—Less than 300 Hz at fundamental, with Phase Lock.

Frequency Stability—kHz/div dispersion range— ±10 kHz throughout line voltage range after 1 minute; ±5 kHz/°C. MHz/div dispersion range— ±200 kHz throughout line voltage range after 1 minute; ±20 kHz/°C.

Phase Lock—Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

Input Impedance—Approx 50 Ω for coaxial inputs.

Maximum Input Power— —30 dBm for linear operation, +15 dBm (25 mW) safe diode power limit.

IF Attenuator— 51 dB in 1-dB steps, ±0.1 dB/dB.

IF Gain Control— >50-dB range.

IF Center Frequency— ±25 MHz adjustment of center frequency from 5 MHz/div to 0.2 MHz/div dispersion positions, ±10-MHz adjustment at 10 MHz/div, ±2.5-MHz adjustment from 500 kHz/div to 1 kHz/div dispersion positions.

Vertical Display (8 Divisions)—Log — ≥40-dB dynamic range. Linear. Square Law— ≥13-dB dynamic range.

HORIZONTAL DEFLECTION

Internal Sawtooth Generator— 10 μs/div to 0.5 s/div in 15 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to approx 1.25 s/div.

Trigger Source—Internal, external, or line. 100-V maximum external input (dc + peak ac).

Trigger Requirements— 0.2-div deflection or 0.2-V external from 20 Hz to 100 kHz.

CRT AND DISPLAY FEATURES

Crt— 8 x 10-div display area (each div = 0.8 cm); P7 phosphor.

Graticule—Internal, no parallax, variable edge lighting.

Display Features—Intensity, focus and astigmatism controls. Intensifier adjusts relative brightness of signal and baseline for convenient viewing and photography.

ENVIRONMENTAL CAPABILITIES

Electromagnetic Interference—Meets specifications of MIL-I-6181D over the following frequency ranges: Radiated (with included crt mesh fitler installed) is 150 kHz to 1 GHz; conducted (power line) is 150 kHz to 25 MHz.

Temperature—Operating: —15° C to +55°C. Nonoperating: —55° C to +75° C.

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

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

Vibration—Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 1 shock per axis.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 V ac or 180 to 272 V ac, 48 to 440 Hz; 55 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Rear Panel Connectors—BNC connectors for external trigger input, sawtooth output (70 to 90 mV p to p) and recorder output (≥4 mV/div of displayed signal in LIN mode, dc-coupled, approx 600-Ω source resistance).

Cabinet Model Dimensions and Weights

Height	≈7 in	18.2 cm
Width	≈12 in	31.6 cm
Depth (incl. panel cover)	≈20 in	50.0 cm
Depth (with handle extended)	≈22 in	54.7 cm
Net weight (w/o panel cover)	30 lb	13.6 kg
Weight (with panel cover and accessories)	38 lb	17.3 kg
Shipping weight	48 lb	21.7 kg

Rack Model Dimensions and Weights

Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	17.5 in	44.4 cm
Net weight	41 lb	18.6 kg
Shipping weight	69 lb	31.3 kg

491 Spectrum Analyzer

Included Standard Accessories—6-ft BNC cable, 50-Ω miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); 2-ft TNC cable, RG 223/U coax (012-0115-00); wave guide mixer, 12.4 to 18 GHz (119-0097-00); wave guide mixer, 18 to 26.5 GHz (119-0098-00); wave guide mixer, 26.5 to 40 GHz (119-0099-00); 10-dB attenuator, Type N fittings (011-0085-00); 20-dB attenuator, Type N fittings (011-0086-00); 40-dB attenuator, Type N fittings (011-0087-00); two BNC male and N female adapters (103-0058-00); two BNC female to N male adapters (103-0045-00); wave guide mixer adapter (119-0104-00); power cable (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); clear crt protector plate (386-0118-00); ornamental ring (354-0248-00); two one-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); instruction manual (070-0598-01). The R491 includes all above accessories except the front cover and protective cover, also includes slide-out assembly and hardware.

ORDERING INFORMATION

491 Spectrum Analyzer **$5195**
R491 Spectrum Analyzer (rackmount) **$5295**
Option 1 (10 MHz to 2 GHz) ..... **Subtract $1395**
Option 2 (1.5 GHz to 40 GHz) ..... **Subtract $1195**
1105 Battery Power Supply **$525**

See index for the location and full description of the 1105.

491 OPTION 1

The 491 Option 1 has a center frequency range of 10 MHz to 2000 MHz. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N) of the option. The appearance is the same as that of the 491 with the following exceptions: the C-band input is removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

Included Standard Accessories (491 Option 1 Only)—6-ft BNC cable, 50-Ω miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); power cable (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear crt protector plate (386-0118-00); and special instruction manual.

The R491 Option 1 also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

491 OPTION 2

The 491 Option 2 has a center frequency range of 1.5 GHz to 40 GHz with optional accessories. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N). The appearance is the same as that of the 491 with the following exceptions: the A and B band inputs are removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

Included Standard Accessories (491 Option 2 Only)—6-ft N cable, RG 223/U coax (012-0114-00); power cable (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); ½-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear crt protector plate 386-0118-00); and special instruction manual.

The R491 Option 2 also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

OPTIONAL ACCESSORIES FOR THE 491 OPTION 2

NOTE: These accessories are required to extend the frequency range of the Option 2 from 12.4 GHz to 40 GHz.

Cable, TNC, coaxial, 2 feet (012-0115-00) ..... **$ 11**
Waveguide mixer adapter (119-0104-00) ..... **$ 50**
Waveguide mixer 12.4-18.0 GHz (119-0097-00) ..... **$ 85**
Waveguide mixer 18.0-26.5 GHz (119-0098-00) ..... **$ 97**
Waveguide mixer 26.5-40.0 GHz (119-0099-00) **$150**

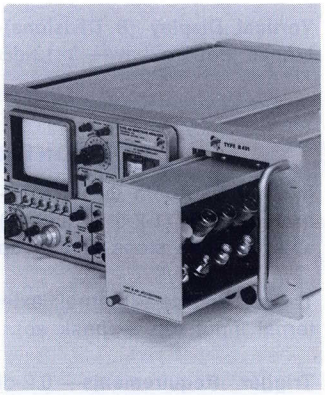
OPTIONAL ACCESSORIES FOR THE 491 OPTION 1 AND 2

BNC male to N female adapter (103-0058-00) ..... **$ 5**
BNC female to N male adapter (103-0045-00) ..... **$ 5**
10-dB attenuator, Type N fittings (011-0085-00) **$55**
20-dB attenuator, Type N fittings (011-0086-00) **$55**
40-dB attenuator, Type N fittings (011-0087-00) **$65**

CONVERSION KITS

Portable To Rack-Model—Kit includes hardware and instructions to convert the 491 Analyzers for rack installations.
Order 040-0444-00 ..... **$165**

Rack Model To Portable—Kit includes cabinet, panel cover, oscilloscope cover, and instructions to convert the R491 Analyzers for portable operation.
Order 040-0445-00 ..... **$100**



Accessory Storage—Included panel cover for the 491 and drawer for the R491 hold all standard accessories except manual and protective cover.

Curve Tracers

7

Curve Tracers are self-contained measurement systems which include power supplies, function generators, measurement circuitry and crt displays. Great measurement range and flexibility qualify Curve Tracers for evaluating and analyzing many different types of components. Curve Tracers also are powerful tools for in-circuit troubleshooting.

Current vs. voltage characteristics are conventionally displayed for components whether in or out of their circuit environments. The ability to plot a characteristic curve rather than obtain a numerical answer is one of the curve tracer's truly unique features. A curve is actually a plot of answers that show how and why parameters change throughout a component's operating range. The result is more information and insight. A curve tracer's crt display reveals effects that remain hidden from instruments providing only numerical or go, no-go answers.

Tektronix offers two Curve Tracer product lines, the 576 and the 577 systems. Both systems provide a general-purpose or standard Curve Tracer. Additional plug-in Test Fixtures expand the capabilities of each system along different lines. The 576 system may be expanded to include semiautomatic testing and very high current measurements. The 577 system includes a Test Fixture for linear integrated circuits. Another significant innovation in the 577 system is the availability of a storage display.

THE 576 SYSTEM

The 576 Curve Tracer with the standard test fixture is a rugged, high power measurement system which has become an industry standard over the past several years. The Collector Supply is capable of delivering up to 220 watts peak to the device-under-test. The Step Generator can deliver up to 2A in both its current and voltage modes of operation.

A very noticeable feature of the 576 is its display-area READOUT. Adjacent to the crt are alphanumeric indicators of vertical and horizontal deflection factor, step amplitude, and Beta/div or gm/div. Readout decreases set-up time and the chances for operator error. It also provides a permanent record of major knob settings in photographs of characteristics. The Beta or gm readout also eliminates bothersome arithmetic in arriving at these parameters.

Another unique feature of the 576 is the Calibrated Display Offset. Combining a calibrated position control and a display magnifier, the Display Offset increases resolution and allows an operator to make more precise measurements.

Other distinct features of the 576 Curve Tracer are: adjustable current limiting in the Step Generator, either 300 μs or 80 μs pulse width in pulsed base operation, push buttons to check display zero and calibration, and illuminated graticule.

For a description of plug-in capability see the 172 and 176 sections.

THE 577 SYSTEM

The 577/177 Curve Tracer with Standard Test Fixture retains most of the important features and performance of the 576 and is smaller and lighter. New design techniques enhance the 577/177 with unique advantages of its own. Low current measurements are facilitated by several features. First, current sensing resistors are small, resulting in less capacitive looping. (Electronic overrange detection and protection in the 577/177 substitutes for the high power resistors of the 576). Second, current sensing always takes place in the Collector Supply lead, permitting measurements on three terminal active devices at the lowest current ranges and eliminating the need for a correction to the horizontal deflection factor. Third, a display filter reduces vertical deflection noise. Fourth, the availability of a storage display permits the operator to trace a curve where otherwise only a dot display would be available, a typical situation for very low current measurements.

Although the 577/177 Collector Supply has lower power capability (the 576 can deliver approximately 2.2 times as much power to the device under test), approximately the same test current is available, 10 A continuous peaks at line frequency. The 577/177 provides its highest currents at a lower voltage than does the 576.

Other innovations in the 577/177 Curve Tracer are an emitter-base breakdown position on the lead selector switch, availability of approximately 95 steps from the Step Generator, an uncalibrated bias supply, knob skirt readout that indicates scale factor changes, independent magnifiers that increase resolution on either or both crt axes, fewer controls and a beam finder.

The 178 extends curve tracer measurements to include many parameters of linear integrated circuits. It is designed to operate in a 577/D1 (storage) curve tracer mainframe. As with a general purpose or standard curve tracer, parameters are obtained from the crt display, not from meter readings, numeric indicators or go, no-go lights. The result is more information about the device-under-test.

STORAGE IN CURVE TRACERS

Storage display (available in the 577 system only) provides new measurement capability and convenience to the Curve Tracer. Characteristics of a device-under-test can be stored on the crt during heating or cooling of the device. The results can show temperature sensitivity and zero T.C. points. Dot displays (generated during high current pulsed testing or during very low current testing under dc conditions) can be transformed into complete characteristic curves by simply moving them across the crt while in the Storage Mode.

The split screen feature of the storage display is useful for making comparisons, whether simply comparing one component with another or for troubleshooting. When using the Curve Tracer to troubleshoot a circuit board for example, the I-V characteristic of a good circuit can be stored in one-half of the screen while the corresponding response of a suspect circuit is displayed on the lower half.

Comparisons can also be made by overlaying the characteristics of one device on top of the stored characteristics of another. By using the Curve Tracer's ability to invert the display polarity, the characteristics of a PNP transistor may be overlayed on those of an NPN.

PRODUCT	PAGE	MEASUREMENT CAPABILITIES	PRICE
577/177	216	A general-purpose, Standard Curve Tracer with storage display. With non-storage display.	**$2495** **$1995**
178	218	A Linear IC Test Fixture for the 577. Measures dc and low frequency parameters of amplifiers and regulators.	**$ 950**
576	221	A general-purpose, Standard Curve Tracer with display-area READOUT. Without display-area READOUT.	**$3500** **$3100**
172	223	A Programmable Test Fixture for the 576. Programs up to eleven measurements for faster measurements and fewer errors in applications such as device manufacturing, incoming inspection and device evaluation.	**$1610**
176	225	A Pulsed High-Current Fixture for the 576 which extends collector current range to 200 amps peak and base current range to 20 amps peak.	**$1725**
5CT1N	226	A plug-in curve tracer for the TEKTRONIX 5000-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	**$ 375**
7CT1N	226	A plug-in curve tracer for the TEKTRONIX 7000-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	**$ 400**
CT71	171	A low-cost semiconductor tester which displays characteristic curves of transistors, FETs and diodes. Manufactured by Telequipment, a Tektronix, Inc. subsidiary.	**$ 845**

Curve Tracers

General purpose system with storage display available

Storage or Non-Storage Display

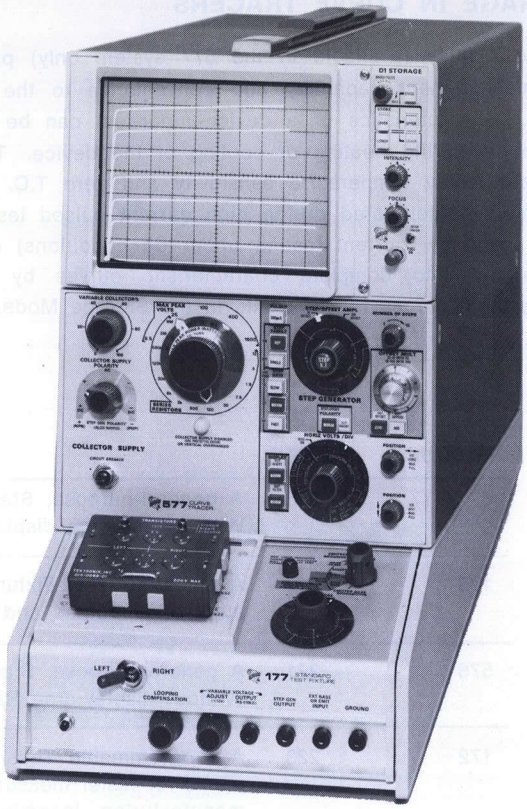
Better Low-Current Measurements

Kelvin Sensing for High-Current Tests

Knob Skirt Scale Factor Readout

Fewer Controls

Optional Linear IC Test Fixture



A general description of the 577/177 Curve Tracer is located in the Curve Tracer Reference section.

CHARACTERISTICS

Characteristics of the 577 Curve Tracer Mainframe operating with a 177 Standard Test Fixture.

COLLECTOR SUPPLY

Five modes of Collector Supply operation are selectable. These are: ac at line frequency, positive full wave rectified, negative full wave rectified, positive dc or negative dc.

Voltage—The voltage is variable up to the maximum peak volts selected.

MAX PEAK VOLTS Open Circuit	6.5 V	25 V	100 V	400 V	1600 V
Continuous Current, Peak	10 A	2.5 A	0.6 A	0.15 A	0.04 A
Peak Pulse Current	20 A	5 A	1.25 A	0.30 A	0.08 A

Series Resistance—14 values from 0.12 Ω to 8 MΩ. Coupling of series resistance and voltage controls maintains maximum peak power to the device-under-test when changing voltage ranges.

Collector Supply Interlock—Protects operator from 100-, 400- and 1600-volt ranges. Momentary button provides for overriding interlock.

STEP GENERATOR

Number of Steps—Selectable from 1 to 10 full-amplitude steps. Selectable up to approximately 95 steps when using STEP X0.1 multiplier.

Offset—The amplitude of the entire set of steps can be offset in a continuously variable and calibrated manner to either AID or OPPOSE steps. Maximum range of offset is 10 full-amplitude steps.

Current Mode—Step amplitude range is 5 nA/step (with STEP X0.1) to 200 mA/step, in a 1-2-5 sequence. Available current is at least 2A on the highest amplitude setting with 5 volts or more compliance. For opposing offset, available current is at least 10 mA with voltage limited between 1 V and 5 V.

Voltage Mode—Step amplitude range is 5 mV/step (with STEP X0.1) to 2 V/step, in a 1-2-5 sequence. Current is limited between 100 mA and 200 mA. For opposing offset, available current is at least 10 mA (at 0 volts) derating to 0 mA at 20 volts.

Accuracy—Incremental; within 2% between steps. Absolute; within 3% of total output or AMPLITUDE setting, whichever is greater. When STEP X0.1 is actuated the absolute step accuracy is 4%.

Automatic Scale Factor Readout—Change in step amplitude is indicated by lights behind the knob skirt when using the STEP X0.1 multiplier.

Step Rate—Selectable at 1X (SLOW), 2X (NORM) or 4X (FAST) line frequency.

Step Family—Repetitive or single family.

Pulsed—Steps can be gated on for a duration of approximately 300 μs for testing at low duty cycle.

Polarity—With NORM POLARITY selected the Step Generator polarity is the same as the Collector Supply polarity, and positive in the ac position. Polarity can be independently inverted with STEP/OFFSET POLARITY control or from the test fixture.

DEFLECTION CONTROLS

VERTICAL DEFLECTION	NORMAL	MAGNIFIED
Collector Current (1-2-5 Sequence) Accuracy	2 nA/div to 2 A/div 3% ± 1 nA	0.2 nA/div to 0.2 A/div 4% ± 1 nA
HORIZONTAL DEFLECTION	**NORMAL**	**MAGNIFIED**
Collector Volts (1-2-5 Sequence) Accuracy	50 mV/div to 200 V/div 3%	5 mV/div to 20 V/div 4%
Base Volts (1-2-5 Sequence) Accuracy	50 mV/div to 2 V/div 3%	5 mV/div to 0.2 V/div 4%
Step Generator Accuracy	1 step/div 4%	0.1 step/div 5%

Accuracies are a percentage of highest on-screen value.

Automatic Scale Factor Readout—Change in deflection factor is indicated by lights behind the knob skirt when using X10 MAG.

Automatic Positioning—Trace (or spot) is automatically positioned when Collector Supply polarity is changed when using the 177.

Display Invert—Single control inverts display and repositions trace.

Display Filter—Selectable low pass filter reduces vertical noise for easier high sensitivity measurements.

CRT

Crt—Rectangular 6½-inch with 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.

OTHER CHARACTERISTICS

Device Lead Selection—Switch provides six different lead configurations. Three positions for EMITTER GROUNDED measurements provide STEP GEN, OPEN (OR EXT) and SHORT base terminal connections. Two positions for BASE GROUNDED measurements provide STEP GEN and OPEN (OR EXT) emitter terminal connections. One position provides for EMITTER BASE BREAKDOWN or leakage measurements up to 25 volts.

Left-Right Switch—Selects left or right test connections. Off in center position. Test connection area accepts all TEKTRONIX Curve Tracer adapters and protective cover. Kelvin connections are provided for emitter and collector terminals.

Looping Compensation—Reduces display loops due to test adapter capacitance and some device capacitance.

Variable Voltage Supply—Continuously variable bias supply from −12 V to +12 V. Source resistance is 10 kΩ or less.

Power Requirements— 100, 110, 120 Vac or 200, 220, 240 Vac all within ±10%. 50 to 60 Hz, 155 watts maximum at 110 Vac and 60 Hz.

Ambient Temperature—Performance characteristics are valid over an ambient temperature of +10°C to +40°C.

Dimensions and Weights

	577/D1 or 577/D2		177	
Height	19.8 in	50.3 cm	4.0 in	10.2 cm
Width	8.8 in	22.4 cm	7.9 in	20.1 cm
Depth	23.0 in	58.4 cm	6.0 in	15.2 cm
Net Weight	40 lb	18.1 kg	2.5 lb	1.1 kg
Shipping Weight	50 lb	22.7 kg	6 lb	2.7 kg

Note: When the 577 and 177 are ordered together their combined shipping weight is: Domestic ≃53 lb or ≃24 kg.

Included Accessories—Transistor adapter for most bipolar transistors and some MOS FET's (013-0098-01), axial lead diode adapter with Kelvin sensing terminals (013-0111-00) and protective shield for test connection area (337-1194-00).

ORDERING INFORMATION

177 Standard Test Fixture **$345**
577/D1 Storage Curve Tracer Mainframe **$2150**

ALTERNATE MAINFRAME

The following mainframe is identical to the 577/D1 except it has a non-storage display unit.

577/D2 Curve Tracer Mainframe **$1650**

(Note: The 577/D1 Storage Curve Tracer mainframe is recommended for use with the 178 Linear IC Test Fixture).

Option 10, 10 x 10-cm Graticule ..... **Add $35**

The Option 10 provides a crt with a 10 x 10-cm graticule (10 x 12 usable area). The standard crt has an 8 x 10-div graticule. Option 10 is available with either storage or nonstorage display.

OPTIONAL ACCESSORIES

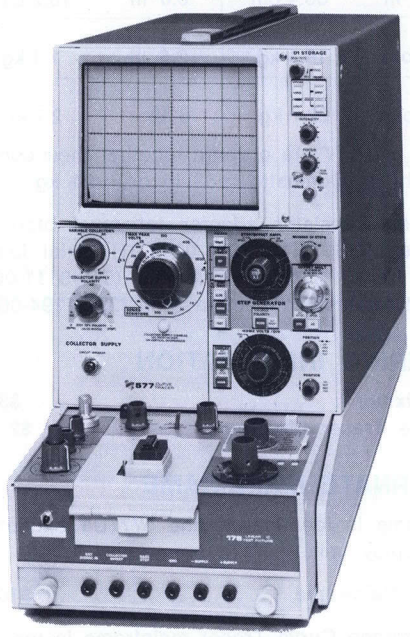
Camera—C-5, see camera section for complete description.
Order C-5 Camera **$195**

SCOPE-MOBILE® Cart—With storage drawer.
Order 201-1 ..... **$165**

Test set-up chart—Package of 250.
Order 070-1639-00 ..... **$6**

Curve Tracers

A linear IC test fixture for the 577



Measures:
- **Gain**
- **Offset V**
- **Bias I**
- **Cmrr**
- **Psrr**

Displays:
- **Thermal Effects**
- **Popcorn Noise**
- **Parameter Nonlinearities**

Operational amplifiers make up the greatest single class of linear integrated circuits. In order to test amplifiers, the 178 Linear IC Test Fixture departs from the open-loop approach used in a standard curve tracer. In a standard curve tracer the control lead of the device-under-test (DUT) is subjected to one or more test signals and the response or output is displayed on the crt. However, the operational amplifier's high gain (100,000 is common) makes this measurement technique impractical. For this reason the 178 tests an amplifier DUT in closed-loop configuration, by making it part of a feedback loop. The DUT's output is determined by the 178 front panel. In some tests it remains at a fixed dc voltage and in others it follows a low frequency signal. At all times the DUT's input remains under the control of the feedback loop so that the required output is achieved. It should be noted that the 178 reverses the customary roles of dependent and independent variables by controlling output and measuring input.

An operational amplifier's GAIN is one of the important parameters that can be measured using the 577 Curve Tracer with the 178 Test Fixture. While the amplifier DUT is actually part of a feedback loop, the gain measurement still determines the DUT's open-loop gain. Figure 1 shows a stored display of an amplifier's characteristics, its inverting input (vertical deflection factor 100 μV/div) as a function of its output voltage (horizontal deflection factor 5 V/div). Two curves are shown for comparison purposes; one with an output load of 50 K ohms, the other 1 K ohms. True zero volts dc on the vertical axis is far off screen (offset voltage measured over 400 μV on this amplifier). However, in gain measurement, only the relative change of input voltage is needed. The curves were traced at approximately .05 Hz and effectively represent the dc transfer characteristics of the operational amplifier.

The well-behaved linear curve is produced with the 50 kilohm load. Such a curve is the response of an ideal dc amplifier. The amplifier's gain of 110,000 can be determined by dividing the change in output voltage by change in input voltage; this gain holds true for large or small output signals. With such ideal curves the amplifier performance can be predicted from a single numeric value for its gain. In addition, the measurement of amplifier gain can be made using either large or small signals.

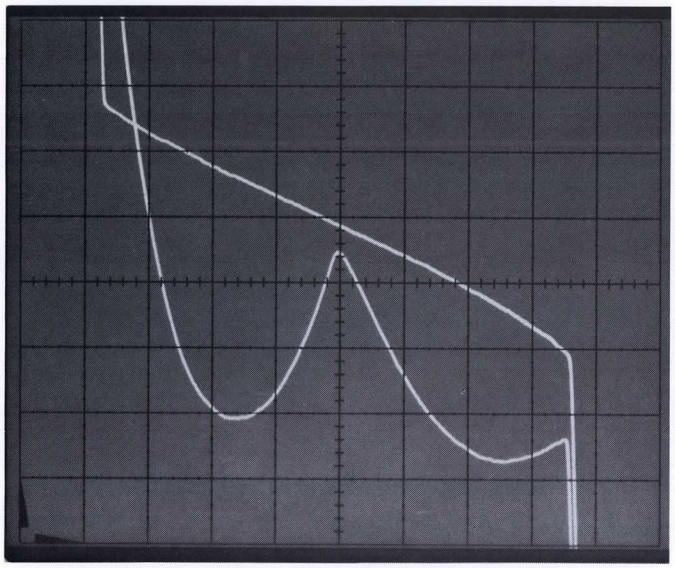


Figure 1

The unusually shaped curve is produced with the 1 kilohm load on the amplifier's output terminal. With such a characteristic curve it is difficult to assign a single numeric value for dc gain. Thermal effects completely overshadow and effectively mask any input voltage change that is due to amplifier gain. The result, as shown, is degraded dc performance. For an output voltage change from zero volts to plus five volts the input voltage changes 185 μ volts, reflecting an effective gain of only 27,000. This gain is only one-fourth of the value measured with a 50 K ohm load.

Another undesirable characteristic of operational amplifiers that readily shows up on the curve tracer's crt is popcorn noise (also called flicker noise). Figure 2 is the GAIN curve for an amplifier that has a large amount of popcorn noise. The vertical deflection factor is 100 μV/div, the horizontal 5 V/div. Because of the closed-loop testing, popcorn noise appears directly as equivalent input noise signal.

Other characteristics displayed by the curve tracer with a 178 test fixture are input offset voltage, input currents, common mode rejection, power supply rejection and power supply currents.

CHARACTERISTICS

VERTICAL DEFLECTION (1-2-5 Sequence)	NORMAL	MAGNIFIED
Input Voltage or Δ Input Voltage	10 μV/div to 50 mV/div	1 μV/div to 5 mV/div
Accuracy	3%	4%
Input Current	50 pA/div to 0.2 mA/div	5 pA/div to 20 μA/div
Accuracy	3% $\pm$ 50 pA	4% $\pm$ 50 pA
Power Supply Current	0.1 μA/div to 50 mA/div	10 nA/div to 5 mA/div
Accuracy	3% $\pm$ 0.1 μA	4% $\pm$ 0.1 μA
Collector Supply Current	1 nA/div to 50 mA/div	0.1 nA/div to 5 mA/div
Accuracy	3% $\pm$ 1 nA	4% $\pm$ 1 nA

Accuracies are a percentage of highest on-screen values.

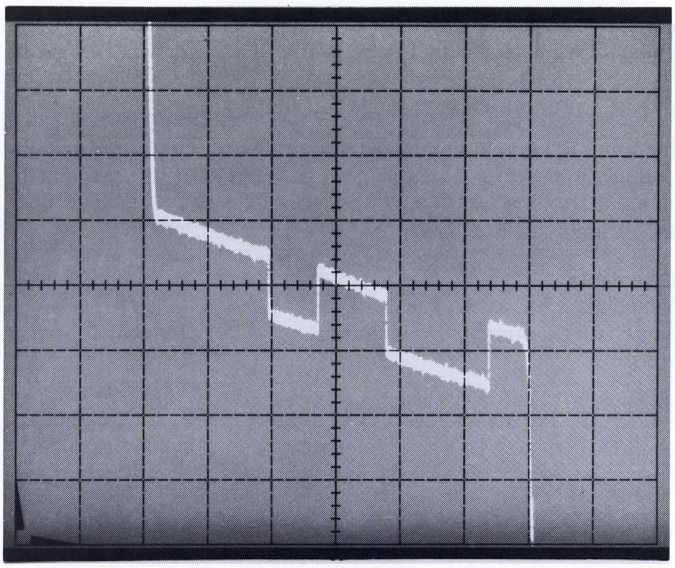


Figure 2

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% $\pm$ 100 mV. Negative supply can be independently adjusted by an uncalibrated control.

Sweep Generator—A sinusoidal signal controls the output, common mode input or the power supply voltages of the device-under-test. The frequency is adjustable from 0.01 Hz to 1 kHz; amplitude is adjustable up to 30 volts peak.

Source Resistance—Four input resistor pairs selectable, 65 Ω, 10 kΩ, 20 kΩ and 50 kΩ, or external resistors may be used. When the vertical deflection factor is in one of the less sensitive positions, 1 mV through 50 mV/div, the input resistance values are 400 Ω greater.

Load Resistance—Six selectable load resistors, 100 Ω, 1 kΩ, 2 kΩ, 5 kΩ, 10 kΩ, 20 kΩ and 50 kΩ, or external resistors may be used.

Collector Supply—The 25 V and 100 V ranges of the Collector Supply (located on 577 mainframe) are available to the 178 test fixture. Supply output is located on the 178 front-end panel and on the device card. Automatic positioning with supply polarity is inoperative when using the 178 test fixture. (See 577/177 characteristics for Collector Supply performance).

Step Generator—All the capabilities of the Step Generator (located on 577 mainframe) are available to the 178 test fixture. Generator output is located on the 178 front-end panel and on the device card. (See 577/177 characteristics for Step Generator performance).

DUT Supplies Disconnect—A single switch disconnects all power to the device-under-test: both plus and minus power supplies, Collector Supply and Step Generator.

Function Switch—Selects vertical and horizontal deflection signals and connection of the test signal. Except as noted, the horizontal display monitors the point controlled by the sweep

generator signal and the deflection factor is selected on the collector volts segment of the 577 HORIZ VOLTS/DIV switch. In tests where the amplifier's output V is not displayed, the output V is held to zero volts.

Input V is the differential voltage between the amplifier's inverting and non-inverting inputs. Δ input V is the change in this voltage with any offset voltage nulled out. Range of nulling voltage is ± 25 mV.

Selectable Functions with Standard Op Amp Card	Vertical Display	Horizontal Display
OFFSET V	input V	output V
+ INPUT I	+ input I	common mode V
— INPUT I	— input I	common mode V
CMRR	Δ input V	common mode V
GAIN	Δ input V	output V
+ PSRR	Δ input V	+ Supply V
— PSRR	Δ input V	— Supply V
± PSRR	Δ input V	+ Supply V[1]
+ SUPPLY I	+ Supply I	+ Supply V
— SUPPLY I	— Supply I	— Supply V
COLLECTOR SUPPLY I	Collector Supply I	Collector Supply V[2]

[1]The + Supply and — Supply are both swept out of phase at the same amplitude in ± PSRR function. Horizontal display is the + Supply voltage only.

[2]The Sweep Generator is not utilized in COLLECTOR SUPPLY 1 function.

Zero—Single push button provides a zero reference to the crt display and, in functions four through eight, nulls out offset voltage in order to measure Δ input V on the vertical display axis.

Dimensions and Weights

Height	4.5 in	11.4 cm
Width	7.9 in	20.1 cm
Depth	7.8 in	19.8 cm
Net Weight	3.3 lb	1.5 kg
Shipping Weight	8 lb	3.6 kg

Included Accessories—Dual-in-line 16 pin IC socket (136-0442-00). Standard Op Amp Card adapter with cover and ten patch cords (013-0149-00), interchangeable nomenclature panel for function switch (333-1770-00).

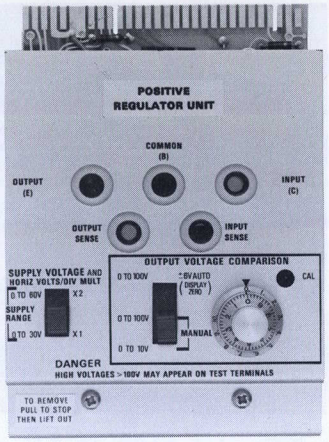
178 Linear IC Test Fixture **$950**

OPTIONAL ACCESSORIES

Standard Op Amp Card Adapter—(One included) Additional cards may be ordered as accessories.
Order 013-0149-00 ..... **$65**

Hardwire Card Adapter—A stripped down version of the standard op amp card. Allows customer to wire card to any configuration desired.
Order 013-0150-00 ..... **$40**

Regulator Test Fixtures—Two fixtures for testing positive and negative three-pin regulators. Parameters which can be tested include output voltage, load regulation, line regulation, ripple rejection, quiescent current and common terminal current.



TEST FIXTURE 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 250 mV.
INPUT SWEPT FREQUENCY—Dc to 1 kHz.
300 μs PULSED CURRENT—5 mA to 2A.
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.

	Vertical	Horizontal
Output Voltage	Output Voltage minus Comparison Voltage 1 mV to 50 mV/μdiv ±3%	Load Current ±4% or Input Voltage ±3%
Load Regulation	Change in Output Voltage 1 mV to 50 mV/div ±3%	Load Current ±3%
Line Regulation & Ripple Rejection	Change in Output Voltage 1 mV to 50 mV/div ±3%	Input Voltage ±4%
Quiescent Current	Quiescent or Common Terminal Current ±3%	Load Current ±4%

Load current is controlled by the step generator in the 577. It is displayed by selecting the STEP GENERATOR position of the Horiz. Volts/Div Switch.
The Horizontal and Vertical Magnifiers extend the sensitivity by a factor of ten and add an additional 1% to the specified accuracies.
Positive Regulator Fixture
Order 013-0147-00 ..... **$200**
Negative Regulator Fixture
Order 013-0148-00 ..... **$200**

Auto Scale-Factor Readout Including β/div or g_m/div

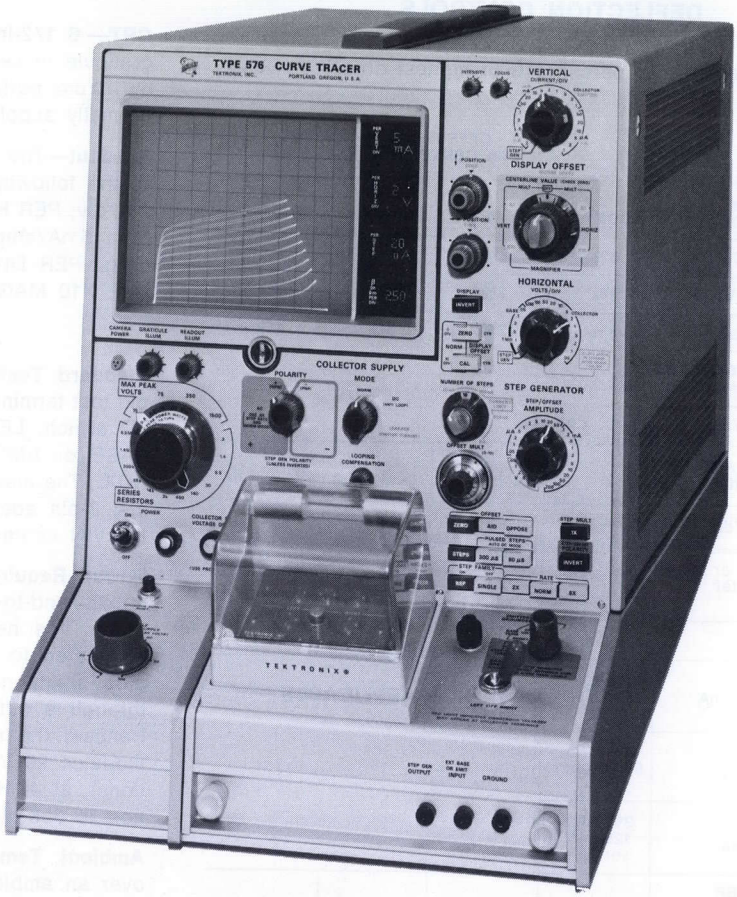
Calibrated Display Offset with Magnifier

Kelvin Sensing for High Current Tests

Optional Test Fixtures

Programmable Test Fixture

High-Current Fixture



A general description of the 576 Curve Tracer is located in the Curve Tracer Reference Section.

CHARACTERISTICS

COLLECTOR SUPPLY

Modes—NORM: positive or negative full wave rectified ac (line frequency); dc: positive or negative dc; LEAKAGE: emitter current rather than collector current measurements with an increase in the basic vertical deflection factor to 1 nA/div.

Voltages—Peak open circuit voltages within +35% and −5% of indicated range.

RANGE	15 V	75 V	350 V	1500 V
MAX CONTINUOUS PEAK CURRENT	10 A	2 A	0.5 A	0.1 A
PEAK PULSE MODE CURRENT	≥20 A	≥4 A	≥1 A	≥0.2 A

Series resistance is from 0.3 Ω to 6.5 MΩ in 12 steps, all within 5% or 0.1 Ω. Peak power limit setting: 0.1 W, 0.5 W, 2.2 W, 10 W, 50 W, 220 W.

Safety Interlock—Protects operator from 75 V, 350 V, and 1500 V collector voltages.

STEP GENERATOR

Current Mode—Step/offset amplitude range is 5 nA/step (with 0.1X MULT) to 200 mA/step, 1-2-5 sequence. Max current (steps and aiding offset) is X20 AMPLITUDE setting, except X10 (2 A) at 200 mA/step and X15 (1.5 A) at 100 mA/step. Max voltage (steps and aiding offset) is at least 10 V. Max opposing offset current is X10 AMPLITUDE switch setting or 10 mA, whichever is less. Max opposing voltage is limited at 1 V to 3 V.

Voltage Mode—Step/offset amplitude range is 5 mV/step (with 0.1X MULT) to 2 V/step, 1-2-5 sequence. Max voltage (steps and aiding offset) is X20 AMPLITUDE switch setting, 40 V max. Max current (steps and aiding offset) is at least 2 A at 10 V, derating linearly to 10 mA at 40 V. Short circuit current limiting is 20 mA, 100 mA, 500 mA +100%, −0%; 2 A +50%, −0%. Max opposing offset voltage; X10 AMPLITUDE switch setting. Max opposing current; limited at 5 mA to 20 mA.

Accuracy—Incremental; within 5% between steps, within 10% with 0.1X MULT. Absolute; within 2% of total output including offset, or 1% of AMPLITUDE setting, whichever is greater. Offset multiplier; 0 to X10 the AMPLITUDE setting, continuously variable. Polarity AID(s) or OPPOSE(s) the step polarity.

Step Rates—0.5X, 1X (NORM), and 2X the collector supply rate. The collector supply rate is twice line frequency.

Pulsed Steps—Approx 80 μs or 300 μs width, at NORM or 0.5X rates.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity, and positive in the ac position. Step polarity may be inverted by actuating the INVERT push button.

Step Family—REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps—Digitally selectable between 1 and 10.

DEFLECTION CONTROLS

Display Accuracies—As percentage of highest on-screen value.

NORM and DC MODES	NORMAL	OFFSET and MAGNIFIED with CENTERLINE VALUE from: 100-40 div	35-15 div	10-0 div
Vert Collector Current	3%	2%	3%	4%
Horiz Collector Volts	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
LEAKAGE MODE Vert Emitter Current/div:				
10 nA-2 mA/div	3% ± 1 nA			
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA
5, 2, 1 nA/div	5% ± 1 nA			
Horiz Collector or Base Volts with Emitter Current/div of:				
≥1 μA	3%	2%	3%	4%
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT APPLICABLE		
200, 20 or 2 nA	3% plus 50 mV/vert div			
500, 50 or 5 nA	3% plus 125 mV/ vert div			
VERT STEP GEN POSITION	4%	3%	4%	5%
HORIZ STEP GEN POSITION	4%	3%	4%	5%

Vertical Deflection Factor—Collector current is 1 μA/div to 2 A/div, 20 steps in 1-2-5 sequence (0.1 μA/div with X10 magnification). Emitter current is 1 nA/div to 2 mA/div, 20 steps in 1-2-5 sequence. Step generator is 1 step/div.

Horizontal Deflection Factor—Collector volts; 50 mV/div to 200 V/div, 12 steps (5 mV/div with X10 magnification). Base volts; 50 mV/div to 2 V/div, 6 steps (5 mV/div with X10 magnification). Step generator; 1 step/div.

Displayed Noise—1% or less or:

RANGE	15 V	75 V	350 V	1500 V
VERTICAL—COLLECTOR	1 μA	1 μA	2 μA	5 μA
VERTICAL—EMITTER	1 nA	1 nA	2 nA	5 nA
HORIZONTAL—BASE	5 mV	5 mV	5 mV	5 mV
HORIZONTAL—COLLECTOR	5 mV	5 mV	20 mV	200 mV

Calibrator (CAL)—Dc voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls—Fixed 5-div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset—21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

CRT and READOUT

CRT—6 1/2-inch rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied; P7 optional without extra charge.

Readout—The readouts, adjacent to crt, are digital indicators of the following parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

OTHER CHARACTERISTICS

Standard Test Fixture—A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

Power Requirements—Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-change line-voltage range selector accommodates 90 Vac to 136 Vac or 180 Vac to 272 Vac (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of +10°C to +40°C.

Dimensions and Weights		
Height	15.0 in	38.1 cm
Width	11.5 in	29.2 cm
Depth	23.0 in	58.2 cm
Net Weight	70.5 lb	32.0 kg
Shipping weight	≈107 lb	≈48.5 kg

Included Accessories—Transistor adapter (013-0098-01), FET adapter (013-0099-01). TO3 adapter (013-0100-00), TO66 adapter (013-0101-00), axial lead diode adapter (013-0111-00), stud diode adapter (013-0110-00), large in-line adapter (013-0138-00), small in-line adapter (013-0139-00) and protective cover (337-1194-00).

576 Curve Tracer **$3500**

INSTRUMENT OPTION

The 576 Option 1 deletes the parameter readout module, but maintains provision for insertion of the module (020-0031-00) at any time.

Order Option 1 ..... **Sub $400**

Order Auto Scale-Factor Readout Module (020-0031-00) .. **$580**

Order Option 76, P7 Phosphor ..... **No Charge**

OPTIONAL ACCESSORIES

Camera—See Oscilloscope/Camera Adapters chart in camera section of this catalog.

SCOPE-MOBILE® Cart—With Storage drawer.
Order 202-1 ..... **$165**

Test Set-up Chart—Package of 250
Order 070-0970-01 ..... **$6**

For additional accessories, see Curve Tracer Accessories pages.

Programs Tests on J FETs, Transistors and Diodes

Up to 11 Program Tests

576 with 172 inserted

The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program a sequence of tests on J FETs, transistors and diodes.

The 172 can greatly reduce total test time in applications where more than one measurement is made on a batch of many devices. Without the 172 all devices in the batch must be repeatedly inserted in the test fixture, once for every measurement. However, the 172 programmable test fixture performs as many as eleven different tests on each device while the device remains in the test socket.

The 172 can also greatly reduce the chance for error. Even experienced operators are likely to make errors in applications where repeated adjustments in control settings are needed. The 172 removes this error source. Once the 172 is programmed, an operator with little or no experience can make tests quickly and accurately since the automatic programming removes human errors.

The 172 sequences through the various tests either automatically or manually. A variable RATE control is provided for the operator to set the test sequence at a rate which is best for him. A new operator requires more time per test, but with experience he will want to test at a faster rate. A front-panel switch or an optional foot switch advances the test in the manual mode.

Programming is straightforward. Inserting plastic pins in holes in the programming card sets individual test conditions. Omit the pin from a particular test hole and the 172 skips that test. After installing the program pins in the card, the card is put into the card reader portion of the 172 and the operator starts the test sequence.

Standard accessories include a plastic limit card upon which the programmer graphs the test limits. This card is then placed against the 576 display area for quick comparison of test results and limits. When testing several different devices, program and limit cards may be made up in advance. Retaining the programmed cards speeds incoming inspection. When a shipment is received, the operator selects the card for a device, inserts it into the 172 and completes the inspection. Programmed testing frees technically trained personnel to concentrate on more creative processes.

The 172 makes three types of tests that are under the control of the programming card. First, for measurements such as β and saturation voltage, single characteristic curves can be programmed. Second, leakage measurements can be made with three different lead arrangements. Third, breakdown voltage measurements can be made with five different lead arrangements. In addition to these tests that are controlled from the program card, the 172 permits tests controlled manually from the 576 front panel.

CHARACTERISTICS

VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies—The same as the 576 Curve Tracer with its included Standard Test Fixture.

	TESTS THAT CAN BE PERFORMED ON:			PROGRAMMABLE
TEST	XSTR	J FETs	DIODES	CAPABILITIES
1*	H_{FE}, $V_{CE(sat)}$	V_P	V_F	PEAK CURRENT up to 10 A PEAK VOLTS up to 350 V
2	V_{BE}			Horiz range is 100 mV/div to 2 V/div (Other conditions same as Test 1)
3	H_{FE}, $V_{CE(sat)}$	I_{DSS}, $R_{DS(on)}$		Base Drive: 100 nA to 110 mA. When testing J FETs the base terminal is shorted to the emitter terminal. Collector Sweep: Three fixed ranges; 2 V, 5 V and 20 V peak. Short circuit currents on these ranges are 1.5 A, 2 A and 150 mA respectively.
4	Same as #3			
5	I_{CEO} or I_{CES}, I_{CER} with external short or resistor			Voltage Supply: 1 V to 500 Vdc. Leakage current measurements to 0.5 mA. The most sensitive deflection factor is 1 nA/div.
6	I_{CBO}	I_{GSS}		Same as #5
7	I_{EBO}		I_R	Same as #5
8	$V_{(BR)CEO}$ or $V_{(BR)CER}$ with external resistor		V_F	Current Supply: 100 nA to 11 mA dc for breakdown voltage measurements to 500 V. Up to 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.

Vertical Deflection Factor—Test 1 and 2 (Collector or Emitter Current): I_c, 1 μA to 2 A/div in 20 steps. Test 3, 4, and 8, 9, 10, 11 (Collector or Breakdown Current): 1 μA to 0.5 A/div in 18 steps. Test 5, 6, 7 (Leakage Current): 1 nA to 0.5 A/div in 27 steps. All steps are in a 1, 2, 5 sequence.

Horizontal Deflection Factor—Test 1: 0.05 V/div to 200 V/div in 12 steps. Test 2 (Base Voltage): 100 mV/div to 2 V/div in 5 steps. Input Z for test 2, at least 100 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

Height w/cover	6.5 in	16.5 cm
Width	7.8 in	19.8 cm
Depth	12.4 in	31.4 cm
Net weight	11.5 lb	5.2 kg
Shipping weight	≈18.0 lb	≈8.2 kg

Included Accessories—One protective cover, five programming cards, 250 programming card pins, five crt overlay limit cards.

Order 172 Programmable Test Fixture **$1610**

OPTIONAL ACCESSORIES

Programming Cards—Package of 25 programming cards without pins or limit cards.
Order 016-0198-01 ..... **$35.00**

Crt Limit Cards—Package of 25 limit cards without programming cards or pins.
Order 016-0510-01 ..... **$17.00**

Programming Pins—Package of 1000 programming pins without programming or limit cards.
Order 016-0519-01 ..... **$20.00**

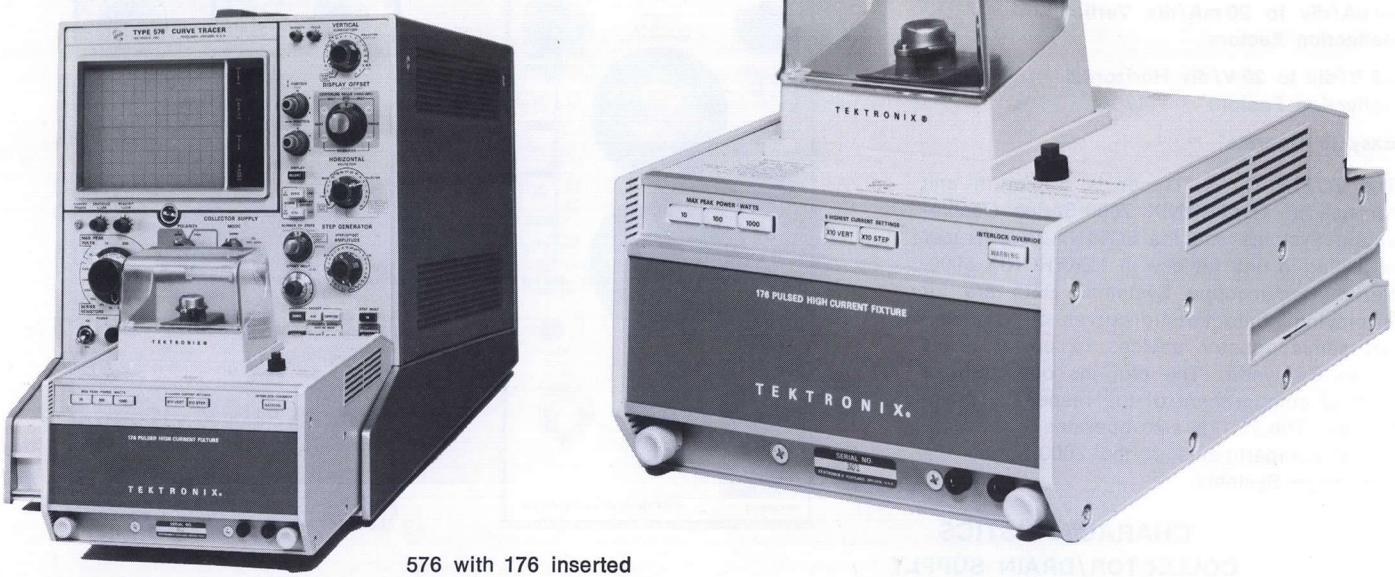
Foot Switch—For manually sequencing the programmed test.
Order 260-1189-01 ..... **$20.00**

Programming Accessories Package—Includes one programming card, one CRT limit card and 50 programming card pins.
Order 016-0518-00 ..... **$5.00**

Program Set-up Charts—Package of 250
Order 062-1615-00 ..... **$6.60**

200 Amp Peak Collector Displays

20 Amp Peak Base Supply



576 with 176 inserted

The 176 Pulsed High-Current Fixture extends the capabilities of the 576 Curve Tracer by providing pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over dissipation. The 176 "front porch" configuration fits in place of the 576 Standard Test Fixture, and is programmed from the 576 mainframe except for controls not provided on the mainframe. The collector pulse is slaved to the 576 in regard to width and repetition rate. The pulse width is selected by depressing the 300 μs or 80 μs push button on the 576 mainframe (usually, 300 μs should be selected). The rep rate is automatically set when the 176 is inserted in the mainframe. Rep rate is also dependent on power-line frequency. The five highest VERTICAL CURRENT/DIV (0.1 A/div to 2 A/div) of the 576 can be multiplied X10 by actuation of the X10 VERT push button on the 176. This feature enables viewing of up to a 200 amp peak display. The five highest STEP GENERATOR AMPLITUDE base current steps of the 576 (10 mA to 200 mA) can be multiplied X10 by actuation of the X10 STEP push button on the 176. This feature enables the pulsed base step generator on the 176 to provide up to a 20 amp base step (tenth step). Both X10 VERT and X10 STEP push buttons provide inputs to the fiber-optic readout to display actual values. **If STEP GENERATOR AMPLITUDE or VERTICAL CURRENT/DIV controls are moved out of the five highest current settings, the multiplication of the affected function automatically drops back to X1.**

CHARACTERISTICS

COLLECTOR SUPPLY (PULSED)

Width— 300 μs or 80 μs determined by 576.

Repetition Rate—Power-line frequency.

Polarity— + or — determined by 576 polarity control.

Amplitude—Ranges are 15, 75, 350 volts nominal, controlled by MAX PEAK VOLTS switch on 576. Current (minimum available at low line into shorted load) is 15 V range, 200 A; 75 V range, 40 A; 350 V range, 8 A.

Maximum Peak Watts—Three illuminated push buttons select 10, 100, 1000 watts maximum peak power.

STEP GENERATOR

Current Ranges (X10 STEP selected)—Step-Offset Amplitude Range is 100 mA to 2 A, 5 steps in a 1-2-5 sequence. Max Current (Steps and Aiding Offset) is X200 576 AMPLITUDE setting or 20 A, whichever is less. Max Voltage (Steps and Aiding Offset) is at least 5 V up to 10 A and 2 V up to 20 A.

576 Offset Multiplier— 0 to X100 576 AMPLITUDE switch setting.

Step Rate—Power-line frequency.

Pulsed Steps— 300 μs or 80 μs wide.

Step/Offset Polarity—The STEP GEN polarity is the same as the COLLECTOR SUPPLY polarity. Step polarity may be inverted by actuating the INVERT push button.

Accuracy (Current steps including offset)—Incremental is within 5% between any two steps; within 10% with 0.1X STEP MULT. Absolute is within 3% of total output ± 1% of one step or within 3% of one step, whichever is greater.

VERTICAL AMPLIFIER

Deflection Factor (X10 VERT selected)— 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid over a temperature range of 0°C to +40°C.

Dimensions and Weights

Height	4.6 in	11.8 cm
Width	7.9 in	20.0 cm
Depth	11.4 in	28.9 cm
Net weight	12.8 lb	5.8 kg
Shipping weight	18.0 lb	8.2 kg

Included Accessories

TO-36 adapter (013-0112-00); stud diode adapter (013-0110-00); protective shield (337-1194-00).

Order 176 Pulsed High-Current Fixture **$1725**

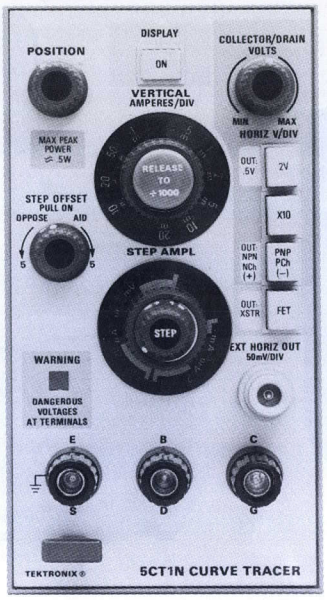
Tests Semiconductor Devices to 0.5 W

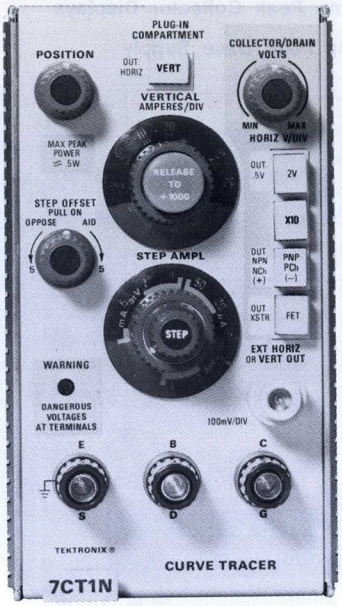
10 nA/div to 20 mA/div Vertical Deflection Factors

0.5 V/div to 20 V/div Horizontal Deflection Factors

Easy to Operate

The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 5000-Series Oscilloscope Systems. Both are for displaying characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watts. The plug-ins operate in a vertical compartment of the respective mainframes. The 7CT1N also operates in the horizontal compartments of the 7000-Series Oscilloscope Systems.





CHARACTERISTICS

COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Maximum Open Circuit Voltage—Within ±20%. Maximum short circuit current, within 30%.

Series Resistance—Automatically selected with horizontal volts/div switches. Peak power is 0.5 W or less, depending upon control settings.

High Voltage Warning—When the horizontal volts/div switch is in the X10 position, a flashing warning light appears on the front panel indicating that dangerous voltages may exist at the test terminals.

STEP GENERATOR

Transistor Mode—Step amplitude range is 1 μA/step to 1 mA/step, 1-2-5 sequence. Maximum current (steps plus aiding offset) is X15 amplitude setting. Maximum voltage (steps plus aiding offset) is at least 13 V. Maximum opposing offset current is at least X5 amplitude setting.

FET Mode—Step amplitude range is 1 mV/step to 1 V/step, 1-2-5 sequence. Voltage amplitude (steps plus aiding offset) is X15 amplitude setting, 13 V maximum. Source impedance is 1 kΩ ± 1%.

Accuracy—Incremental; within 3% between steps. Absolute; within ± (3% + X0.3 amplitude setting).

Step Polarity—The step generator polarity is the same as the collector/drain supply in the transistor mode and opposing in the FET mode.

Number of Steps—Selectable in one-step increments between 0 and 10.

Offset—Selectable from 0 to 5 steps. Polarity aids or opposes the step polarity.

Vertical Deflection Factors— 10 nA/div to 20 μA/div with the ÷1000 control activated. 10 μA/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy—Within 5% in the X1 mode. Within 5% ±0.2 nA per displayed horizontal volt when in the ÷1000 mode.

Horizontal Deflection Factors—Selectable: 0.5 V, 2 V, 5 V, or 20 V.

5CT1N Horizontal Display Accuracy—Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 5000-Series plug-ins) with a 50 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 5000-Series Oscilloscope mainframe.

7CT1N Horizontal Display Accuracy—Within 5% plus the deflection factor accuracy of the plug-in being driven. The plug-in would be a vertical or horizontal amplifier (such as the TEKTRONIX 7000-Series plug-ins) with a 100 mV/div deflection factor and an input R of at least 50 kΩ and would be used in the horizontal compartment of the 7000-Series Oscilloscope mainframe.

OTHER CHARACTERISTICS

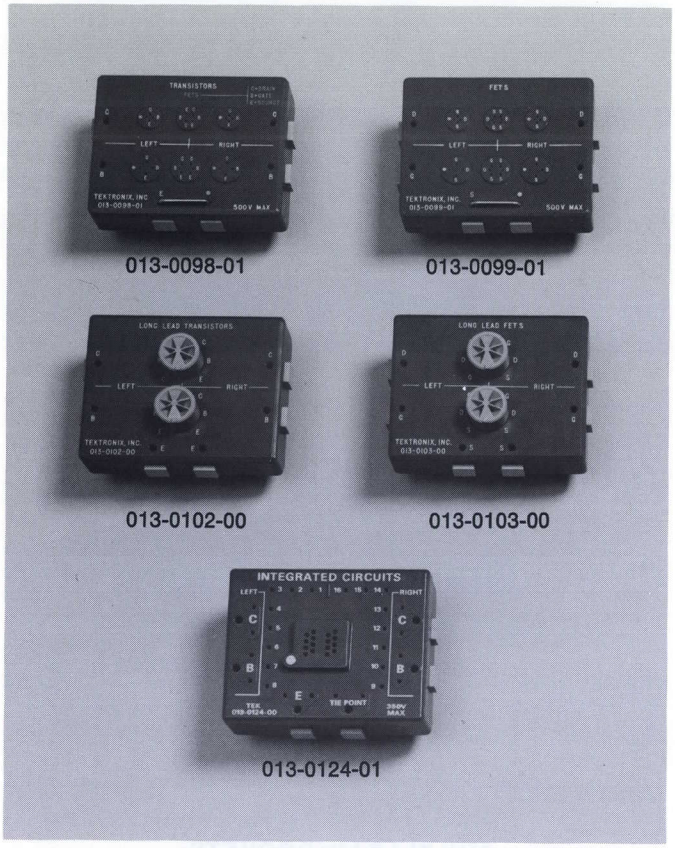
Ambient Temperature—Performance characteristics are valid from 0°C to +50°C.

	5CT1N		7CT1N	
Dimensions	**In**	**cm**	**In**	**cm**
Length	12.0	30.5	14.5	36.8
Width	2.6	6.6	2.8	7.1
Height	5.0	12.7	5.0	12.7
Weight	**lb**	**kg**	**lb**	**kg**
Net	1.8	0.8	2.5	1.1
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 **$375**
Order 7CT1N Curve Tracer **$400**

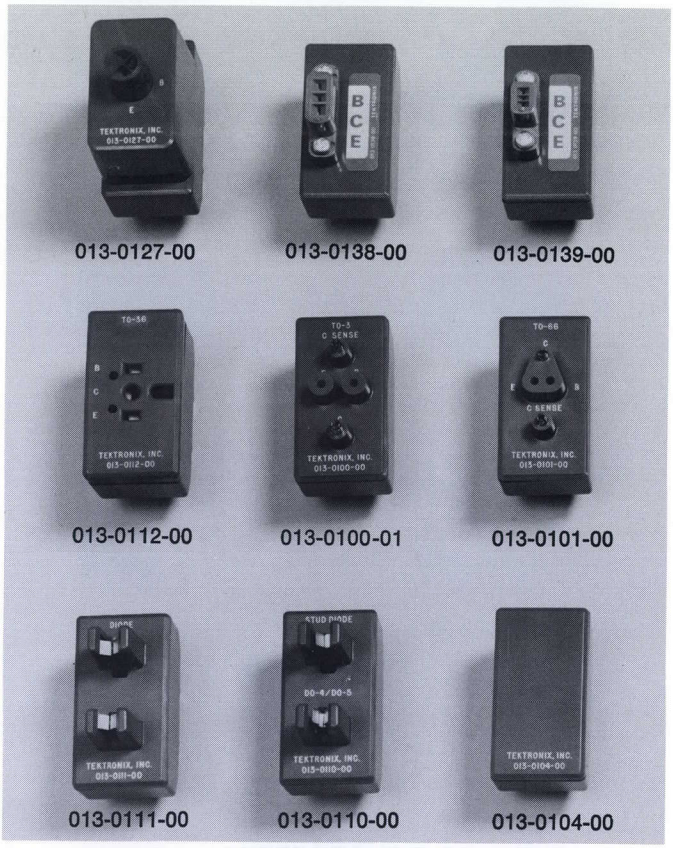
For optional accessories see 3 pin adapters on page 228.



013-0098-01 013-0099-01

013-0102-00 013-0103-00

013-0124-01



013-0127-00 013-0138-00 013-0139-00

013-0112-00 013-0100-01 013-0101-00

013-0111-00 013-0110-00 013-0104-00

DUAL WIDTH ADAPTERS

The following accessories fit the side-by-side terminals on test fixtures of the 576, 576/172 and 577/177 Curve Tracers.

Transistor Adapter—Useful for most single and dual bipolar transistors and some MOS FET's.
Order (013-0098-01) **$40**

FET Adapter—Useful for most single and dual FET's.
Order (013-0099-01) **$40**

Long Lead Transistor Adapter—Accepts dual or single transistors with untrimmed leads.
Order (013-0102-00) **$34.50**

Long Lead FET Adapter—Accepts dual or single FET's with untrimmed leads.
Order (013-0103-00) **$34.50**

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 ... **$66**

KELVIN SENSING ADAPTERS

The following accessories fit the test fixtures of the 576, 576/172, 576/176 and 577/177 Curve Tracers.

Transistor Adapter—Accepts long or short transistors. Can be rewired to accommodate nonstandard configurations.
Order (013-0127-00) **$25**

Large In-Line Adapter—Accepts large transistors with in-line leads. Approx spacing between terminals is 0.18 inch. It is wired for a B-C-E terminal configuration but may be easily rewired for the C-B-E configuration.
Order (013-0138-00) **$26**

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) **$26**

TO3 Adapter—Can be rewired to accommodate nonstandard configurations.
Order 013-0100-01 ..... **$25**

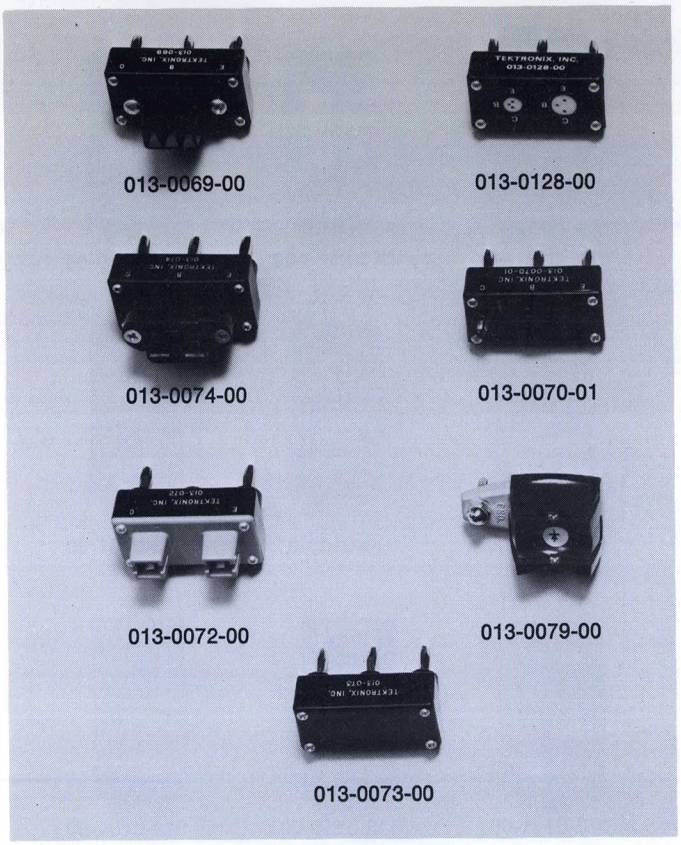
TO36 Adapter—Order (013-0112-00) **$20**

TO66 Adapter—Order (013-0101-00) **$20**

Axial Lead Diode Adapter—Order (013-0111-00) **$16**

Stud Diode Adapter—Order (013-0110-00) **$16**

Blank Adapter—For mounting special sockets.
Order (013-0104-00) **$10**



3 PIN ADAPTERS

The following accessories may be used with any of the TEKTRONIX Curve Tracer products. They do not have Kelvin sensing contacts.

Long Lead Transistor Adapter—Order (013-0069-00) **$10**

TO5 or TO18 Transistor Adapter—Order (013-0128-00) .. **$12**

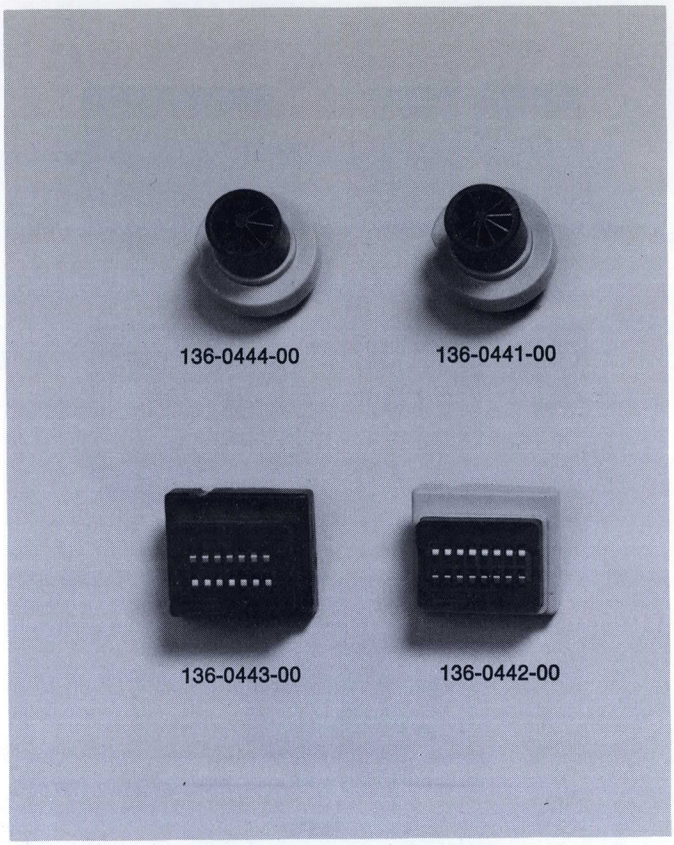
Power Transistor Adapter—For power transistors with hook leads.
Order (013-0074-00) **$14**

TO3 or TO66 Transistor Adapter—Order (013-0070-01) .. **$12**

Diode Test Adapter—Holds axial-lead diodes.
Order (013-0072-00) **$9**

Diode Test Adapter—Magnetically holds steel axial-lead diodes.
Order (013-0079-00) **$50**

Blank Adapter—For mounting special sockets.
Order (013-0073-00) **$6**



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.

8 lead TO package—Order (136-0444-00) **$11**

10 lead TO package—Order (136-0441-00) **$12**

14 lead dual-in-line package—Order (136-0443-00) **$8**

16 lead dual-in-line package—Order (136-0442-00) **$9**

(These four sockets are the most commonly required in curve tracer applications. Additional socket configurations are available from Amphenol Sales Division, 2875 South 25th Avenue, Broadview, Illinois 60153).

Oscilloscope Cameras

8

Modern oscilloscope cameras provide a convenient means of obtaining a permanent accurate record of the crt display, and for the study of high-speed transient phenomena, a means of obtaining data that cannot be gathered by visual observation alone. The specialized family of TEKTRONIX Cameras offered here complements the broad line of TEKTRONIX Oscilloscopes to meet a wide range of crt recording needs.

Reference 230
C-50 Series 233
C-5 239
C-12, C-27 240
C-30 Series 244
Writing Speed Enhancer 246
Adapters 247

CHOOSING A TEKTRONIX CAMERA

Just as no single oscilloscope can make every measurement, no single camera can meet every possible mechanical, electrical, and optical requirement. The specialized family of TEKTRONIX Cameras complements the broad line of TEKTRONIX Oscilloscopes to meet a wide range of trace-recording needs.

Which combination to choose?

The next three pages can help you. In them we define the major characteristics of an oscilloscope camera, and how they relate to your needs. We've also summarized these camera characteristics in a check list, along with some other important factors to consider when choosing a camera system.

Specification data for the cameras is presented in convenient chart form throughout the catalog. First, a master chart classifies all the TEKTRONIX Cameras by Primary Use, and allows easy comparison of their major benefits. The pages following contain similar detailed charts for each camera series or family.

To complement these charts, the Oscilloscope/Camera/Adapter Guide page lists most TEKTRONIX Oscilloscopes and the camera recommended for each of them. The Guide also lists nineteen Camera Adapters, and the many camera/oscilloscope combinations they allow.

CAMERA SELECTION CHECK LIST

The check list here briefly notes important things to consider when choosing a camera system. Following the list, each point is elaborated.

CAMERA MOUNTING AND USE—Is the camera mechanically and optically compatible? Specific camera types are designed for use primarily with a particular series of oscilloscopes or display units. By means of optional adapters, most cameras can be mounted on a wide variety of instruments, but they must of course be optically compatible to produce useful photos.

LENS SPEED—Does it match the task? For photographing a stored or recurrent stable crt display, a slow or medium-speed lens is suitable and economical. For recording a high-speed, single-sweep trace you may need the fastest lens available.

FIELD of VIEW—Cameras are available for the crt displays that range in size from 6 x 8 cm to 10.2 x 12.7 cm. Does the camera have sufficient field of view to fully record the entire display on the size film of your choice?

LENS MAGNIFICATION—Will the lens produce the size photo image you want? Magnification of the lens also affects the field of view and writing speed.

FILM BACKS—Is it desirable to interchange different types of film backs to allow use of different film types, picture sizes, and emulsion speeds? Except for the C-5, all TEKTRONIX Cameras have interchangeable film backs.

MULTIPLE IMAGES—Is it desirable to record more than one crt display on a single photo? The C-12 and C-27 Cameras have rotatable, indexed sliding backs that allow recording multiple images on one photo.

FILMS—Films for crt trace recording come in sheet, pack, and roll form. They vary in size, speed, contrast, spectral response, resolution, and cost. Some provide a positive print, and some provide a negative; two types of Polaroid film provide both. Will the film backs available for the camera accommodate the type film you want to use?

FILM FOGGING—Will it be needed as a technique to increase writing speed? The Writing Speed Enhancer is an optional accessory that provides controlled film fogging, and is available for eight TEKTRONIX Cameras. See page 246 for details.

VIEWING—Is it important to be able to view the display while photographing it? Most TEKTRONIX Cameras allow this, but some compact cameras don't have a viewing port.

SHUTTER TRIGGERING—Must the shutter be operable by remote electrical control, or is manual operation of a mechanical shutter adequate? The all-electric C-50-Series Cameras need only a switch closure to ground for triggering; the optional Electric Shutter system for the C-12, C-27, and C-30-Series Cameras requires an insulated switch closure.

GRATICULE ILLUMINATION—Is it desirable to photograph the crt graticule along with the trace? The graticules of some oscilloscopes and display units are not illuminated. Only the C-5 Camera with its built-in flash lamps can back-light and photograph the graticule of an oscilloscope that does not have graticule illumination.

CAMERA POWER—Four of the C-50-Series Cameras are electrically operated from +15 volts. Can your oscilloscope provide power, or will a Battery Pack be needed?

VIEWING

Except for the C-30 Series, all TEKTRONIX Cameras have a viewing port which provides a binocular view of the crt. All TEKTRONIX Cameras, except the C-5, are hinge mounted and can be swung aside to allow a wide-angle view of the crt. The lightweight C-5 can easily be slipped off the crt bezel to allow a direct view of the crt. The C-27 and C-50-Series Cameras have an off-axis viewing hood that accommodates eyeglasses for a comfortable binocular view of the crt display without interference from ambient light.

By means of mirrors, the C-12 viewing tunnel provides a straight-on view of the crt to minimize parallax errors when photographing an external graticule. The optional Projected Graticule accessory for the C-12 provides parallax-free changeable graticules of any design.

FILMS

Conventional films provide a negative from which unlimited contact prints or enlargement prints can be made. 120, 220, and 70 mm roll films offer high frame capacity with fast manual or automatic advance for photographing a large number of displays in rapid sequence.

Conventional sheet films, and 70 mm and 120-size roll films can be used with Graflok Backs and the proper holder or adapter. A few of the many types of holders for these films are shown on page 243.

Conventional films manufactured by Agfa, Ansco, DuPont, Eastman Kodak, Gevaert, and Ilford are available in several types and forms at ASA speeds from 64 to 1250. A detailed list of film types and their characteristics can be obtained from their respective manufacturers.

The ASA film-speed rating signifies the exposure requirements for general pictorial photography where the light has a very wide color spectrum. Since crt phosphors emit light over a narrow spectrum, the ASA speed cannot be used to accurately predict the exposure requirements for oscilloscope trace photography, especially when recording fast, dim, single-sweep traces. Actual relative speeds of Polaroid films are shown on page 246.

The three types of backs used on TEKTRONIX Cameras accommodate most of the films that are useful for crt trace recording. These include sheet films, roll films, and several Polaroid Land films.

Polaroid films are convenient to use. They offer the advantages of development in seconds to a finished dry print with broad spectral response, good resolution, and high sensitivity.

POLAROID LAND BLACK & WHITE FILMS

Film Type	ASA Equivalent Speed	Format	Actual Image Area	Characteristics	Resolution	Crt Recording Applications
PACK FILMS— 3¼ x 4¼ in.						
105	75	Positive Print. 8-Exp. Pack	7.3 x 9.5 cm/2⅞ x 3¾ inches	Medium Contrast with wide grey scale.	Print: 20-25 line-pairs/mm; Negative: 150 line-pairs/mm	Stable Patterns and tv-type displays
107	3,000	Positive Print. 8-Exp. Pack	7.3 x 9.5 cm/2⅞ x 3¾ inches	Medium Contrast	22-28 line-pairs/mm	Stable Patterns and tv-type displays
ROLL FILMS— 3¼ x 4¼ in.						
42	200	Positive Print. 8-Exp. Roll	7.3 x 9.5 cm/2⅞ x 3¾ inches	Wide Grey Scale	22-28 line-pairs/mm	Stable Patterns and tv-type displays
47	3,000	Positive Print. 8-Exp. Roll	7.3 x 9.5 cm/2⅞ x 3¾ inches	Medium Contrast	22-28 line-pairs/mm	Stable Patterns and single-sweep wave-forms
410	10,000	Positive Trans-parency 8-Exp. Roll	7.3 x 9.5 cm/2⅞ x 3¾ inches	High Contrast	22-28 line-pairs/mm	Very-fast single-sweep wave-forms
46-L	800	Positive Trans-parency 8-Exp. Roll	6.2 x 8.3 cm/2-7/16 x 3¼ inches	Medium Contrast	32-35 line-pairs/mm	Stable Patterns and tv-type displays
SHEET FILMS— 4 x 5 in.						
52	400	Positive Print. Single Packet	8.9 x 11.4 cm/3½ x 4½ inches	Wide Grey Scale	22-28 line-pairs/mm	Stable Patterns and tv-type displays
55 P/N	50	Positive Print and Negative Single Packet	8.9 x 11.4 cm/3½ x 4½ inches	Wide Grey Scale	Print: 14-17 line-pairs/mm; Neg: 150-165 line pairs/mm	Stable Patterns and tv-type displays
57	3,000	Positive Print. Single Packet	8.9 x 11.4 cm/3½ x 4½ inches	Medium Contrast	22-28 line-pairs/mm	Stable Patterns and fast-single-sweep waveforms

LENSES

The following table lists the approximate relative light-gathering power of most TEKTRONIX camera lenses.

Camera	Lens	Magnification	Relative Lens Speed
C-5	f/16	0.68	0.02
C-12†	f/1.9	0.85	0.65
	f/1.4	1.0	0.9
	f/1.3	0.5	1.7
C-27	f/1.9	0.85	1.0
	f/1.4	1.0	1.4
	f/1.3	0.5	2.6
C-30A	f/1.9	0.7	1.0
C-30A Opt 1	f/1.9	0.8	0.9
C-31	f/1.2	0.5	2.9
C-31 Opt 1	f/1.2	0.5	2.9
C-32	f/1.5	1.0	1.4
C-50	f/1.9	0.7	1.2
C-51	f/1.2	0.5	3.0
C-52	f/1.4	1.0	1.4
C-53	f/1.9	0.85	1.0
C-58	f/2.8	1.0	0.4
C-59	f/2.8	0.67	0.65

†The C-12 beam-splitter mirror transmits 65% of the CRT light to the lens, and reflects 35% through the viewing tunnel.

TEKTRONIX camera lenses differ mainly in speed, magnification, and field of view.

SPEED—The f-number of a lens inversely signifies its aperture area and speed. For example, the aperture area of an f/1.4 lens is four times that of an f/2.8 lens of the same magnification and gathers four times more light. For recording a stored or stable recurrent crt display, a lens as slow as the f/16 type in the C-5 Camera is adequate. On the other hand, to record a fast, dim, single-sweep trace, you may need a lens as fast as the f/1.2 types in the C-31 and C-51 Cameras.

FIELD OF VIEW—The description for each TEKTRONIX camera includes a statement of its field of view; this signifies how large a crt display the camera can fully record. It is determined by the combined effects of the magnification and angular field of view of the lens, any field-limiting apertures in the camera adapter, camera body, film holder, and the image area of the film.

MAGNIFICATION—Modern optical technology has made possible wide-aperture, wide-angle, flat-field lenses with short focal length for more compact cameras. To realize their inherent low distortion, high resolution, and uniform focus, these fixed focal length lenses must be used at their design center magnification.

Operating such lenses at a different magnification tends to compromise their important performance characteristics. For this reason, most TEKTRONIX cameras are designed for use at one lens magnification. Even the four interchangeable lenses for the C-12 and C-27 Cameras have fixed magnification. One exception is the C-30A Camera which has a magnification range of 0.7 to 1.5 to accommodate several portable oscilloscopes that have displays ranging in size from 3.8 x 6.3 cm to 8 x 10 cm. The rated magnification of a lens signifies its image-to-object ratio.

$$M = \frac{\text{Image}}{\text{Object}} \text{ or Image} = M \times \text{Object.}$$

For maximum resolution, the lens should produce the largest complete image possible within the image area of the film. The film most widely used for oscilloscope trace recording is Polaroid Type 107 Pack Film which has an image area of 73 x 95 mm.

In most cases, the magnification is selected to provide the largest possible complete image of a particular display. In the case of some 0.5 magnification lenses, it is to achieve high writing speed by concentrating the trace light in a smaller area on the film.

PHOTOGRAPHIC WRITING SPEED

Photographic writing speed signifies the ability of a particular oscilloscope/camera system to provide a useful photographic record of a fast single-sweep trace. It is stated as an oscilloscope performance characteristic and is expressed in cm/μs or cm/ns. It is designed to answer the question, "What is the speed of the fastest single-sweep trace the system can record?" All statements of writing speed must specify the measurement conditions, including the crt phosphor and film used, and the definition of a readable trace image.

The method used for measuring and stating the photographic writing speed of TEKTRONIX oscilloscope/camera systems is described in an Application Note: "Photographic Writing Speed" which is available from your Tektronix Field Office or Representative.

Relative light-gathering power of TEK lenses is listed on the preceding page. Actual relative speeds of Polaroid Films are shown in a table on page 246.

CAMERA SUMMARY

As shown in the chart below, each TEKTRONIX Camera is offered for use primarily with a particular series of oscilloscopes or display units for optimum system performance at a commensurate price.

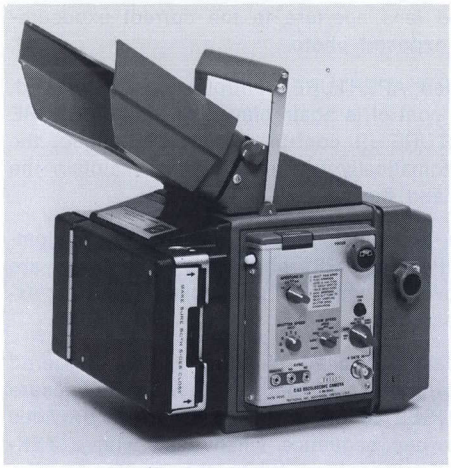
Most TEKTRONIX Cameras can also be used effectively with many instruments other than those they were primarily designed for. The Oscilloscope/Camera/Adapter Guide on page 247 shows the many additional combinations possible.

CAMERA	PAGE	PRIMARY USE	PERFORMANCE FEATURES AND BENEFITS	LENS				SHUTTER	FILM BACKS		PRICE with back ordinarily used
				MAXIMUM RELATIVE APERTURE	MAG	RELATIVE SPEED*	FIELD OF VIEW (with 3¼ x 4¼-inch Polaroid Film except where noted)		ORDINARILY USED	OPTIONAL AND INTERCHANGEABLE	
C-5	239	5100-Series Oscilloscopes and TELEQUIPMENT D-83	Low price; easy to use	f/16	0.68	0.02	10.2 x 12.7 cm/ 4 x 5 inches	MECHANICAL	Polaroid Pack	None	$195
C-12	240	Small monitors and large lab scopes with crt's up to 8 x 10 cm.	Straight-on binocular viewing. Optional Projected Graticule. Movable film backs. Four changeable lenses.	f/1.9 (standard lens)	0.85	0.65†	8 x 10 cm/ 3.15 x 3.93 inches	MECHANICAL (Standard)	Polaroid Pack	Polaroid Roll Film and 4 x 5-inch Graflok	$620
C-27	240	Small monitors and large lab scopes with crt's up to 10 x 10 cm.	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 inches (with Polaroid 4 x 5-inch film)				$610
C-30A	244	400-SERIES PORTABLE OSCILLOSCOPES	General-purpose with variable mag lens.	f/1.9	0.7 to 1.5	1.0[5]	8 x 10 cm/ 3.15 x 3.93 inches at 0.85 MAG setting[3]	ELECTRIC (Optional)	Polaroid Pack	Polaroid Roll and 2¼ x 3¼-inch Graflok	$560
C-30A Opt 1	244		General Purpose; Full Coverage of 8 x 10-cm crt display.	f/1.9	0.8	0.9	8 x 10 cm (no vignetting)		Polaroid Pack		$570
C-31	244		Fast writing speed with 0.5 mag lens.	f/1.2	0.5	2.9	8 x 9 cm/ 3.15 x 3.5 inches		Polaroid Roll	Polaroid Pack and 2¼ x 3¼-inch Graflok	$695
C-31 Opt. 1	244		Fast writing speed with 0.5 mag lens. Full coverage of 8 x 10-cm crt display.	f/1.2	0.44	2.9	8 x 10 cm/ 3.15 x 3.93 inches (no vignetting)		Polaroid Roll	Polaroid Pack and 2¼ x 3¼-inch Graflok	$705
C-32	244		Full-size image with medium writing speed.	f/1.4	1.0	1.4	7 x 9 cm/ 2.75 x 3.5 inches at 1.0 MAG setting		Polaroid Pack	Polaroid Roll and 2¼ x 3¼-inch Graflok	$750
C-50	233	5403/D40 OSCILLOSCOPE	General-purpose with 0.7 mag lens. Medium writing speed.	f/1.9	0.7	1.2	10.2 x 12.7 cm/ 4 x 5 inches[4]	ELECTRIC	Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$825
C-51	233	7000-SERIES OSCILLOSCOPES with 8 x 10 crt's	Fastest writing speed with 0.5 mag lens.	f/1.2	0.5	3.0	8 x 10 cm/ 3.15 x 3.93 inches		Polaroid Roll	Polaroid Pack and 4 x 5-inch Graflok	$1140
C-52	233		Full-size image with medium writing speed.	f/1.4	1.0	1.4	8 x 10 cm/ 3.15 x 3.93 inches (with Polaroid 4 x 5-inch film)		4 x 5-inch Graflok	Polaroid Pack and Roll Film	$1110
C-53	233		General-purpose with 0.85 mag lens.	f/1.9	0.85	1.0	8 x 10 cm/ 3.15 x 3.93 inches		Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$835
C-58	233		Full-size image of largest field at lowest price.	f/2.8	1.0	0.4	8.9 x 11.4 cm/ 3½ x 4½ inches (with Polaroid 4 x 5-inch film		4 x 5-inch Graflok	Polaroid Pack and Roll Film	$605
C-59	233	5403/D40 and 7000-Series Oscilloscopes with 6½-inch crt's; TELEQUIPMENT D-83	General-purpose at low price.	f/2.8	0.67	0.65	10.2 x 12.7 cm/ 4 x 5 inches	MECHANICAL	Polaroid Pack	Polaroid Roll and 4 x 5-inch Graflok	$475

[3] Possible corner vignetting with some instruments
[4] Slight corner vignetting
[5] At 0.7 MAG setting
* Relative light gathering power
† Beam-splitter mirror transmits 65% of crt light to the lens and 35% to the viewing tunnel

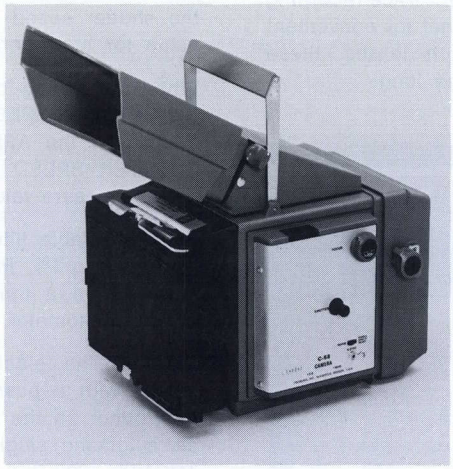
COMMON C-50 SERIES FEATURES

Compact Lightweight **Interchangeable Film Backs** **Lift-Off Mounting** **Swing Away Hinging**



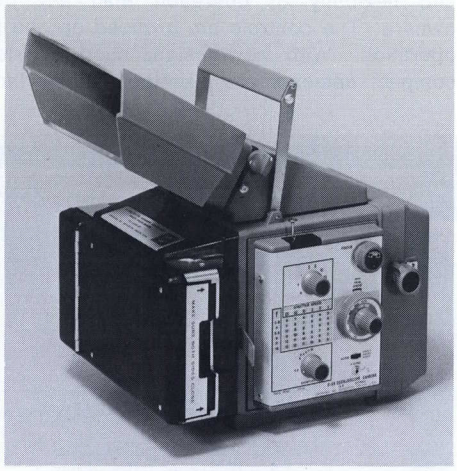
C-50, C-51, C-52, and C-53

Electronic-Controlled Shutter
Photometer Exposure Aid
Range-Finder Focusing
Automatic Single-Sweep Control



C-58

Low Cost
Unity-Magnification Lens
Wide Field Of View With No Vignetting



C-59

Low Cost
Photometer Exposure Aid
Range-Finder Focusing
Internal Battery Power

Three distinct versions comprise the C-50-Series Cameras: (1) The C-50, C-51, C-52, and C-53, all with photometer exposure aid and electronic-controlled shutter; (2) the low-cost C-59 with photometer exposure aid and mechanical shutter; and (3) the C-58 with mechanical shutter and wide-angle unity-magnification lens.

The six C-50-Series Cameras are designed for use with all TEKTRONIX 7000-Series Oscilloscopes. They can also be adapted to most TEKTRONIX 5000-Series Oscilloscopes and 600-Series Display Units. Please refer to the Oscilloscope/Camera/Adapter Guide, page 247.

All the C-50-Series Cameras can be ordered with a Polaroid Pack-Film or Roll-Film Back, or Graflok 4 x 5-inch Back. All three backs can easily be removed and interchanged without fogging the film, and without need to refocus the camera.

See next five pages for details and waveform photographs.

See page 238 for Accessories and Ordering information.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-50	C-51	C-52	C-53	C-58	C-59
PERFORMANCE FEATURES AND BENEFITS	General purpose for crt's up to 6½ inches; Medium writing speed, electric shutter	Fastest writing speed 0.5 mag lens; electric shutter	Full-size image; Medium writing speed; electric shutter	General purpose for 7000-Series with 8 x 10-cm crt's**, electric shutter; medium writing speed	Full-size image of largest field at lowest price. Slow writing speed	General purpose at lowest price. For crt's up to 6½ inches; slow writing speed
LENS	f/1.9	f/1.2	f/1.4	f/1.9	f/2.8	f/2.8
MAGNIFICATION	0.7	0.5	1.0	0.85	1.0	0.67
RELATIVE LENS SPEED*	1.2	3.0	1.4	1.0	0.4	0.65
FIELD OF VIEW	10.2 x 12.7 cm with 3¼ x 4¼-inch film	8 x 10 cm with 3¼ x 4¼-inch film	8 x10 cm with Polaroid 4 x 5-inch film	8 x 10 cm with 3¼ x 4¼-inch film	8.9 x 11.4 cm with Polaroid 4 x 5-inch film	10.2 x 12.7 cm with 3¼ x 4¼-inch film
SHUTTER	Electrically actuated, 4 to 1/60 second, plus Bulb and Time				Mechanically actuated 1 to 1/100 sec, Bulb and Time	Mechanically actuated 1 to 1/50 sec, Bulb and Time
FILM BACKS	These cameras may be ordered with a Polaroid Pack Back which accepts 3,000-speed film, a Polaroid Roll Back which accepts 3,000- and 10,000-speed film, or a 4 x 5-inch Graflok Back which accepts a Polaroid 4 x 5-inch Film Holder and 4 x 5-inch sheet-film holder. See ORDERING INFORMATION and ACCESSORIES, page 238.					
PRICE (With Film Back Ordinarily Used)	$825 (Pack Back)	$1140 (Roll Back)	$1110 (Graflok Back)	$835 (Pack Back)	$605 (Graflok Back)	$475 (Pack Back)

DIMENSIONS AND WEIGHTS WITH FILM BACK ORDINARILY USED

	C-50-P		C-51-R		C-52-G		C-53-P		C-58-G		C-59-P	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
Height	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2
Width	7.5	19.1	9.8	24.8	7.5	19.1	7.5	19.1	7.7	19.3	7.7	19.3
Length	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3	10.8	27.3
Weight (Approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	7.5	3.4	9.5	4.3	8.0	3.6	7.5	3.4	6.0	2.7	7.0	3.2
Shipping	12.0	5.4	15.0	6.8	12.0	5.4	12.0	5.4	10.0	4.5	11.0	5.0

*Relative light-gathering power. (See Camera information for comparison of all TEKTRONIX Cameras.)
**The C-53 lens records the largest practical image of an 8 x 10-cm crt display on Polaroid 3¼ x 4¼-inch film.

C-50, C-51, C-52, and C-53 CAMERAS

These electrically-powered cameras offer more convenience and flexibility of operation than any other trace-recording camera. The controls are grouped on one panel for convenient operation. With new-design, short-focal-length lenses, these compact cameras are less than eleven inches long.

COMMON FEATURES

Mode Switch—Turns on camera power and selects four modes of operation: Normal, Time, Bulb, and Single Sweep.

Focus—When the spring-loaded FOCUS control knob is pushed in, two vertical bars of light are projected onto the crt screen. By turning the FOCUS control, the camera body can be moved in and out until the light bars coincide, which indicates that the camera is focused on the crt screen. When the FOCUS control is released, the lamps extinguish and the camera is locked in focus.

Photometer Exposure Aid—The photometer exposure aid operates similarly to exposure-value meters in conventional cameras. Mechanical analogues of film speed, phosphor type, shutter speed, and crt-trace brightness are set by panel controls into a gear train which properly relates these factors. The operator can quickly and easily set the shutter controls for the exposure value that will provide properly exposed photos of recurrent crt displays over a wide range of trace brightness.

In procedure, the FILM SPEED knob is first set to match the ASA index of the film being used. Normally, the SHUTTER-SPEED selector is slaved to the APERTURE (f) control. Depressing the APERTURE control disengages it from the shutter, and it can be turned without affecting the shutter speed. Depressing the APERTURE control knob also turns on the photometer light, which appears in the viewing tunnel as a small spot of light on the crt screen. By turning the APERTURE control, the brightness of the photometer spot can be adjusted to match the brightness of the crt trace. This sets the shutter speed and lens aperture to the correct exposure-value for a properly exposed photo.

When the spring-loaded APERTURE control knob is released, the SHUTTER SPEED control is again slaved to the APERTURE control. If the APERTURE (f) control setting is changed, the SHUTTER SPEED automatically tracks with it to maintain the same exposure value and the same film exposure.

Four selectable filters allow matching the color of the photometer spot to P1, P2, P11, and P31 phosphors. The filters are mounted on a thumbwheel which is interlocked with the exposure-photometer gear train.

Shutter—The electrically-controlled shutter can be triggered locally with a push button, or remotely with a switch closure to ground. In the SINGLE SWEEP mode, the camera provides an automatic single-sweep sequence when used with a TEKTRONIX 7000-Series Oscilloscope. When the shutter is triggered open, the camera arms the oscilloscope sweep. The shutter stays open until the sweep occurs, then closes five seconds after the sweep ends.

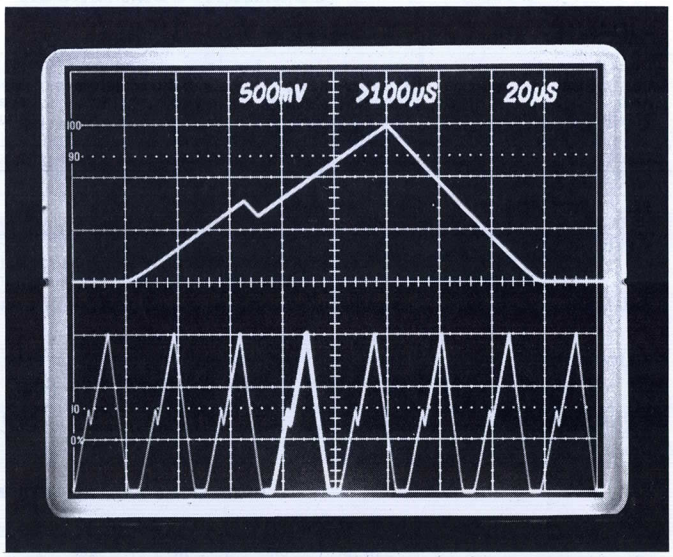
Camera Power and Sweep Reset—A 3-pin connector on the bezel of the TEKTRONIX 7000-Series Oscilloscopes provides +15 V power to the camera, and a sweep-reset signal (in single-sweep mode only) back to the oscilloscope. An optional Battery Pack allows use of these cameras with other oscilloscopes.

See page 238 for ordering information and accessories.

C-50, C-51, C-52, and C-53 LENS SYSTEMS

The following four photos show each camera's field of view and lens magnification.

C-50 GENERAL-PURPOSE CAMERA



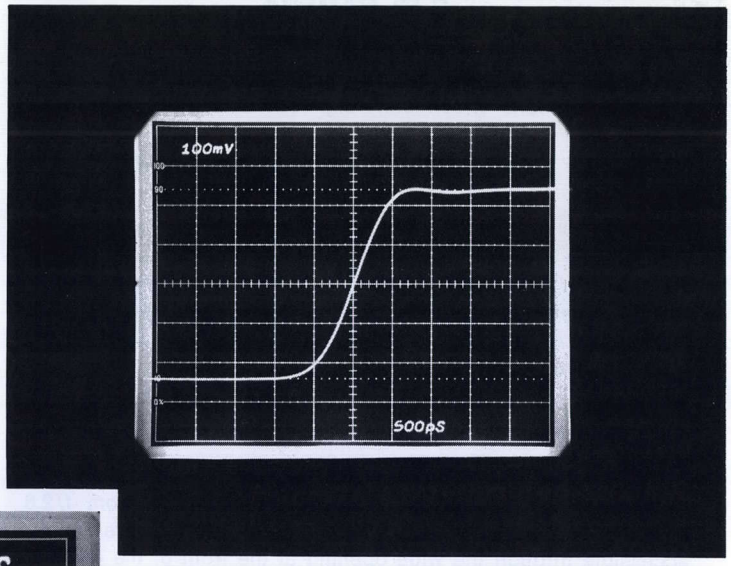
(Actual image area of Polaroid Type 107 Film)

(Photo: 7704A with 8 x 10-cm crt)

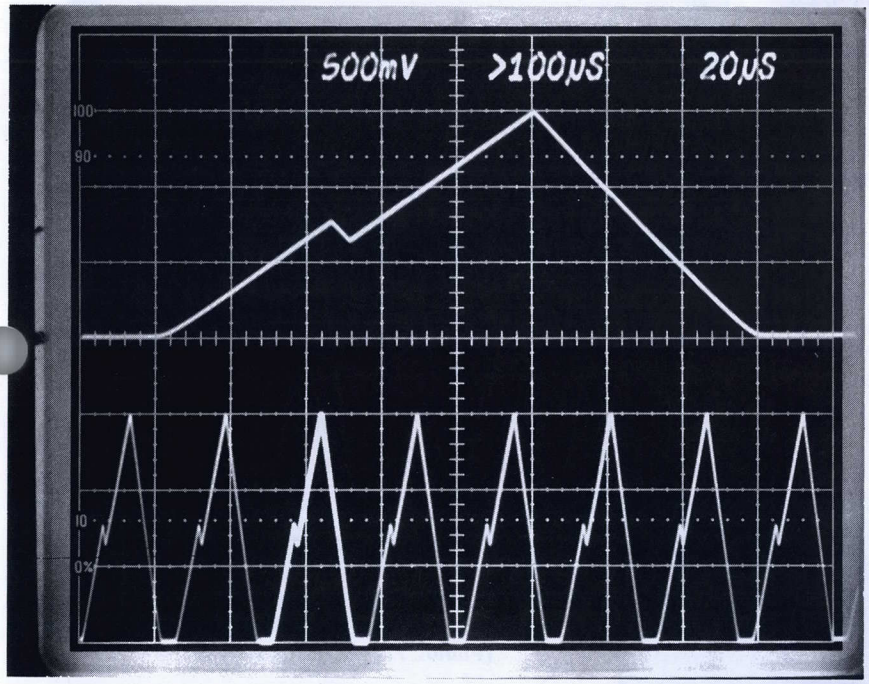
The C-50 can also record the 9.76 x 12.2-cm crt display of the 5403, 5441, 7403 and 7603 on Polaroid 3¼ x ¼-inch film. The C-50 Camera's f/1.9, 0.7 lens has a relative light-gathering power of 1.2.

C-51 CAMERA
MAXIMUM WRITING SPEED
(Photo: 7904 with 8 x 10-cm crt)

The C-51 Camera provides the fastest writing speed of all the C-50-Series Cameras, and is recommended for use with all TEKTRONIX 7000-Series Oscilloscopes where maximum single-sweep writing speed is desired. Its f/1.2, 0.5 magnification lens has a light-gathering power of 3.0.



(Actual image area of Polaroid Type 107 Pack Film)



(Actual image area of Polaroid Type 57 4 x 5-inch Film)

C-52 CAMERA
FULL-SIZE IMAGE
MEDIUM WRITING SPEED
(Photo: 7704A with 8 x 10-cm crt)

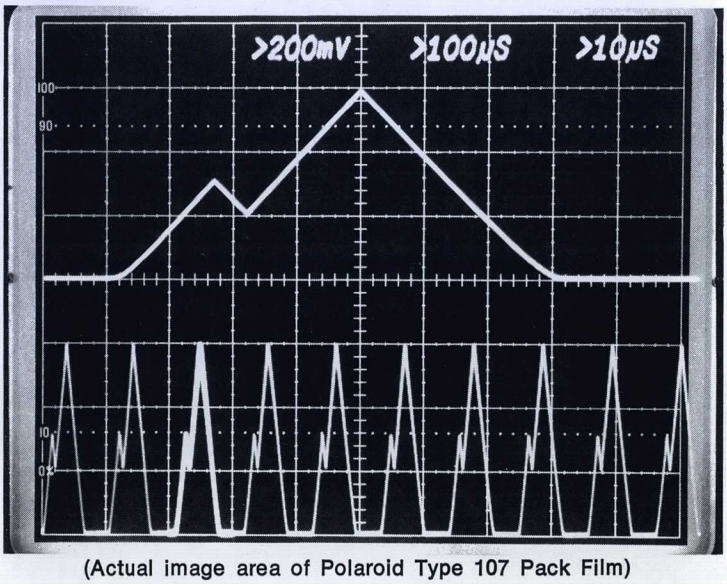
The C-52 Camera, using a Graflok Back, provides a full-size image with sufficient writing speed for most medium-speed single-sweep applications. Its f/1.4, unity-magnification lens has a light-gathering power of 1.4.

Polaroid Pack Film and Roll Film Backs can be used with the C-52 but the 3¼ x 4¼-inch films used with these backs limit the camera's field of view to their actual image area, which is 7.3 x 9.5 cm.

C-53 CAMERA
GENERAL PURPOSE
(Photo: 7704A with 8 x 10-cm crt)

The C-53 f/1.9 lens, which has a relative light-gathering power of 1.0, provides adequate writing speed for most general-purpose applications. The 0.85-magnification lens provides the largest practical image of an 8 x 10-cm crt display that will fall within the 7.3 x 9.5-cm image area of Polaroid 3¼ x 4¼-inch film.

The C-58 and C-59 Cameras are described on the next two pages.



(Actual image area of Polaroid Type 107 Pack Film)

C-58 CAMERA
FULL-SIZE IMAGE

The C-58 Camera features an extra-wide-angle f/2.8 unity-magnification lens which can fully record all the image area of 4 x 5-inch film with no vignetting. Its simplified design with mechanically actuated shutter provides easy operation and low cost.

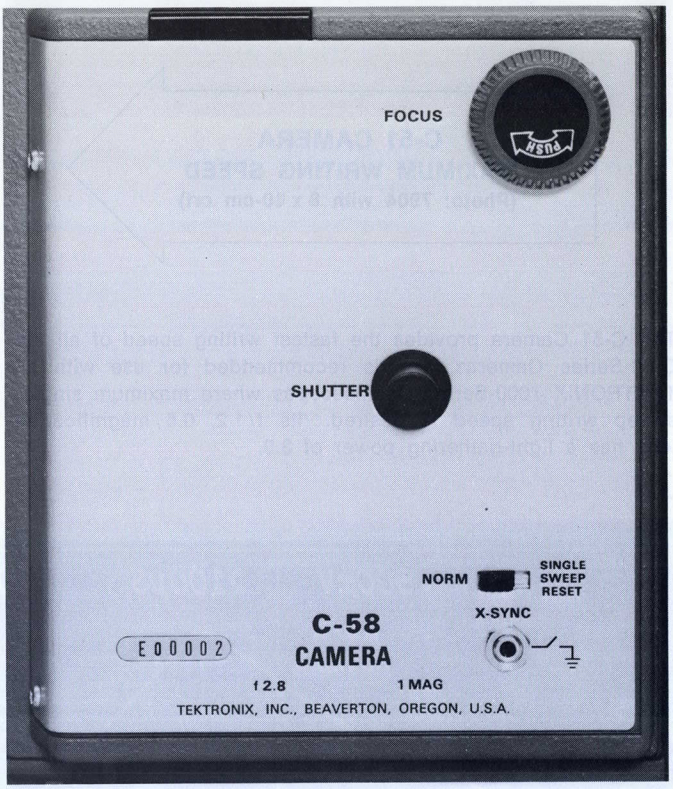
The C-58 is an ideal camera for general-purpose oscilloscope photography where full-size photos are desired but without the need for fast writing speed. It is also well suited for providing vignette-free photos of brightness-modulated crt displays such as those of scanning electron microscopes, ultrasonic scanners, and IR thermogram instruments.

Shutter—The mechanical shutter is actuated by a plunger on the control panel. It has six selectable speeds from 1 to 1/50 second, with Time and Bulb modes.

Aperture—The aperture is continuously adjustable from f/2.8 to f/16. The aperture and shutter speed controls are readily accessible through the wide opening at the front of the camera.

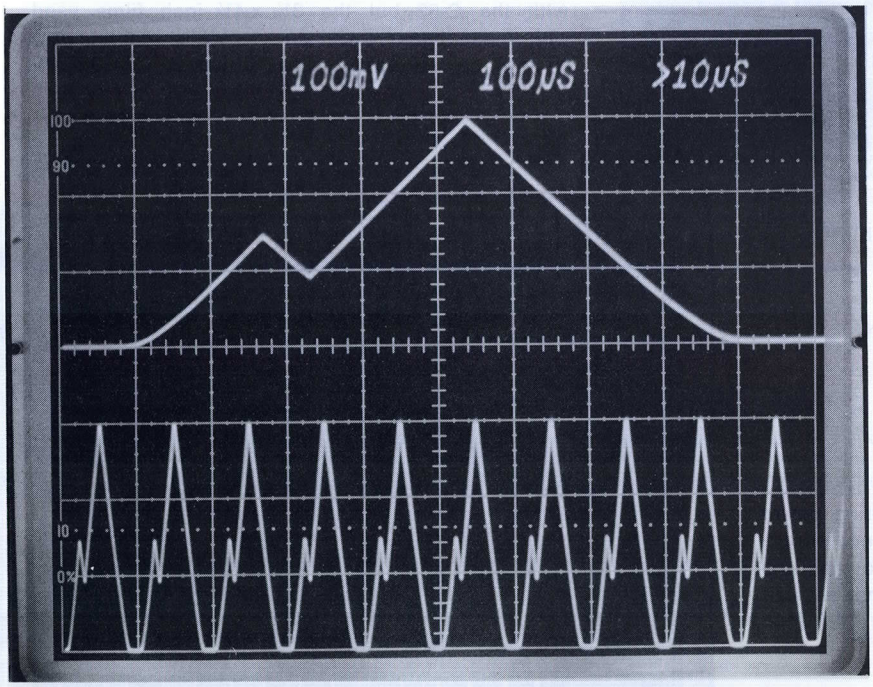
Focus Control—The spring-loaded knob is pushed in and turned to focus the camera while observing the crt display on the Graflok Back focusing screen, or a focus plate if a Polaroid Film Back is used. When the knob is released, the camera is locked in focus.

X-Sync Switch—A normally-open switch in the shutter closes when the shutter is operated fully open. One contact of this switch is grounded, and the other is connected to the X-SYNC switch on the control panel. When this panel switch is in NORM position, connection can be made to the mini-phone jack (just below the switch) for controlling test circuitry in conjunction with the camera shutter operation.



When the X-SYNC switch is in the SINGLE-SWEEP-RESET position, the shutter switch is connected via an adapter/bezel connector to the sweep-reset line of a 7000-Series Oscilloscope. When the camera shutter opens, the shutter switch arms the oscilloscope sweep when it is in Single-Sweep Mode.

See page 238 for ordering information and accessories.



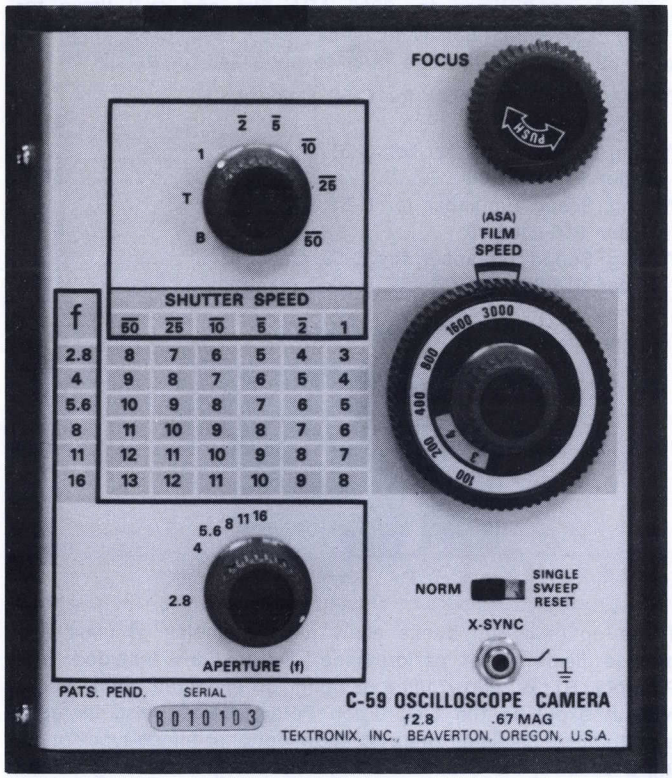
(Actual image area of Polaroid Type 57 4 x 5-inch Film)

C-58 CAMERA
FULL-SIZE IMAGE
(Photo: 7704A with 8 x 10-cm crt)

The C-58 Camera, using a 4 x 5-inch Graflok Back provides a full-size image without vignetting on 4 x 5-inch film. Its f/2.8, unity-magnification lens has a relative light-gathering power of 0.4. Polaroid Pack Film and Roll Film Backs can also be used with the C-58. However, the 3¼ x 4¼-inch films for these backs limit the camera's field-of-view to their actual image area which is 7.3 x 9.5 cm.

C-59 CAMERA
LOW COST — GENERAL PURPOSE

The C-59 is a general-purpose camera with an f/2.8-0.67 magnification lens which is suitable for most trace-recording needs. It is designed primarily for use with TEKTRONIX 7000-Series Oscilloscopes that have 6½-inch crt's, but also fits directly onto all other 7000-Series Oscilloscopes with its standard adapter. The C-59 can also be used with any other oscilloscope that accommodates a TEKTRONIX C-27 Adapter; see Oscilloscope/Camera/Adapter Guide page 247 for oscilloscope compatibility.



FEATURES

Focus—When the spring-loaded FOCUS control knob is pushed in, two vertical bars of light are projected onto the crt screen. By turning the FOCUS control, the camera body can be moved in and out until the light bars coincide, which indicates that the camera is focused on the crt screen. When the FOCUS control is released, the lamps extinguish and the camera is locked in focus.

Photometer Exposure Aid—The FILM SPEED control is set to match the ASA index of the film being used. Depressing the PHOTOMETER switch 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.

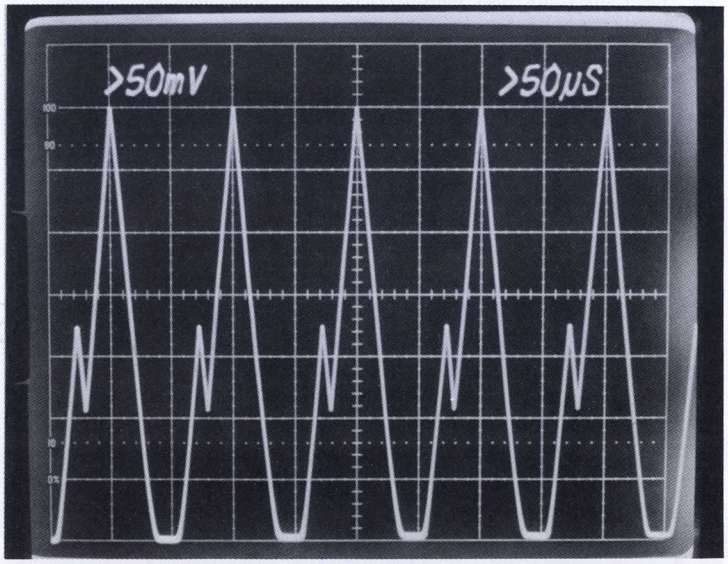
An absorption filter over the photometer lamp provides an approximate color match of the photometer light spot to P31 phosphor.

X-Sync Switch—A normally-open switch in the shutter closes when the shutter is operated fully open. One contact of this switch is grounded, and the other is connected to the X-SYNC slide switch on the control panel. When this panel switch is in NORM position, connection can be made to the mini-phone jack (just below the switch) for controlling test circuitry in conjunction with the camera shutter operation. When this switch is in the SINGLE-SWEEP RESET position, the shutter switch is connected internally to the single-sweep reset line in the oscilloscope (7000-Series only).

Camera Power and Sweep Reset Connector—A three-pin connector on the crt bezel of TEKTRONIX 7000-Series Oscilloscopes mates with a similar connector on the standard C-59 Adapter to provide +15 V power and ground connection to the camera. The third pin connects the camera shutter X-Sync SWITCH to the single-sweep-reset line in the oscilloscope. Internal batteries supply power for the photometer and focus lamps when the C-59 is used with an oscilloscope other than a 7000 Series. Whenever the C-59 is attached to a 7000-Series Oscilloscope, the camera automatically disconnects its internal batteries and selects +15 V power from the oscilloscope.

See page 238 for ordering information and accessories.

(Photo: 7603 with 6½-inch crt)



(Actual image area of Polaroid Type 107 3¼ x 4¼-inch Film)

The C-59 Camera can record the entire display of 6½-inch crt's on Polaroid 3¼ x 4¼-inch film. Its f/2.8, 0.67 magnification lens has a light-gathering power of 0.65.

ORDERING INFORMATION

All C-50-Series Cameras include a mounting adapter 016-0249-03 for TEKTRONIX 7000-Series Oscilloscopes. See Oscilloscope/Camera/Adapter Guide page 247 for camera/oscilloscope compatibility and other mounting adapters.

C-50

C-50-P CAMERA, Pack-Film Back **$825**
C-50-R CAMERA, Roll-Film Back **$860**
C-50-G CAMERA, 4 x 5 Graflok Back **$795**

C-51

C-51-P CAMERA, Pack-Film Back **$1105**
C-51-R CAMERA, Roll-Film Back **$1140**
C-51-G CAMERA, 4 x 5 Graflok Back **$1075**

C-52

C-52-P CAMERA, Pack-Film Back **$1140**
C-52-R CAMERA, Roll-Film Back **$1175**
C-52-G CAMERA, 4 x 5 Graflok Back **$1110**

C-53

C-53-P CAMERA, Pack-Film Back **$835**
C-53-R CAMERA, Roll-Film Back **$870**
C-53-G CAMERA, 4 x 5 Graflok Back **$805**

C-58

C-58-P CAMERA, Pack-Film Back **$635**
C-58-R CAMERA, Roll-Film Back **$670**
C-58-G CAMERA, 4 x 5 Graflok Back **$605**

C-59

C-59-P CAMERA, Pack-Film Back **$475**
C-59-R CAMMERA, Roll-Film Back **$510**
C-59-G CAMERA, 4 x 5 Graflok Back **$445**

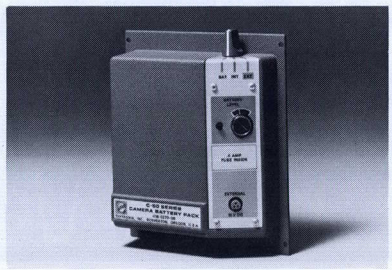
Eight AA alkaline cells are included with each C-59 Camera.

Included Accessories—For all camera modules: Focus plate for Polaroid Pack-Film Back (387-0893-02); focus plate for Polaroid Roll-Film Back (387-0893-01); (Graflok Back has an integral focusing screen).

C-50 SERIES OPTIONAL ACCESSORIES

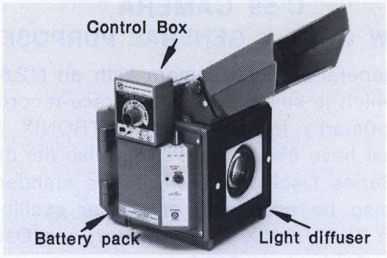
Camera Mounting Adapters—Available for other TEKTRONIX Oscilloscopes and 600-Series Display units. See page 247 for compatibility and adapter part numbers.

BATTERY PACK



Provides an auxiliary +15 V power source for the C-50, C-51, C-52, and C-53 when using them with oscilloscopes that don't provide camera power. A three-position mode switch on the Battery Pack also allows the camera to be powered from a 7000-Series Oscilloscope for an external +15 V source. Net weight of pack, including batteries, is 1.2 pounds.
Order 016-0270-00 ..... **$90**

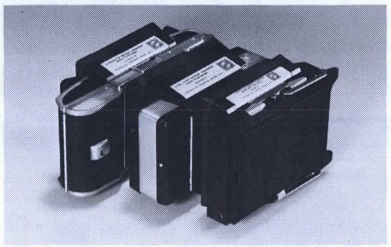
WRITING SPEED ENHANCER



Provides automatic controlled film-fogging to increase writing speed by ≈3 times for 3000 ASA film and ≈2 times for 10,000 ASA film. For C-50, C-51, C-53, and C-59 only; not for C-52 and C-58. Please refer to page 246 for details.

Writing Speed Enhancer for C-50 Camera,
Order 016-0278-00 ..... **$175**
Writing Speed Enhancer for C-51 Camera,
Order 016-0279-00 ..... **$175**
Writing Speed Enhancer for C-53 Camera
Order 016-0300-00 ..... **$175**
Writing Speed Enhancer for C-59 Camera,
Order 016-0290-00 ..... **$175**

FILM BACKS



Three optional film backs allow a wide choice of films and provide flexibility of performance. Dark slides included with Polaroid Backs allow interchanging of all three films backs without exposing the film. Each Polaroid Back also includes a split-image focusing plate to allow optional image-type focusing if desired; the Graflok Back has an integral focusing screen and light shield.

Polaroid Pack Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film. **Order 122-0926-00** **$100**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000- or 10,000-speed roll film. **Order 122-0929-00** **$135**

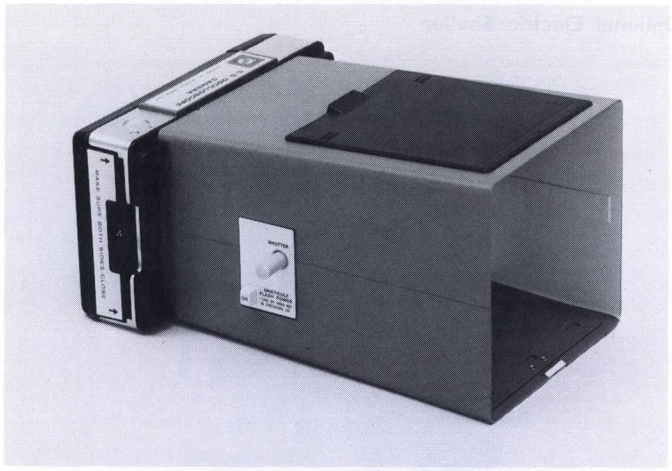
Graflok Back, 4 x 5—Accepts Polaroid Land 4 x 5-inch film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders (see accessory page). **Order 122-0931-01 $70**

ADDITIONAL SPLIT-IMAGE FOCUSING PLATES

For Polaroid Pack Back, **Order 387-0893-02** **$1.25**
For Polaroid Roll Back, **Order 387-0893-01** **$1.25**

CARRYING CASE

Holds a complete C-50-Series Camera with extra film-backs and accessories. **Order 016-0177-00** **$95**



Easy to Use **Lightweight**

Fixed Focus **Low Cost**

Graticule Illumination

The C-5 is a low-cost general-purpose camera with a Polaroid Pack-Film Back and pulsed graticule illumination. It is especially recommended for photographing the 6½-inch crt's of the TEKTRONIX 5100-Series Oscilloscopes, the 604 Display Monitor and the 1420, 1421, 1422 Vectorscopes, all of which have non-illuminated internal graticules. The C-5 attaches directly to these instruments without need for an adapter. It also mounts directly onto all 5400-Series and 7000-Series Oscilloscopes, the 601, 602 and 605 Display Units, the 528 TV Monitor, and the 577 Curve Tracer. No adapters are available for other instrument types.

Graticule illumination is provided by two internal incandescent lamps which are flashed when the shutter opens. The burst of light illuminates the phosphor, causing it to glow and back-light the dark graticule lines. The illumination is easily adjustable.

A hinged door in the top of the camera housing provides a full view of the crt.

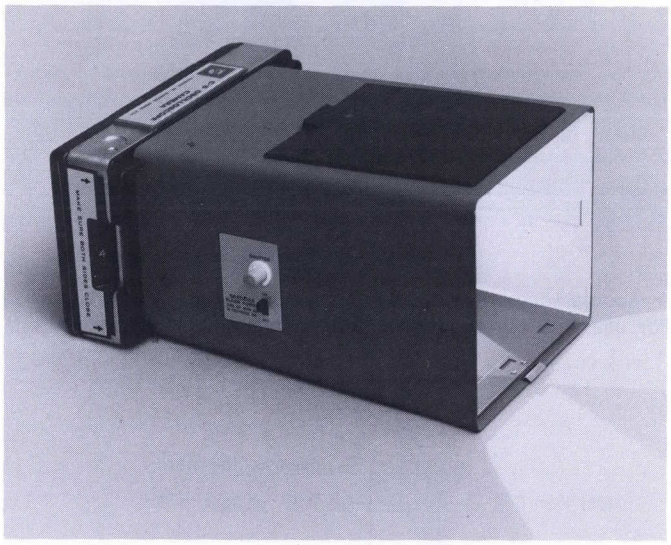
The C-5's f/16 lens is relatively slow and is not recommended for photographing single-sweep waveforms.

The C-5 lens system was designed for use with Polaroid 3,000-speed film. The C-5 will also accept Polaroid Type 105 Positive/Negative Pack Film, but its slow speed of 75 (ASA equivalent) would require use of the shutter in BULB or TIME mode for exposure of several seconds when photographing crt displays of average brightness.

Lens—f/16 (fixed) with a magnification of 0.68. Provides a 2¾ x 2⅜-inch image of 4 x 5-inch crt displays, a 5.3 x 6.6-cm photo image of 8 x 10-cm crt displays; and a 4.9 x 6 cm image of 7.2 x 9 cm displays all on Polaroid Type 107 Pack Film.

Shutter—Mechanically actuated with speeds of 1/5, 1/10, and 1/25 second plus BULB and TIME.

Focus—Fixed. The lens has an extremely wide depth-of-field so adjustable focus is not needed.



Graticule Illumination—Provided by two internal incandescent lamps with variable intensity control. External GRATICULE FLASH POWER switch: ON and OFF.

Power Required—Two standard NEDA 1604 nine-volt transistor batteries for graticule illumination. Typical life; approximately 1000 flashes or more if GRATICULE FLASH POWER switch is turned off between flashes.

Film Back—Permanently attached Polaroid Pack-Film Back accepts 3000-speed pack film which develops outside the camera in 15 seconds.

DIMENSIONS	inches	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.2	13.3	NET	2.9	1.3
WIDTH	7.5	19.1	SHIPPING	5.0	2.3
LENGTH	10.0	25.4			

Includes—Two 9-V batteries (146-0017-00).

Order C-5 Camera **$195**

C5A
Beginning of
camera section

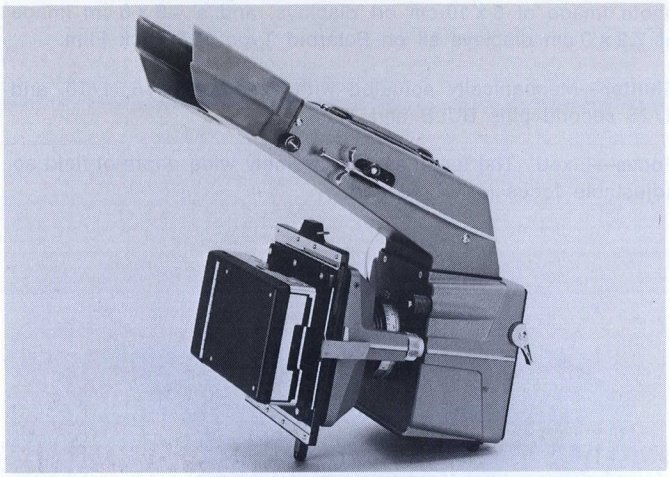
COMMON FEATURES

Lift-off Mounting, Swing-away hinging

Optional Interchangeable Lenses

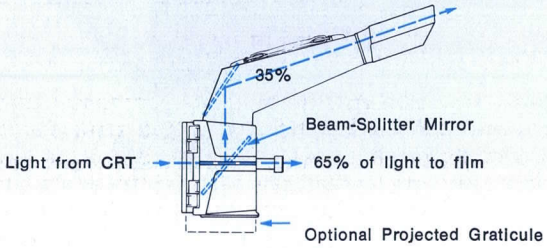
Rotating and Sliding Film Backs

Optional Electric Shutter



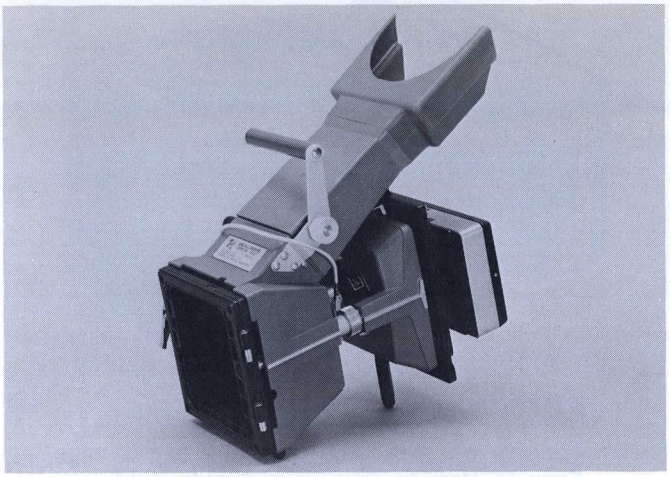
C-12 CAMERA

A modular camera with interchangeable lenses and film backs. For use with lab scopes with crt displays up to 8 x 10 cm.



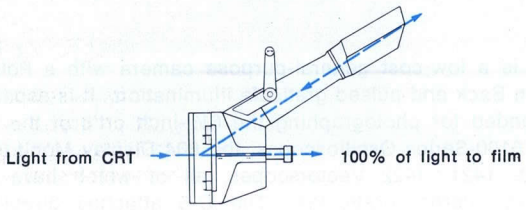
C-12 MAIN FRAME

The C-12 mirror system provides a straight-on view of the crt, and minimizes parallax due to an external graticule. An optional Projected Graticule accessory provides changeable parallax-free graticules of various patterns.



C-27 CAMERA

A modular camera with interchangeable lenses and film backs. For use with large lab scopes with crt displays up to 10 x 10 cm.



C-27 MAIN FRAME

The C-27 provides a direct view of the crt, and maximum light transmittance from crt to film. Removable viewing tunnel and folding carrying handle allow rack-stacking the C-27 on 7-inch vertical centers. The frame can be rotated to place the viewing port at either side, or at the bottom.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-12 $620 (With Pack Back)	C-27 $610 (With Pack Back)
PERFORMANCE FEATURES AND BENEFITS	Straight-on binocular viewing via beam-splitting mirror. Optional Projected Graticule for zero parallax.	Off-axis binocular viewing. No mirrors; max light-transmittance to film. Four viewing-tunnel positions. Removeable viewing tunnel for compact stacking on rack-mounted oscilloscopes.
FIELD OF VIEW	Up to 8 x 10 cm depending on lens magnification and film size.	Up to 10 x 10 cm depending on lens magnification and film size.
STANDARD LENS	f/1.9 0.85 magnification. Three other interchangeable optional lenses are also available (See next two pages.)	
RELATIVE† LENS SPEED	0.65 Light-dividing action of beam-splitter mirror taken into account.	1.0 (Reference)
STANDARD SHUTTER	Mechanically actuated; Speeds: 1 to 1/100 sec., plus Bulb and Time.	
OPTIONAL ELECTRIC SHUTTER	Speeds; 1 to 1/60 sec, plus Bulb and Time. Remote triggering with insulated switch closure. Power requirements: 115/230 V. 50 to 60 Hz.	
OPTIONAL FILM BACKS	Both cameras can be ordered with a Polaroid[1] Pack-Film Back for 3,000-speed film, a Polaroid Roll Back for 3,000 and 10,000-speed film, or a 4 x 5-inch Graflok Back for Polaroid 4 x 5-inch Film Holder, and various sheet-film holders. See ORDERING INFORMATION and ACCESSORIES on next two pages.	

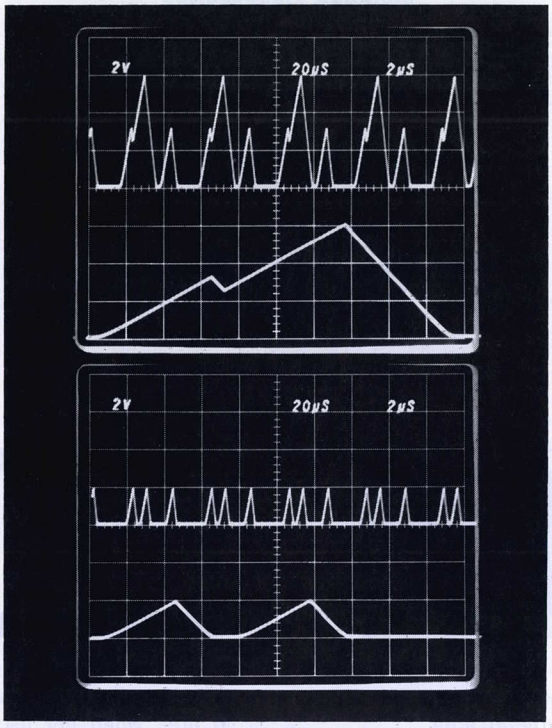
DIMENSIONS	C-12		C-27	
	In	cm	In	cm
Height	15.4	39.1	17.2*	43.6
Width	7.5	19.1	7.5	19.1
Length	17.3	43.9	13.4*	34.1

WEIGHTS	C-12		C-27	
	lb	kg	lb	kg
Net	12.3	5.5	10.5	4.7
Shipping	16.0	7.2	14.0	6.3

*Without viewing tunnel, the C-27 height is 8 inches and length is 12 inches.

†Relative light-gathering power. For relative speed of optional lenses, see CUSTOM CAMERAS on next page. See Camera Reference Information for comparison with other TEKTRONIX Cameras.

FILM ECONOMY



Actual Image Area Of Polaroid 3¼ x 4¼-Inch Film

Photo above is an 8 x 10-cm crt taken with a C-27 with f/1.3-0.5 mag lens.

C-12 or C-27 with 0.5 Mag Lens

The C-12 and C-27 film backs can be oriented vertically or horizontally and through nine detent positions to allow multiple exposure on one photo.

ORDERING INFORMATION

Included Accessories—For C-12 and C-27: cable release (122-0586-02); split-image focus plate for Polaroid Pack-Film Back (387-0893-02); split-image focus plate for Polaroid Roll-Film Back (387-0893-01); (Graflok Back has an integral focusing screen).

All C-12 and C-27 cameras are sold without mounting adapters; see table on adapter pages for oscilloscope compatibility and adapter part numbers.

MECHANICAL SHUTTER CAMERAS

(with f/1.9, 0.85 magnification lens)

C-12

C-12-P Camera, Pack-Film Back **$620**
C-12-R Camera, Roll-Film Back **$645**
C-12-G Camera, 4 x 5 Graflok Back **$595**

C-27

C-27-P Camera, Pack-Film Back **$610**
C-27-R Camera, Roll-Film Back **$635**
C-27-G Graflok Camera, 4 x 5 Graflok Back **$585**

OPTION 9 for C-12 and C-27 Cameras ..... **Add $10**

Replaces mechanical shutter with electric shutter only. The SPEEDCOMPUTER power-supply control box and mounting bracket are not included. Control voltage must be supplied by customer. When ordering, include "OPTION 9" with regular camera order number.

ELECTRICALLY ACTUATED CAMERAS

(with f/1.9, 0.85 magnification lens and electrically controlled shutter)

Includes Electric Shutter and SPEEDCOMPUTER power-supply-control box.

See Specification Chart on preceding page for details.

C-12

C-12-PE Camera, Pack-Film Back **$920**
C-12-RE Camera, Roll-Film Back **$945**
C-12-GE Camera, 4 x 5 Graflok Back **$895**

C-27

C-27-PE Camera, Pack-Film Back **$910**
C-27-RE Camera, Roll-Film Back **$935**
C-27-GE Camera, 4 x 5 Graflok Back **$895**

C-12 and C-27 CUSTOM CAMERA OPTIONS

All versions of the C-12 and C-27 Cameras can be ordered with any of the three optional lenses listed here. When ordering desired lens option, include OPTION NUMBER below with regular camera order number.

LENS TYPE & PURPOSE	RELATIVE SPEED†	OPTION NUMBER	PRICE
FILM ECONOMY—f/1.9, 0.7 magnification. Records two 6 x 10-cm, or three 4 x 10-cm on 3¼ x 4¼-inch film. Also records one 10 x 10-cm display on same size film with C-27 only.	0.78 with C-12 1.2 with C-27	Option 1	**Add $20**
FULL-SIZE IMAGE—f/1.4, 1.0 magnification. Records full-size image of 8 x 10-cm crt display on 4 x 5-inch film with optional Graflok Back.	0.9 with C-12 1.4 with C-27	Option 3	**Add $190**
HIGH WRITING SPEED—f/1.3, 0.5 magnification. Records two 8 x 10-cm crt displays on 3¼ x 4¼-inch film.	1.7 with C-12 2.6 with C-27	Option 4	**Add $180**

†Relative light-gathering power. Light loss through beam-splitting mirror taken into account for C-12. See Camera Reference Information.

CUSTOM C-12 and C-27 CAMERAS

The C-12 and C-27 cameras can be ordered with any of four optional lenses, with any of three types of film backs and with mechanical or electric shutter.

OPTIONAL ACCESSORIES

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes and some non-TEKTRONIX Oscilloscopes. See adapter page for oscilloscope compatibility.

C-12 Projected Graticule—Provides changeable parallax-free graticules with an area for write-in data. For details, see next page.

Writing Speed Enhancer—Provides automatic-controlled film-fogging to increase writing speed ≈3 times for 3000 ASA film and ≈2 times for 10,000 ASA film. The enhancer can be used with any of the interchangeable lenses available for the C-12 and C-27, including the f/1.4—1.0 magnification lens. Refer to page on writing speed enhancer for details and ordering information.

Optional Film Backs—Polaroid Roll-Film and Pack-Film Backs, and 4 x 5 Graflok backs allow a wide choice of films and provide flexibility of performance. All three film backs can be interchanged without fogging the film. Several types of cut-film and roll-film holders are available for use with the Graflok back. See page on accessories for more information.

X-Sync Cable—Coiled cable has standard ASA connector which mates to the flash sync connectors on the C-12 and C-27 camera shutters and SPEEDCOMPUTER. Other end of cable has miniature phone plug. **Order 012-0364-01** **$10**

Carrying Case—Holds one C-12 or C-27 Camera, **Order 016-0208-01** **$115**

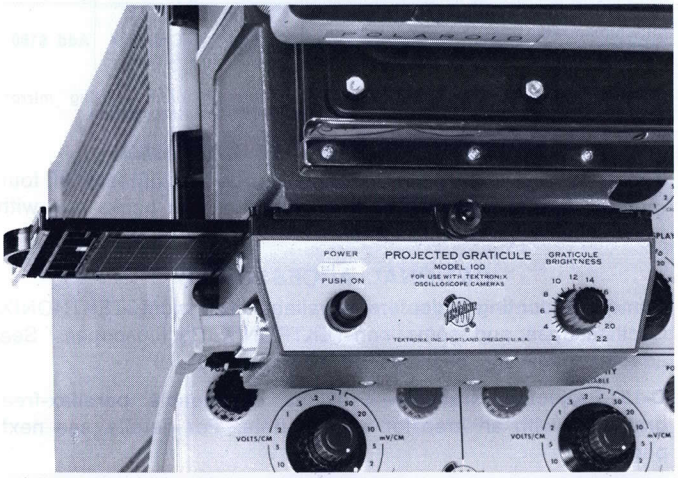
PROJECTED GRATICULE FOR C-12

The Projected Graticule provides changeable parallax-free graticules of any pattern, and a means of recording write-in data on the photograph.

Parallax is the difference between the crt-and-graticule display as seen in the C-12 viewing tunnel, and as seen through the lens when the oscilloscope has an external graticule. It occurs because (1) the external graticule is separated from the crt phosphor plane by the optical thickness of the crt face-plate, and (2) the operator's view of the display through the viewing tunnel is approximately 20 inches away, whereas the lens is much closer to the crt. The difference in the two distances and in the angles-of-view over the display field produces a small amount of parallax between the viewed and photographed images.

The Projected Graticule utilizes the beam-splitter mirror in the C-12 to present a virtual image of a graticule at the object plane of the camera. When the camera is focused on the crt trace, the graticule image lies in the same optical plane as the crt phosphor screen. Accordingly, the camera photographs the graticule and the crt display in exactly the same relationship as observed in the C-12 viewing tunnel.

Special graticules, reference waveforms, or any pattern that can be produced on a film transparency can be imposed on the crt display. The maximum pattern size is 8 x 10 cm.



In use, the Graticule Film transparency is held in a plastic holder which is easily slipped in and out of the Projected Graticule case, making possible rapid changes of graticules.

The Graticule Film holder included with the Projected Graticule has a clear window. Additional film holders are available in three colors so that the graticule image can approximate or contrast the color of the crt display.

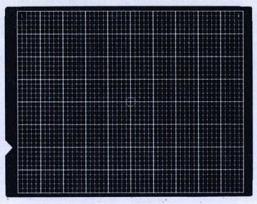
Operates on 90 to 130 V, or 180 to 260 V; 50 to 440 Hz.

Although the Projected Graticule case is small, and extends only 2¼ inches below the camera, it may interfere with some plug-in unit/probe combinations. If in doubt about compatibility, please consult your Tektronix Field Engineer, Representative, or Distributor.

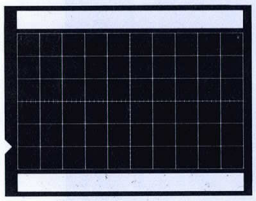
Included Accessories

Power cable (161-0015-01)

One clear-window Graticule Film Holder (122-0659-00), two Graticule Films and one mask film as shown here:



8 x 10-cm Graticule Film with full minor lines



6 x 10-cm Graticule Film with short minor lines and write-in area

6 x 10-cm Graticule-mask Film to black out the write-in area when not used

Projected Graticule for 115 volts.
Order 016-0204-00 ..... **$195**

Projected Graticule for 230 volts.
Order 016-0234-00 ..... **$195**

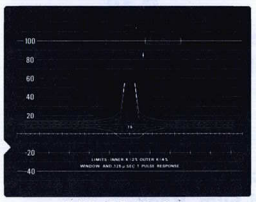
OPTIONAL ACCESSORIES

Additional Graticule Film Holders ..... **$4.50 each**

Clear Window	Green Window
122-0659-00	122-0668-00
Blue Window	Amber Window
122-0667-00	122-0669-00

Additional Graticule Films and Mask Films ..... **$1.70 each**

Shown below is one of seventeen additional Graticule Films and Mask Films that are also available. Please consult your Tektronix Field Office, Representative, or Distributor for information on film patterns available.



331-0161-04

MECHANICAL SHUTTER/LENS

Shutter speeds from 1 to 1/100 second, plus Bulb and Time.

f/1.9—0.7 MAG lens, film economy;
Order 122-0547-00 ..... **$230**

f/1.4—1.0 MAG lens, full-size image;
Order 122-0608-00 ..... **$400**

f/1.3—0.5 MAG lens, high writing speed;
Order 122-0662-00 ..... **$390**

f/1.9—0.85 MAG lens, general purpose;
Order 122-0692-00 ..... **$210**

Mechanical Shutter/Lens Assembly

Electric Shutter/Lens Assembly

ELECTRIC SHUTTER/LENS

Requires SPEEDCOMPUTER for operation. SPEEDCOMPUTER and electric shutter are included with all C-12-E and C-27-E Cameras.

f/1.9—0.7 MAG lens, film economy, electric shutter.
Order 122-0772-00 ..... **$240**

f/1.4—1.0 MAG lens, full-size image, electric shutter.
Order 122-0840-00 ..... **$410**

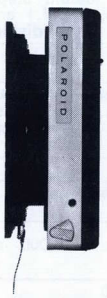
f/1.3—0.5 MAG lens, high writing speed, electric shutter.
Order 122-0769-00 ..... **$400**

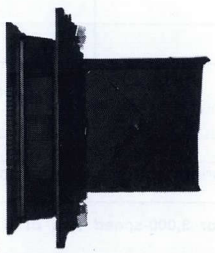
f/1.9—0.85 MAG lens, general purpose, electric shutter.
Order 122-0771-00 ..... **$220**

SPEEDCOMPUTER. **Order 122-0767-02** **$290**

Bracket for C-12, C-27. **Order 122-0713-00** **$10.00**

FILM BACKS





Polaroid Pack-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film. Split-image focusing plate included.
Order 122-0671-00 ..... **$95**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000 and 10,000-speed roll film. Split-image focusing plate included.
Order 122-0603-00 ..... **$120**

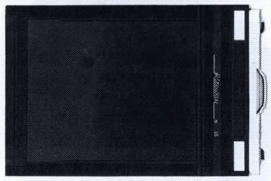
Additional split-image focusing plates
for Polaroid Pack Back, **Order 387-0893-02** **$1.25**
for Polaroid Roll Back, **Order 387-0893-01** **$1.25**

4 x 5-inch Graflok Back with Focusing Screen—accepts standard cut-film holders, film-pack adapters, roll-film holders, Polaroid 4 x 5-inch Film Holder. **Order 122-0604-00** **$70**

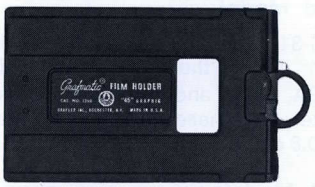
ACCESSORIES FOR GRAFLOK BACKS

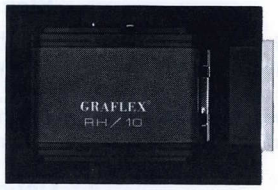
(For C-12, C-27, C-30 Series and C-50 Series)

Shown here are a few of the film holders available for use with the Graflok Backs to allow use of sheet film, roll film, film packs, and Polaroid 4 x 5-inch Film. Order these accessories from the manufacturer or from your local camera store.



Graphic Cut-Film Holder—Darkroom load-2 sheets of cut film. (Two dark slides required). Fidelity brand ASA type or equivalent for 4 x 5-inch Graflok Backs.





Grafmatic Film Holder—Darkroom load-6 sheets of cut film. Graflex Catalog #1268 for 4 x 5-inch Graflok Backs.

RH/10 120 Roll-Film Holder—10 exposures, 2¼ x 2¾ inches, use with 0.5 MAG lens. Graflex Catalog #1295 for 4 x 5-inch Graflok Backs.

RH/20 220 Roll-Film Holder—20 exposures, 2¼ x 2¾ inches, use with 0.5 MAG lens. Graflex Catalog #1297 for 4 x 5-inch Graflok Backs.

RH/50 70 mm Holder— 50 exposures, 2¼ x 2¾ inches; use with 0.5 or 0.7 MAG lens depending upon crt display size. Graflex Catalog #1240 for 4 x 5-inch Graflok Backs only.

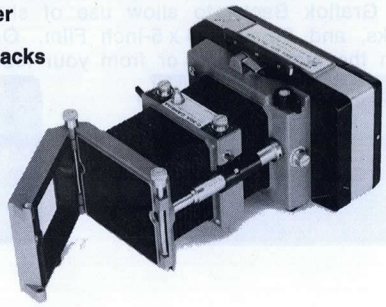
Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5-inch single exposure Film Packets.

Compact, Lightweight

External Controls

Optional Electric Shutter

Interchangeable Film Backs



The C-30-Series Cameras are recommended primarily for the TEKTRONIX 400-Series Portable Oscilloscopes. They can also be used with many other TEKTRONIX Oscilloscopes and Display Units by means of adapters listed on pages 247-248.

Standard Model

The standard C-30A, and the C-31 and C-32 are supplied with an 016-0306-00 Adapter which allows the camera to slide-mount directly onto the 422, 453A, 454A, and 485 Oscilloscopes and the 491 Spectrum Analyzer; all these instruments have an 8 x 10 division crt display (0.8 cm/div).

Option 1 Models

The C-30A and C-31 can also be ordered as an Option 1 Model which has an Adapter Frame/Corrector Lens to allow its use on the 432, 434, 464, 465, 466, and 475 Oscilloscopes. The Adapter Frame/Corrector Lens increases the field-of-view so it can photograph the entire 8 x 10-cm crt display of these oscilloscopes; the 434 crt display is actually 7.8 x 9.8 cm, but it also requires the Option 1 Model of the C-30A for full-screen coverage.

CONVERTING OPT 1 MODEL TO STANDARD MODEL

The Option 1 versions of the C-30A and C-31 Cameras can be converted to standard models by simply slipping off the Corrector Lens, removing the Adapter Frame, and adding an 016-0306-00 Adapter. Please refer to the oscilloscope/camera adapter guide page for prices and compatibility.

CONVERTING STANDARD MODEL TO OPT 1 MODEL

A standard-model C-30A or C-31 can be converted to an Option 1 model by means of the appropriate Adapter Frame/Corrector Lens: 016-0301-00 for C-30A; 016-0269-02 for the C-31. Please refer to the oscilloscope/camera adapter guide page for prices and compatibility.

HINGING

All C-30-Series Cameras swing open left or right, and can be quickly detached from the adapter at the hinges.

ELECTRIC SHUTTER OPTION

All cameras can be ordered with an integral Electric Shutter in place of the standard mechanical shutter; these "E" model cameras include a SPEEDCOMPUTER control box which supplies operating power to the electric shutter.

SUMMARY COMPARISON OF MAJOR CHARACTERISTICS

CAMERA	C-30A	C-30A OPTION 1	C-31	C-31 OPTION 1	C-32
PERFORMANCE FEATURES AND BENEFITS	General Purpose with variable magnification for 422, 453A[1], 454A, 485 and 491	General Purpose with full coverage of 8 x 10 cm crt of 432[1], 434, 464, 466, 465, 475	Fast Writing Speed with 0.5 Magnification for 422, 453A[1], 454A, and 485 Oscilloscopes	Fast Writing Speed with full coverage of 8 x 10 cm crt of 432[1], 434, 464, 466, 465, 475.	Full-Size image with Medium Writing Speed for 422, 453A[1], 454A, 485 and 491
LENS	f/1.9	f/1.9	f/1.2	f/1.2	f/1.4
MAGNIFICATION	1.5 to 0.7 in ten detent steps	0.8 with corrector lens.	0.5 fixed	0.44 fixed	1.0 (detent steps also at 0.85, 0.9, 1.1 and 1.2 but wth some distortion)
RELATIVE LENS SPEED*	1.0 at MAG setting of 0.7	0.9	2.9	2.9	1.4
FIELD OF VIEW	8 x 10 cm at MAG setting of 0.85. (Possible corner vignetting with some instruments)	8 x 10 cm	8 x 9 cm	8 x 10 cm (no vignetting)	7 x 9 cm at MAG setting of 1.0 (increases to 8 x 10 cm MAG setting of 0.85 but with some distortion)
STANDARD SHUTTER	Mechanically actuated, 1 to 1/60 sec, plus Bulb and Time.				
OPTIONAL ELECTRIC SHUTTER	Speeds: 1 to 1/60 sec, plus Bulb and Time. Remote triggering with insulated switch closure. Power requirements: 115/230 v, 50 to 60 Hz. See next page for ordering information.				
FILM BACKS	All cameras can be ordered with a Polaroid Pack Back for 3,000-speed film or a Polaroid Roll Back for 3,000- and 10,000-speed film.				
PRICE (With Film Back Ordinarily Used)	$560 (With Pack Back)	$570 (With Pack Back)	$695 (With Roll Back)	$705 (With Roll Back)	$750 (With Pack Back)

DIMENSIONS AND WEIGHTS WITH FILM BACKS ORDINARILY USED

	C-30A-P		C-30A-P Option 1		C-31-R		C-31-R Option 1		C-32-P	
	Inches	cm	Inches	cm	Inches	cm	Inches	cm	Inches	cm
Height	5.1	13.0	5.1	13.0	5.5	14.0	5.5	14.0	5.5	14.0
Width	7.5	19.1	7.5	19.1	9.1	23.1	9.1	23.1	7.5	19.1
Length	10.4	25.4	10.4	26.4	10.6	26.9	10.6	26.9	10.0	25.4
Weight (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
Net	4.8	2.2	5.0	2.3	6.8	3.1	7.0	3.2	5.0	2.3
Shipping	9.0	4.1	9.0	4.1	11.0	5.4	11.0	5.4	9.0	4.1

*Relative light gathering power—(See Camera Reference Information for comparison of all TEKTRONIX cameras)

[1]The internal graticule in the 432, and 453A Models 1, 2, 3, and 4 is non-illuminated and thus is not photographable. The 434 graticule is also nonilluminated, but it will photograph when the crt is in the stored mode.

ORDERING INFORMATION

All C-30-Series Cameras except the C-30A and C-31 Option 1 models include a Mounting Adapter 016-0306-00 for the 422, 453A, 454A, and 485 Oscilloscopes, and the 491. The C-30A and C-31 Option 1 models include an Adapter Frame/Corrector Lens for the 432, 434, 464, 465, 466 and 475 Oscilloscopes.

MECHANICAL SHUTTER CAMERAS

C-30A

C-30A-P Camera, Pack-Film Back **$560**
C-30A-R Camera, Roll-Film Back **$585**
Option 1, With Adpt-Frame Corr-Lens ..... **Add $10**

C-31

C-31-P Camera, Pack-Film Back **$670**
C-31-R Camera, Roll-Film Back **$695**
Option 1, With Adpt-Frame Corr-Lens ..... **Add $10**

C-32

C-32-P Camera, Pack-Film Back **$750**
C-32-R Camera, Roll-Film Back **$775**

ELECTRICALLY-ACTUATED CAMERAS

(Includes SPEEDCOMPUTER control box)

C-30A

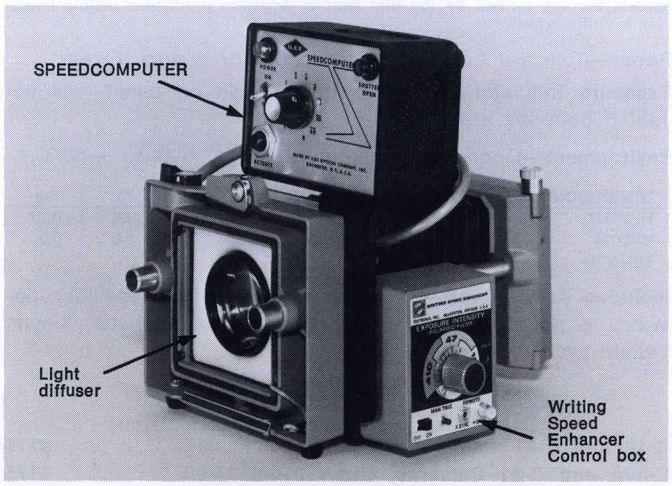
C-30A-PE Camera, Pack-Film Back **$860**
C-30A-RE Camera, Roll-Film Back **$885**
Option 1, With Adpt-Frame Corr-Lens ..... **Add $10**

C-31

C-31-PE Camera, Pack-Film Back **$960**
C-31-RE Camera, Roll-Film Back **$985**
Option 1, With Adpt-Frame Corr-Lens ..... **Add $10**

C-32

C-32-PE Camera, Pack-Film Back **$1040**
C-32-RE Camera, Roll-Film Back **$1065**



C-31-PE shown with Writing Speed Enhancer (film back removed) and SPEEDCOMPUTER which controls the electric shutter.

Included Accessories—For all camera models: Split-image focusing plate for Polaroid Pack-Film Back or Polaroid Roll-Film Back.

OPTIONAL ACCESSORIES

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes. See page 247 for camera/oscilloscope compatibility and adapter part numbers.

Writing Speed Enhancer—Provides automatic controlled film-fogging to increase writing speed ≈ 3 times for 3000 ASA film and ≈ 2 times for 10,000 ASA film/ For C-30A and C-31 only. Please refer to page 246 for details.
Order 016-0284-00 ..... **$175**

Film Backs—Two optional film backs allow a wide choice of films and provide flexibility of performance. Dark slides are included with Polaroid backs to permit interchanging film backs without exposing the film. Each Polaroid Back also includes a split-image focusing plate.

Polaroid Pack-Film Back—Accepts Polaroid 3¼ x 4¼-inch 3000-speed pack film, **Order 122-0752-00** **$95**

Polaroid Roll-Film Back—Accepts Polaroid 3¼ x 4¼-inch 10,000- or 3000-speed roll film, **Order 122-0754-00** **$120**

Additional Split-Image Focusing Plates

For Polaroid Pack Back, **Order 387-0893-02** **$1.25**
For Polaroid Roll Back, **Order 387-0893-01** **$1.25**

Carrying Case—Holds any C-30 Series Camera with any type Film Back and Writing Speed Enhancer control box attached. Room also for additional Film Back **or** Speedcomputer (detached from camera); additional Adapters **or** film. Camera Instruction Manual stores in cover of case. Case is molded of heavy-gage, high-impact plastic, with flexible polyurethane foam liners. Dimensions are 18½ x 14½ x 8 inches.
Order 016-0587-00 ..... **$33**

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 setups. At a distance of 21 inches, the camera covers an area of 19 x 21 inches. With the camera's aperture control set to f/16, objects several feet beyond 21 inches will also be in focus. The portra lens can be used with both the C-30A and C-30A Option 1 Cameras.
Order 016-0246-02 ..... **$15**

X-Sync Cable—Coiled cable has standard ASA connector which mates to the flash sync connector on C-30-Series Cameras, C-12 and C-27 Cameras and SPEEDCOMPUTERS. Other end has miniature phone plug. **Order 012-0364-01** **$10**

Writing Speed Enhancer

The TEKTRONIX Writing Speed Enhancer provides automatic, accurately-controlled fogging of the film to increase writing speed.

The writing speed of Polaroid Type 47 3,000-speed Roll Film and Type 107 3,000-speed Pack Film can be increased ≈ 3 times, while the writing speed of Polaroid Type 410 10,000-speed Roll Film can be increased ≈2 times.

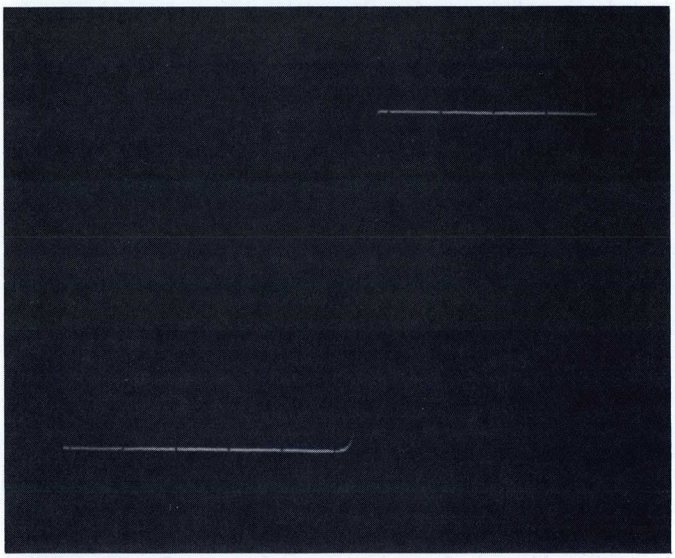
The battery-powered unit is easy to install and easy to use. It is available for all TEKTRONIX cameras except the C-5, C-32, C-52, and C-58.

The Enhancer consists of a battery-powered control box which mounts on the camera, and four light-emitting diodes in a plastic light diffuser which fits around the camera's rear lens. When the Enhancer is triggered, the four diodes emit a half-second burst of low-level red light which is diffused directly onto the film to provide a uniform fog background.

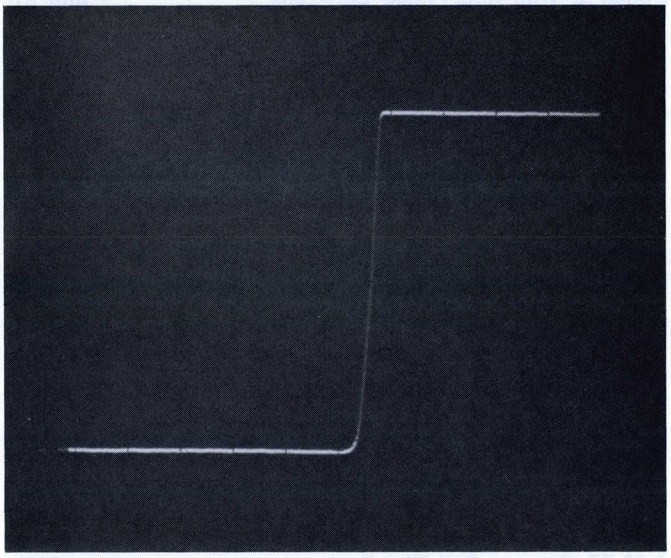
The intensity of the light from the diodes is set by a control knob which has a dial showing ranges of adjustment for Polaroid Film Types 47, 107, and 410.

The Enhancer can be triggered in three ways: by a push button on the control box, remotely with a switch closure to ground (such as provided by the camera-shutter X-sync switch), or by the oscilloscope-sweep + gate. Thus, the film can be fogged before the sweep occurs, after the sweep occurs, or at the same time the sweep occurs. These techniques are respectively called prefogging, post fogging, and simultaneous fogging. Of these modes, simultaneous fogging provides the greatest gain in writing speed. Automatic simultaneous fogging is easily achieved by triggering the Enhancer with the oscilloscope-sweep + gate.

The following photos illustrate how the controlled fog exposure from a Writing Speed Enhancer can reinforce an extremely dim trace exposure to increase writing speed and still maintain good contrast.



This Polaroid Type 107 3,000-speed Pack Film was exposed to the single-trace display of a pulse waveform with a fast-rising leading edge too dim to produce a developable image.



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.

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

Polaroid Film		Actual Relative Film Writing Speed		
		Unfogged		Fogged
Type	ASA EQUIVALENT SPEED	Print viewed with front illumination	Print viewed with back illumination	Print viewed with front illumination*
107	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.

CHARACTERISTICS

Triggering—Manual push button, or automatic when connected to camera X-sync, or oscilloscope + gate.

Exposure Time—Approximately 0.5 seconds.

Repeatability—Within 5%.

Illumination—Four light-emitting diodes in a specially designed diffuser. Brightness adjustable by Exposure Intensity Control.

Power—Two 9-V batteries; life expectancy approx 1 year.

Exposure Indicator—A light-emitting diode on panel (will not light if batteries are low).

Environment—Operating temperature range, 0°C to +50°C.

DIMENSIONS	In	cm	WEIGHTS (approx)	lb	kg
HEIGHT	3.0	7.6	NET	0.6	0.27
WIDTH	1.3	3.3	SHIPPING	2.0	0.9
LENGTH	2.5	6.4			

Included Accessories—Cable for triggering from oscilloscope-sweep + gate; cable for triggering from camera-shutter X-sync switch; two 9-V batteries.

ORDERING INFORMATION
WRITING SPEED ENHANCER for:

C-12 and C-27 Cameras, Order 016-0280-00 ..... $175
C-30A and C-31 Cameras, Order 016-0284-00 ..... $175
C-50 Camera, Order 016-0278-00 ..... $175
C-51 Camera, Order 016-0279-00 ..... $175
C-53 Camera, Order 016-0300-00 ..... $175
C-59 Camera, Order 016-0290-00 ..... $175

C30A TO 314, 326, 1502, 1503
P/N 016-0327-00 — FEN 5/16/95

TYPE OSCILLOSCOPE	RECOMMENDED CAMERA	C-12 ADAPTER PART NUMBER	C-27 ADAPTER PART NUMBER	C-30 SERIES ADAPTER PART NUMBER	C-50 SERIES ADAPTER PART NUMBER[4]
422	C-30A			016-0306-00 (included with camera)	
432[1], 434[2] 464, 466	C-30A Opt 1			016-0301-00 Adapter Frame/ Corrector Lens (included with camera)	
453A, 454A	Any C-30 Series			016-0306-00 (included with camera)	
465, 475	C-30A Opt 1 or C-31 Opt 1			016-0301-00 (C-30A) 016-0269-02 (C-31) Adapter Frame/ Corrector Lens (included with camera)	
485	Any C-30 Series			016-0306-00 (Included with camera)	
491	C-30A				
502A	C-59				
503, 504	C-12 or C-27	016-0226-01	016-0225-03	016-0243-00	016-0225-03
519	C-51[4] or C-27 Opt 4		Integral with 519		Integral with 519
520A, 521 522	C-59		016-0295-00		016-0295-00
528	C-59		016-0249-03	016-0248-00	016-0249-03
529	C-59	016-0217-00	016-0224-00	016-0244-00	016-0224-00
544, 545B	C-27 or C-12				
546, 547	C-27 or C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03
549	C-12			016-0243-00[5]	
556	C-27 or C-12			016-0243-00	
561B, 564B	C-27 or C-12	016-0217-00	016-0224-00	016-0244-00	016-0224-00
565	C-59	016-0226-01	016-0225-03	016-0243-00	016-0225-03
568	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00
575	C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03
576	C-12, C-27, C-50 or C-59	See Adapter Frame/Corrector Lens Systems at right			
577[6]	C-5 or C-59[2]	016-0263-00[6]	016-0249-03[6]	016-0248-00[6]	016-0249-03[6]
601, 602	C-30A	016-0263-00	016-0249-03	016-0248-00	016-0249-03 (integral with camera)
603[6,7]	C-5 or C-59				
604[6,8]	C-5				
605	C-30A	016-0263-00	016-0249-03	016-0248-00	016-0249-03
647A	C-27 Opt 4 or C-51[4]		016-0223-00		016-0223-00
1420, 1421, 1422	C-5	016-0263-00[1]	016-0249-03[1]	016-0248-00[1]	016-0249-03[1]
5030 5031	C-12, C-27 C-50 or C-59	See Adapter Frame/Corrector Lens Systems at right			
5100 Series[6]	C-5	016-0263-00[2,6]	016-0249-03[2,6]	016-0248-00[2,6]	016-0249-03[2,6]
5403/D40	C-5, C-59, C-27 Opt 1, or C-50[4]	016-0263-00[6]	016-0249-03[6]	016-0248-00[6]	016-0249-03[6]
5403/D41	C-30A, C-12, or C-27	016-0263-00	016-0249-03	016-0248-00	016-0249-03
7313	C-53	016-0263-00			
7403N	C-59 or C-50	016-0299-00[6]	016-0249-03[6]	016-0248-00[6]	
7503, 7504 7514	C-53	016-0263-00			
7603	C-59 or C-50	016-0299-00[6]			
7603N Opt 11	C-53				
7613	C-53 or C-58P	016-0263-00	016-0249-03	016-0248-00	016-0249-03 (included with camera)
7633, 7623A	C-53 or C-58P				
7704A	C-51				
7844/R	C-51	016-0263-00 (For Bench Model Only)			
R7903, 7904	C-51	016-0263-00			
Tekequip-ment D83[6]	C-59 or C-5				
Some Hewlett-Packard scopes with 5-in round crt only	call TEKTRONIX Field Office or Representative	016-0229-00	016-0228-00		016-0228-00
Some DuMont scopes with 5-in round crt only			016-0227-00		016-0227-00

CAMERA ADAPTER PART NUMBERS and PRICES

016-0217-00	$22.50	016-0243-00	$22.00
016-0223-00	30.00	016-0244-00	24.00
016-0224-00	33.00	016-0248-00	33.00
016-0225-03	29.00	016-0249-03	27.50
016-0226-01	27.00	016-0263-00	25.00
016-0227-00	33.00	016-0269-02	35.00
016-0228-00	30.00	016-0295-00	28.00
016-0229-00	36.00	016-0299-00	28.00
016-0242-00	30.00	016-0301-00	42.00
		016-0306-00	38.00

C-30A/C-31 OPTION 1 ADAPTER FRAME/CORRECTOR LENS

The C-30A and C-31 Option 1 Cameras have an adapter Frame/Corrector Lens to allow their use with the 400-Series Oscilloscopes that have 8 x 10-cm crt's. To use these cameras with the smaller-screen 400-Series scopes, remove the corrector lens and use adapter 016-0306-00.

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-inch 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-inch 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 upper 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 ..... $45

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 $58

For C-59 Camera, Order 016-0288-00 $58

[1]Graticule is nonilluminated and will not photograph.

[2]Graticule is nonilluminated and will not photograph except when crt is in the stored mode.

[3]Increases camera's field-of-view so that the full 8 x 10-cm crt display area can be recorded.

[4]C-50, C-51, C-52, and C-53 Cameras require Battery Pack 016-0270-00 for power when not used with 7000-Series Oscilloscopes.

[5]C-30-Series Cameras can only be mounted and removed from the 549 by means of the camera hinges.

[6]Only the C-5 and C-59 Cameras can entirely record the 6½-inch crt display without cropping.

[7]The C-59 is suitable for the standard-model Type 603 but it cannot photograph the nonilluminated graticule of the Option 1 Model.

[8]The C-59 also mounts directly onto the Type 604 but it cannot photograph the nonilluminated graticule of the standard model.

TEKTRONIX Adapters for mounting Beattie Coleman, DuMont, and Hewlett-Packard cameras on TEKTRONIX Oscilloscopes. The outside diameter of the mounting ring is 5⅝ inches. Net weight of each adapter is approximately 1 pound.

INSTRUMENT	CAMERA	ADAPTER	PRICE	INSTRUMENT	CAMERA	ADAPTER	PRICE
520A, 521, 522, 540 & 550 Series, 502A, 503, 504, 565 and 575.	Beattie Coleman: Models K-5, K-5R, KD-5, Mark IIA, Mark II-911, 565A, & Polexa. DuMont: Models 295, 296, 297, 298, 299, 302(B), 321A, 352, 353, 450(A), & 453/454A Series.	014-0018-00	$16.00	647A	Beattie Coleman: Models K-5, K-5R, KD-5, Mark 11A, Mark 11-911, 565A & Polexa. DuMont: Models 295, 296, 297, 298, 299, 302(B), 321A, 352, 353, 450(A), & 453/454A Series. HP: Models 195A, 196(A), & 197A.	014-0017-00	$17.00
529(RM), 561B, 564B, 567, and 568.	HP: Models 195A, 196(A), & 197A.	*014-0016-00 014-0031-00	$14.00 $10.00	528, 601, 602, 603, 604, 605, 1420, 1421, 1422, 5100 Series 5400 Series 7000 Series	Beattie Coleman: All models listed above. DuMont: 450(A) and 453/453/A Series. HP: Models 195A and 197A.	014-0045-00	$50.00

*There is 3/16-inch clearance between the adapter mounting ring and the two upper mounting nuts which secure the adapter to the oscilloscope. The mounting clamp ring of some cameras may be too thick to fit in this gap and won't allow the camera to fully seat on the adapter. Although most cameras will still clamp securely, the lack of full seating may cause a focus problem. If so, adapter 014-0031-00 may be more suitable since its mounting ring is centered about 7 mm below the crt axis to provide 3/8-inch clearance between the mounting ring and the mounting nuts.

GLOSSARY OF CAMERA AND PHOTOGRAPHIC TERMS

ASA FILM-SPEED INDEX—The method of specifying film speed for general photography in the United States. Since the ASA index is based on the response of film to sunlight and tungsten light, it cannot be used directly as an accurate exposure guide for the narrow color spectrum emitted by crt phosphors, especially for recording fast single-sweep traces where exposures fall at the threshold sensitivity of the film.

CAMERA ADAPTER—Attaches to an oscilloscope so that a camera can be mounted on it. Adapters are needed for all TEKTRONIX Cameras except the C-5.

CRT BEZEL—The front-panel frame around the crt; it may be a removable graticule cover or a flanged frame which is integral to the instrument.

EXPOSURE VALUE—For every product of film speed (ASA) times luminance (footlamberts), there is a product of lens opening (f-number)^2 times inverse shutter speed (I/t) that will produce a picture. The exposure value, E_v is 2 log (f-number) — log t. When luminance and film speed are fixed, the inverse shutter speed and the f-number can be varied inversely, keeping their product constant, or keeping the sum of their logs, E_v, constant.

FIELD OF VIEW—The effective field of view of an oscilloscope camera may be defined as the maximum-size crt display that the camera can record. It is determined by the combined effects of the magnification and angular field of view of the lens, and field-limiting apertures in the camera adapter, camera body or film holder, and the image area of the film.

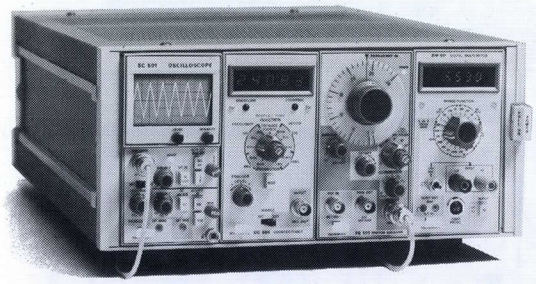
FILM FOGGING—A technique of increasing writing speed by deliberately fogging the film to enhance the undeveloped trace image.

FILM IMAGE AREA—The actual area of the film which can produce an image. The image area of conventional sheet films, and roll films that don't have sprocket holes, is as large as the film. Polaroid prints are masked to produce a border; for example, Type 107 Pack Film is designated as 3¼ x 4¼-inch film; its actual image area is 9.5 x 7.3 cm or 2⅞ x 3¾ inches.

LENS MAGNIFICATION—A number M which signifies the image-to-object ratio of a lens system. $M = \frac{\text{Image size}}{\text{Object size}}$ or image size = M x Object size.

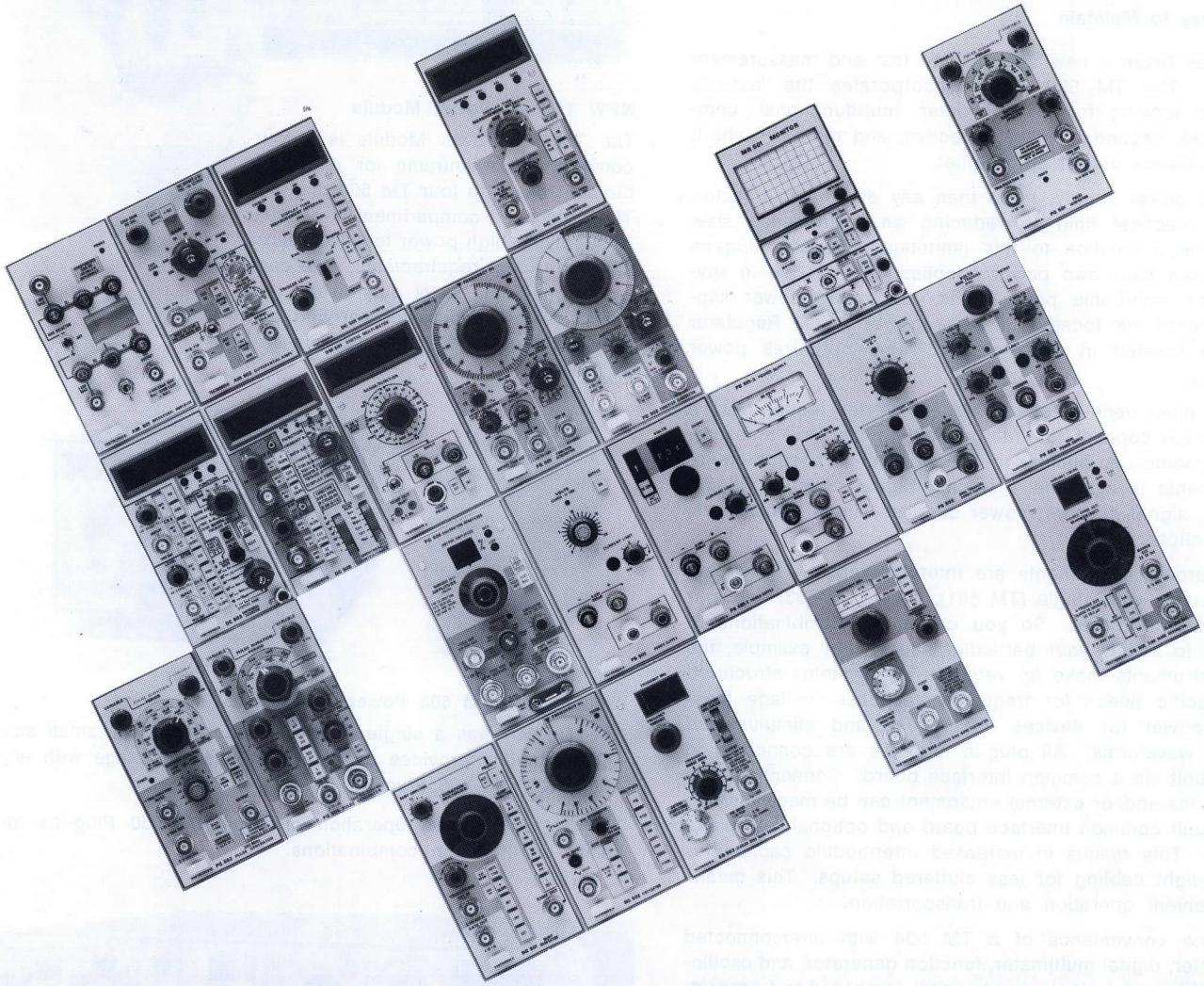
LIGHT-GATHERING POWER—The illumination in an image plane that a lens can produce from an object, relative to the brightness or luminance of the object. It is sometimes referred to as "lens speed."

VIGNETTING—The loss of the periphery of the image due to restriction of off-axis light rays by the lens-mounting barrels or edges of the glass elements. In a positive print, it usually appears as darker areas of the image at the corners of the photo. It contributes to the angular limits of the field-of-view of the lens.



TM 500-Series
Test and Measurement Instruments

9



The TM 500 Series represents a most economical approach in test and measurement products. Relatively "fixed" packaging costs for frames, covers, primary power circuits, unregulated secondary power circuits and other items are a significant portion of a typical instrument's cost. Since so-called "fixed costs" associated with packaging are shared by multi-functions in the TM 500 series, the cost per function is lower than comparable one or two function instruments. Therefore, because of its modularity, expandability, and versatility, the TM 500 Series usually provides the lowest cost per test/measurement when considering multi-function use.

Presently, 29 test and measurement instruments are available. However, new instruments are in various stages of development, and others are being refined. So, Tektronix will continue to expand the capability and performance of the TM 500 Series using new devices and technology. When new modules are introduced, you can expand your TM 500 Series. And, at the same time, keep test and measurement costs to a minimum.

Counters

Multimeters

Power Supplies

Signal Sources

Signal Processors

Crt Monitors

Oscilloscopes

TM 500-Series Test and Measurement System

A versatile plug-in system for a wide variety of measurements

Low Cost Per Function

Interchangeable Plug-ins

Small Size for Easy Setup and Reduced Clutter

Designed for Bench, Rack, or Mobile Use

Rear Panel Access to Plug-in Interface

Intra-Compartment Plug-in Interface for Specific Applications

Front Panels Color Coded by Function

Reliable, Easy to Maintain

Tektronix has taken a new approach to test and measurement instruments. The TM 500 Series incorporates the features you've been looking for: it's modular, multifunctional, compact, portable, dependable, cost effective, and more. In short, the TM 500 Series puts it all together.

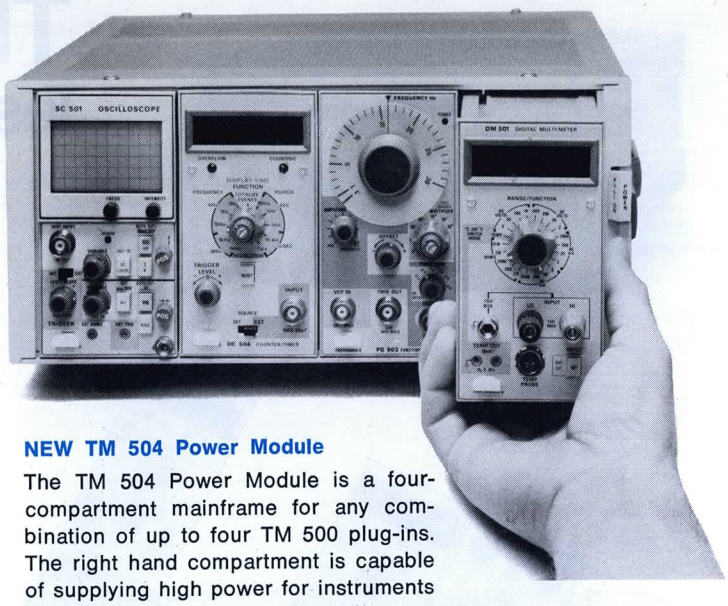
The generic power supply, more than any other single factor, imposes a practical limit to reducing an instrument's size. Tektronix has a solution to this limitation. TM 500 plug-ins do not contain their own power supplies, but operate in several different mainframe power units. Expensive power supply components are located in these power units. Regulator circuits are located in each plug-in. This optimizes power supply voltages.

One of the chief benefits of the TM 500 Series results from a modular design concept for interconnecting test and measurement instruments. A nucleus of 29 general-purpose modular test instruments is available, including digital counters, digital multimeters, signal sources, power supplies, signal processors, and crt monitors.

The multipurpose instruments are interchangeable. They plug into power units with single (TM 501), triple (TM 503) and four (TM 504) compartments. So you can make combinations of instruments to satisfy your particular needs. For example, the TM 500 instruments make up versatile test systems structured to suit specific needs for frequency response, voltage measurement, power for devices under test, and stimulus and modulating waveforms. All plug-in modules are connected in the power unit via a common interface board. Connections between modules and/or external equipment can be made through the power unit common interface board and optional rear panel connectors. This results in increased intermodule capabilities and out-of-sight cabling for less cluttered setups. This means more convenient operation and transportation.

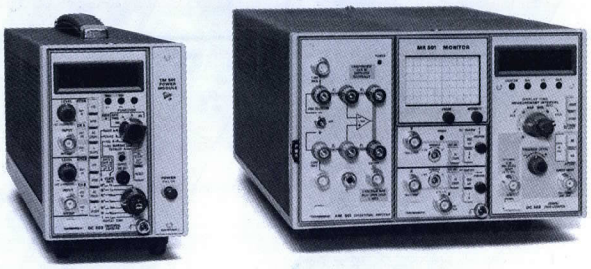
Consider the convenience of a TM 504 with interconnected digital counter, digital multimeter, function generator, and oscilloscope plug-ins and a single power cord, compared to transporting, setting up and tearing down four comparable single function instruments with associated interconnecting cable and power cords.

The TM 500 Series is not an oscilloscope system, but it borrows extensively from techniques, processes, and devices we've developed designing and building oscilloscopes. It includes many Tektronix-built parts and components: special integrated circuits, multilayer circuit boards, semiconductors, crt s, transformers, and more. This not only assures effective performance and long life, but it also accounts for the small size of the instruments. A single specialized integrated circuit, for example, performs all the operations previously performed by many discrete components. In addition, even though it's new, the TM 500 series is based on proven technological principles developed in oscilloscopes.



NEW TM 504 Power Module

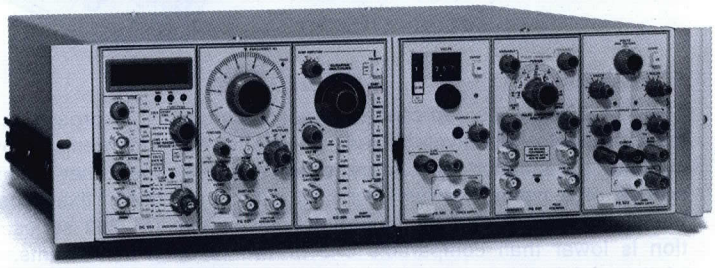
The TM 504 Power Module is a four-compartment mainframe for any combination of up to four TM 500 plug-ins. The right hand compartment is capable of supplying high power for instruments with high input requirements. The case is designed for heavy duty usage and has a flexible handle for carrying and provision for standing the case on end or its side.



TM 501 and TM 503 Power Modules

The TM 501 has a single plug-in compartment. Its small size and portability provides an ideal instrument package with any one of 29 TM 500 Plug-ins.

The TM 503 allows operation of three TM 500 Plug-ins for handy multifunction combinations.

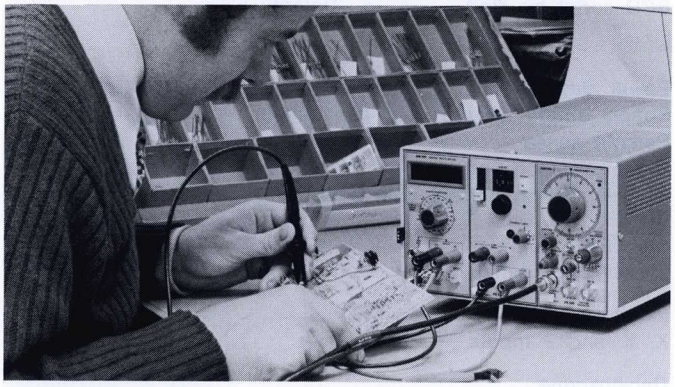


Two TM 503 Mainframe Power Modules may be rackmounted with an available conversion kit. The rack installation allows up to six TM 500 plug-ins in 5¼ inches of rack height.

A TM 503 may also be combined in a rackmount configuration with the 605 Variable Persistence Storage Monitor, the 604 Monitor or the 603 Storage Monitor. Each monitor is available with internal time base or may be swept with the RG 501 TM 500 plug-in.

Mobile Test Station

The 203 Option 1 SCOPEMOBILE Cart holds a TM 503 which powers up to three TM 500 Plug-ins. It also stores up to four additional plug-ins. Available also is the 204 Option 1 cart which is similar but stores five plug-ins. A scope or other instrument mounts on the tilting platform.



Compact

A three-compartment TM 503 power unit is only 6″ x 8.7″ x 15.3″. This saves valuable bench space. Two TM 503s joined are only 17″ wide and permit installation of up to six TM 500 plug-ins in a conventional 5¼″ x 19″ rackmount. The TM 500 instruments are two to six times smaller than comparable instruments. But don't be misled by size. TM 500 plug-ins have all the performance characteristics of much larger single function instruments. A typical plug-in combination may include a general-purpose digital counter, digital multimeter, and versatile power supply in a compact package weighing 14-18 pounds. You can carry a complete test and measurement system across the room, or across the country—with ease. A snap-on cover is available to protect instrument faces.

MAINFRAMES

PRODUCT		PAGE
TM 501	Easy to carry; Power any one of 29 plug-ins	250
TM 503	Compact, multifunction, (powers any three plug-ins	250
TM 504	Powers any four TM 500 plug-ins	250
203 Option 1	Mobile Test Station accepts a TM 503 Power Module	253
204 Option 1	Mobile Test Station accepts a TM 503 Power Module	253

SIGNAL PROCESSORS

AF 501	Bandpass Filter/Amplifier, sine wave generator	254
AM 501	High performance, Operational Amplifier	255
AM 502	DC-coupled, Differential Amplifier	255
DM 501	4½ digit, 0.1% DC voltage accuracy	262
DM 502	3½ digit, six functions and dB	263

DIGITAL COUNTERS

DC 501	7 digit 110 MHz direct counting	256
DC 502	7 digit 110 MHz direct counting, 550 MHz with prescaler	256
DC 503	7 digit Universal Counter-Timer, 100 MHz	258
DC 504	5 digit Counter/Timer, direct counting to 80 MHz	260
DC 505	7 digit Universal Counter/Timer, 225 MHz on two channels	258

POWER SUPPLIES

PS 501	Floating output 0-20 V, current limit 0-400 mA	270
PS 501-1	Same as PS 501, readout by 10 turn potentiometer	270
PS 501-2	Same as PS 501, readout by dual-range meter	271
PS 503	Dual power supply, 0-20 V or 0-40 V	271
PS 505	Variable, low voltage, high current dc supply	271

GENERATORS

FG 501	Function Generator, 5 waveforms, .001 Hz to 1 MHz	264
FG 502	Function Generator, 5 waveforms, 0.1 Hz to 11 MHz	265
FG 503	Function Generator, 3 waveforms, 1.0 Hz to 3 MHz	265
PG 501	Pulse Generator, 5 Hz to 50 MHz	268
PG 502	Pulse Generator, 250 MHz general purpose	268
PG 505	Pulse Generator, 100 kHz, 80 V general purpose	269
RG 501	Ramp Generator, 10 μs minimum ramp duration	274
SG 502	RC Oscillator, 500 kHz sine and squarewaves	274

MONITORS, OSCILLOSCOPES

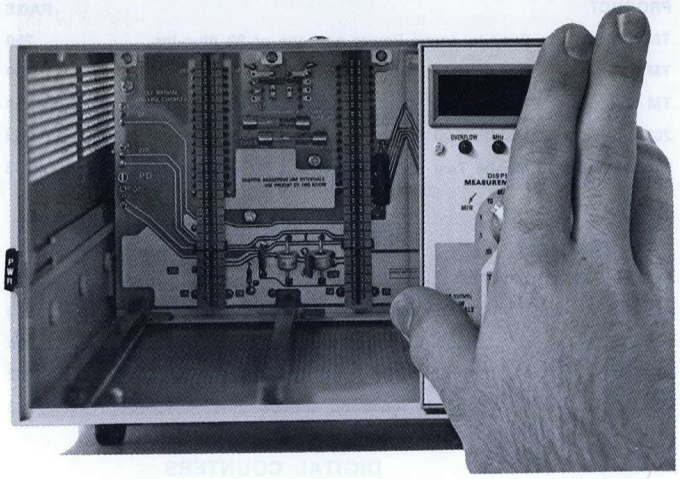
MR 501	2 MHz X-Y Monitor	266
SC 501	5 MHz General-Purpose Oscilloscope	267

CALIBRATION EQUIPMENT

PG 506	Amplitude Calibrator, 1.0 ns rise-time output, 60 V	272
SG 503	Sine Wave Oscillator, 250 kHz to 250 MHz	272
TG 501	Time Mark Generator, 1 ns-to-5 s markers	273

SPECIAL APPLICATION

DD 501	Digital Events Delay for oscilloscope trigger	261



Significant cost savings are made in the individual plug-ins by operating them in TM 501, TM 503 and TM 504 power modules. These three units contain the necessary power supply components—transformer, rectifiers, filter caps and pass transistors to operate any of the TM 500 Series plug-ins. Regulator circuits are located in each plug-in, allowing a very flexible interface. All TM 500 modules are connected to the power unit's intra-compartment interface via a common board.

The modules "talk to each other" permitting multi-function applications. Many input-output lines connect directly from the front panel to the interface board via a multi-pin edge connector. Also many internal lines with generated information such as serial BCD are brought to this interface board. Approximately 30 spare input-output lines are available for special connections by the user in each compartment. As an option, BNC connectors and a multi-pin connector can be installed to provide rear panel access for input/output lines to other equipment. This interfacing capability can result in a synergistic effect: instruments working together perform more functions than the same instruments working independently.

STANDARD INTERFACE

Each plug-in has selected lines brought to its interface. Some of these are parallel to front panel connections, others are present only at the interface. Normally, these lines are left open, but they may be connected by the user to reduce front panel clutter or to perform functions not otherwise available. For example, digital counters have serial BCD outputs which may be brought out for data logging or processing.

A typical example of interface connection between modules is to connect the ramp output of the RG 501 to the VCF input of the FG 501 for frequency sweep, or the output of a power supply to the input of the DM 501 for voltage monitoring.

Line and terminal assignments are common for each family of modules. Each family has its own pattern of circuit board notches at the interface. Interface terminal barriers may be inserted in the mainframe so that it only accepts plug-ins of one family. A supply of barriers (and square-pin jumpers) is shipped with the power module when it is ordered with the optional connectors installed (Option 2).

CHARACTERISTICS

Power Requirements— 100, 110, 120, 200, 220 and 240 V ac ±10%; internally selected with quick change jumpers. Line frequency range; 48 to 440 Hz.

Power Consumption—Maximum primary power approx 200 W (TM 504), 120 W (TM 503), and 35 W (TM 501) at high line (with plug-ins). Actual power consumption depends on plug-in selection and operating modes.

Operating Temperature— 0° to 50°C. Includes power modules and all plug-in combinations. The TM 503 and TM 504 power modules contain a thermal cutout for over-temperature protection.

LINES AVAILABLE AT THE MODULE INTERFACE CONNECTOR

Digital Counters

BCD serial by digit	Reset
Range code (Except DC 502)	Time slot zero
Scan clock out	Data good
Scan clock in and internal scan disable	Signal in (selected by front panel switch) (except DC502)

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 Multimeter

Scan clock out	Most significant digit
Decimal point	Data transfer
BCD serial by digit	Polarity
Least significant digit	

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

Signal Sources

SIGNAL	FG 501	FG 502	FG 503	PG 501	PG 502	PG 505	RG 501	SG 502
Trigger Out	X	X	X	X	X	X		
Trigger In					X	X	X	
Signal Out	X	X	X				X	X
Gate Out							X	
Gate In	X	X				X		
VCF In	X	X	X					
Amplitude Monitor				X				
Square-wave out								X
Sync In								X

OPTIONAL INTERFACE

If the power module is ordered with Option 2, it will be delivered with a rear panel multi-pin 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 is also supplied with square pin connectors on the rear interface board for connection between modules using the supplied jumpers terminated with square-pin receptacles. However, it is feasible to solder the desired connections without the square pins installed. Also, it is feasible to install the rear panel BNC and multi-pin connectors at a later date.

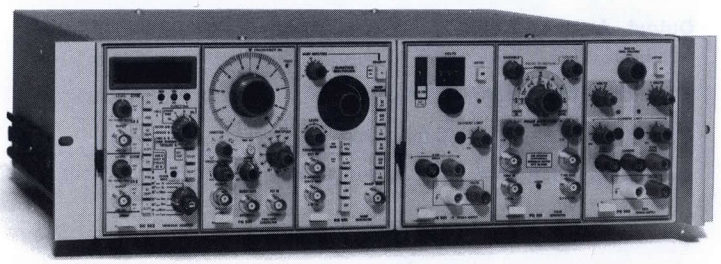
Power Module Dimensions and Weights

	CABINET						RACK-MOUNT	
	TM 501		TM 503		TM 504			
Dimensions	in	cm	in	cm	in	cm	in	cm
Height	6	15.2	6	15.2	6	15.2	5.3	13.5
Width	3.9	9.9	8.7	22.1	12.2	31	19.0	48.0
Length	15.3	38.8	15.3	38.8	20	50.8	15.6	39.6
Weight (approx)	lb	kg	lb	kg	lb	kg		
Net	5.4	2.4	9.5	4.3	20.5	9.3		
Shipping	9.	4.1	16.	7.2	18.5	8.4		

ORDERING INFORMATION

(Plug-ins Not Included)

TM 501 Power Module **$125**
Option 2 Interface ..... **Add $55**
TM 503 Power Module **$175**
Option 2 Interface ..... **Add $75**
TM 504 Power Module **$225**
Option 2 Interface (Contact field representative for pricing)

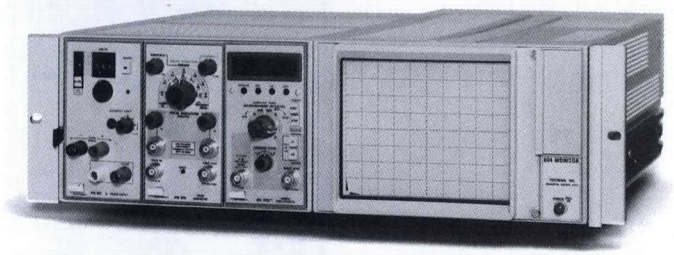


RACKMOUNTING FOR TM 503

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 ..... **$51**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0617-01 ..... **$69**

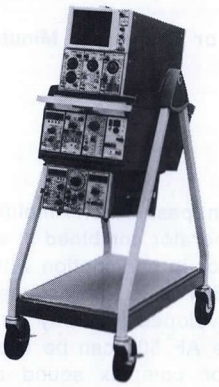
Rackmount-to-cabinet conversion kit equipped to convert a rackmount TM 503 to a cabinet style.
Order 040-0618-01 ..... **$22**



Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 603, 604 or a 605 in a standard rack width.
Order 040-0624-00 ..... **$44**

MONITOR ORDERING INFORMATION

603 Storage Monitor **$1150**
Option 4 Time Base ..... **Add $125**
604 Monitor **$735**
Option 4 Time Base ..... **Add $125**
605 Storage Monitor **$1675**
Option 4 Time Base ..... **Add $125**



MOBILE TEST STATIONS

203 Option 1 SCOPE-MOBILE® Cart is an easy to move test station. It accepts any TM 503 Power Module (ordered separately) and can store four additional plug-ins for use in the TM 500 system.
Order 203, Option 1 ..... **$215**

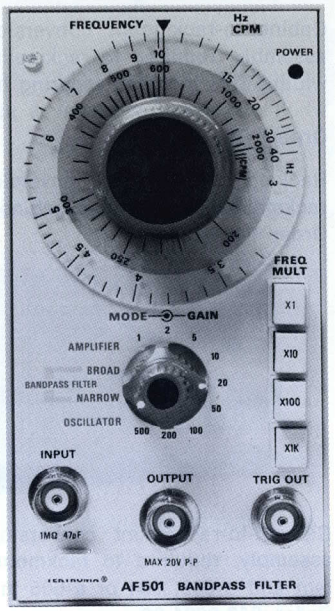
204, Option 1 SCOPE-MOBILE® Cart (not shown) is similar to the 203, Option 1 but stores five TM 500 plug-ins. It accepts any TM 503 Power Module (ordered separately).
Order 204, Option 1 ..... **$225**

NEW

AF 501

TM 500-Series Test and Measurement System

Highly Versatile Bandpass Filter/Amplifier



Tunable Bandpass Filtering to 35 kHz

Signal Amplification to 50 kHz

Sinewave 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 sinewave generator combined in a single TM 500-Series module. Used alone or in conjunction with other TM 500-Series instruments, the AF 501 is a highly versatile and accurate signal analysis tool. Developed primarily for the mechanical measurement domain, the AF 501 can be used as a manual-sweep spectrum analyzer for complex sound and vibration signals. Single-frequency tuning facilitates isolation of 1X RAM 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 sinewave 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 between 3-20, <10% dial 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).

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 slew rate of 400 V kHz).

OSCILLATOR

Sinewave 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.

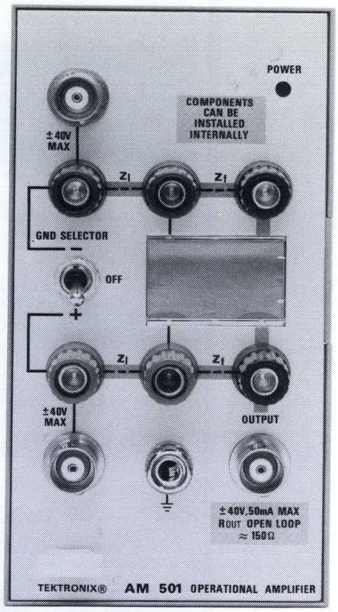
Min. Signal Required— 500 mV, p-p.

Rise and Fall Time— <1 μs.

Output Impedance— ≈50 Ω.

AF 501 Bandpass Filter/Amplifier **$395**

AM 501



±40 V, 50 mA Output

Open Loop Gain 10,000

50 μV/s Slew Rate

The AM 501 Operational Amplifier features high input impedance (FET), high slew rate, a wide range of input and output voltage, and high output current. Applications include: amplification; impedance transformation; integration; differentiation and summing. It is well suited as a post-amplifier or offset-generator for signal sources, including the TM 500 modules. Components may be added externally or internally making it ideal for teaching op-amp amplification theory.

OPERATIONAL AMPLIFIER

Open Loop Gain—At least 10,000 into 800 Ω load.

Unity Gain Bandwidth—At least 5 MHz into 800 Ω load.

Common-Mode Rejection Ratio—At least 10,000 to 1 at 60 Hz.

Slew Rate—At least 50 V/μs into a 800 Ω load.

INPUT

Common-Mode Input Voltage Range—At least ±40 V.

Input Leakage Current—Less than 500 pA at 20°C.

Equivalent Input Drift—Less than 100 μV/°C.

Equivalent Input Noise—Less than 10 μV rms.

Maximum Safe Differential Input— 80 V.

OUTPUT

Voltage Range—At least ±40 V.

Current Limit—At least ±50 mA.

Open Loop Output R—Approximately 150 Ω.

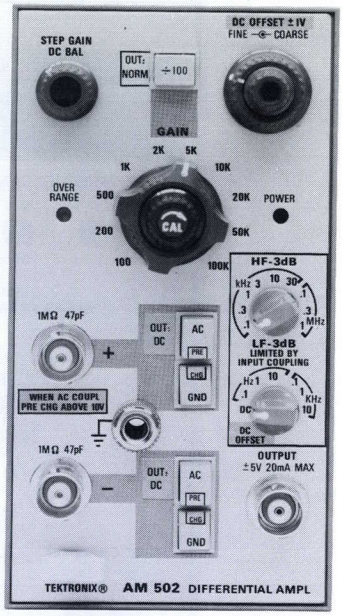
Power Consumption— 8 watts.

ACCESSORIES

Terminal Accessory Adapter Kit (013-0146-00) **$8.25**

AM 501 Operational Amplifier **$225**

AM 502



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—Dc to 1 MHz within +25%, Dc coupled. 2 Hz or less (low frequency —3 dB point) with input ac coupled.

HF —3 dB POINT—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz.

LF —3 dB POINT—Selectable in 6 steps from 0.1 Hz to 10 kHz.

Dc Offset—At least + or — 1 V to offset signal dc component.

Normal Mode Cmrr—At least 100 dB, dc to 50 kHz, range, ±5 V.

÷ 100 Mode Cmrr—At least 50 dB, dc to 50 kHz, range, ±50 V.

Maximum Safe Inputs—Normal mode dc coupled: 15 V (dc + peak ac). ÷ 100 Mode dc coupled: 350 V (dc + peak ac). Ac Coupled: 350 V (dc + peak ac) with coupling capacitor precharged.

Input R and C— 1 MΩ paralleled by approx 47 pF. Input impedance can be increased to FET input via a simple internal jumper change.

OUTPUT

Maximum Output— ±5 V, ±20 mA, output resistance is 5 Ω or less.

Minimum Load Impedance— 250 Ω.

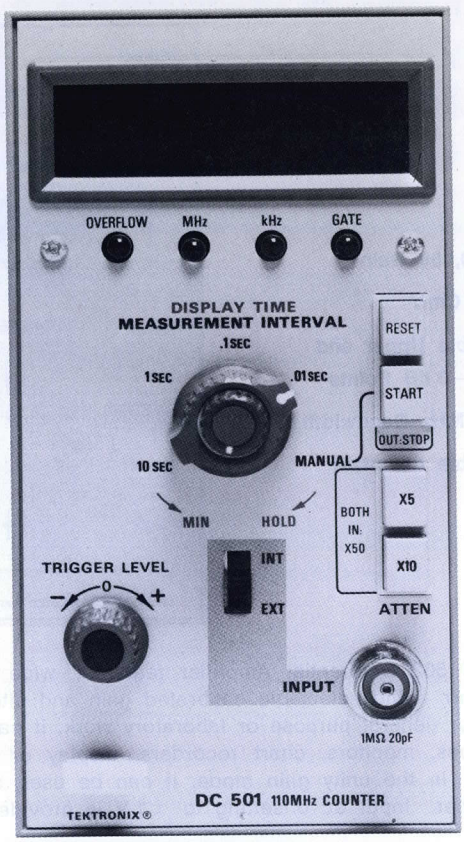
Maximum Input Gate Current— 50 pA at 25° C.

Maximum Noise— 25 μV or less (tangentially measured).

Overrange—Front-panel lamp indicates most overrange conditions.

Maximum Voltage Drift— 100 μV/°C

AM 502 Differential Amplifier **$500**



Direct Counting to 110 MHz

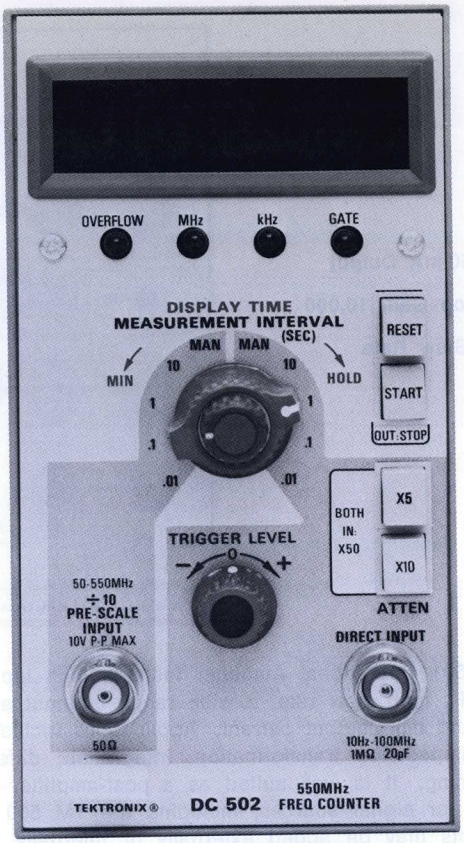
7-Digit LED Display

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 LED's 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 1×10^{-5} accuracy (0° to 50°C) and an aging rate of 1×10^{-5} per month. An optional clock with 5×10^{-7} accuracy (0° to 50° C) and an aging of 1×10^{-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 **$625**
Option 1 5 MHz Time Base ..... **Add $95**
Option 2 Auto Measurement ..... **Add $65**
Option 4 Calculator ..... **Add $20**



Counts to 550 MHz with ÷10 Prescale (50-Ω Input)

Direct Counting to 110 MHz **Manual Start/Stop (Totalize)**

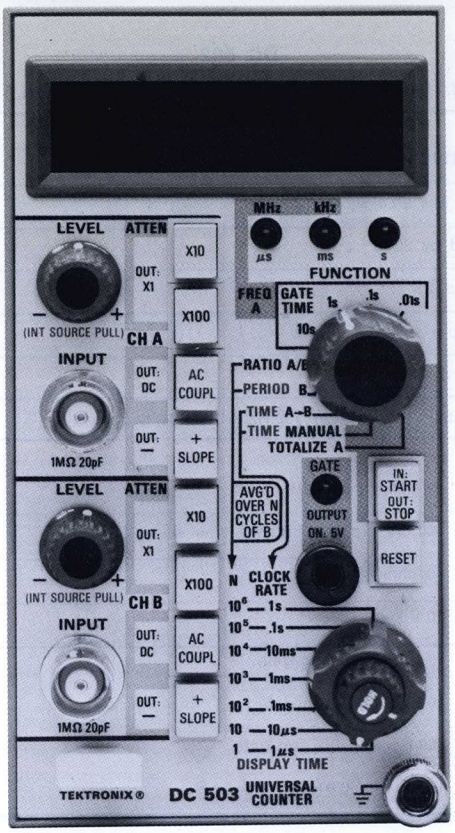
7-Digit LED Display **Time Base Option**

The DC 502 Digital Counter measures frequencies from 10 Hz to 550 MHz or totalizes events up to the register capacity of 10^7 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 PRE-SCALE 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 pre-scale input, 1 displayed count per 10 input events will result. Measurement display is accomplished with seven-segment LED's 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. LED's indicate when the gate is open, whether units are 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 1×10^{-5} accuracy (0° to 50°C) and aging rate of 1×10^{-5} per month. An optional clock with 5×10^{-7} accuracy (0° to 50°C) and aging rate of 1×10^{-7} per month is available at extra cost.

DC 502 Digital Counter **$975**
Option 1 5 MHz Time Base ..... **Add $95**
Option 4 Calculator ..... **Add $20**

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 & peak ac, or p-p ac) at ≤ 1 kHz	
Attenuation	X1, X5, X10, or X50	
Resolution	0.1 Hz with 10 sec gate, 1 Hz with 1 sec gate, 10 Hz with 0.1 sec gate, 100 Hz with 0.01 sec gate	
÷ 10 PRESCALE INPUT		
Frequency Range	NOT APPLICABLE	50 MHz to 550 MHz
Sensitivity		500 mV p-p (170 mV rms sine wave)
Impedance		50 ohms
Max Safe Input		10 V p-p
Resolution		1 Hz with 10 sec gate 10 Hz with 1 sec gate 100 Hz with 0.1 sec gate 1 kHz with 0.01 sec 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%)	
Accuracy	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%)	
Accuracy	Adjustable within 5 parts in 10^9 (0.0000005%)	
FCC Type Approval	Option 1 FCC Type Approval for frequency monitoring in AM and FM broadcast bands and on tv channels 2-6	Option 1 FCC Type Approval 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 push-buttons	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 Module	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 9,999,999 MHz	
CALCULATOR INTERFACE	Option 4—Adds appropriate decimal point output data for compatibility with TEKTRONIX 31/53 Calculator Instrumentation System	



DC 503

Direct Counting to 100 MHz

Six Measurement Functions

Period and Ratio Averaging

Interval Measurement Capability

NEW

DC 505

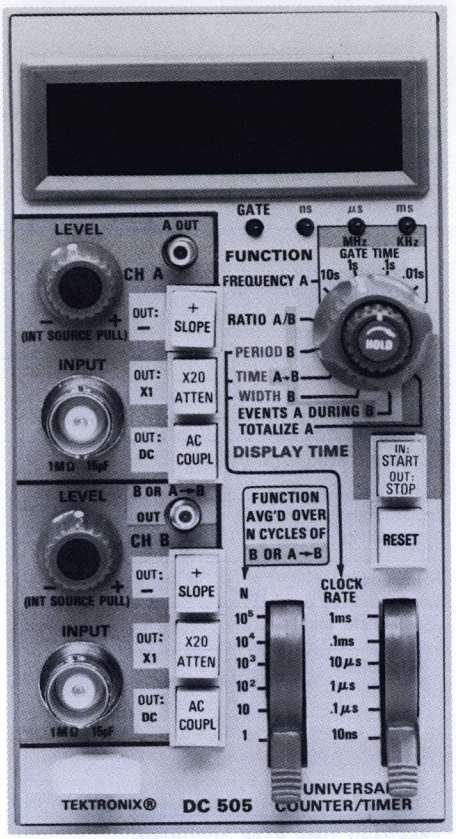
Direct Counting to 225 MHz

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 503 Universal Counter offers counting to 100 MHz. It has the versatility of six measurement functions; frequency, period, ratio, time A-B, time manual, and totalize. The two channels (A and B) have BNC inputs and separate trigger level, attenuator, and coupling mode controls. Seven-digit readout is via seven-segment light emitting diodes (LED's) 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 in digital controls, or teletype communications. 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 ..... **$725**
Option 1 (Time Base) ..... **add $ 95**
Option 4 (Calculator) ..... **add $ 20**

The DC 505 is a high-performance Universal Counter featuring direct counting to 225 MHz. Both channels, A and B, have equal response for ratio, time interval or other measurements requiring two channels. The DC 505 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 505 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 505 ..... **$1295**
Option 1 (Time Base) ..... **add $ 95**

COMPARISON OF CHARACTERISTICS

	DC 503	DC 505
DISPLAY	7 digits (7 seqment 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 ± timebase 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 ± timebase error; other contributions negligible	± 1 count ± timebase error. ± trigger error CH A* ± trigger error CH B*. ± channel delay match error of 2 ns max. $\pm \frac{\text{trigger level diff (CH A-CH B)}}{\text{dv/dt (CH A)-dv/dt (CH B)}}$ Best absolute accuracy, 6 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		≤ 100 picoseconds with 10 ns clock and 10^5 avg. factor. Clock rate selectable 10 ns to 1 ms. Avg. factor independently selectable from to 10^5 2 ns minimum pulse width
Accuracy		±1 count ± timebase error + trigger error**. Best absolute accuracy 3 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	± 1 count ± timebase error ± $\frac{\text{trigger error}}{N}$	± 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
EVENTS A DURING B	NOT APPLICABLE	Averaged over 1 to 10^5 occurances of signal at B.
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 sinewave) 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 ±2.5 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) ≤ 1 kHz 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/DC 502	
REAR OUTPUTS	Same as DC 501/DC 502	
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 AB, and TOTALIZE A. Logical zero is at ground (± .1 V). Logical one is 1 V (± .2 V) into an open circuit, or .5 V (± .1 V) into 50 Ω. Propagation delay from CH A INPUT to A OUT is ≈ 10 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 ≈ 10 ns.
CALCULATOR INTERFACE	Same as DC 501/DC 502	

* = $\left(\frac{.01\text{ V}}{\text{ddV/dt of stop edge}}\right)/N$

** = $\frac{.1\text{ V}}{\text{dV/dt of triggering edge}} \pm \left(\frac{.01\text{ V}}{\text{dV/dt of start edge}}\right)/N$

Note: Accuracies with averaging are dependent on the laws of statistics in the following cases.

1. Time A⇀B and Width B
2. Events A during B

TM 500-Series Test and Measurement System

0 Hz to 80 MHz Counter/Timer

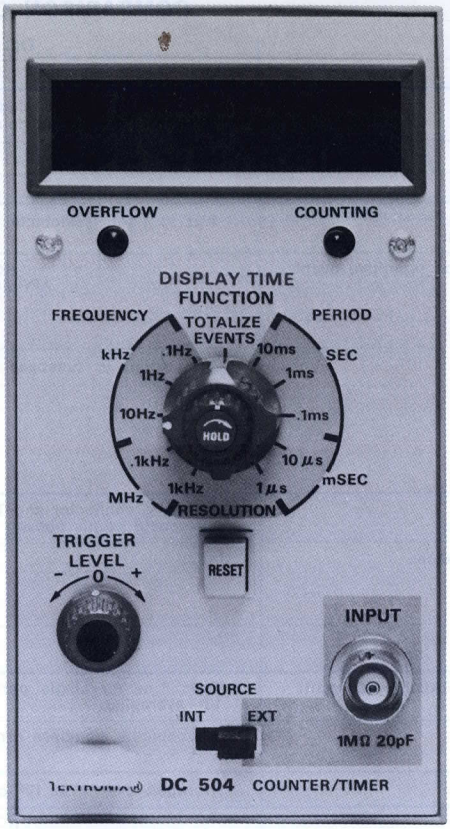
Direct Frequency Counting to 80 MHz

Period Measurement for Resolution at Low Frequency

RPM Counting

5-Digit LED Display

Low Cost



The DC 504 Counter/Timer measures frequency from 0.1 Hz (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 (LED's) 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

Frequency (or RPM)—Dc coupled: 0 Hz to at least 80 MHz. Ac coupled: 10 Hz to at least 80 MHz.

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).

Maximum Voltage— 250 V (dc and peak ac) at 500 kHz or less.

Impedance— 1 MΩ paralleled by approximately 20 pF.

Coupling—dc or ac.

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 10^8 per month	1 part or less in 10^7 per month
Accuracy	Adjustable to within 1 part in 10^7	Adjustable to within 5 parts in 10^9

Display Accuracy— ±1 count ± time-base accuracy (± trigger error in period mode only).

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).*

*Assuming transducer output is one pulse per revolution.

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 routing to optional rear-panel connectors on all Power Modules, or for intra-compartment routing in the TM 503 Power Module. BCD serial-by-digit (parallel data for one digit at a time) plus timing and control functions.

DC 504 Counter/Timer **$325**

Option 1 5 MHz Time Base ..... **Add $90**

Digital Events Delay For Oscilloscope Trigger

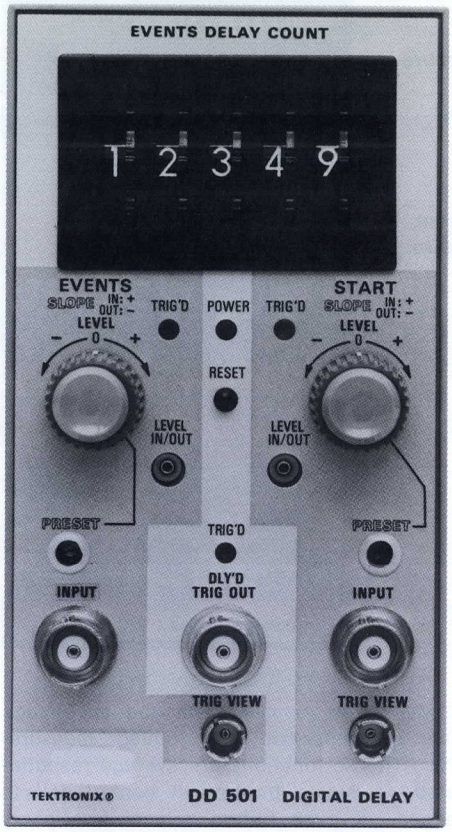
Delay to 99,999 Events

Divide by N up to 40 MHz

Pulse Counting to 80 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 DL'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.

CHARACTERISTICS
EVENTS DELAY

Count— 0 to 99,999 events.

Count Rate— Up to 80 MHz.

Throughput Time— 30 nsec or less.

Recycle Time— 25 nsec or less.

Start Pulse Lead Time—Simultaneous or ahead of the events pulse.

Reset—Resets start gate and events counter circuit.

TRIGGER

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

Input Impedance— 1 MΩ, 20 pF.

Sensitivity— 85 mV peak-to-peak.

Trigger Level Range and Slope— ±1 V.

Frequency Response—Up to 80 MHz.

Minimum Detectable Pulse Width— 5 nsec.

Trigger View Out—At least 0.5 V (200 Ω or less source impedance).

Triggered Light—Visual indication of events, Visual indication of start gate open.

OUTPUT

Width—Events pulse width plus 6 nsec or less.

Voltage— +0.8 V or less to at least +2.0 V into 50 Ω.

Light—Indicates output trigger.

Timing between EVENTS START and EVENTS—Lead time needed for EVENTS START to ensure recognition of next EVENTS pulse: 0 ns.

DD 501 Digital Delay **$495**
(See page 165 for description of the DD 501 in triggering applications with oscilloscopes, counter, etc.)

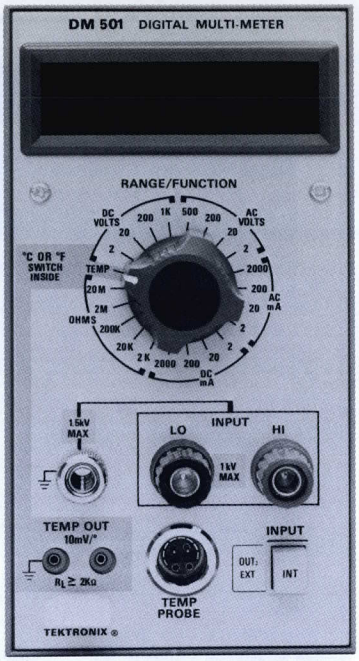
0.1% Dc Voltage Accuracy

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 push button 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 LED's. 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, accurate 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 & 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 10 kHz ±0.6% of reading, ±10 counts, 1 kHz to 10 kHz. Useful to 100 kHz.

Input R— $\frac{0.2\ \text{V}}{\text{Range Setting}} + 0.1\ \Omega$

RESISTANCE

Range— 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ full scale (19999 max reading). Accuracy with 0.3% ±2 counts to 2 MΩ, 0.5% ±2 counts on 20 MΩ scale.

Resolution— 0.1 Ω.

TEMPERATURE MEASUREMENT

Range— 55°C to +150°C (—67°F to +302°F selected by internal switch), using included temperature probe, accurate with 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°. 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; this capability cannot be ordered at a later date. By adding two connections inside DM 501, temperature probe can also be used as voltage/current/resistance probe, selectable by DM 501 external/internal source switch.

OTHER CHARACTERISTICS

Overrange Indication—Blinking display.

Measurement Rate— 5 measurements/second.

Maximum Input Voltage— 1kV. The front panel HI and LO connectors may be floated 1.5 kV maximum above ground, the rear inputs 350 V maximum. 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.

ORDERING INFORMATION

DM 501 Digital Multimeter **$505**

Option 1 Without Temp Probe (P6058) ..... **Sub $ 70**

Option 2 Without Temp Capability and Probe ..... **Sub $110**

Optional Accessory—High Voltage Probe to 40 kV
Order 010-0277-00 ..... **$55**

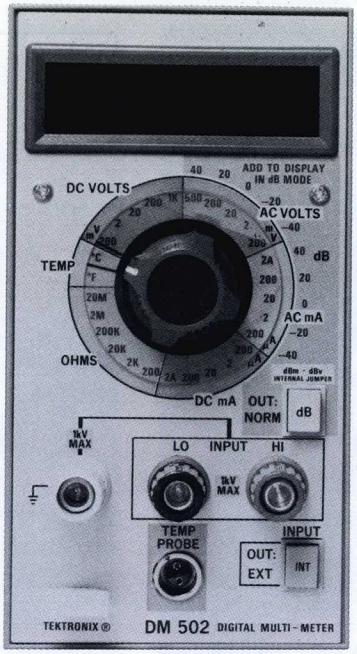
NEW DM 502

Selectable DB Readout

Six Functions including Temperature

0.1% Dc Voltage Accuracy

Auto Polarity



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 push buttons select dB readout of ac functions in lieu of ac voltage or current, and 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 LED's. The decimal point is automatically positioned by the RANGE/FUNCTION switch. Polarity indication is automatic. Maximum display at stated accuracy is 1999. A blinking display indicates overrange. Most digital meters provide no useful information in the overrange condition. The DM 502, however, has a usable 50% capability in dc voltage, dc current, and resistance modes. Thus, for example, dc voltages between 2.000 and 2.999 volts can be usably measured on the 2 V full scale range; however, the most significant digit (the 2) will be blanked, the display will blink to indicate overrange, but the three digits displayed will be of usable accuracy. Maximum safe inputs of 1,000 V dc and 2 amps dc must still be adhered to.

Non-floating BCD output (referenced to the low input), is available at the rear interface connector if user wired.

Inputs—The maximum input voltage is 1 kV. The front panel HI and LO connectors may be floated 1 kV maximum above ground, the rear inputs 350 V. Current measuring functions are fused at 2.5 A.

DC VOLTAGE

Range— 0.2 V, 2 V, 20 V, 200 V, 1000 V; accurate 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— <½ 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, accurate 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.

DB Range— —40, —20, 0, 20, 40. Reference is dBv (1 V) or dBm (1 mW dissipated in 600 Ω, 0.7746 V).

Accuracy (on any range)

DISPLAY READING	FREQUENCY RANGE	MAXIMUM ERROR
0 to +19.99	20 H 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

Usable to 100 kHz. Resolution 0.01 dB.

Response Time— ≤5 s.

RESISTANCE

Ranges— 200 Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2 MΩ, 20 MΩ.

Accuracy— 200 Ω range, 0.5%, ±1 count +.1 Ω; 2 kΩ thru 2 MΩ range, ±0.5%, ±1 count; 20 MΩ range, 1.0%, ±1 count.

Measurement Current and Voltage

Range	Current	Full Scale Voltage
200 Ω	1 mA	0.2 V
2 kΩ	1 mA	2 V
20 kΩ	100 μA	2 V
200 kΩ	10 μA	2 V
2 MΩ	1 μA	2 V
20 MΩ	0.1 μA	2 V

Response Time— 200 Ω, 20 kΩ, 20 kΩ, 200 kΩ, 2 MΩ Ranges, ≤½ s; 20 MΩ Range, ≤5 s.

DC CURRENT

Ranges— 200 μA, 2 mA, 20 mA, 200 mA, 2 A. Accuracy ±0.2% of reading, ±1 count.

Response Time— <½ s.

Input Impedance— $\frac{0.2\text{ V}}{\text{Range Setting}} + 0.1\ \Omega.$ (<2 kΩ with 200 μA range)

AC CURRENT

Current Range— 200 μA, 20 mA, 20 mA, 200 mA, 2 A accurate within ±0.6% of reading, ±1 count, 40 Hz to 10 kHz. Usable to 100 kHz.

DB Range— —40, —20, 0, 20, 40. Reference is 1 mA (dBV) or 0.7746 mA (dBm). Accuracy: see table under AC VOLTAGE above.

Response Time— <5 s.

Input Impedance— $\frac{0.2\text{ V}}{\text{Range Setting}} + 0.1\ \Omega.$ (<2 kΩ with 200 μA range)

TEMPERATURE MEASUREMENT

Ranges—Centigrade: —55°C to +150°. Fahrenheit: —67° to +200°. 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).

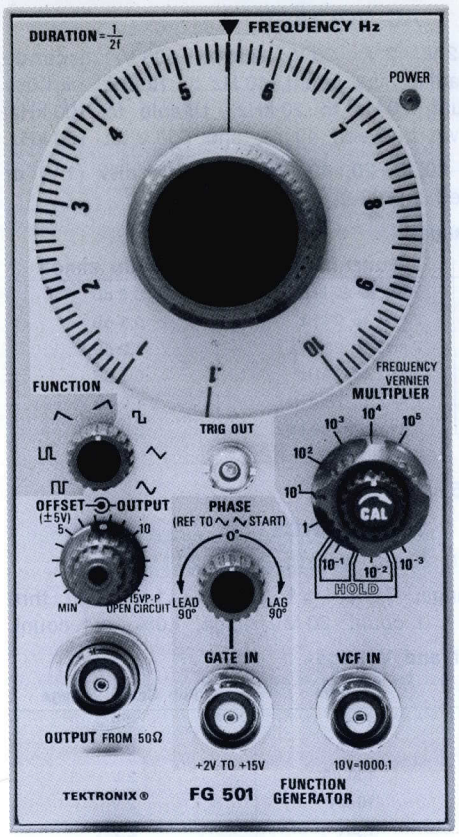
Standard Accessories— 1 Pair Test Leads (003-0120-00), 1 P6430 Temp Probe (010-6430-00).

ORDERING INFORMATION

DM 502 Digital Multimeter **$395**

Option 2 without Temp Capability and Probe ..... **Sub $100**

Optional Accessory—High Voltage Probe to 40 kV Order (010-0277-00) **$55**



FG 501

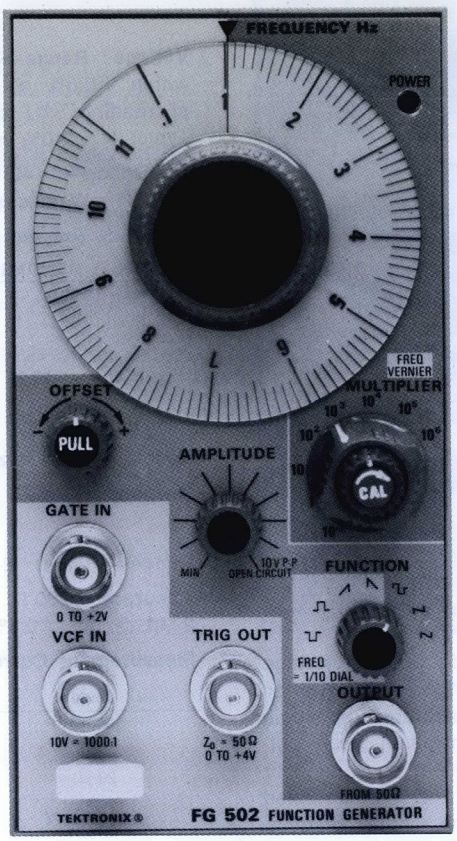
Five Waveforms

.001 Hz to 1 MHz

VCF and Gated Burst

Hold Mode

The FG 501 is a general-purpose, low frequency function generator producing low distortion sine, square, triangle, pulse, and ramp waveforms. Frequency is selectable from .001 to 1 MHz (switched in decade steps). An external VCF input permits controlling 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 up 7.5 V p-p into a 50-ohm load, with dc offset also adjustable up to ±2.5 V.



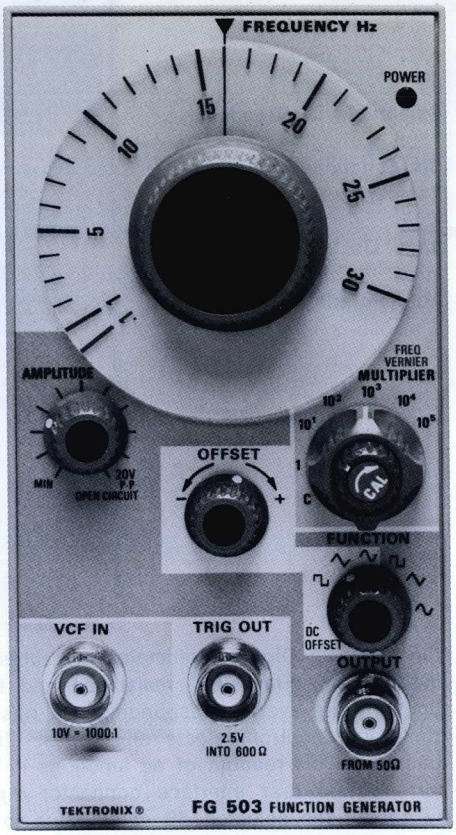
FG 502

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 pulse. Output frequency is continuously variable from 0.1 Hz to 11 MHz and can be controlled either from the front panel or remotely by an external voltage. 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. This higher frequency capability allows measuring bandwidth of filters or frequency response of video amplifiers, and simulating transmitted signals into broadcast band frequency receivers. 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 places in the telephone industry.



NEW FG 503

Three Waveforms

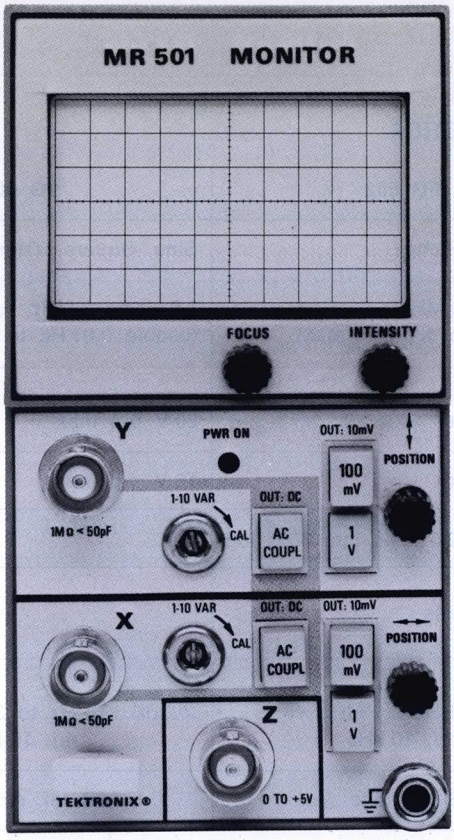
1.0 Hz to 3 MHz

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 select frequencies in overlapping ranges from 1 Hz to 3 MHz. The output frequency may be swept over a 1,000:1 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.

COMPARISON CHARACTERISTICS

	FG 501	FG 502	FG 503
Waveforms	Sine, Square, Triangle, Pulse, Ramp		Sine, Square, Triangle
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)
Amplitude			
Open Circuit	15 V p-p max, 0.5 V p-p min	10 V p-p max	20 V p-p max
Into 50 ohms	7.5 V p-p max, 0.25 V p-p min	5 V p-p max	10 V p-p max
Offset	±5 V dc open circuit, ±2.5 V dc into 50 Ω load		
Output Impedance	50 ohms		
Amplitude Flatness			
Sinewave	±1.5 dB, 0.01 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
Square, Triangle	±1 dB ref. sine	±3 dB ref. sine	± 1dB ref. sine
Frequency Stability	≤0.05% for 10 min, ≤0.1% for 1 hour, ≤0.5% for 24 hours		
Sinewave Distortion	≤0.5% 1 Hz to 20 kHz ≤1.0% 20 kHz to 100 kHz ≤2.5% (—32 dB) 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
Squarewave Response	≤100 ns rise and fall ≤5% total aberrations	≤25 ns rise and fall ≤5% total aberrations	≤60 ns rise and fall ≤3% total aberrations
Triangle Linearity	1% 0.001 Hz to 100 kHz 2% 100 kHz to 1 MHz	1% 0.1 Hz to 110 kHz 3% 100 kHz to 1.1 MHz 5% 1 MHz to 11 MHz	1% 1.0 Hz to 100 kHz 5% 100 kHz to 3.0 MHz
Voltage Controlled Frequency	1000:1 max with 0 - 10 V external signal. Input impedance, 10 kΩ. Bandwidth, ≥50 kHz	1000:1 max with 0 - 10 V external signal. Max input slew rate, ≥0.5 V/μs	
Burst/Gate	Input impedance, 1 kΩ. Control signal required +2 V; +15 V max. Bursts are synchronous with gate. Phase continuously variable from —90° to +90°.	Control signal required, +2 V, not to exceed +15 V. Bursts are synchronous with gate	Not Applicable
Trigger Output	TTL compatible; +2.5 V into 600 Ω	+2.5 V into 50 Ω	+2.5 V into 600 Ω
Price	**FG 501 ..... $400**	**FG 502 ..... $490**	**FG 503 ..... $265**



2 MHz X-Y Bandwidth

10 mV to 10 V Deflection Factors

Dc to 200 kHz Z-Axis Input

Compatible with RG 501

Small size, 2 MHz X-Y bandwidth and selectable sensitivity make the MR 501 a highly desirable monitor oscilloscope. It may be used with the RG 501 to form a complete oscilloscope having a wide range of sweep rates and full triggering facilities. Up to six X-Y channels are available in a rack width TM 500 system.

VERTICAL and HORIZONTAL AMPLIFIERS

Bandwidth—Dc to at least 2 MHz.

Deflection Factor—10 mV/div to 1 V/div in decade steps. Accurate within 3%, continuously variable between steps and to at least 10 V/div.

Input R and C—1 MΩ paralleled by less than 50 pF.

Input Coupling—Ac or dc.

Maximum Safe Input Voltage—350 V (dc + peak ac).

X-Y Phase Shift—within 1° from dc to 100 kHz.

Z AXIS AMPLIFIER

Bandwidth—Dc to at least 200 kHz.

External Input Voltage—Plus 5 volts turns crt beam on from an off condition (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 divisions, 0.203 inch/div.

Phosphor—P31

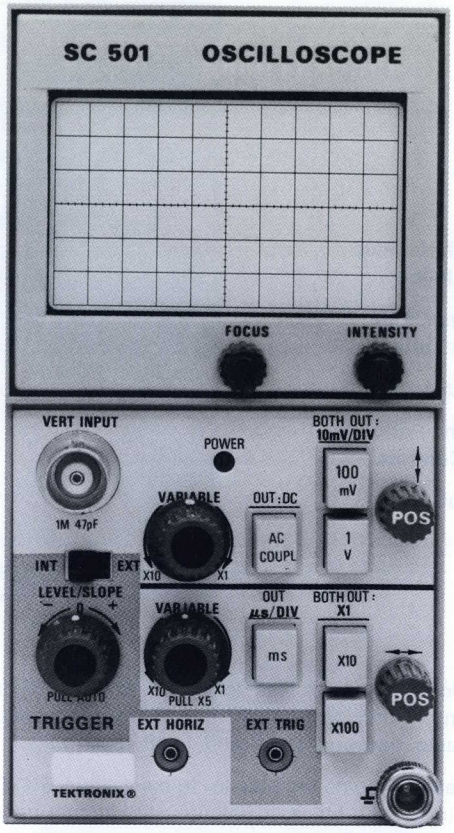
MR 501 X-Y Monitor **$445**

5 MHz Bandwidth

Single Compartment Size

2½-inch Crt

Versatile Operating Features



The SC 501 is a single channel 5 MHz plug-in unit oscilloscope with a 2.5 inch crt display which occupies a single TM 500-Series plug-in compartment. This oscilloscope capability significantly enhances the application of the multifunctional TM 500 Series, Test and Measurement Instruments.

With the SC 501 a multitude of versatile test systems may be structured from the TM 500 Series to suit specific needs for time and frequency response, modulating waveforms, power for devices under test, stimulus and response studies and voltage, current, resistance and temperature measurements. The SC 501 fits easily into a single compartment of any TM 500 mainframes, for use 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 and 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

Maximum 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 division portion within center eight divisions): ≥5%.

External Horizontal Amplifier—Bandwidth: dc to 100 kHz. Input impedance: ≥100 kΩ paralleled by 25 pF. Maximum input voltage: ±3 V.

TRIGGER

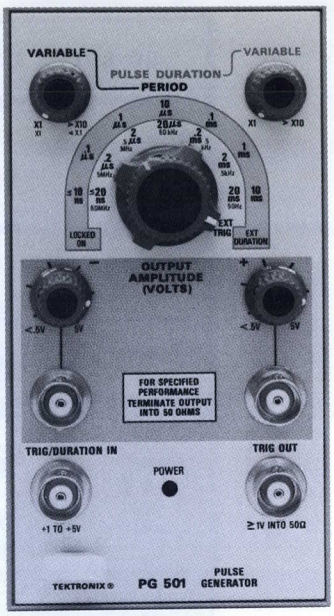
Normal Trigger Sensitivity (Trigger Level/Slope In)—Internal: dc coupled, 0.4 major division of deflection at dc; increasing to 1.0 major division of deflection at 5 MHz. External: dc coupled, 1 V minimum to 5 V maximum from dc to 5 MHz. External trigger input impedance: 22 kΩ paralleled by approximately 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

Graticule—Type: Internal black lines, nonilluminated. Area: Six divisions vertical by 10 divisions horizontal. Each division equals 0.203 inch. Phosphor: P31 standard

SC 501 Plug-in Oscilloscope **$650**



5 Hz-to-50 MHz Plus Triggered Mode

Simultaneous Plus and Minus Outputs

5 V and 3.5 ns Into 50 Ω

Independent Period and Duration Controls

Trigger Out

Pulse Period— 20 ns or less to 20 ms (within 5% from 0.2 μs to 2 ms and within 15% at 20 ms) in decade steps. Continuously variable between steps and to at least 0.2 s.

Pulse Duration— 10 ns or less to 10 ms (within 5% from 0.1 μs to 10 ms) in decade steps. Continuously variable between steps and to at least 0.1 s.

Duty Factor—At least 70% for periods of 0.2 μs or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Risetime and Falltime— 3.5 ns or less.

Aberrations—Within 3.5% at 5 V amplitude.

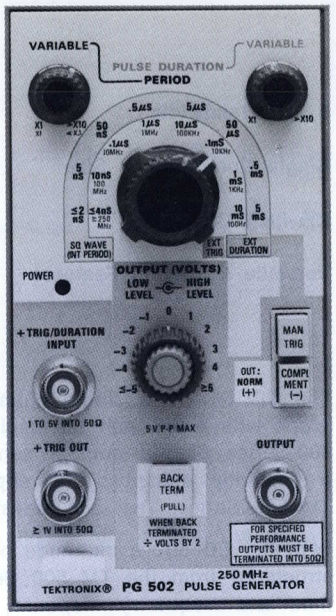
Pulse Amplitude—0.5 V or less to at least 5 V into 50 Ω load.

Pulse Coincidence (+ and − outputs)—Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output—At least +1 V into 50-Ω load, occurring approx 8 ns prior to pulse output.

External Trigger/Duration Input—At least +1 not to exceed +5 V (dc + peak ac). Trigger/Duration Recognition Level, +1 V or less. Trigger/Duration reset level, +100 mV or less. Minimum on and off time is 10 ns.

PG 501 Pulse Generator **$325**



10 Hz to 250 MHz

1 ns Rise Time

5 V Pulse Amplitude Into 50 Ω

Independent Pulse Top and Bottom Level Controls

Selectable Internal Reverse Terminations

Short Proof Output

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 circuits.

Pulse Period— 4 ns or less to 10 ms (within 5% in calibrated positions except 15% on 10 ms range) in decade steps. Continuously variable between steps and to at least 100 ms.

Pulse Duration— 2 ns or less to 5 ms (within 5% in calibrated positions except 15% on 5 ms range) in decade steps. Continuously variable between steps and to at least 50 ms. Square-wave mode approximately 50% duty factor.

Duty Factor—At least 50% in normal mode, approximately 100% in complement mode. Minimum off time is 2 ns.

Pulse Risetime and Falltime—Less than 1 ns.

Aberrations—Within ±5% at 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 μs after transition.

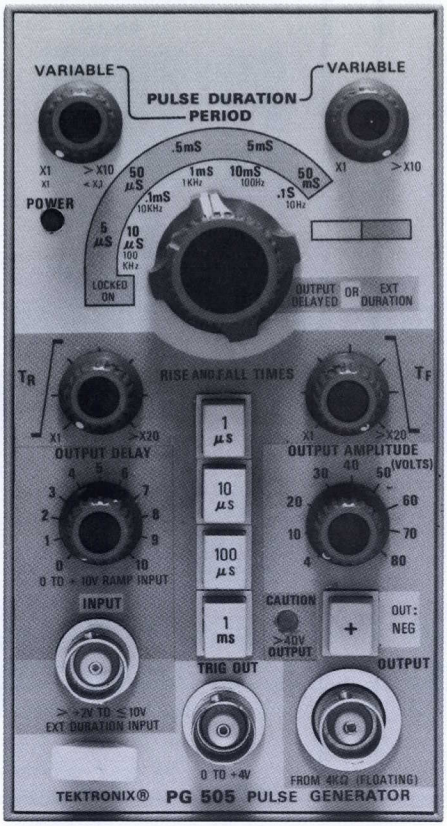
Pulse Amplitude—Pulse high and low levels independently adjustable over a −5 to +5 V range, with pulse amplitude limited between ≥0.5 V and ≤5 V. Complement switch inverts pulse between same two selected voltage levels. Front panel selectable 50 Ω internal back termination divides output levels by two.

Offset— ±5 V maximum, depends on amplitude setting.

Trigger Output—At least 1 V into 50 Ω, occurring approx 10 ns prior to pulse output.

External Trigger/Duration Input—Trigger threshold less than 1 V; reset threshold greater than 0.1 V; maximum input 5 V.

PG 502 Pulse Generator **$1150**



10 Hz-to-100 kHz

80 V Output

Variable Duration

Variable Rise Time and Fall Time

Delay Mode

The PG 505 Pulse Generator features: floating output; high output amplitude (80 volts); independently adjustable rise and fall times; and variable pulse period. The instrument is useful in physiological laboratories for simulating nerve impulses and in the educational lab as a general-purpose pulse generator. 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 on the ramp, thus providing controllable time delay at any 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% peak to peak at maximum output into 4 kΩ, 20 pf load.

Residual Dc Offset—less than 0.5% at maximum output.

Pulse Amplitude— 4 V or less to at least 80 V from a 4 kΩ source. Polarity selectable for + or — output.

Isolation of Pulse from Ground— 200 V dc.

Trigger Output— 0 to +4 V into 50 Ω.

External Trigger/Duration Input—Accepts TTL level signals.

Delay Mode—Delay range (with respect to delay signal) 0 to 10 V within 5%.

Delay Jitter—Less than 0.1% with a 10 V ramp input signal.

Custom Pulse Duration Range— 5 μs and slower depending on internally installed capacitor.

Custom Pulse Period Range— 10 μs and slower depending on internally installed capacitor.

PG 505 Pulse Generator **$295**

COMMON CHARACTERISTICS

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 Vdc at 1 A (20°C to 30°C).

Load Regulation—Within 100 mV with a 1 A load change.

Line Regulation—Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A)— 5 mV p-p or less; 100 mV rms or less.

Stability—0.5% or less drift.

Overload Protection—Automatic current limiting and over-temperature shutdown.

Data Inputs/Outputs

Available at plug-in connector for routing to optional rear-panel connectors on all Power Modules, or for intra-compartment routing in the Power Module.

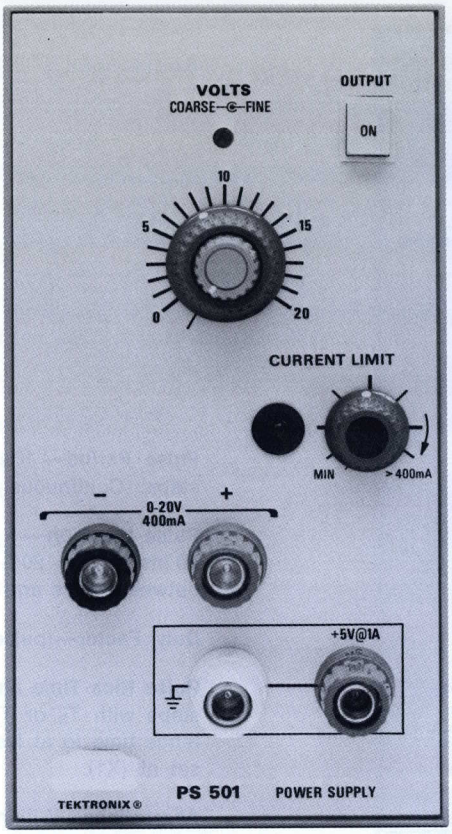
Supply output through rear connection

Remote sense

Remote analog voltage control

Remote analog current limit control

Front-panel controls and connections should be disabled if interface access is desirable.



PS 501
POWER SUPPLY

Floating Output, 0 - 20 V

0 to 400 mA

Precise Regulation

Low Ripple and Noise

Fixed Output + 5 V

Output— 0 V to ±20 VDC.

Current Limit— 0 mA to 400 mA.

Minimum Resolution— 10 mV.

Line Regulation—Within 5 mV for a ±10% line voltage change.

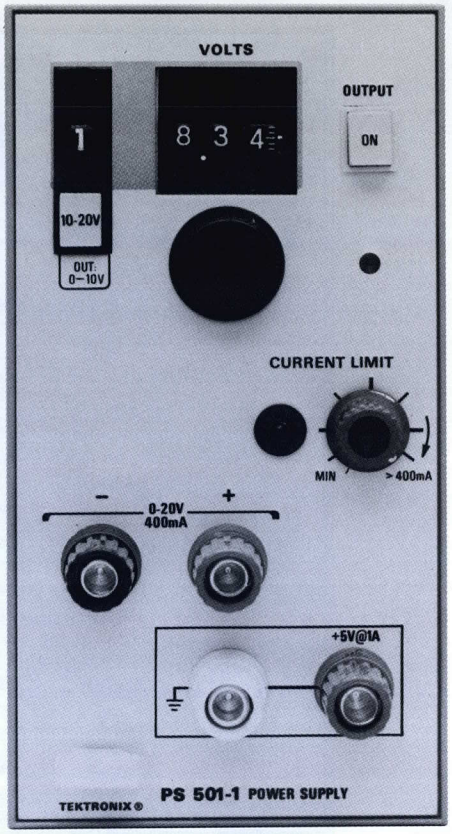
Load Regulation—Within 1 mV with a 400 mA load change.

Ripple and Noise— 0.5 mV p-p or less; 0.1 mV rms or less.

Temperature Coefficient— 0.01%/°C or less.

Transient Recovery Time— 20 μs or less for a constant voltage to recover within 20 mV of nominal output voltage after a 400 mA change in output current.

PS 501 Power Supply **$95**



PS 501-1
POWER SUPPLY

Precision Voltage Control

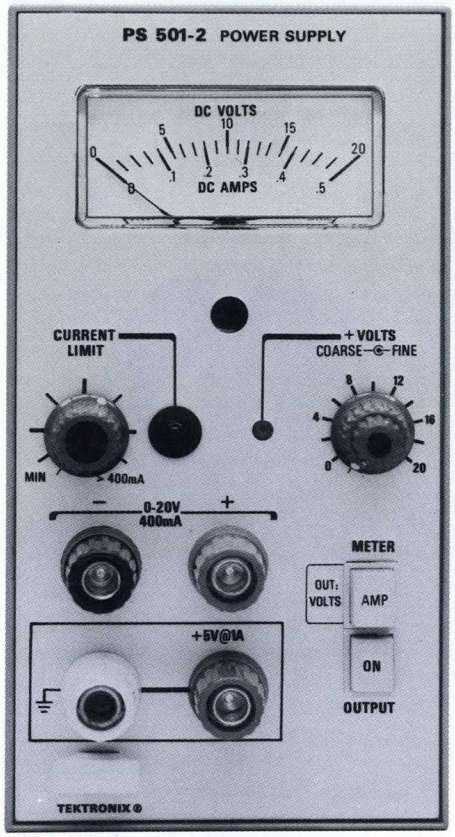
Easy To Read and Set

Other Features of PS 501

Minimum Resolution— 1.6 mV.

Voltage is selectable within 0.5% by a 10 turn potentiometer with a 3-digit in-line dial and range switch.

PS 501-1 Power Supply **$130**



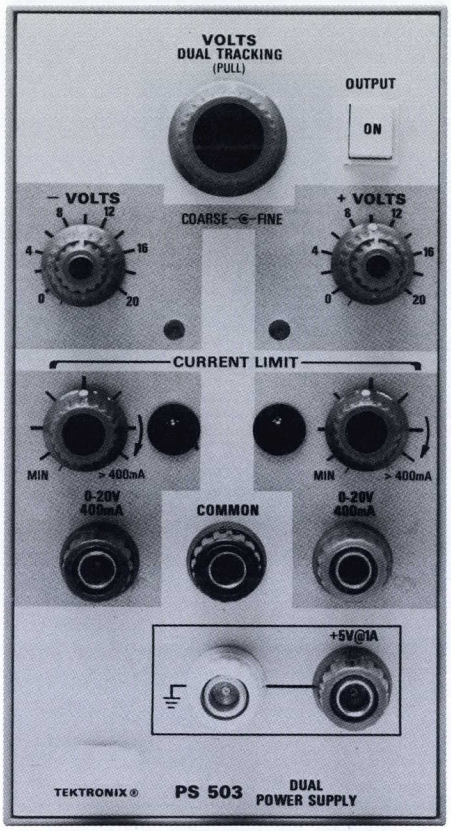
PS 501-2 POWER SUPPLY

Dual-Range Meter Readout

Other Features of PS 501

Meter—Dual-range, 0 to 500 mA or 0 to 20 Vdc.

PS 501-2 Power Supply **$150**



PS 503 DUAL POWER SUPPLY

+ and — Independent Controls

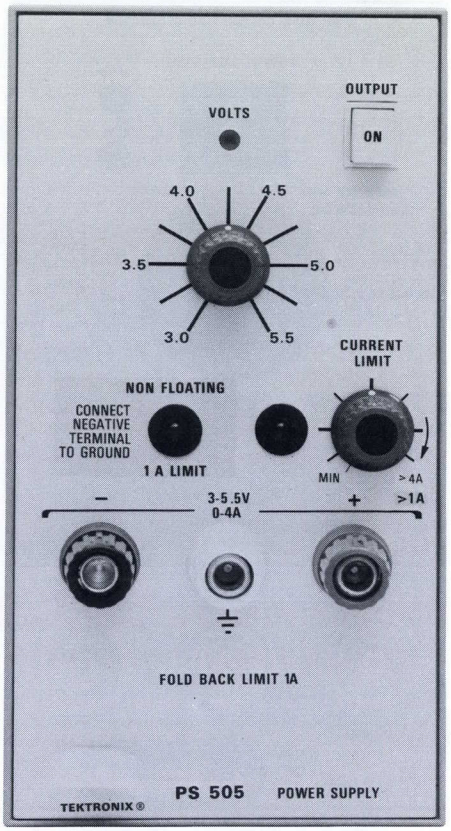
Tracking Voltage Control

Other Features of PS 501

Output— 0 V to ±20 Vdc with respect to the common terminal or 0 V to 40 Vdc across the + and — terminals. Outputs can be varied independently or at a constant ratio.

Current Limit— 0 to 400 mA on each supply.

PS 503 Power Supply **$195**



NEW PS 505 POWER SUPPLY

Floating Output

3 to 5.5 V at 4 A

Overvoltage Protection Standard

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 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.

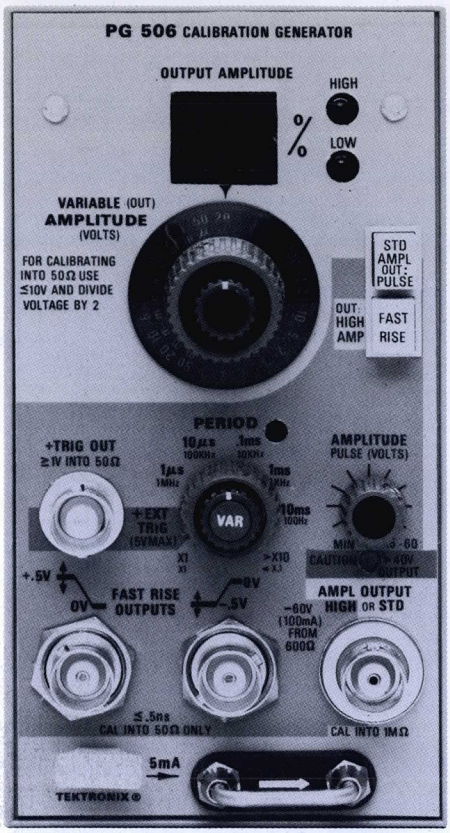
Ripple and Noise— 3 mV peak-to-peak or less.

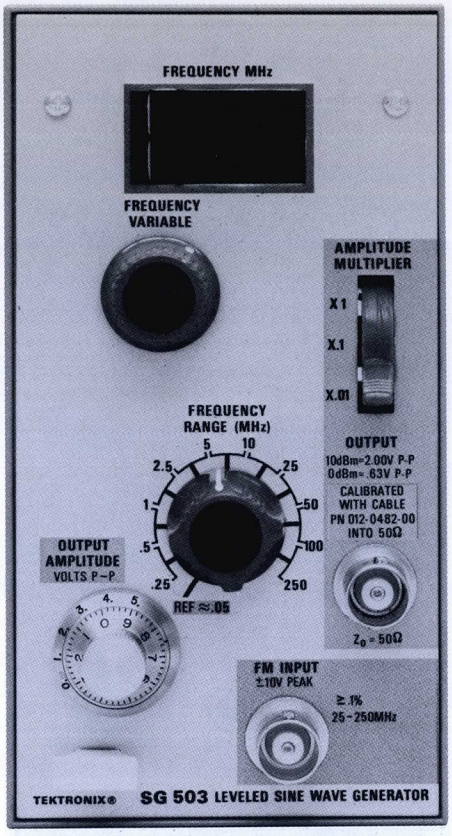
Temperature Coefficient— 0.01%/°C or less.

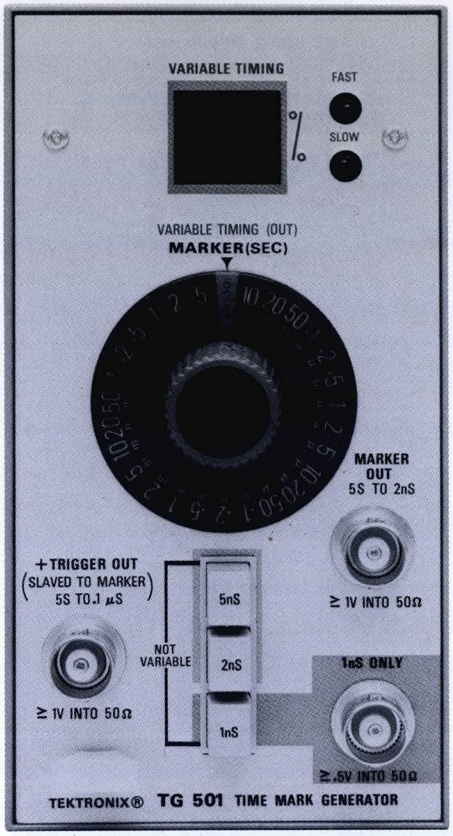
Stability—0.1% +5 mV of drift in 8 hours.

Foldback Current—When output current exceeds 4.1 A, current folds back to less than 1.5 A and latches.

PS 505 Power Supply **$150**







PG 506
CALIBRATION GENERATOR

Three Square-Wave Output Modes

10 Hz to 1 MHz

Direct Readout of Scope 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 sensitivity error. Simultaneous plus and minus low-level fast-rise (1.0 ns) square waves or high amplitude (60 volt) extremely clear square waves are available at frequencies from 10 Hz through 1 MHz for checking attenuator performance and transient response of oscilloscopes. 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 100 volts to 200 microvolts. In this same mode, amplitude may be varied around the calibrated level until the square wave aligns with the oscilloscope graticule divisions; scope sensitivity 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 approximately 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 MODE

Period—One microsecond to 10 milliseconds (within 5%) in decade steps with the VARIABLE control on CAL position. VARIABLE extends period to at least 100 milliseconds.

Symmetry—Approximately 50% duty cycle.

HIGH AMPLITUDE OUTPUT

Risetime—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 25 mV p-p, whichever is greater, when terminated in 50 Ω.

Polarity—Positive. Measured from a negative potential to ground.

Output Resistance Source— 600 Ω within 5%.

FAST RISE OUTPUTS

Risetime (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 7.5 mV p-p, whichever is greater, during first 10 ns.

Flatness—Within 0.5% after first 10 ns.

Polarity—Simultaneous positive and negative. Positive is measured from a negative potential to ground. Negative is measured from a positive 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 **$975**

SG 503
SIGNAL GENERATOR

Regulated, Constant-Amplitude Output

Variable, 250 kHz to 250 MHz

Autoranging Frequency Counter

The SG 503 Signal Generator is a general-purpose leveled sine-wave oscillator. It provides a regulated, constant-amplitude output 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. The SG 503 is essentially intended for use as an oscilloscope calibration device. It is ideally suited for measuring bandwidths up to 250 MHz, virtually including all but the very highest performance oscilloscopes currently available. The three-digit counter output provides a much more accurately known output frequency than is available from simply reading a calibrated dial. The wide range of calibrated outputs is also desirable to measure not only one fixed amplitude into the oscilloscope, but covers enough range to measure the performance of oscilloscope attenuators anywhere in the frequency range.

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 peak-to-peak into 50 Ω termination in three decade ranges.

Amplitude Accuracy—At 50 kHz reference, within 3% of indicated amplitude on (X1) range, 4% on (X.1) range and 5% on (X.01) range.

Flatness—(peak-to-peak). From 50 kHz to 100 MHz, output amplitude will not vary more than 1% of value at 50 kHz. From 100 MHz to 250 MHz, amplitude variation is within 3%.

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 **$690**

TG 501
TIME MARK GENERATOR

Marker Outputs, 5 s to 1 ns

Direct Readout of Scope 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 indicating percentage of timing error between the selected marker and the resultant display. This feature not only provides direct readout in terms of percent error, but also helps eliminate errors associated with visually determining accuracy from a display. Pulses at accurately known repetition rates are provided through a stable internal quartz standard, useful for checking and adjusting time bases in oscilloscopes. Variable output, with direct readout of oscilloscope time base error is invaluable as a means of quickly verifying oscilloscope performance without going through full calibration. A wide range of timing signals is available and provides for checking and adjusting calibrated time bases of any oscilloscope. An external trigger output is provided for the oscilloscope.

Markers— 5 s through 1 ns in a 1-2-5 sequence.

Marker Amplitude—≥1 V peak on 5 s through 10 ns markers. ≥750 mV peak-to-peak into 50 Ω on 5 ns and 2 ns markers. ≥200 mV peak-to-peak 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 of 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
Accuracy	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.

Error Readout Range—to ±7%.

Error Readout Resolution—to 0.1%.

TG 501 Time Mark Generator **$745**

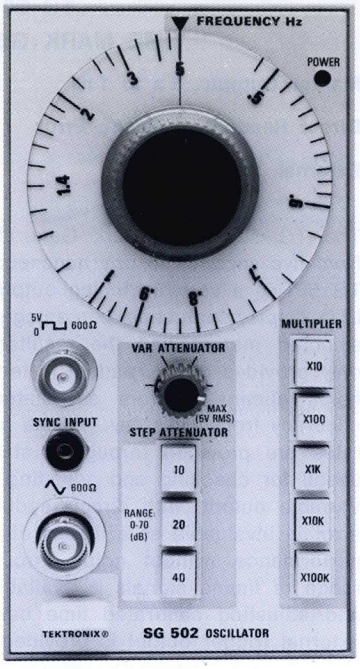
Option 1 5 MHz Time Base ..... **Add $95**

5 Hz to 500 kHz Sine and Square Waves

Low Distortion Sine

5 V Rms Open Circuit—600 Ω Source

0-40 dB Continuously Variable Plus 0 - 70 dB in 10-dB Steps



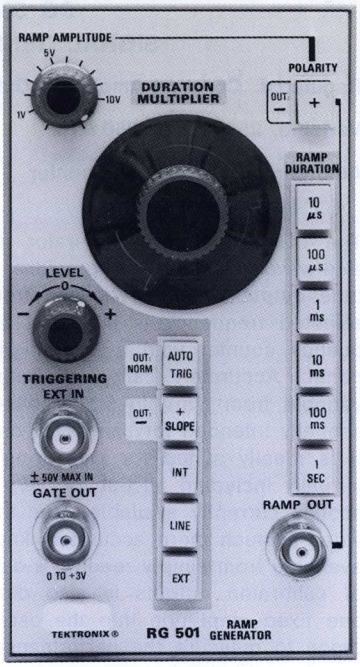
10 μs to 10 s Ramp Duration

Plus or Minus Output

10-V Amplitude

Scope-type Trigger Functions

Gate Out, TTL Compatible



SINEWAVE

Frequency Range— 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of dial setting from 5 Hz to less than 50 kHz; within 10% of dial setting from 50 kHz to 500 kHz.

Amplitude Response—Flatness is 0.3 dB over entire range (1 kHz reference).

Attenuation—Selectable from 0 dB to 70 dB in 10, 20 and 40 dB steps with push buttons. Accurate within 2% for each step selected, additive. An uncalibrated control provides continuous variation from 0 dB to 40 dB.

Harmonic Distortion—Less than 0.1% from 20 Hz to 50 kHz. Less than 1% over the remaining frequency range. Typical less than 0.03% from 20 Hz to 50 kHz, less than 0.2% over the remaining range.

Hum and Noise—Less than 0.1% of rated output.

Maximum Output Voltage— 5 V rms open circuit; 2.5 V rms into 600 Ω.

Output Impedance—600 Ω.

SQUAREWAVE

Frequency Range—Same as sinewave. The square wave switches on at the 0° and 180° of sine out.

Rise and Fall Time—50 ns or less.

Amplitude— +5 V, fixed, open circuit

Output Impedance—600 Ω.

SYNC INPUT

Oscillator can be synchronized to external signal. Sync range, the difference between sync frequency, and set frequency is a linear function of sync voltage.

Input Impedance—10 kΩ.

Measurements made at rated output and terminated in 600 Ω.

SG 502 Oscillator **$325**

RAMP

Ramp Duration—Decade ranges of 10 μs to 1 s, extends to 10 s with 1-10 duration multiplier. Accurate within 3% when multiplier is at X1 (multiplier not calibrated).

Ramp Amplitude—Continuously variable from 50 mV or less to at least 10 V, either polarity. Dc level between ramps, 0 V within 20 mV.

Ramp Gate—From a low state of 0 V, within 100 mV, the ramp gate rises to +3 V, within 0.6 V, in 100 ns or less. Falltime is 100 ns or less. Gate source impedance is 160 Ω, within 5%.

Output Characteristics—Minimum load resistance, 3 kΩ; maximum load capacitance, 300 pF.

TRIGGERING

Auto Triggering—Provides free-running signal in absence of trigger. Locks automatically to trigger with a frequency above 20 Hz and at least 200 mV amplitude.

External Triggering—Sensitivity is at least 200 mV p-p, dc to 100 kHz. Input impedance approx 9.5 kΩ. 50 V (dc + peak ac) maximum input.

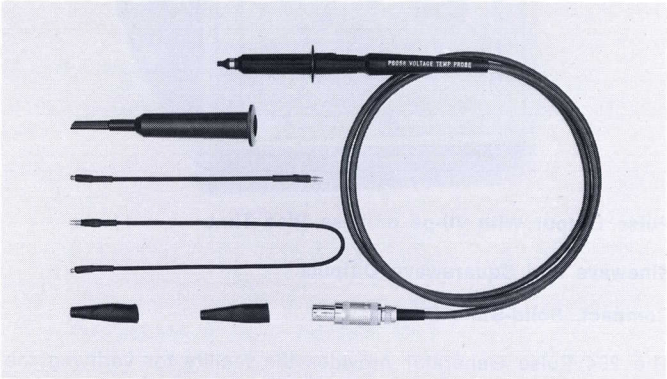
Internal Triggering—Same as external except that the trigger source is via the rear interface.

Line Trigger—Triggers at line frequency.

Trigger Level Range—±1 V.

RG 501 Ramp Generator **$175**

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. Provision for user options with special-purpose hardware provide added 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 VOLTAGE/TEMPERATURE PROBE

The P6058 Probe is a combination 0 to 500 V dc voltage and temperature measuring device. It is designed with special tips, leads and clip configurations for voltage and temperature measurements specifically with the DM 501. It has a 46-inch cable, including probe body. Connections supply power to the probe sensor transistor and signals to the digital multimeter.

P6058 Probe, Order 010-0260-00 ..... $75

Includes: P6058 Probe (010-0259-00); probe retractable hook tip (013-0121-00); 5-inch ground lead (screw-in, 175-0848-01); 12-inch ground lead (screw-in, 175-0848-02); two miniature alligator clips (344-0046-00).

PROTECTIVE FRONT COVERS

A snap-on front cover of high impact plastic is available for the TM 503 (shown) and TM 504 mainframes. The covers protect panel faces during transit or storage. Covers add 1¾" to the length of the mainframes and clear the longest knob projections on any of the plug-ins.

Front Panel Cover (TM 503), Order 200-1566-00 ..... $10
Front Panel Cover (TM 504), Order 200-1727-00 ..... $11

FLEXIBLE EXTENDER CABLE

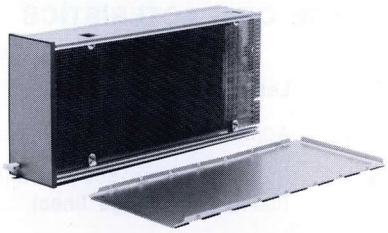
Designed to couple with TM 501, TM 503 and TM 504 mainframe inside rear interface board connections. It provides a completely flexible connecting point outside the mainframe for plug-in operation during test or check-out.

Extender Cable, Order 067-0645-01 ..... $44

TM 500 CARRYING CASES

Luggage-type case molded of high-strength glass epoxy. 12 pounds in weight, includes rubber feet, lockable latches plus handle. The TM 503 model (shown) has a foam insert molded to accept a TM 503, with or without cover. Also holds a spare TM 500 plug-in or a 200-Series miniscope and a third compartment accepts accessories or tools. A TM 504 model is fitted for the TM 504 only.

TM 503 Carrying Case, Order 016-0565-00 ..... $ 93
TM 504 Carrying Case, Order 016-0608-00 ..... $100



TM 500-SERIES BLANK PLUG-IN KIT

Provides a perforated blank printed circuit board, plug-in frame, panel and securing hardware for those who wish to design a special-purpose plug-in.

Blank Plug-in Chassis, Order 040-0652-00 ..... $17

TM 500-SERIES BLANK PANEL

When operating TM 500-Series instruments with less than the full complement of plug-ins, the blank panel can be used to cover unused compartments.

Blank Plug-in Panel, Order 016-0195-01 ..... $4.70

50-Ω PRECISION COAXIAL CABLE

For use with the PG 502, PG 506, SG 503 and SG 504. These instruments are internally calibrated for use with this 3-ft. 50-Ω coaxial cable into a 50-Ω load. (Cable is furnished as an accessory with these instruments).

50-Ω Cable, Order 012-0482-00 ..... $13.25

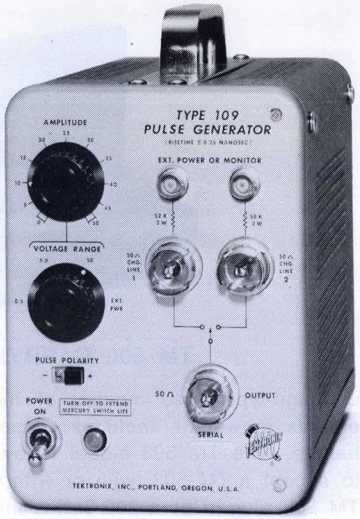
RISE TIME LIMITER

For use with the PG 502 Pulse Generator. Limits one nanosecond fast pulse to six nanoseconds for some applications.

Rise Time Limiter, Order 015-0249-00 ..... $25

ADDITIONAL ACCESSORIES

Terminal Accessory Adapter Kit for AM 501, Order 013-0146-00 ..... $8.25
Terminal Accessory Adapter Kit for PS 501, PS 503, Order 013-0152-00 ..... $8.25
Manual (one shot) Trigger Generator for RG 501, PG 501, PG 505. Order 016-0597-00 ..... $25.00
40 kV High Voltage Probe for DM 501, DM 502, Order 010-0277-00 ..... $55



250-ps Rise Time Pulses

Alternate Pulses of Equal or Different Time Duration

0-55 V Calibrated Variable Amplitude

Selectable Polarity

The 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS

CHARACTERISTICS	PERFORMANCE
Risetime	Less than 250 ps
Amplitude	Adjustable from 0 through 50 V
Repetition Rate	Preset between 550 p/s and 720 p/s (using two charge lines)
Pulse Duration	0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate
Decay	approx 10% in 300 ns
Polarity	Positive or negative
Output Impedance	50 Ω

Charge Lines—Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

External Dc Charge Voltage Inputs—Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volt input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

Power Requirement—Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

Dimensions and Weights

Height	≈8 in	19.7 cm
Width	≈5 in	12.2 cm
Length	≈12 in	30.2 cm
Net weight	≈8 lb	3.8 kg
Shipping weight	≈13 lb	≈5.9 kg

Included Accessories—Charge network (017-0067-00); three 5-ns 50-Ω RG123 cables (017-0502-00); 3-conductor power cable (161-0010-03).

109 Pulse Generator **$595**

Pulse Output With 70-ps or Less Rise Time

Sinewave and Squarewave Outputs

Compact, Solid-State Design

The 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pretrigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent 50-Ω signal source for TDR measurements. The 284 is available in a cabinet version, or modified for rackmounting in a standard 19-inch rack using the optional Rack Adapter.

OUTPUT CHARACTERISTICS

Pulse Output—70 ps or less risetime with a pulse width of more than 1 μs and a repetition rate of approx 50 kHz. Aberrations immediately following positive-going transitions are less than ±3%, 3% total peak-to-peak; after 2 ns less than ±2%, 2% total peak-to-peak. Pulse amplitude is more than +200 mV into 50 Ω. Source resistance is 50 Ω.

Squarewave Output—Periods of 10 μs, 1 μs, or 100 ns. Output amplitude is 10 mV, 100 mV, or 1 V into 50 Ω.

Sinewave Output—Periods of 10 ns or 1 ns. Output amplitude is 100 mV into 50 Ω.

Trigger Output—Squarewave, sinewave, or pretrigger pulse output, depending on the selected main signal output. Amplitude is 200 mV, accurate within 40%. When PULSE OUTPUT is selected, the trigger can be switched to arrive 5 ns ±5 ns, or 75 ns ±5 ns ahead of the main pulse. Risetime is 3 ns or less; pulse width is 10 ns or greater.

Timing and Amplitude Accuracy

Output	Period	Timing Accuracy	Amplitude Accuracy		
			1 V	100 mV	10 mV
Pulse	20 μs	±10%			
Square-wave	10 μs	±0.5%	±0.5%	±1%	±1.5%
	1 μs				
	100 ns	±0.05% *	±2%†	±2.5%†	±3%†
Sine-wave	10 ns	±1%		±20%	
	1 ns				

* crystal controlled

† 20 ns after transition

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements—6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

Dimensions and Weights

Height	6 in	15.3 cm
Width	≈5 in	11.4 cm
Depth	15 in	38.1 cm
Net weight	8 lb	3.6 kg
Shipping weight	≈14 lb	≈6.3 kg

INCLUDED ACCESSORIES

50-Ω, BNC coaxial cable (012-0057-01); right angle, 3-conductor power cable (161-0024-03) standard; (161-0031-00) with Option 1.

284 Pulse Generator **$770**

Option 1 Mod 146B ..... **Sub $25**
(less cabinet, for mounting in rack adapter listed on page 195)

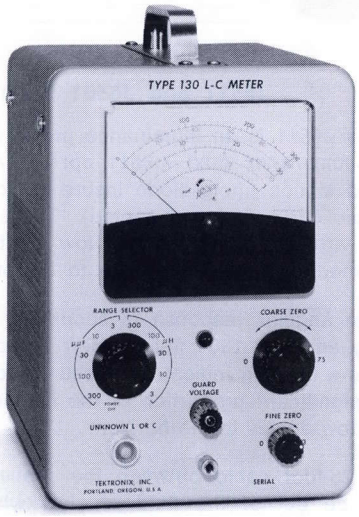
L-C Meter 130

Direct-Reading Measurement of Small Reactances

Measures Up to 300 μH or 300 pF

Easy-to-Read 4½-inch Meter

Convenient Operation



The 130 L-C Meter is a direct-reading reactance meter that measures small reactances in a series mode at a frequency between 125 kHz and 140 kHz. Meter indicates inductance up to 300 μH and capacitance up to 300 pF. The unknown inductor or capacitor is part of a resonant circuit whose frequency is compared to a 140-kHz reference oscillator. Meter indicates the two oscillators' frequency difference but is calibrated directly in μH and pF. Measurement of very small reactances is possible by using special measurement procedures that are described in the instrument instruction manual.

The 130 is particularly useful for measuring small capacitances in the presence of environmental strays. A front-panel Guard Voltage output connector provides in-phase drive to the environmental capacitance to eliminate strays from the measurement. Thus it is possible to measure vacuum tube interelectrode capacitances. Up to 300 pF environmental capacitance around an unknown capacitor can be guarded if the guard terminal loading is not excessive. Loading limits are outlined in the instruction manual.

Resistance loading compensation is optimized for 117-volts RMS operation. The following loads will not appreciably alter the measurement indication:

Capacitance: as low as 100-kΩ shunt.

Inductance: as low as 20-kΩ shunt, up to 10-Ω series.

Correction tables in instruction manual indicate needed corrections for other values of load resistance. Actual corrections determined for each instrument at time of each recalibration.
Range Selection—Microhenrys— 0 to 3, 10, 30, 100, and 300. Picofarads— 0 to 3, 10, 30, 100, and 300.

Accuracy—Meter indicates within 3% of full scale accuracy of any one range can be improved by special calibration at the time measurement is made.

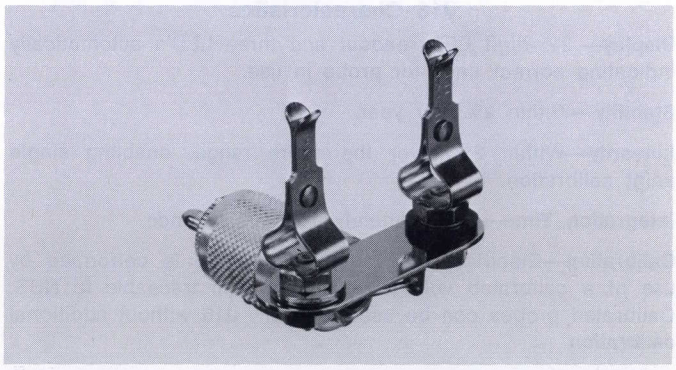
Power Requirement— 40 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V operation.

Dimensions and Weights

Height	≈11 in	27.0 cm
Width	≈11 in	17.8 cm
Depth	7 in	28.3 cm
Net weight	9 lb	4.1 kg
Shipping weight	≈13 lb	≈5.9 kg

Included Accessories—P93C Probe package (010-0003-00); black output lead (012-0014-00); red output lead (012-0015-00); 3-conductor power cable (161-0010-03).

130 Direct-Reading L-C Meter **$400**



Production Test Fixture—Reduces production time required to sort and test capacitors and inductors, **order 013-0001-00 $8.00**

Digital LED Readout

Freedom from Saturation Effects over Entire Range

Metric and US Versions Available

Accurate Spectral and Cosine Corrections

Internal Rechargeable Batteries

Environmentalized

Eight Silicon Sensor Probes Quickly Interchanged without Recalibration

J16 Photometer/Radiometer

The TEKTRONIX J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory or in the field.

Eight quickly interchangeable probes are available for measuring illuminance, irradiance, luminance, light-emitting diode output, and relative intensity. Recalibration is not necessary when probes are changed. Connection of a probe to the J16 automatically selects the correct front panel units indicator. The 2½-digit LED display can be easily read under low ambient conditions.

All probes use silicon photo-diodes and multi-element glass filters for maximum stability and accuracy. The excellent stability eliminates the need for routine zero adjustments. Integrated circuits are used extensively in the J16 to achieve stable operation, low power requirements, small size, and light weight.

Under normal usage, internal rechargeable nickel cadmium batteries will only need recharging weekly. A battery charger is supplied. For continuous operation, an ac power supply is available which replaces the battery pack.

A shoulder strap provides carrying ease. The cabinet and probes have a standard threaded socket (¼ inch x 20) for convenient mounting on a tripod or optical bench.

J16 Characteristics

Display— 2½-digit LED readout and three LED's automatically indicating correct units for probe in use.

Stability—Within 2% per year.

Linearity—Within 2% over the entire range, enabling single point calibration.

Integration Time—Approximately 100 milliseconds.

Calibration—Electrical calibration of the J16 is performed by use of a calibrated voltage source of dvm traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

Power Requirements—Internal rechargeable NiCd batteries only need recharging weekly in normal usage. Two hours of continuous operation is provided. (A battery charger is supplied.)

J6511 and J6501 Illuminance Probes

The J6511 is an illuminance probe with readout in footcandles or lumens/m^2 (lux) (J6511 opt 2). A multi-element glass filter and silicon photo-diode insure a close match to the CIE photopic curve (color corrected). The silicon-sensor recovery time is virtually instantaneous; low light levels can be measured immediately after exposure to bright sunlight.

The angular response is accurately cosine corrected, simulating an ideal 180° field-of-view detector. The low-profile probe has a leveling indicator to assure accurate measurements where a significant proportion of the illumination comes from sources at low angles to the horizon.

A 25-foot cable between the probe and J16 allows the user to be out of the field of view while making measurements. Typical applications include measurement of roadway illumination, office lighting, and illumination of work surfaces. Where cosine correction is not necessary, a standard probe is available (J6501) with the same photopic correction as the J6511.

J6502 and J6512 Irradiance Probes

The J6502 measures irradiance in microwatts/cm^2 or milliwatts/m^2 (J6502 opt 2). The spectral response is flat from 450 to 950 nanometers, ±7%. The response is typically down 50% at 400 and 1030 nm. Typical applications include laser research experiments and measurements of radiant efficiency.

An optional filter holder is available to mount standard 1-inch diameter customer-supplied filters of up to ⅜ inch thickness. Where high intensity sources are used (over 1990 μWatt/cm^2), neutral density filters can be used to extend the range of the J16. (An ND 1 filter has 10% transmission, an ND 2 filter has 1%, etc.)

Where the 1 sq cm sensor is not completely filled by the source, for example with a laser beam, the reading obtained represents μWatts instead of μWatts/cm^2 (J6502), or milliwatts x 10^{-4} instead of milliwatts/m^2 (J6502 opt 2). Small variations in sensor area can add ±5% uncertainty to this measurement.

A low-profile version of the probe (J6512), physically similar to the J6511, is available for use where space is restricted.

J6503 Luminance Probe

The J6503 measures luminance in footlamberts or candelas/m² (nit) (J6503 opt 2) where light scattered or emitted by a surface must be measured. The probe is pointed at the emitting surface. Typical applications include measuring brightness of television screens and street signs, and light reflected from work surfaces and movie screens.

The probe's response is closely matched to the CIE photopic curve, assuring accurate results even when measuring spectrally different light sources.

The acceptance angle is approximately 8°, which is determined by internal field stop apertures. Providing that the 8° field is uniformly filled, the probe can be held at any distance from the source. At 12 inches from the front of the probe, the field of view is approximately three inches in diameter. The footlambert or candelas/m² (nit) (J6503 opt 2) indicator automatically lights when the J6503 is connected.

J6504 and J6514 Uncorrected Probes

These probes are designed for applications where only relative measurements need be made. The J6504 has the widest spectral range, and is the most sensitive probe. Use is made of a UV-enhanced silicon sensor and a UV-transmitting window rather than spectral-correction filters. The J6504 is useful for checking light sources used in photoresist or photoprocessing applications and comparisons of ultraviolet light sources.

A HOLD switch allows the reading to be stored at any time. No units are indicated on the three front panel indicators when using the J6504, since it provides relative readings only.

An optional filter holder may be used to mount standard 1-inch diameter filters on standard-configuration probes. Ultraviolet, visible, or near infrared filters can be used to select the wavelength of interest and exclude ambient light.

A low-profile version of the probe (J6514), physically similar to the J6511, is available for use where space is restricted.

The optional filter holder does not fit low profile probes. Two-inch round filters of up to ¼-inch thickness will fit the J6514 without need for adapters.

J6505 LED Test Probe

The principal application of the J6505 is measurement of light-emitting diodes (LED) having spectral outputs in the red region (600 to 710 nm). The J6505 measures illuminance in footcandles or lumens/m² (lux) (J6505 opt 2), which can easily be converted into luminous intensity in candelas.

An adapter supplied with the probe provides a controlled spacing between the sensor and the LED under test. The adapter excludes ambient light, and has internal baffles to prevent stray reflections during the measurement. Three inserts are supplied with the adapter to fit common sizes of LED's (0.080 inch, 0.125 inch, and 0.200 inch in diameter). These inserts are made of soft plastic that can be easily modified by the user.

With the adapter in place, a reading of 1 footcandle on the J16 represents 100 millicandelas of luminous intensity. With a metric version of the J16/J6505 (opt 2), 1 lumen/m² represents 10 millicandelas. A 10X increase in sensitivity is available on special order.

In the J6505, the silicon photodiode-filter combination provides an excellent match to the photopic curve in the region 600 to 710 nm. This close match requires compromising in the 380 to 600 nm region making this probe unsuitable for general illuminance measurements. For LED measurements in the yellow or green region, the adapter must be used with the J6501 and the same conversion factor for luminous intensity applies.

Environmental Capabilities

Ambient Temperature—Nonoperating, −50°C to +75°C; operating, −15°C to +40°C.

Altitude—Nonoperating, to 50,000 feet; operating, to 15,000 feet.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

PROBE CHARACTERISTICS

	Readout Units	J6501	J6502/J6512	J6503	J6504/J6514	J6505	J6511
Range	US	0.001 to 1990 footcandles	0.001 to 1990 microwatts/cm²	0.1 to 199,000 footlamberts	Relative response only	0.0001 to 199 candelas	0.001 to 1,990 footcandles
	Metric (SI)	0.01 to 19,900 lumens/m² (lux)	0.01 to 19,900 milliwatts/m²	1.0 to 1,990,000 candelas/m² (nits)	Relative response only	0.0001 to 199 candelas	0.01 to 19,900 lumens/m² (lux)
Accuracy (Including J16)	US Metric (SI)	Within 5% of NBS standards and ±1 digit in last place. Probes individually calibrated to tungsten light source traceable to NBS.			Probe-to-probe accuracy within ±5% with tungsten light source	Same as J6501	Same as J6501
Spectral Response	US Metric (SI)	Within 2% (integrated) of CIE photopic curve (color corrected)	Flat within ±7% from 450 to 950 nm	Within 2% (integrated) of CIE photopic curve	UV enhanced silicon spectral curve (250-1200 nm)	Within 2% (integrated) of CIE photopic curve from 600-710 nm)	Same as J6501
Acceptance Angle	US Metric (SI)	50% sensitivity at 48° off axis	50% sensitivity at 48° off axis	8 degrees	Approximately cosine	50% sensitivity at 48° off axis	Cosine corrected
Stability	US Metric (SI)	Within 2% per year					
Linearity	US Metric (SI)	Within 2% over entire range enabling single point calibration					

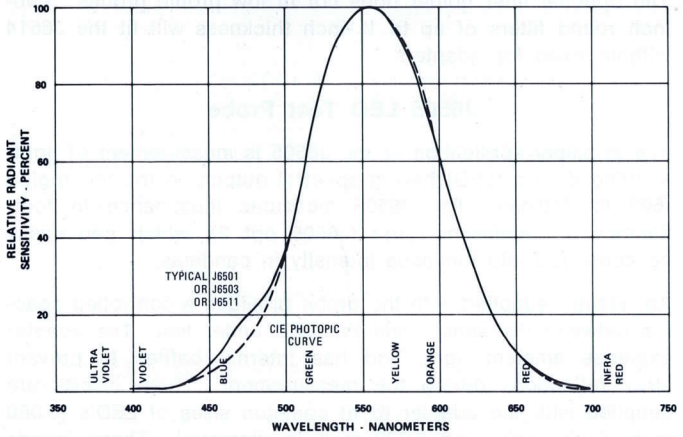
J16 Digital Photometer/Radiometer

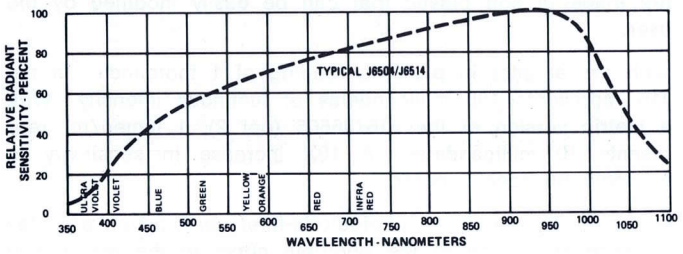
Vibration—Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inches p-p (4 g's) from 10 to 55 to 10 Hz in 1-minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

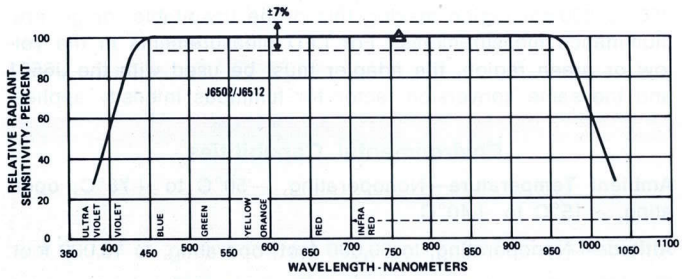
Dimensions & Weights—With probe and battery pack installed.

Dimensions	In	cm	Weights (approx)	lb	kg
Height	2.4	6.0	Net	3.3	1.5
Width	4.6	12.3	Shipping	5.0	2.3
Length	8.0	20.3			

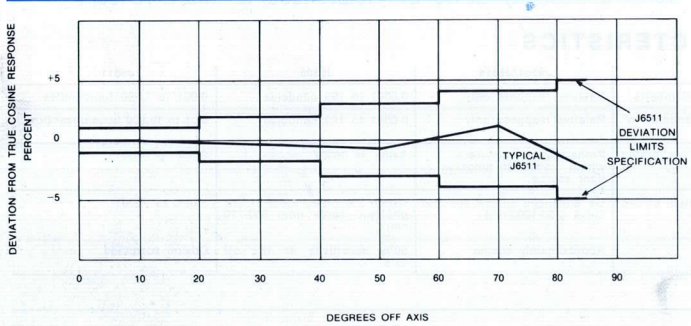
Typical Probe Spectral Characteristics







△ Calibrated at 762 nm using a narrow band filter



J6511 Illuminance Probe, cosine deviation limits and typical J6511

ORDERING INFORMATION

Photometer/Radiometer without Probes

Readout Units*	Power Source	Voltage	Order† Information	Price
US	Battery	115 V, 60 Hz battery charger	J16	$600
US	Battery	230 V, 50 Hz battery charger	J16 opt 1	Add $5
US	Ac	115 V, 60 Hz	J16 opt 3	No Charge
US	Ac	230 V, 50 Hz	J16 opt 4	No Charge

†For a J16 with metric readout, specify option 2 in addition to above ordering information. No additional charge.

*Refer to Readout Units of Probe Characteristics chart.

J16-TV Package—for tv color monitor set-up. The package includes J16 Battery-Operated Photometer, J6502 Irradiance Probe, Light Occluder, Probe Extension Cable.

Order J16-TV for 115 V, 60 Hz battery charger **$920**
Order J16-TV Option 1 for 230 V, 50 Hz battery charger. **Add $5**

For a J16-TV with metric readout, specify Option 2 in addition to above ordering information. No additional charge.

Included Accessories
For battery operated J16—battery charger, shoulder strap, manual.

For ac operated J16—shoulder strap, manual.

Probes

Specify probe with option 2 for metric readout J16's, no additional charge.

Actual spectral curve of any probe is available on initial order. Specify option 5. $35 additional.

J6501, Illuminance Probe **$230**
J6502, Irradiance Probe **$275**
J6503, Luminance Probe **$275**
J6504 or **J6514,** Uncorrected Probe **$170**
J6505, LED Probe, includes LED adapter **$330**
J6511, Illuminance Probe, cosine corrected **$275**
J6512, Irradiance Probe **$285**

Optional Accessories

42-inch Probe Extender Cable—connects J16 and probe.
Order 012-0414-00 ..... **$30**

Cables up to 200 ft in length .... Available on special order

Battery Pack—Order 016-0539-00 ..... **$66**

Analog and BCD outputs ..... Available on special order

A **10X amplifier** for the J6505 probe is available on special order.

Light Occluder—for use when setting up color tv monitors.
Order 016-0305-00 ..... **$15**

Filter Holder—mounts one-inch diameter filters, of up to ⅜ inch thickness, to probes (except J6511, J6512, J6514).
Order 016-0527-00 ..... **$11**

Filter Holder—mounts 2″ diameter filters to J6512 and J6514 probes.
Order 352-0380-00 ..... **$.35**

LED Adapter—Order 014-0047-00 ..... **$55**

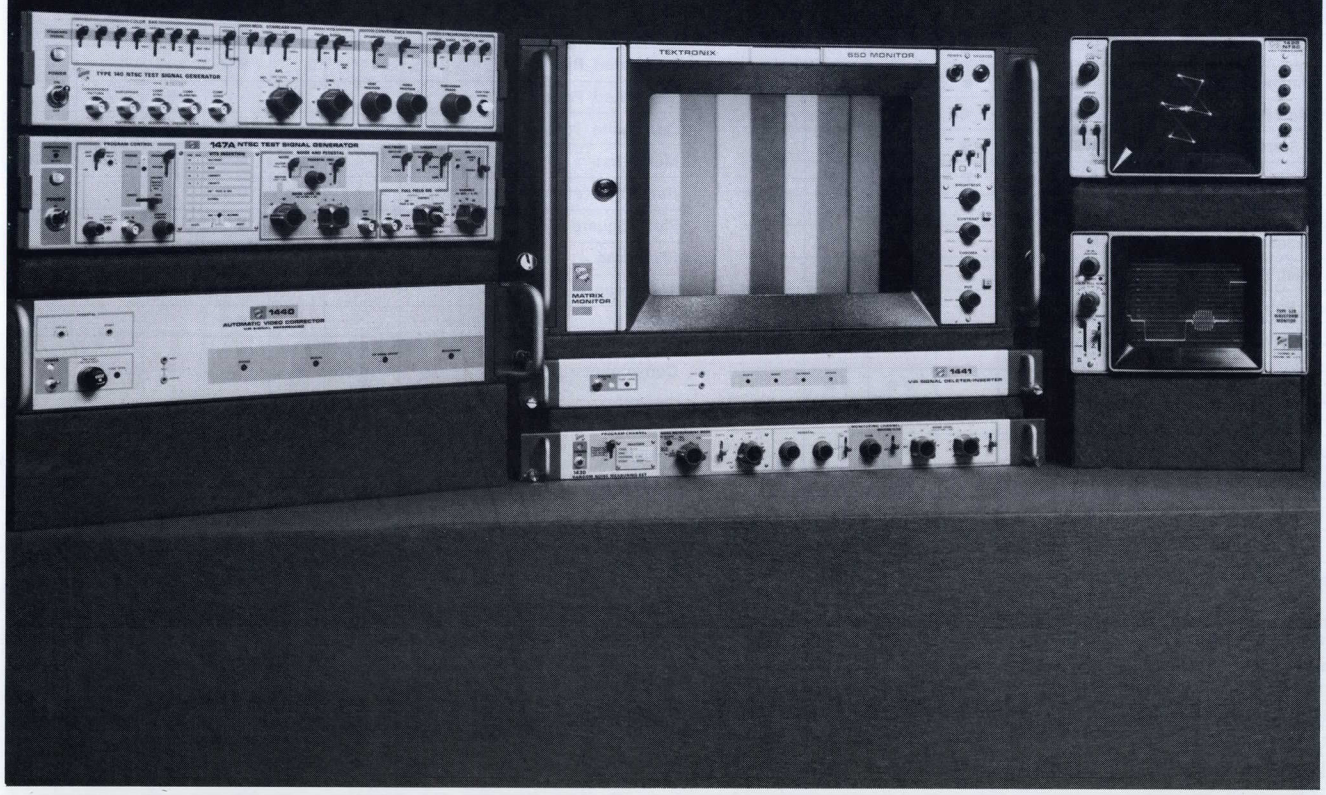
Ac Power Supply—allows J16 to be used without batteries.
Order 119-0404-00 115 V, 60 Hz **$90**
Order 119-0404-01 230 V, 50 Hz **$90**

Please use the return card, inside back cover, to write for application notes describing the use of the J16 Photometer/Radiometer.

Television Products

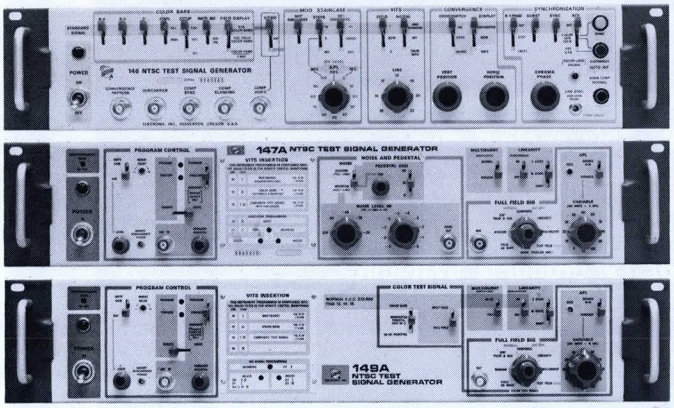
10

TEKTRONIX Television Products time, test, measure, and correct the composite video signal. This section summarizes that capability including information on products for NTSC, PAL, SECAM, and PAL M systems. There is a separate, more complete catalog of TV products available. This TV catalog and more details on Tektronix activities in Television are described in this section.



For more than twenty years, Tektronix, Inc. has produced products used in detecting and measuring television signal distortions. TEKTRONIX Television Products have led the way to better signal quality. Our waveform monitors, vectorscopes, test signal and synchronizing generators and picture monitors are in constant use at almost every point in world-wide television broadcasting systems. Our engineering and marketing people play an active part within the television engineering community developing measurements and techniques that help make the color picture a quality color picture. Tektronix means quality among the world community of television professionals.

TEST SIGNAL AND SYNC PULSE GENERATORS



NTSC Test Signals Available from TEKTRONIX Generators

Signal	140	144	146	147A	149A	1430
Vertical Interval Reference Signal (VIRS)				VITS only	VITS only	
EIA Color Bar	●	●	●			
Color Bar Luminance Signal		●	●		●	
Full-Field Color Bar	●	●	●		●●	
Modulated 5 Step Staircase	●	●	●	●●	●●	
Modulated 10 Step Staircase	●	●	●	●●	●●	
Modulated Ramp				●●	●●	
Modulated Pedestal	●	●	●		●●	
Composite Test Signal				●●	●●	
Convergence Pattern	●	●	●			
Full/Reduced Amplitude Multiburst				●●	●●	
Sin² Pulse & Bar				●●	●●	
Sin² Pulse & Window				●	●	
Field Square Wave				●	●	
Noise Measuring Capability				●●		●●
Flat Field (Variable Level)	●	●	●	●	●	
Flat-Field Bouncing APL				●	●	
Test Signal/Variable APL	●	●	●	●	●	

A few signals may require reprogramming and some signals may not be available simultaneously.

● Full-Field Signal ●● Full-Field signal, also available as VITS.

NTSC Timing Signals

	140	144	146	147A	149A
Gen-lock Input			●	●	●
Comp Sync Output	●	●	●	●*	●*
Subcarrier Output	●	●	●	●*	●*
Comp Blanking Output	●	●	●		
Burst Flag Output	●	●	●		
H Drive Output	●	●	●		
V Drive Output	●	●	●		
External Comp Sync Input	●	●			
External Subcarrier Input	●	●	●		

*When Gen-locked

The 140-Series Signal Generators are compact sources of high-quality television test, drive and convergence signals. All signals needed to time and accurately test, evaluate and adjust both standard broadcast and closed circuit color video equipment are provided. Complete information will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.

PAL and PAL-M Signals

Test Signals	Pal			Pal-M		
Signal	141A	145	148	142	145M	148M
EBU Color Bars	●	●				
Full-Field Color Bars				●	●	
Color Bars/Luminance Reference		●		●	●	
Color Bars/Red Reference		●			●	
Modulated 5 Step Staircase	●	●	●●	●	●	●●
Modulated 10 Step Staircase		●	●●	●	●	●●
Modulated Ramp			●●			●●
Modulated Pedestal		●		●	●	
Composite Test Signal			●●			●●
Multiburst			●●			●●
Sin² Pulse and Window			●●			●●
Field Square Wave			●			●
Flat Field			●			●
ALP Bounce			●			●
Noise Measuring Capability			●●			●●
Convergence Signal	Order Option 1	●		●	●	
ITS, International Per EBU						
Line 17			●●			
Line 18			●●			
Line 330			●●			
Line 331			●●			

Signals are not necessarily simultaneous and a few require simple reprogramming.

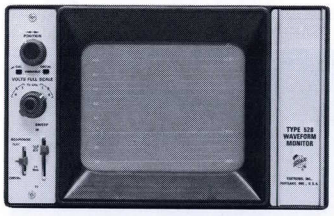
● Full Field only ●● ITS plus Full Field

See Tektronix TV Products Catalog for additional signals and specifications.

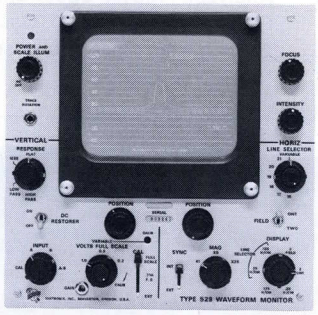
Sync & Timing	Pal			Pal-M		
	141A	145	148	142	145M	148M
Composite Sync	●	●	●	●	●	●
Composite Blanking	●	●		●	●	
Subcarrier	●	●	●	●	●	●
Burst Flag	●	●		●	●	
PAL Pulse	●	●		●	●	
Line Drive	●	●		●	●	
Field Drive	●	●		●	●	
1 MHz Reference	●	●				
25 Hz	●	●				
12.5 Hz	●	●				
30 Hz					●	
15 Hz					●	

● Indicates that the product has this feature.

WAVEFORM MONITORS



528 Waveform Monitor



529 Waveform Monitor

A television waveform monitor is a specialized oscilloscope with vertical amplifier characteristics and time-base features tailored to display and measure television signal waveforms. Tektronix, Inc. makes two families of waveform monitors, the 528 and 529. Versions are available for all standards and in configurations suitable for inclusion in varied installations.

COLOR PICTURE MONITORS

TEKTRONIX 650-Series and 670-Series Color Picture Monitors have the features and accuracy to reliably assess picture quality. There are now versions of the 650 and 670 Series for use in the scanning standard and color system appropriate to your location. A special Sony Trinitron*, with its simplicity of convergence and its adaptability to multi-standard usage, is the heart of each monitor. The construction of the monitor allows us to economically produce monitors for any standard used anywhere in the world. All versions maintain a uniform quality of performance previously unavailable.

The 650-Series Color Picture Monitors are particularly adaptable to precisely determine signal quality, since they feature differential (A-B) inputs. Differential inputs are very useful in matching systems for cable length delays. The 670-Series Monitors have many of the features of the 650 Series and are excellent for applications requiring a larger picture.

MONOCHROME PICTURE MONITOR

The TEKTRONIX Monochrome Picture Monitor is designed for measurement and qualitative evaluation of 525/60 and 625/50 standards. The monitor has many features such as a choice of D6500 or W9300 K phosphors. High resolution is maintained at full drive. Bandwidth is 6 MHz within 0.5 dB with 100% white amplitude. The monitor is all solid-state (except kinescope). A rectangular kinescope with 3:4 aspect ratio is used.

*Registered Trademark Sony Corporation.

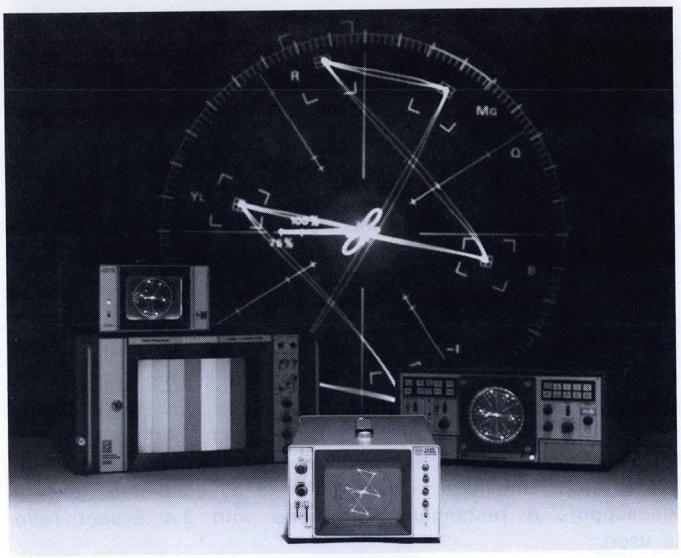
VIRSatility Products for Automatic Video Signal Correction

1440 Automatic Video Corrector

The TEKTRONIX 1440 Automatic Video Corrector adds a totally new dimension to video signal quality control—FULL AUTOMATIC VIDEO SIGNAL MONITORING AND CORRECTION. Overall video gain, black level, color saturation, burst phase and gain, and sync level may be automatically monitored and corrected by the 1440. The necessity for continuous readjustment of proc amp controls to meet changing video signal conditions is done away with. Consistent, high quality video signals are the result.

The 1440 is a VIRS (Vertical Interval Reference Signal) controlled video processing amplifier. When VIRS is present on the video signal, the 1440 samples VIRS and, if necessary, automatically corrects the VIRS and the video signal to the same characteristics achieved at the point of VIRS insertion which is normally program origin. Other TEKTRONIX VIRSatility products are described in our TV Products Catalog.

Complete information is in Tektronix TV Products Catalog.
Use free request postcard enclosed.



VECTORSCOPES

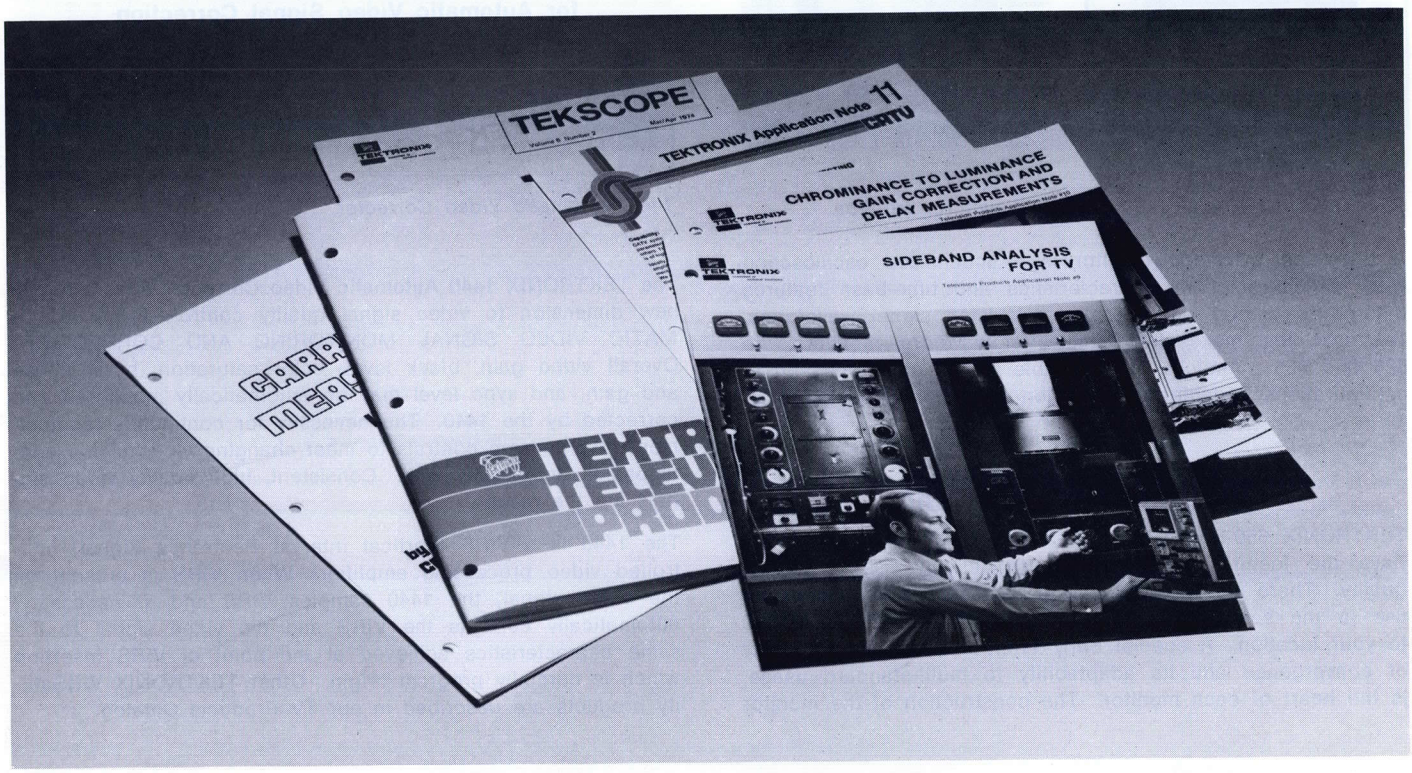
The 1420-Series Vectorscopes are part of a group of Tektronix instruments especially designed for the measurement of the chrominance components of the composite video signal. The 1420 is an economical, yet accurate unit in the Tektronix tradition of excellence. Simple, but accurate vectorscope displays are also available as an option with precision TEKTRONIX Color Picture Monitors. For applications requiring the widest range of display versatility and measurement resolution, the 520A remains the standard of the industry.

1478 CALIBRATED CHROMINANCE LEVEL CORRECTOR

The 1478 is an in-line manual chrominance corrector designed for use with NTSC, PAL and PAL M color video signals. Used with the 12.5 T or 20 T modulated sine-squared pulses, the 1478 is used to manually correct relative chrominance/luminance gain errors which are usually caused by frequency response deficiencies in a video system.

Other Products of Interest:

J16 Digital Photometer-Radiometer, 7L12 Spectrum Analyzer, 1401A Spectrum Analyzer, 1501 Cable Fault Finder, 465 Option 5 Oscilloscope and 7B53A Option 5 Dual Time Base are described elsewhere in this catalog.

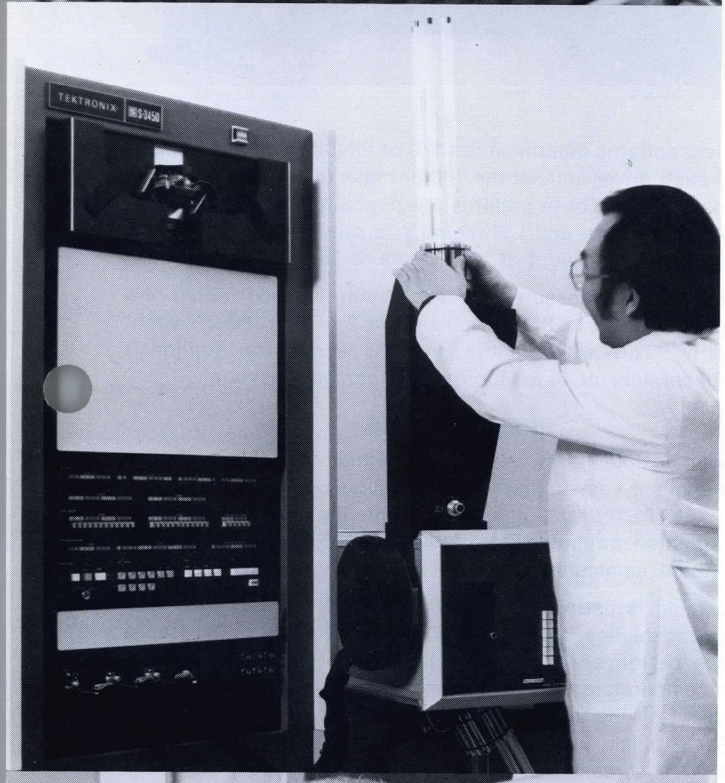


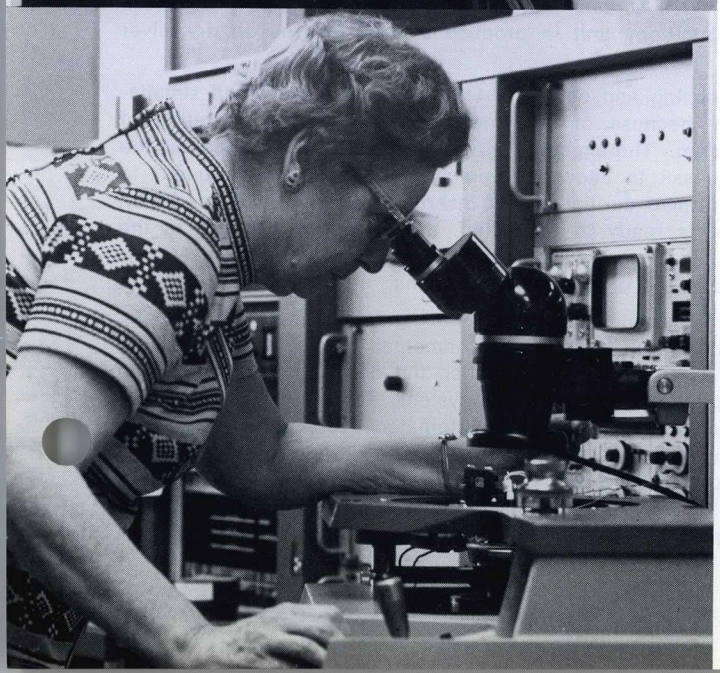
TELEVISION AND CATV MAILING LISTS
TELEVISION CATALOG

Use the enclosed reply card for requesting your copy of the Tektronix Television Products Catalog. Other material of interest, including Television Application Notes, is mailed periodically to our Television and CATV mailing lists in the USA. Television Application Note #9 describing new techniques for TV sideband analysis is an example of information mailed. Request these mailings with the same reply card. Application information outside the USA is available through your Tektronix Field Engineer or Representative.

See pages 327 and 328 for address.

140 NTSC Signal Generator	$2350
R140 NTSC Signal Generator (rackmount)	2350
141A PAL Signal Generator	2350
R141A PAL Signal Generator (rackmount)	2350
141A Opt. 1 (mod 703) PAL Signal Generator	2600
R141A Opt. 1 (mod 703) PAL Signal Generator (rackmount)	2600
142 PAL M Signal Generator	2550
R142 PAL M Signal Generator (rackmount)	2550
144 NTSC Signal Generator	2700
R144 NTSC Signal Generator (rackmount)	2700
145 PAL Signal Generator	3700
R145 PAL Signal Generator (rackmount)	3700
145M PAL M Signal Generator (tentative)	4000
R145M PAL M Signal Generator (rackmount) (tentative)	4000
146 NTSC Signal Generator	2675
R146 NTSC Signal Generator (rackmount)	2675
147A NTSC Signal Generator	3270
R147A NTSC Signal Generator (rackmount)	3270
147A Opt. 1 NTSC Signal Generator	3270
R147A Opt. 1 NTSC Signal Generator (rackmount)	3270
148 PAL Signal Generator	3800
R148 PAL Signal Generator (rackmount)	3800
148M PAL M Signal Generator (tentative)	4000
R148M PAL M Signal Generator (rackmount) (tentative)	4000
149A NTSC Signal Generator	4100
R149A NTSC Signal Generator (rackmount)	4100
149A Opt. 1 NTSC Signal Generator	4100
R149A Opt. 1 NTSC Signal Generator (rackmount)	4100
520A NTSC Vectorscope	3025
R520A NTSC Vectorscope (rackmount)	3025
521A PAL Vectorscope	3025
R521A PAL Vectorscope (rackmount)	3025
522A PAL M Vectorscope	3025
R522A PAL M Vectorscope (rackmount)	3025
528 Waveform Monitor (for 525 line)	1070
Opt. 1 (mod 146B) Waveform Monitor (as above less cover)	1050
Opt. 2 (mod 147B) Waveform Monitor (with blue protective cabinet)	1100
Opt. 3 (mod 188G) Waveform Monitor (for 625 line)	1070
529 Waveform Monitor	1715
Opt. 2 (mod 147B) Waveform Monitor (installed in field case)	1755
Opt. 4 (mod 188D) Multistandard Waveform Monitor	2170
RM529 Waveform Monitor (rackmount)	$1800
Opt. 4 (mod 188D) Multistandard Waveform Monitor (rackmount)	2300
602 Opt. 5 (mod 174V) X-Y Monitor	1020
604 Opt. 5 (mod 174V) X-Y Monitor	765
632 Monochrome Picture Monitor	750
R632 Monochrome Picture Monitor (rackmount)	790
650* NTSC Color Picture Monitor	2700
650-1* NTSC + RGB Color Picture Monitor	2800
651* PAL Color Picture Monitor	2700
651-1* PAL + RGB Color Picture Monitor	2800
652* PAL M Color Picture Monitor	2700
652-1* PAL M + RGB Color Picture Monitor	2800
653* SECAM Color Picture Monitor	3200
653-1* SECAM + RGB Color Picture Monitor	3300
654* RGB Color Picture Monitor	2600
654-1* RGB + RGB Color Picture Monitor	2700
655** NTSC + PAL Color Picture Monitor	3000
655-1** NTSC + PAL + RGB Color Picture Monitor	3100
656** SECAM + PAL Color Picture Monitor	3400
656-1** SECAM + PAL + RGB Color Picture Monitor	3500
657**SECAM + NTSC Color Picture Monitor	3400
657-1** SECAM + NTSC + RGB Color Picture Monitor	3500
658** PAL M + NTSC Color Picture Monitor	3000
658-1** PAL M + NTSC + RGB Color Picture Monitor	3100
659** PAL M + PAL Color Picture Monitor	3000
659-1** PAL M + PAL + RGB Color Picture Monitor	3100
670* NTSC Color Picture Monitor	2700
671* PAL Color Picture Monitor	2700
672* PAL M Color Picture Monitor (tentative)	2700
For Vector Display Option on all 650 and 670 Series	
Option 2 (*single standard) add	40
Option 2 (**dual standard) add	115
1420 NTSC Vectorscope	1450
Opt. 1 Vectorscope as above (less cabinet)	1425
Opt. 2 Vectorscope as above (with carrying case)	1480
1421 PAL Vectorscope	1450
Opt. 1 Vectorscope as above (less cabinet)	1425
Opt. 2 Vectorscope as above (with carrying case)	1480
1422 PAL-M Vectorscope	1500
Opt. 1 Vectorscope as above (less cabinet)	1475
Opt. 2 Vectorscope as above (with carrying case)	1530
1430 Random Noise Measuring Set (525/60)	1500
Opt. 1 Random Noise Measuring Set (625/50)	1500
1440 Automatic Video Corrector	2550
1441 VIRS Deleter Inserter	1325
1478 Calibrated Chrominance Corrector	750





Automated Test Systems

11

Complete characterization capabilities for state-of-the-art IC's

20-MHz test rate

128 active pins (64 input, 64 output)

Individually configured to meet your unique requirements

With over 20 systems installed world-wide, the S-3260 remains today *the* state-of-the-art in Automated Test Equipment. The result of years of test system design and manufacture, the S-3260 combines a full range of test and measurement capabilities in one fully programmable package. S-3260's are found performing in engineering design evaluation, failure analysis, component evaluation; plus being active in such production related tasks as device classification, quality control, and incoming inspection.

The design of the S-3260 allows you, the customer, to perform almost any test you can imagine. Just one example is the ability to program, in real-time, the driver on/off condition and to enable the comparator for each pin. This capability is particularly useful when testing such dynamic, bus-structured devices as a CPU on a chip. Of course, all types of MOS, TTL, ECL, hybrid, the bipolar devices, plus LSI random-access and read-only memories, may be tested by the S-3260.

1803 Test Station

The hub of the system is the 1803 Test Station. To perform efficient testing of a large number of pins (as many as 128) with optimum risetime, and at a very high test rate (up to 20 MHz), the circuits are arranged so as to place the drivers and comparators in close proximity to the dut (device under test). This is accomplished through the use of a Critical Path Fixturing ™ design, providing a state-of-the-art signal environment. All I/O circuits are contained on plug-in sector cards that are inserted in carrousel fashion (like spokes of a wheel) into the card assembly of the 1803 Test Station. (See photo above.)

Each sector card contains a 20-MHz 1032-bit LSI buffer memory, two driver sample-and-hold (S/H) circuits, and a high-speed driver for input conditioning. In addition, output comparison circuits consist of S/H circuits and a dual-strobed comparator. Timing is provided by a high-speed clock generator that delivers seven independent signal phases. The start and duration of each phase can be programmed in 1-ns increments.

Up to four of these clock phases may be used for dut's requiring multiphase timing signals, with the remaining phases used for data input driving and output data strobing. This gives you the ability to program *different* driver signal levels and *different* output comparator levels to *each* dut pin.

Binary test patterns determine the 1/0 or inhibit (high-impedance) state of each driver and set the 1/0 or mask (don't care state) for each comparator. These patterns are normally disk resident, and are buffered by core and LSI memory to provide precise control of timing and word count at word rates to 20 MHz.

The dc and time-measurement subsystem, housed within the 1803, gains access to the dut pins via a 2 x 64-pin 50-Ω switching matrix. This same matrix provides access for (optional) signal generators or a waveform-digitizing oscilloscope.

PROGRAMMING

Extremely flexible hardware requires equally flexible software. A near-english, easy-to-learn test language controls the S-3260. Called TEKTEST III ™, it interacts with the operator to allow device-oriented programming. Test steps are easily interpreted, even without comments.

Programming is performed at the 4010 Graphics Terminal. The graphic capabilities of the S-3260 allows you to draw graphs of device performance with multidimensional coordinates. Voltage vs temperature over time, phase shift, and resistivity are but a few of the many graphic plots that you may wish to use. For a quick, permanent copy of the information displayed on the 4010 screen, just press the button that commands the 4610 hard-copy unit to produce a copy for you on dry silver paper.

Programming and device testing can be accomplished simultaneously because of the foreground/background operation of the system. The executive portion of the software schedules the system task to allow programming functions (background) to be performed during the dut insertion and removal time. When the dut is ready to be tested, the executive switches to the device test program and runs it (foreground); then the executive returns to the programming functions.

Option possibilities such as interfacing automatic device handlers, high-speed line printers, environmental chambers, etc. abound; however, space here has limited the description of the S-3260 to just a quick glance at the system. For a more complete description, please check the Automated Test Equipment box on the business reply card of this catalog and specify the S-3260. Of course, your best and fastest source of information is your local System Applications Engineer. He may be reached through the Tektronix Field Office nearest you.

Fully programmable

Modularly constructed

Dc Parametric and functional testing

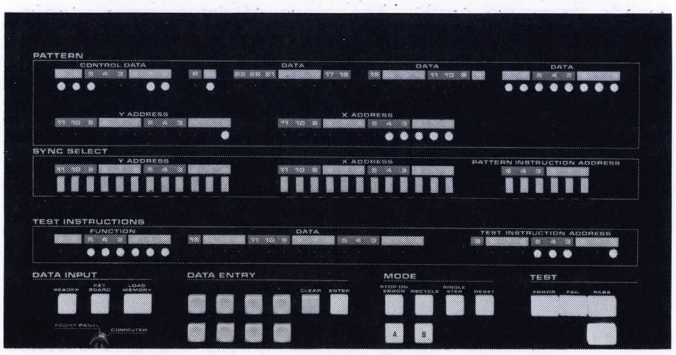
The S-3400 Series is the latest addition to our continually expanding line of Automated Test Equipment. The S-3400 has been designed to meet the testing needs of both the semiconductor memory manufacturers and memory users. Production oriented, the systems are cost-effective solutions for wafer probe, package test, quality control, and incoming inspection.

The systems are fully programmable and capable of completely and effectively testing all types of semiconductor memory devices. RAM's, ROM's, dynamic, static, bipolar memories, and shift registers—each may be tested with the combination of dc parametric and functional tests that most efficiently discover failure modes unique to the memory under test.

At the heart of each S-3400 system is a high-speed mico-programmable pattern generator. This allows functional testing with PING PONG, GALLOPING, DIAGONAL, FLOATING, CHECKERBOARD, and many more patterns. With test rates up to 10 MHz, testing is at the memory's specified frequency.

Dc testing capabilities permit you to test leakage, input current, output voltage, threshold levels, protect diode condition, stress, continuity, and many more.

With the S-3400 systems flexibility and full range of test capabilities, you may configure test programs in the order of the most likely failure modes. This ability can increase throughput and thus lower production costs.



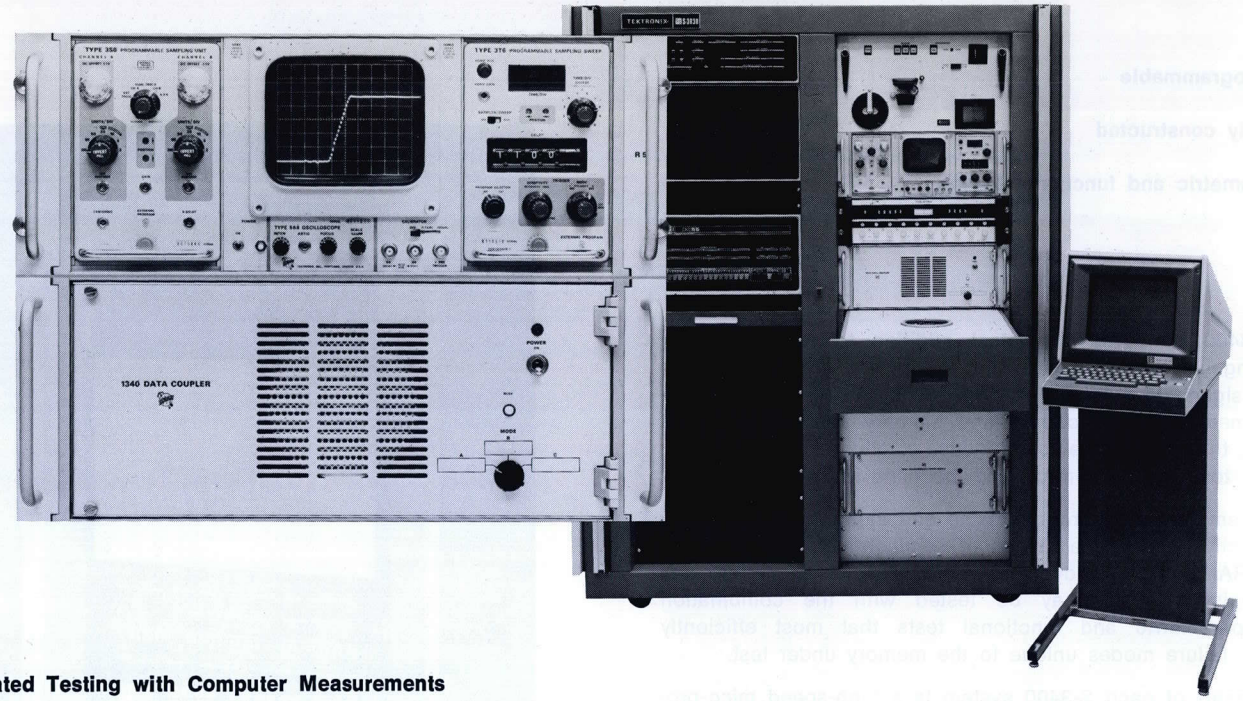
The S-3400's data bus opens up the possibility for future expansion of your system by inserting additional modules.

The S-3400 may be ordered with an additional test head, thus permitting multiple-station operation. Interfaces are available for wafer probers, automatic device handlers, and environmental chambers.

The information you have read here is just a brief overview of the S-3400 Series. For a more complete discussion of the systems and their capabilities, please check the Automated Test Equipment box on the business reply card of this catalog and specify the S-3400 Series. Of course, your best and fastest source of information is your local Systems Applications Engineer. He may be reached through the Tektronix Field Office nearest you.

Measurement Subsystem

Waveform digitizing, expandable to meet your measurement requirements



Automated Testing with Computer Measurements

Custom Systems Around the S-3003 Waveform Digitizer

The S-3000 Series with waveform digitizing and measurement software offers dynamic testing capabilities previously impractical. For example, measurements such as peak-to-peak, root-mean-square, averaging, and multiplication are program calls. Others are only a matter of software rather than elaborate hardware modifications. Coupled with the extensive fixturing and stimuli available from Tektronix, Inc., a sophisticated system may easily be patterned to meet your testing requirements.

The S-3003 Waveform Digitizer is a complete measurement block that interfaces to your computer for measurement superiority and is available separately or integrated into your custom-built system. It consists of a 568 Readout Oscilloscope and a 1340 Data Coupler. The 568 Oscilloscope contains 3S6 Sampling and 3T6 Time-Base plug-in units. The 1340 is configured, by plug-in circuit cards, to interface to the 568 Oscilloscope, the Waveform Digitizer Option, and a minicomputer. (A DEC PDP-11 is standard.)

The Waveform Digitizer interface processes a 10-division displayed waveform into a series of 1000 10-bit words. At sweep rates of 1 ms/div and slower, the system operates in a real-time mode, and, at faster rates, automatically switches to equivalent-time sampling mode. One word is generated for each displayed dot on the sampling display. Since the sampler operates sequentially, each dot is digitized in turn from left to right. The completed words are sent to the computer. This reduces the analog display to a binary image that can be processed with a computer. Measurements may then be made through the WAFORM™ software.

Used as a measurement package, the S-3003 brings the full power of the computer and software to testing. Typical applications include complex-waveform analysis, linear-device testing, processed-data display, data storage for trend analysis, etc.

To support the S-3003, we offer a Software Operating System. Designed to operate in the PDP-11 Series of minicomputers, it assists Test System Engineers in building powerful and flexible programs easily. The kinds of measurements possible are limited only by the programmer's imagination.

By adding optional peripheral equipment to the S-3003, custom systems can be assembled to solve your measurement problems. Many types of programmable units, such as pulse and signal generators, power supplies, sophisticated fixtures and special measurement instruments are available. The many interfaces available for the 1340 Data Coupler include those for several different computers.

For more information and specifications, please check the Automated Test Equipment box on the business reply card in the back of this catalog. Please specify the S-3000-Series in your request.

Flexible/Inexpensive Test Package

Operator Freed from Display Interpretation

The 568/230 Bench-Test System is widely used wherever a flexible/inexpensive test package is required. It measures accurately with high repeatability, because all measurements are performed and displayed digitally. The operator is freed from display interpretation and measurement definition automatically. The same measurement uniformity may be carried to your production applications with a programmable version of the 568/230.

The Bench-Tests System consists of the following equipment:

1 — 230	Digital Unit
1 — 568	Readout Oscilloscope
1 — 3S2	Dual-Trace Vertical Sampling Unit
1 — 3T2	Random Sampling Time Base Unit
2 — S-1	Sampling Heads*

The Oscilloscope combination forms a dual-vertical-channel sampler with dc to 1-GHz bandpass (350-ps risetime using S-1 heads) with sensitivity from 2 mV/div to 200 mV/div in seven calibrated steps. Dc offset, internal-trigger pickoff, and five display modes provide for a variety of operations. The time-base features random or sequential sampling operation. Random sampling permits the user to view the leading edge of a signal, without a delay line or pretrigger. The sweep time/div is displayed digitally in the TIME/DIV window and extends from 100 μs/div to 200 ps/div, expanding to 20 ps/div with X10 DISPLAY MAGNIFIER control. Versatile display and trigger modes extend the capabilities of the package.

The 230 Digital Unit presents oscilloscope measurements in alphanumeric form. The instrument can be used to measure any desired time or voltage parameter associated with the display on the 568 crt. Voltage measurements are made on either Channel A or B, or between the two channels.

Measurement results are displayed on four digits with units of measure, decimal point and polarity information. Limit controls provide for upper- and lower-measurement limits. These function automatically for each digital reading and illuminate one of three lamps. Thus a measurement can be repeated many times, with the operator proceeding on the basis of the limit lights rather than the digital reading.

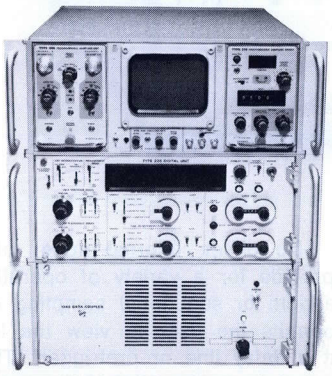
For further details and specifications, request a copy of the S-3100 Series Automated Test Equipment brochure. Please specify this brochure title with the business reply card located in the back of this catalog.

*Sampling heads are described on pages 105 through 110.
Sampling heads required will depend on plug-in selected.

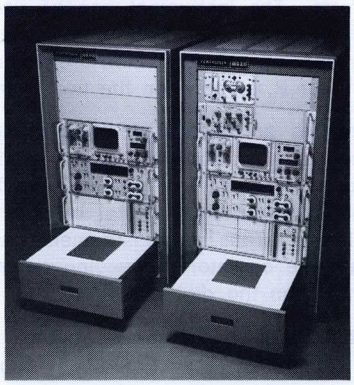
The S-3100 Series of Automated Test Equipment has been designed to solve a wide range of your test and measurement problems. Your unique requirements will determine which system and options will be the best solution. The S-3100 systems are based around the 568 Readout Oscilloscope with programmable plug-ins and the 230 Digital Unit. This portion of an S-3100 system performs the same functions as the Bench Top System described on the previous page.

The S-3100 Series contains the following systems and subsystems:

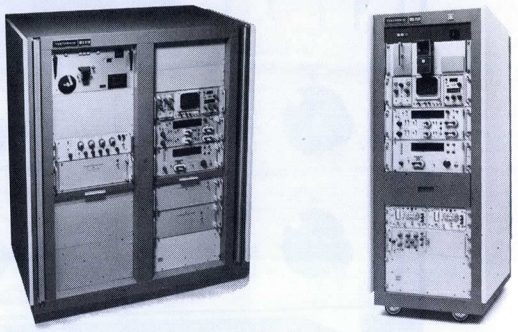
S-3101 Measurement Subsystem—Intended for customer assembled systems that require a sophisticated measurement package. Similar to the Bench Top System, but this package includes programmable plug-ins (3S6 and 3T6 described on the next page).



S-3105—Also intended for customer assembled systems, but adds an R1340 Data Coupler to allow a programmable measurement package through the variety of interfaces contained in the R1340 (described on page 294).

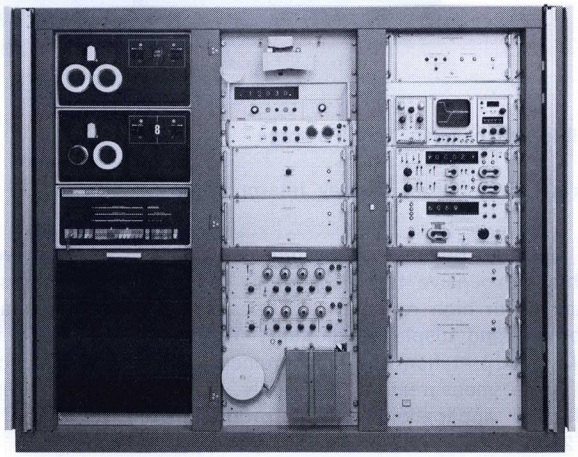


S-3110 and S-3111—designed to measure and test the performance of many types of active devices under simulated operating conditions. The systems are capable of testing such devices as diodes, transistors, integrated circuits, modules, and subassemblies. The systems will sequence up to 15 measurements in less than 150 ms.



S-3120—includes an R240 Program Control Unit and an eight-track disc memory. This allows 1600 tests to be stored that may be performed at up to 100 tests per second. The system is a boon to such activities as incoming inspection quality control and production testing. It is specifically designed to test devices that require long programs, but have stimulus requirements that do not change during the program.

S-3130—A completely automated test system with a large range of options to accommodate testing requirements for many types of devices and subassemblies. This system may be configured with excellent fixturing, signal generators, power supplies, input/output devices, digital multimeters, counters, etc. All are completely programmable and may include user-supplied equipment.



S-3150—The largest and most sophisticated system in the S-3100 Series. At your option are a variety of fixtures, signal generators, power supplies, input/output devices, digital multimeters, counters, etc. All completely programmable with a special interactive program language TEKTEST I ™, a plain English language that enables even new systems programmers to begin writing test programs with a minimum of training.

For a more complete description of the systems and options in the S-3100 Series, please check the Automated Test Equipment box on the business reply card and specify the S-3100 Series. Of course, your best and fastest source of information is your local Systems Application Engineer. He may be reached through the Tektronix Field Office nearest you.

Programmable Volts/div and Dc Offset

Choice of Sampling Heads

The 3S5 and 3S6 sampling units extend the automated measurement capability of the 568 Oscilloscope by allowing remote programming of deflection factor, dc offset, and smoothing.

External programming of the 3S5 can be accomplished by either a front- or rear-panel connector; signal inputs are on the front. The 3S6 has its program and signal inputs on the rear and can be used in the 568 Oscilloscope.

Sampling heads* feature a choice of measurement capabilities and may be mixed or matched to meet specific needs. A front-panel control allows adjustment of the inter-channel time relationship to compensate for external delays.

Sampling heads may be plugged into the 3S5 or located remotely on the optional 3-ft or 6-ft sampling-head extenders. The 3S6 sampling heads are located remotely on an included 6-ft sampling-head extender that connects to the rear of the 568 Oscilloscope.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

*For complete descriptions refer to pages 105 through 110.

Programmable Time/div, Sweep Delay and Samples/Sweep

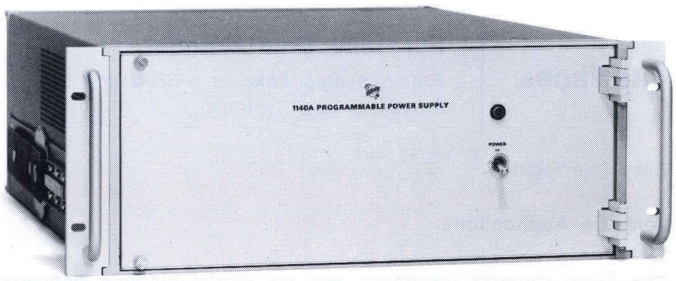
100 ps/div to 500 ms/div Calibrated Sweep Range

External Automatic Trigger

The 3T5 and 3T6 can be externally programmed to extend the automatic measurement capabilities of the 568 Oscilloscope configuration. The 3T5 and 3T6 can also be used manually, using the front-panel controls.

Real-time sampling (1 ms/div to 500 ms/div) and digital delay are provided. An external automatic-trigger mode eliminates the need for adjustments over a wide range trigger-signal characteristics.

1140A Programmable Power Supply



Four Independent Voltages; One Current; All with Programmable Limits

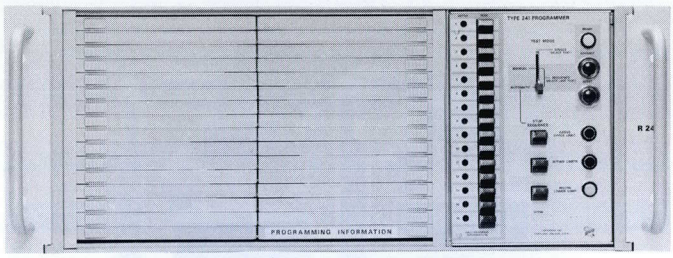
Digital Programming: Latching Inputs, TTL Compatible

Safe, Controlled Transitions, and Remote Sensing

The 1140A Programmable Power Supply provides one current and four voltage outputs for use in high-speed automated test systems. Each supply is independently programmable with separate strobes and data latches. All voltage supplies feature switch-selectable manual or programmable current limits. Single or multiple 1140's can be programmed by a 1340 Data Coupler. Options are available for programming the 1140A using the 1340 or user-supplied program unit.

241 Programmer

Sequences up to 15 measurements in S-3100 Series Systems



Programs up to 15 Measurements

Automatic or Manual Measurement Sequence

Automatic Test Limits Stop

14 Additional Program Lines

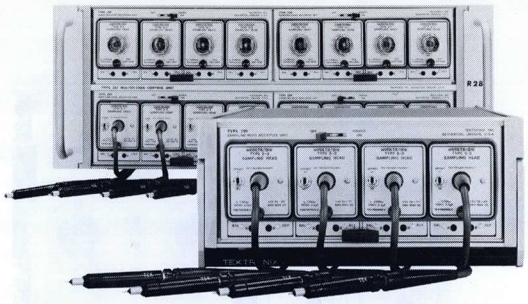
The 241 Programmer unit is designed to program the 568 Oscilloscope, 3T5 or 3T6, 3S5 or 3S6 programmable plug-ins, and 230 Digital Unit. It has 14 lines available for programming other equipment.

Fifteen programmed measurements may be selected by front panel pushbuttons or external control lines actuated manually or automatically. In the automatic modes, an out-of-limits condition can stop the measurement sequence. Each measurement is programmed with quick-insertion diodes, making changing programs a quick and easy plug-in operation.

Where a group of identical measurements is repeated over a variety of DUT input/output connections, the 241 Program Resequencer may be added to extend test capacity to 150 with a single 241 or to 225 with two 241's.

286 287 R288 Sampling-Head Multiplexers

For use in S-3100 Series fixturing



1-4 Heads Multiplexed

5-16 Heads Multiplexed

17-64 Heads Multiplexed

The sampling-head multiplexer system allows the signals from up to 64-test points to be measured by a two-input sampling unit. The measurements are made from a sampling head coupled to each test point. The signals sensed by these sampling heads are then multiplexed into the sampling unit, two signals at a time. Multiplexing is accomplished without affecting sampling-head risetime or input-impedance characteristics such as relay switching would do.

The 286 Sampling Head Multiplexer is the basic component in the multiplexed system, and it operates up to four sampling heads. Head selection commands are digital information that determine which sampling heads are operated.

A 286 can be installed in a 287 or R288, and in either case will then receive its head selection and signal data from these units.

A 287 holds and controls up to four 286's, allowing 16 heads to be multiplexed. An R288 along with up to three 287's may be used for multiplexing of up to 64 sampling heads.

Interfaces

For 1340 Data Coupler

Provides data links in S-3000 and S-3100 Series Systems

Easy Interfacing

Versatile Applications

The Data Coupler interfaces are for communication between the digital instruments and other equipment of an automated test system. There are a variety of interfaces for specific functions as shown here, but for interfaces to accomplish your special system requirements, please contact your local Tektronix field engineer. All interfaces plug into the 1340 Data Coupler, which has its own power supply and has access for 12 plug-in circuit cards (interfaces may be one or more circuit cards).

Special Purpose

Waveform Digitizer
Reference Signals for auto-calibration with AUTOCAL software
Programmable Clock

Control Name	General Purpose Data Exchange
PDP-8L Controller	32 Bit Output
Data Logging	16 Bit IN/OUT
IBM 826 Controller	32 Bit Input
ASCII Data	32 Bit OUT/ECHO
PDP-11 for 2nd 1340	
HP-2100 Controller	

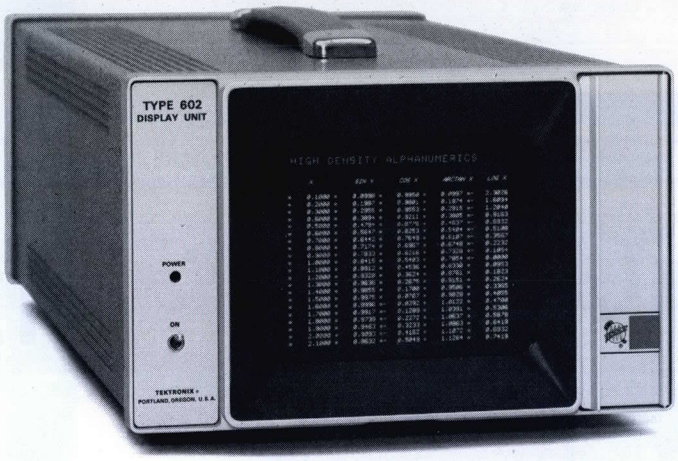
Specific Device Data Exchange

230/240 Program and Data
Paper Tape Reader/Punch
3S6 Program
3T6 Program
1140A Program
230 Program and Data
HP DMA Data Link
1840 Program
WAVETEK 157 Program
S-3260 Station Control Unit
Interfaces to DMM's, Counters, and signal generators are also available.

Display Products

Tektronix offers many instruments for displaying information. Each is designed for specific application areas — from small screen monitors, to stored display monitors, to the large screen 630 series of tv monitors. And each has its own special set of features to provide the exact instruments for most purposes. A new addition to the display product line is the 605 Variable Persistence Storage Monitor. Many of the most sought-after display features are combined in this new low-cost X-Y-Z monitor.

Permanent storage of displays is available through accessories such as the easy-to-operate hard copy units. These units produce high quality copies in a matter of seconds through a dry process. TEKTRONIX cameras are compatible with the smaller screen monitors (the 5″ and 6″ ones) to produce Polaroid prints.



1-MHz X and Y Bandwidth

100-mV/cm X and Y Deflection Factors

X-Y Phase Difference within 1° to 1 MHz

Uniformly Small Spot Size

Dc-Coupled Z Axis

The Type 602 Display Unit is a compact, solid-state instrument with excellent resolution providing accurate displays of information from X, Y, and Z signal inputs. Application areas are: phase shifts and frequency ratios using *Lissajous* figures, graphic and alphanumeric displays from computers, Y-T plots of amplitude versus time displays, and gamma camera displays.

Permanent records of the Type 602 display are provided on Polaroid film using the TEKTRONIX C-30A Camera with adapter. Two Type 602's may be mounted side-by-side using an optional rack adapter.

CRT DISPLAY

Cathode-Ray Tube— 5-inch flat-faced rectangular crt with P31 phosphor standard, P7 phosphor optional.

Display Size— 8 cm vertically and 10 cm horizontally.

Graticule—Standard graticule: Internal, parallax-free, variable illumination supplied with standard 602, as shown above. Optional graticule: Internal 8 x 10-cm outline (no graticule lines) supplied with Option 2.

Trace Width—Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5-μA beam current.

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the crt will not vary more than 2% in the vertical direction, and 6% in the horizontal direction.

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier input circuits are isolated from ground and offer noise-rejection capabilities to minimize noise signals common to the inner and outer conductor of the connecting cables.

Bandwidth—Dc to 1 MHz at 3-dB down.

Deflection Factor—Vertical: 90 mV/cm to 135 mV/cm, internally variable. Horizontal: 90 mV/cm to 110 mV/cm, internally variable.

Phase Difference—Not more than 1° between X and Y amplifiers up to 1 MHz.

Beam Position—Front panel vertical and horizontal position ranges permit setting zero signal position to any point on screen. Position shift is not more than 1 mm/h after 20-min warm up.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— 100 kΩ ±10% paralleled by 30 pF or less.

Maximum Input Voltage— ±10 V dc plus peak ac.

Recommended Source Impedance— 1 kΩ or less.

Z AXIS

A linear Z-axis amplifier permits intensity modulation of the writing beam. Analog input: dc to 1 MHz over 0.0 V to +1 V range. Signal input is a BNC connector on the rear panel.

Input R and C— 100 kΩ ±10% paralleled by 70 pF or less.

Maximum Input Voltage— ±10 V dc and peak ac.

Recommended Source Impedance— 1 kΩ or less.

OTHER CHARACTERISTICS

Power Requirements— 90 to 136 Vac or 180 to 272 Vac, 48 to 440 Hz. 50 watts at 115 Vac, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Temperature—Electrical specifications are valid over the range of 0°C to +50°C ambient.

Finish—Blue vinyl painted cabinet, aluminum construction.

Dimensions and Weights (cabinet included)—

Height	6 in	15.3 cm
Width	8½ in	21.6 cm
Depth	17⅜ in	44.1 cm
Net Weight	17½ lb	7.9 kg
Shipping weight	≈22 lb	≈9.9 kg

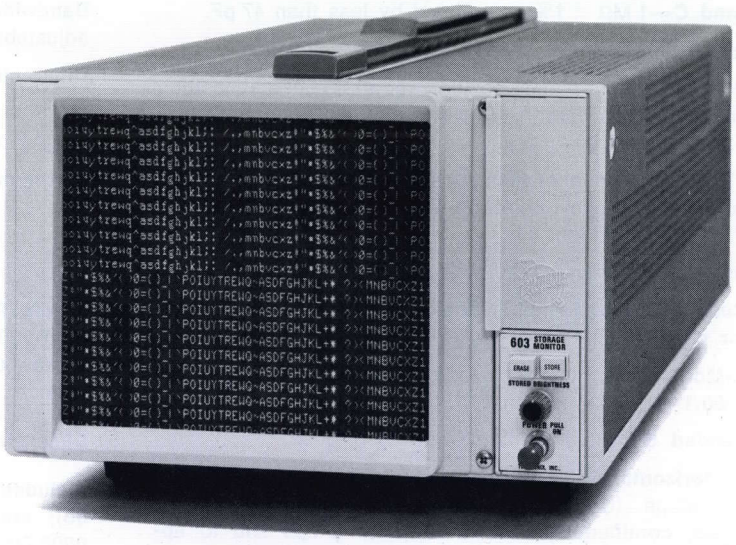
Included Accessories—Smoke-gray filter installed on standard instrument; orange filter installed with Option 76; maintenance manual.

ORDERING INFORMATION

602 Display Unit **$995**
Option 1 without Cabinet ..... **Subtract $25**
Option 2 Internal 8 x 10-cm Outline Graticule .... **No Charge**
Option 5 Vector Display Graticule ..... **Add $25**
Option 76 P7 Phosphor ..... **No Charge**

OPTIONAL ACCESSORIES

5¼-inch rack adapter (016-0115-02); panel assembly (016-0116-00); C-30A camera; Type 602 to C-30A adapter; C-30A camera carrying case.



Low-Cost X-Y Monitor

Time Base Option

6½-Inch Storage Crt

1 Million Dots/Sec Writing Speed

Variable Stored Brightness

View for Extended Periods

Differential Inputs

The 603 is an X-Y monitor for displaying alphanumeric and graphic data in either a refreshed or stored mode on a 6½-inch crt. It is well suited for applications such as ultrasonic detection systems, electron microscope systems, radiation and thermal scanning systems, speech therapy, mechanical pressure, volume and vibration analysis, medical and biophysical systems.

Now available is an optional, horizontal time-base. With calibrated sweep rates, conventional Y-T measurements are a valuable addition to the 603's high-performance X-Y monitor features.

The Tektronix-developed bistable storage crt used in the 603 eliminates the need for costly memory devices to refresh the display. Brightness of stored displays may be adjusted to obtain optimum photographic results, to integrate multiple traces and extend storage time to at least ten hours. Permanent records of the 603 display can be obtained on Polaroid prints using the TEKTRONIX C-5 Camera.

Operating functions are remotely programmable through a rear-panel connector which interfaces directly with TTL systems. X-Y-Z differential inputs are available via BNC connectors. A remote program connector is also available for positive inputs.

CRT DISPLAY AND STORAGE

Cathode-Ray Tube— 6½-inch flat-faced, bistable, storage tube. Phosphor is similar to P1. 3.5-kV accelerating potential. Two storage tubes are available (standard crt for brighter stored display or Option 2 for a faster writing speed). When used in the nonstore mode, both tubes exhibit characteristics of a conventional crt.

Writing Speed—Standard crt, at least 20 div/ms; Option 2, at least 200 div/ms.

Dot Writing Time—Time required to write (store) one dot: standard crt, 4 μs or less; Option 2 crt, 0.5 μs or less.

Information Storage Rate—Standard crt, at least 200 thousand dots/second; Option 2 crt, at least one million dots/second.

Display Size—4 inches vertically, 5 inches horizontally. An internal, nonilluminated graticule is available as Option 1.

Resolution—Stored, equivalent to 80 vertical x 100 horizontal stored-line pairs. Nonstored, equivalent to 128 vertical x 160 horizontal line pairs.

Display Linearity—The voltage required to produce a 1 inch deflection from any point on the crt will not vary more than 5%.

Viewing Time—At least one hour at normal intensity without loss of resolution. Viewing time can be extended to ten hours by utilizing the variable brightness control.

Erase Time—Approximately 250 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—Dc to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—1° or less to at least 500 kHz.

Beam Position—Front-panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Settling Time— 0.2 μsec or less for distances of 1 div or less. 1 μsec or less from any point on the crt to within one spot diameter of final position.

Maximum Input Voltage— ± 100 V dc plus peak ac.

Linear Common-Mode Signal Range—±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz, 50:1 to 100 kHz with 5X attenuator.

Recommended Source Impedance—10 kΩ or less.

Optional Horizontal Time Base— 1μs/div to 0.1 s/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 s/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam in nonstored mode. Positive input to + input increases the display intensity.

To insure storage of each written dot the Z-axis on-time should be at least 4 μs with the standard crt and at least 0.5 μs with Option 2 crt. The Z-axis pulse should be timed so that the system settling time is completed before unblanking occurs.

Bandwidth—Dc to 5 MHz over usable range. Sensitivity is adjustable from 1 to 5 V.

Differential Input—Cmrr at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

Maximum Input Voltage— ±100 V dc plus peak ac.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz. 75 watts maximum at nominal line voltage.

Dimensions and Weights—See next page.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00); external graticule (331-0303-00).

ORDERING INFORMATION

603 Storage Monitor		**$1150**
Option 1	**Internal Graticule**	**No Charge**
Option 2	**Fast Writing Crt**	**Add $25**
Option 3	**Without Handle and Feet**	**Sub $10**
Option 4	**Time Base**	**Add $125**

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

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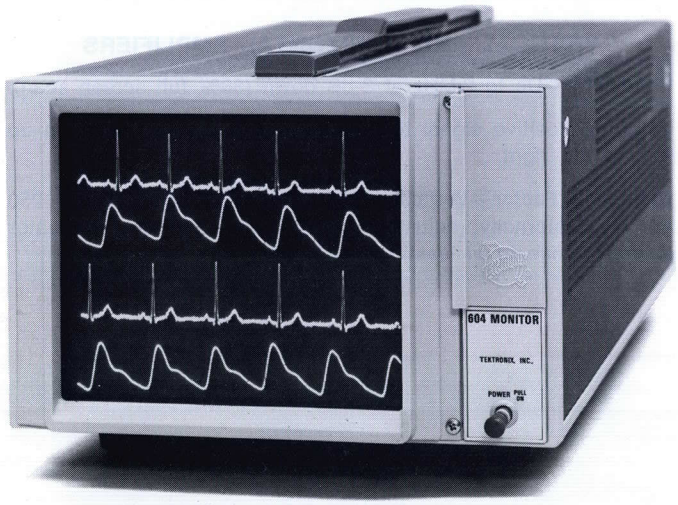
604 Display Unit

Low-Cost Monitor with 6½" Screen

12



Low-Cost Monitor

Time Base Option

6½-Inch, Easy Viewing Crt

2 MHz X and Y Bandwidth

Dc-Coupled 5 MHz Z Axis

X-Y Phase Difference within 1° to 500 kHz

Differential Inputs

The 604, with a 6½-inch crt, ideally meets the display and space requirements of system designers in such applications as pulse-height analysis, infrared detection, data communications systems testing, component and logic testing, vibration analysis and medical instrumentation. The 604 is also well

suited for many other applications including: phase shifts and frequency ratios using Lissajous figures, raster displays with intensity modulation and apparent dynamic three-dimensional illustrations. Calibrated horizontal sweep rates, available optionally, provide a convenient extension of the 604 measurement field. Visual display of computer-processed data enhances understanding of the processed information. Permanent records of the 604 display can be obtained on Polaroid prints using the TEKTRONIX C-5 Camera. Differential inputs are available via BNC connectors on the rear panel. Plus inputs are also available via a 25 pin connector.

CRT DISPLAY

Cathode-Ray Tube—6½-inch flat-faced rectangular crt with P31 phosphor. P7 phosphor optional (includes orange filter).

Display Size—Internal parallax-free, nonilluminated graticule marked in 8 vertical and 10 horizontal divisions (½ in/div). Option 1 is without graticule.

Display Linearity—The voltage required to produce a 1 inch deflection at any point on the crt will not vary more than 5%.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—Dc to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

Input R and C—1 MΩ ±1%, paralleled by less than 47 pF.

X-Y Phase Difference—Not more than 1° to at least 500 kHz.

Beam Position—Front panel position controls permit setting zero to any point on screen. Position shift is 1 mm/h or less after 20-min warm-up.

Maximum Input Voltage—±100 V dc plus peak ac.

Linear Common-Mode Signal Range—±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio—At least 100:1 to at least 100 kHz, 50:1 to 100 kHz with 5X attenuator.

Recommended Source Impedance—10 kΩ or less.

Optional Horizontal Time Base—1 μs/div to 0.1 s/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 s/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth—Dc to 5 MHz over usable range, sensitivity is adjustable from 1 to 5 V.

Differential Input—Cmrr at least 100:1 and common-mode range at least ±5 V.

Input R and C—1 MΩ ±1% paralleled by less than 47 pF.

Maximum Input Voltage—±100 V dc plus peak ac.

OTHER CHARACTERISTICS

Power Requirements—Line voltage selector allows operation from 100, 110, 120, 200, 220 and 240 V (±10% on each range), 50 to 60 Hz and 400 Hz, 56 watts maximum at nominal line voltage.

Included Accessories—External program connector (131-0570-00); connector cover (200-0821-00).

ORDERING INFORMATION

604 Monitor		**$735**
Option 1	**Without Graticule**	**No Charge**
Option 3	**Without Handle and Feet**	**Sub $10**
Option 4	**Time Base**	**Add $125**
Option 5	**Vector Display Graticule**	**Add $30**
Option 76	**P7 Phosphor**	**No Charge**

Optional Accessories—5¼-inch rack conversion kit, C-5 Camera.

RACKMOUNTING FOR 603 AND 604

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a 603 Option 3 or 604 Option 3 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.
Order 040-0601-00 ..... **$77**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two 603 Option 3s or two 604 Option 3s side-by-side in a standard rack width.
Order 040-0600-00 ..... **$50**

Rackmount-to-cabinet conversion kit required to convert a rackmount 603 or 604 to a cabinet style.
Order 040-0602-00 ..... **$25**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 603 or a 604 in a standard rack width.
Order 040-0624-00 ..... **$44**

603/604 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in	cm
Height	6.65	16.9	5.25	13.5
Width	8.4	21.4	8.4	21.4
Length	19.25	48.9	19.0	48.25
Weights (approx)	lb	kg	lb	kg
Net	17.5	7.9	17.5	7.9
Shipping Weight	23.0	10.4	23.0	10.4

NEW

605

Storage Display Unit

3 MHz Variable Persistence Storage Monitor

Low Cost X-Y-Z Monitor

Variable Persistence Storage

1 Div/μs Writing Speed

3 MHz X-Y Bandwidth

5 MHz on Z axis

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 2000 times 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 minutes. The 605 combines variable persistence 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 spot 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-inch, flat-faced, rectangular tube with P31 phosphor. 8.5 kV accelerating potential.

Display Size— 8 divisions vertically, 10 divisions horizontally at 0.9 cm/div.

Graticule—Standard graticule, external. Internal 8 x 10-div graticule supplied as Option 1.

Maximum Writing Speed—At least 1 div/μs for 1 minute viewing time.

Storage View Time—Greater than 5 minutes 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 fl.

Erase Time— $\simeq$500 ms.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—Dc to 3 MHz at 3 dB down (80% full screen 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 5.1 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 zero-signal position to any point on screen. Position shift is 0.09 cm/hr or less after 20 minute warm-up.

Spot Response Time—Typically 0.5 μs to settle within 1 spot diameter.

Maximum 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 six calibrated steps (decade sequence), accurate within 3%. Uncalibrated continuously variable between steps and to approximately 1 s/div, TRIG SLOPE/LEVEL Control for stable, triggered displays. For nontriggered display, an internal switch selects bright base line 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 adjustable from ±1 V to ±5 V for full intensity control.

Differential Input—Cmrr at least 100:1 to 100 kHz up to ±5 V.

Input R and C— 1 MΩ paralleled by less than 47 pF.

Maximum 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 volts (±10% on each range), and 50 to 60 Hz. Power consumption is 40 watts maximum at nominal line voltage.

Included Accessories—External program connector (131-0570-00); connector cover (200-0281-00).

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
Weights (approx)	lb	kg	lb	kg
Net	17.5	7.9	17.5	7.9
Shipping Weight	23.0	9.9	23.0	9.9

ORDERING INFORMATION

605 Variable Persistence Storage Monitor **$1,675**

Option 1 Internal Graticule ..... **No Charge**

Option 3 Without Handle and Feet ..... **Sub $10**

Option 4 Internally Triggered Time Base ..... **Add $125**

Rackmounting for 605

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a 605 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized.

Order 040-0601-00 ..... **$77**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two 605 Option 3's side-by-side in a standard rack width.

Order 040-0600-00 ..... **$50**

Rackmount-to-cabinet conversion kit, required to convert a rackmount 605 to a cabinet style.

Order 040-0602-00 ..... **$25**

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 modular test system and a 605 in a standard rack width.

Order 040-0624-00 ..... **$44**

611 Storage Display Unit

For displays of exceptional density and high resolution

High-Resolution Alphanumeric and Graphic Displays

Flicker-Free Bistable Storage

Eliminates Costly Memory Devices

Hard-Copy Compatible

Remote Programming of Display Functions

The 611 Storage Display Unit provides stored displays of combined alphanumeric and graphic information from analog sources and digital computers, using built-in digital to analog converters. 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, Nonstore, and View) are remotely programmable. The 4601 Hard Copy Unit will copy the 611 Display.

DESIGN CHARACTERISTICS

The Display—The 611 uses an 11″ (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 approximately 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 VAC (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) **$3495**

611-2 Storage Display Unit (horizontal format) **$3495**

613 Storage Display Unit

Bright, large screen data storage display

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 analog sources and digital computers, using built-in digital to analog converters.

Horizontal or vertical display formats are available. Hard copies of stored displays can be made using a TEKTRONIX 4610 Hard Copy Unit.

DESIGN CHARACTERISTICS

The Display—The 613 uses an 11″ (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-on (unblanked) level is + 1 V; beam turn-off (blanked) is + 0.5 V or less. Input R and C is 10 kΩ shunted by approximately 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 VAC, (LO, MED, HI), 48-66 Hz, and requires 180 watts (maximum) at 115 VAC, 60 Hz.

Included Accessories—Maintenance manual.

ORDERING INFORMATION

613 Storage Display (Horizontal format) **$2495**

613-1 Storage Display (Vertical format) **$2495**

User Convenience

Permanent Copies Of Stored Displays

Copy Costs As Low As 6 Cents A Copy

Accurate 8½" x 11" Information Copy

The 4601 Hard Copy Unit is a convenient, economical way of permanently copying alphanumeric and graphic displays. High resolution displays obtained on the 611 Storage Display or 4002A Graphic Computer Terminal are copied by the 4601, providing an accurate representation of the stored display on 3M Type 777 Dry-Silver Paper.

Copy command is initiated manually by pressing a front panel control, or by supplying an external command under program control.

CHARACTERISTICS

Copy Size—Adjusted to 8½ x 11 inches at factory, variable between 8½ x 6 and 8½ x 14 inches.

Copy Time— 18 seconds for first copy.

Warmup Time— 20 minutes.

Resolution (with 3M Brand Type 777 Paper)—Essentially the same as displayed on the 611 Display Devices or 4002A Graphic Display Terminal. Actual-size copies of a 4000-character display, based on a 90 x 70-mil matrix, are clearly legible.

Power Source (factory-wired options)— 90 to 136 Vac, 115 V nominal, 50 to 60 Hz. Maximum power consumption is 1450 W for first 40 seconds after turn on, 220 to 520 W for normal operation, 100 W standby.

Included Accessories—Two 6-foot interconnection cables; 8-foot detachable power cord.

ORDERING INFORMATION

4601 Hard Copy Unit **$3995**
115-volt, 60-Hz power

4601-1 Hard Copy Unit **$3995**
230 volts, 50-Hz power

Paper—One roll is included with the 4601. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$40**

For one carton of 4 rolls, order 006-1603-01 ..... **$143**

OPTIONAL ACCESSORIES

Copy Catcher, Order 016-0298-00 ..... **$101**

Dry-Process Hard Copies from Graphic Computer Terminals and Storage Display Units

Same Resolution as Storage Crt

Copies in Only 18 Seconds

Sharp, permanent hard copies are made from the crt display of 613 Storage Display, or any 4010-family Computer Display Terminal by the 4610 Hard Copy Unit. The 4610 can be multiplexed to provide a copying capability from one to four Computer Display Terminals and/or 613 Storage Displays.

Operation is simple. A single push-button control on the 4610 front panel or a rocker switch on the computer terminal initiates copy-making manually, or program control will accomplish it from the computer.

CHARACTERISTICS

Copy size— 8½ x 11 inches.

Copy Time— 18 seconds for first copy.

Warmup Time— 20 minutes.

Resolution (with 3M brand Type 777 paper)—Essentially the same stored on the display.

Power Source (factory-wired options)— 90 to 136 Vac, 115 volt nominal, 50 to 60 Hz. Maximum power consumption 1450 watts for first 40 seconds after turn-on, 220 to 520 watts for normal operation, and 100 watts standby.

Included Accessories— 8-foot detachable power cord, 10 ft. interconnecting cable.

ORDERING INFORMATION

4610 Hard Copy Unit **$3895**
115-volt, 60-Hz power

4610-1 Hard Copy Unit **$3895**
220-volt, 50-Hz power.

Option 1 Multiplexing Circuitry ..... **Add $400**
Provides copying capability from one to four Computer Display Terminals or 613 Display Unit. Applies to both 4610 and 4610-1.

Option 2 ..... **Add $400**
Compatible with 4014-1 and 4015-1 Computer Display Terminals.

Paper—One roll is included with the 4610 or 4610-1. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$40**

For one carton of 4 rolls, order 006-1603-01 ..... **$143**

OPTIONAL ACCESSORIES

Copy Catcher, order 016-0298-00 ..... **$101**

NEW

4623 Hard Copy Unit

Hard Copies of 4023 Alphanumeric Terminal Displays

Simple, Quiet Operation

Completely Self-Contained

Dry Process Developing

The 4623 Hard Copy Unit is designed to produce permanent high quality, 8½″ x 11″ copies from the 4023 refreshed alphanumeric terminal. Operation is simple and quiet, with dry-process development within one lightweight unit.

Installation is easy and simple. The 4623 is plug-to-plug compatible to the 4023. Four-channel input, which accommodates up to four 4023's, is standard, allowing copying capabilities from one to four terminals.

DESIGN CHARACTERISTICS

Standard copy size adjustment is 8½ inches by 11 inches for horizontal raster display (4:3 aspect ratio). Copy time is approximately 18 seconds for the first copy and about 8 seconds for additional copies of the same display. Machine warmup time is 20 minutes. The recommended ambient temperature for operation is 0°C to +35°C.

Remote Signal Inputs—Remote copy. A logic level "LO" (ground closure) initiates a copy command.

Power Requirements—The 4623 operates on 100, 115, 200, or 230 Vac, 50-60 Hz. These are factory-wired options.

Included Accessories—One 10-foot 15-pin interconnecting cable.

ORDERING INFORMATION

4623 Hard Copy Unit **$3395**
Option 1 Copy Counter ..... **Add $50**

Standard color is tan if color is not specified.

Option 56 Gold ..... **Add $40**
Option 57 Red ..... **Add $40**
Option 58 Green ..... **Add $40**

Paper—One roll is included with the 4623. Refills are available from Tektronix, Inc.

For one roll, order 006-1603-00 ..... **$40**
For one carton of 4 rolls, order 006-1603-01 ..... **$143**

4632 Video Hard Copy Unit

Dry Process Development within One Lightweight Unit

Permanent 8½″ x 11″ 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 inches by 11 inches for horizontal raster display (4:3 aspect ratio). Copy time is approximately 18 seconds for the first copy and about 8 seconds for additional copies of the same display. Machine warmup time is 20 minutes. 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. Maximum input is 10 Vdc 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 Vac, or 200-230 Vac, 50-60 Hz; these are factory wired options.

Included Accessories—Users manual, one 75-ohm termination.

ORDERING INFORMATION

4632 Video Hard Copy Unit **$3395**

Option 1, Copy Counter ..... **Add $50**

Option 2, 4-channel Multiplexer ..... **Add $500**

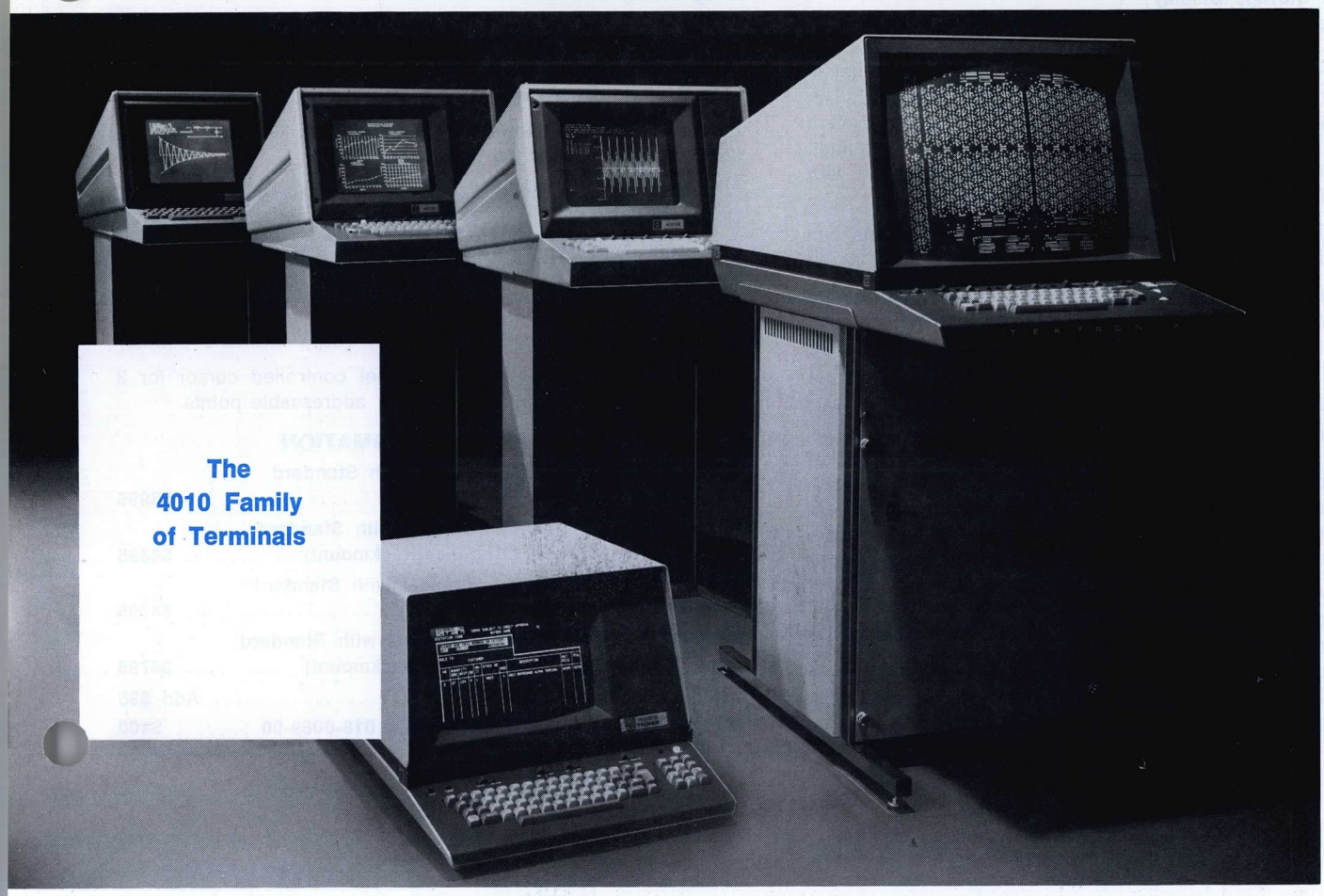
Option 3, Set up for 625 Line, 50 Hz Field Operation ..... **No Charge**

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 ..... **$40**
For one carton of four rolls, order 006-1603-01 ..... **$143**

Terminal Products



The 4010 Family of Terminals

The 4010 family of terminals, (the 4010, 4012, 4013, 4014, and 4015), have capabilities to fit a variety of situations. The 4010 family can be adapted to most computer systems and tasks by using the right combination of interfaces, software, and peripheral equipment.

They are each shipped with a Standard Data Communication Interface installed if no option is specified. Also available is an option (option 1) for full or half duplex Data Communication system operations. Six additional options are also offered to provide connections at the TTY port of the most commonly used minicomputers. (Special TTY interfaces are available by special quote). In addition, there are two code converting interfaces available for operation in a 2741 environment or a CDC synchronous environment.

A complete line of software which can be used with any of the 4010 family of terminals further increases flexibility of application. (Software listed on page 309).

Any of the 4010 family can be used with the 4911 Paper Tape Reader/Perforator Unit, the 4921 and 4922 Flexible Disc Memory Units and the 4953 and 4954 Graphic Tablets.

Model variations are also available to be compatible with the 4610 Hard Copy Unit, providing permanent copies of display information.

4010
4010-1

Computer Display Terminal

For low-cost graphics and alphanumerics

Supports Alphanumeric Plus Low-Cost Computer Graphics
Convenient Pedestal Design for User Environments
Flicker-Free Storage Display
Complete Software Support

Despite 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. You can start with a simple, low-cost terminal, leaving room for future expansion, or you may enlarge it with a variety of options for larger systems.

With the 4010-1, permanent hard copies of displayed data can be obtained, using a 4610 Hard Copy Unit.

Physical Configurations—The keyboard and display unit may be secured at the top of the pedestal in a convenient free-standing model, or may be mounted on a desktop. An extra-cost rack-mount is also available.

The Keyboard—The 4010 has a TTY style keyboard featuring 63 printing characters (including upper case alphanumerics), and standard ASCII control characters. Convenient rocker switches above the keyboard select Local or Line operation and (on the 4010-1) produce hard copies from the 4610. Independently-operated X and Y axis thumb-wheels 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.

Minibus Extender, Option 30—This circuit card allows up to 5 additional interfaces, options and/or peripherals to be plugged into 4010-Series terminals.

DESIGN CHARACTERISTICS

Screen Size—The screen is a direct-view storage crt 8¼ inches wide by 6⅜ inches 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 **$3995**

R4010 Computer Display Terminal with Standard Data Communications Interface (Rackmount) **$4395**

4010-1 Computer Display Terminal with Standard Data Communications Interface **$4395**

R4010-1 Computer Display Terminal with Standard Data Communications Interface (Rackmount) **$4795**

Option 30 Minibus Extender ..... **Add $95**

Minibus Extender added later, order 018-0069-00 ..... **$100**

4012

Computer Display Terminal

A high resolution, cost-effective graphic terminal

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. In addition, the 4012 offers higher resolution graphics in two operational modes. The 4012 is compatible with the 4610 Hard Copy Unit, for providing permanent copies of display information.

The Display—The TEKTRONIX storage display tube permits circuit simplification, making the 4012 easy to operate, inexpensive to maintain, and economical to purchase.

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.

Physical Configurations—The keyboard and display unit may be secured to the top of the pedestal in a convenient free-standing model, or may be mounted on a desktop. An extra-cost rackmount version is also available.

The Pedestal—The 4012 pedestal contains the Power Supply and the Terminal Minibus. The Minibus adaptability makes the 4012 an extremely versatile data-handling device.

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 thumb-wheel 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 inches wide by 6⅜ inches 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 **$5295**

R4012 Computer Display Terminal with Standard Data Communications Interface (Rackmount) **$5695**

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.

Another advantage of the 4013 is copying capability from the 4610 Hard Copy Unit.

The Display—The 4013, like other 4010 series terminals, has all the advantages of the storage display tube, such as high resolution display.

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 keyboard.

Physical Configurations—The 4013 keyboard and display unit may be secured to the pedestal base, or may be detached and mounted on a desktop. An extra-cost rackmount version is also available.

The Pedestal—The Power Supply and Terminal Minibus are contained in the pedestal. The Minibus contains space for up to five additional options and/or interface cards.

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 inches wide by 6⅜ inches 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 **$5495**

R4013 Computer Display Terminal with Standard Data Communications Interface (Rackmount) **$5895**

Computer Display Terminal

Interactive graphics and large-screen capabilities

4014
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 4610 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.

The Keyboard—Alphanumeric and control entries are made from the keyboard, where the TTY lock key and graphic cross-hair cursor controls are also located.

Physical Configuration—The display unit (with keyboard) is secured to the pedestal to form a desk-height unit. The pedestal contains power supply and control circuitry, character generator, plus communication interfaces and optional interface space. An optional cable is available to allow desktop mounting of the display unit.

DESIGN CHARACTERISTICS

Screen Size—A direct-view storage crt, 15 inches wide by 11 inches 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 **$8995**

4014-1 Computer Display Terminal with Standard Data Communications Interface **$9495**

Option 34 Enhanced Graphics Module ..... **add $700 (Factory Installed Only)**

4015
4015-1

Computer Display Terminal

Large-screen graphic capabilities for use with APL

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 4610 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.

The Keyboard—APL characters are depicted on the top surfaces of the keys, with ASCII symbol differences on the forward surfaces.

Physical Configurations—The keyboard and display unit is secured to the top of the pedestal to form a desk-height unit. An optional cable is available for desktop use of the keyboard and display unit.

The Pedestal—The 4015 pedestal contains a power supply, control circuits, character generator, plus communication interfaces and option interface space.

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 inches wide by 11 inches 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 **$9495**

4015-1 Computer Display Terminal with Standard Data Communications Interface **$9995**

Option 34, Enhanced Graphics Module ..... **Add $700 (Factory Installed Only)**

4023

Computer Display Terminal

For refreshed upper and lower case alphanumerics

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. Hard copies are available by connecting the 4023 to the 4623 Hard Copy Unit.

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. Standard terminal features permit the cursor to be addressed to any one of the 1920 character positions.

The 4023 can communicate directly with a computer, bypassing the buffer; or it can communicate via the buffer. Communicating directly to the computer is a character-by-character process; whereas, in buffered communications the data can be sent as one complete block.

Function Control and Numeric Pad—A cluster of 12 keys to the right of the keyboard serves a dual purpose: one, to provide control for editing, transmission, cursor movement, etc.; and two, by pressing the NUM LOCK key, to function as a numeric pad.

Editing Capabilities—Insert character and line, delete character and line, erase to end, erase page. Editing is speeded by tab, back tab, and repeating character keys.

Field and Data Formatting—Displayed data can be arranged to resemble the source document. Forms information can then be rapidly retrieved, updated, edited, and entered. Visual field formats include: inverted, blinking, blanked, and dim fields. Logical formats include: transmittable, non-transmittable, protected, non-protected, and non-alpha fields.

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.

Software—A special software package, Dataform, has been created for the 4023.

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.

Character Code— 128 ASCII, 96 printing upper and lower case characters.

ORDERING INFORMATION

4023 Computer Display Terminal **$2995**

Option 31 Rulings Character Set ..... **Add $ 330 (Factory Installed Only)**

Option 56 (gold), Option 57 (red), Option 58 (green) **No Charge**

Through these interfaces, the 4010-Series terminal can communicate directly to your computer or mini-computer, or remotely by data-communications. TTY port interfaces which communicate directly with mini-computers are available, as well as interfaces for data-communication with large timeshare computers, for both basic and more complex functions.

Standard Data Communications Interface—This is the standard interface which is included with each 4010-Series terminal, unless another interface is selected. It is RS-232 C compatible, full duplex, and has strap selectable input-output data rates of 150, 300, 600, 1200, 2400, 4800, and 9600 bits/s.

Option 1—Optional Data Communication Interfaces with additional flexibility and convenience to fit the more sophisticated data communcations requirements of complex systems. Convenient switch-selectable functions include: local-echo, full-duplex, half-duplex and independent transmit and receive rates of 110, 150, 300, 600, 1200, 1800, 2400, 4800, 9600 bits/s.

2741 Correspondence Code/APL Interface—Operates in any data communications environment with APL or standard 2741 correspondence code character sets. Features externally switchable data communication rates— 134.5, 300, 600, 1200 baud.

Teletype Interfaces—

Option 2 (DEC PDP-11 with KL-11 Controller)

Option 3 (DEC PDP-8/i, 8/I, 12, 15)

Option 4 (Data General Nova, Super Nova, Nova 800, Nova 1200, Nova 1220)

Option 6 (Hewlett-Packard 2100 Series, with 12531 B or C I/O Controller)

Option 16 (DEC PDP-11 with DL-11 Controller and PDP 11/05)

Option 17 (DEC PDP 8/e with Module M8650)

Additional interfaces may be available upon request. Contact your Tektronix Applications Engineer for availability and quotations.

ORDERING INFORMATION

Any Optional Interface, except Option 20 ..... **Add $330**
(Specify interface at time of order)

Ordered separately or as additional interfaces **$660**

Provides Low-Cost Graphics for CDC 6000-Series Computers

Synchronous and Asynchronous Modes

Tektronix offers a complete CDC-compatible Synchronous Interface for use with TEKTRONIX 4010 Family Graphic Display Terminals. The interface sends and receives the communcations protocol for CDC systems. The interconnecting plug is RS-232C compatible, enabling full duplex asynchronous communication from the same terminal, if desired, with standard modem hook-ups. The Interface includes standard site address code ability that can significantly reduce data transmission charges. With its multi-drop polling capability, one phone line can serve several terminals at once.

NEW Synchronous Interface

Editing features include easy character delete and one-key rubout. The code expander shifts quickly to expand the standard 64 characters to the full 127-character code, thus enabling graphics.

In the Asynchronous Mode, standard baud rates are easily set, up to 4800 and in-between rates are diode programmable. Two optional PLOT-10 Software packages (TCS and AG-II) will provide substantial graphics support.

ORDERING INFORMATION

Synchronous Data Communications Interface, Order Option 20 ..... **Add $2665**

If ordered separately, part number 021-0135-00 ..... **$2995**

Software Products

Make maximum use of TEKTRONIX graphics terminals

Most Extensive Graphics Software Available Anywhere

Interfaces to a Variety of Minicomputers

Compatible with Major Timesharing Systems

Tektronix, Inc. has expanded its graphics software support to provide the most extensive offering of programming support ever. The graphics software is compatible with most timesharing systems, and specific packages are offered for IBM O/S and TSO, CDC SCOPE/INTERCOM, APL\360, and numerous minicomputers.

The following list is a summary of the graphics software that is available. For more detailed information, check the box labeled "Software Guide for Computer Products" on the Business Reply Card, or contact your local Applications Engineer.

PLOT-10/Terminal Control System: Standard Function Package, Implementation for IBM with TSO, Implementation for PDP-11 with DOS, Implementation for CDC 6000 Systems.

PLOT-10/Advanced Graphing-II: Standard Function Package, Implementation for CDC 6000 Systems.

PLOT-10/Character Generation System

PLOT-10/Preview Routines for CalComp Plotters

PLOT-10/Display Multiplexer Utility Routines

PLOT-10/Flexible Disc Utility Routines

PLOT-10/Graphics Tablet Utility Routines

PLOT-10/360-370 Graphics Software

PLOT-10/Minicomputer Software

PLOT-10/APL GRAPH-II: Standard Function Package, Implementation for APL\360.

Dataform: Standard Function Package, implementation for IBM with TSO.

4911 Paper Tape Reader/Perforator

An efficient peripheral to extend your system's capabilities

Saves Money and Time

Saves Computer Core

The 4911 Paper Tape Reader/Perforator is an efficient and useful peripheral that can enhance your graphic capabilities. With the appropriate interface card inserted into the minibus extender of the 4010 series of graphic display terminals, the 4911 can significantly reduce cost and on-line time by entering data or programs from pre-punched tape at slack computer times. This same capability can also expand the limited memory capacity of a minicomputer. Programs and data that would otherwise consume valuable space in core storage can be kept in permanent off-line form, and can be readily updated using a 4010-series Computer Display Terminal. Data can then be entered into the computer, using the 4911, at rates up to 200 characters per second.

Tape loading and operation of the reader and perforator are quick and simple through convenient grouping of front panel push-button controls. The 4911 uses standard, easily obtained one-inch paper, paper mylar, or aluminum-mylar tapes with a thickness range of 0.0030 to 0.0043 inch.

The 4911 requires Minibus Extender (Option 30). See page 306.

DESIGN CHARACTERISTICS

Punch Speed— 75 characters per second.

Reader Speed— 200 characters per second.

Tapes—Paper, aluminum, or mylar, on roll form.

Bit Format— 8 bit (8 channel).

ORDERING INFORMATION

4911 Reader/Perforator Unit **$3295**
(including one roll paper tape)

NEW 4921 4922 Flexible Disc Memory

Desk-side graphics memory for 4010-Series of terminals

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 extraordinary 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 **$3495**
(single drive with interface)

4922 Flexible Disc Memory **$5750**
(dual drive with interface)

NEW 4953 4954 Graphic Tablet

High resolution, real-time graphic input

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 push-button 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

4954 Graphics Tablet **$4995**
(with interface)

4953 Graphics Tablet **$2795**
(with interface)

Cursor (119-0622-00) ..... **$ 200**

Programmable Calculator Products

14

The 21 and 31 programmable calculators are designed for easy interaction between you and your machine. There are no machine rules or languages to learn. Just natural, English-like programming keys and a simple keyboard that does math the way you write it down. Data entry is in floating, scientific or mixed notation.

PROGRAMMING EASE

With simple keyboards for extensive programming and the use of pre-programmed software libraries, the TEKTRONIX calculators are a step ahead in removing the error in hand-keying program execution. Both the 21 and 31 offer individual register and program step memories. Magnetic tapes can be used for permanent storage on the 31. In addition, both calculators have non-erasable, Programmable-Read-Only-Memory (PROM) capability, which only adds to any chosen memory configuration.

To simplify the program or keying operations, even for inexperienced users, Tektronix offers the user-definable feature. Simply key in a sequence of steps which you use repeatedly and store under any User Definable key (F1 to F7 on the 21, or 24 of the function keys on the 31). Next, label the key location(s) on the overlay card with your own definition and place the

card on the appropriate keyboard. From that point on, a single keystroke will recall and execute that special sequence of steps.

VERSATILITY HAS BEEN ADDED

With its flexibility, programmability and input/output features the 31 is a natural system controller. As a result, Tektronix has introduced a line of calculator-based products—which not only fill needs ignored until now—but at low cost. For example: the 31/53 Instrumentation System, a versatile way to fill test, measurement, monitoring and control requirements. A low cost alternative to many minicomputer based systems for data acquisition and processing. Likewise the 31/10 Graphic Calculator System, a combination of the 31 Calculator and 4010 Graphic Display Terminal which gives the user immediate data displays in graphic or alphanumeric form. System software makes it easy to get plots going with options for more complex displays. The 4610 Hard Copy Unit or the 4661 Digital Plotter can be interfaced to duplicate your screen images on paper.

See DPO WD1100 series page 38 for additional configurations.

4661 DIGITAL PLOTTER

The best way we know for producing low cost copies of your calculator computations. The 4661 has the advantages of low initial cost, excellent repeatability, and large format, to mention a few. This low maintenance, digital-movement plotter can be operated from front panel switches, or put under complete program control.

INTERFACES

Tektronix recognizes the advantages of interfacing the 21 or 31 Calculator to electronic equipment produced by other manufacturers. The benefits range from lower system costs to the simple matter of user convenience. As a result, Tektronix has developed and now offers a new line of interfaces.

The 152 Calculator General Purpose BCD Interface has features like 56 parallel programmable outputs and 64 bit-parallel inputs; the 152 can be used to combine your 21 or 31 with counters, DVM's or most programmable peripherals.

The 153 Calculator Instrumentation Interface is now available for those already using 31 calculators, but requiring additional components to complete a 31/53 Instrumentation System.

The 154 Calculator RS-232-C Interface allows calculator communication with a wide variety of computer peripherals such as teletypes, crt terminals, paper tape punch/readers and line printers. The 154 also has the capability to drive current loop ASCII devices.

21 Programmable Calculator

Easy to use—easy to program—in natural math language

35 Built-in Math Functions

Prom Capability

8 User-definable Keys

In addition to the many built-in math functions, the 21 offers eight user-definable keys. This allows you to customize a sequence of keystrokes to suit your need. Data entry is easy. Any combination of ordinary floating, scientific floating or mixed decimal is accepted, and all in easy natural math hierarchy.

STANDARD CHARACTERISTICS

Data Storage Memory—Ten registers are built-in for data storage. Each register can store any number shown in the display.

Program Memory—The program memory is organized into 8 blocks of 16 steps each, for a total of 128 steps. These blocks can be used individually with an overlay for user-definable operation or linked together for complete programs. Program memory may be increased with optional expansion packs.

Permanent Storage—Programs can easily be transcribed on 256-step magnetic cards. For longer programs, the cards can be linked together.

Easy Programming—Features include: • conditional branching • unconditional branching • single key register arithmetic • indirect addressing • step forward editing • overrange indication.

Display—A 10-digit mantissa with a 2-digit exponent.

Standard Accessories— 21 Verification program • Power cord • 25 magnetic storage cards (256 steps each) • 25 user-definable overlays.

ORDERING INFORMATION

21 Programmable Calculator	**$1850**
Option 1 Numeric Thermal Printer	**Add $ 450**
order 040-0684-00 if added later	**$ 500**
(Installation charge as quoted)	
Option 2 Memory Expansion Pack, 256 steps	**Add $ 250**
order 020-0084-00 if added later	**$ 250**
Option 3 Memory Expansion Pack, 512 steps	**Add $ 400**
order 020-0084-01 if added later	**$ 400**

OPTIONAL ACCESSORIES

Carrying Handle Kit (016-0575-00)	**$ 25**
Magnetic Card Package (016-0576-00) 25/package	**$ 20**
Program Overlay Package (016-0577-00) 25/package	**$ 10**
PROM (062-1648-00) (256 steps)	**$ 330**
PROM (062-1649-00) (384 steps)	**$ 415**
PROM (062-1650-00) (512 steps)	**$ 495**
Statistics Program Library, Vol. 1/(062-1590-00)	**$ 40**
Mathematics Program Library, Vol. 1/(062-1591-00)	**$ 40**

35 Built-in Math Function Keys

24 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, non-erasable 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 040-0685-00 if added later	$ 750
	(Installation charge as quoted)	
Option 2	1024 steps, 128 registers	Add $ 400
Option 3	1536 steps, 192 registers	Add $ 700
Option 4	2048 steps, 256 registers	Add $1000
Option 5	2048 steps, 640 registers	Add $2000
Option 6	3584 steps, 448 registers	Add $2000
Option 7	5120 steps, 256 registers	Add $2000
Option 8	2048 steps, 1000 registers	Add $2800
Option 9	5120 steps, 640 registers	Add $2800
Option 10	8192 steps, 256 registers	Add $2800
PROM/(062-1651-00) (1000 steps)		$ 600

OPTIONAL ACCESSORIES

Carrying Handle Kit/(016-0575-00)	$ 25
Magnetic Tape Cartridge/(020-0082-00)	$ 12
User-Definable Overlay Package/(016-0578-00) (10/package)	$ 15
Thermal Printer Paper/(006-1775-00) (5 rolls/package)	$ 7.50
Software Options (Presumes the Use of Option 1)	
Statistic Program Library, Vol. 1/(062-1592-00) (Manual only)	$ 50
Statistics Program Library, Vol. 1/(062-1592-10) (Manual and Mag Tape)	$ 250
Mathematics Program Library, Vol. 1/(062-1593-00) (Manual only)	$ 50
Mathematics Program Library, Vol. 1/(062-1593-10) (Manual and Mag Tape)	$ 250

Graphic Calculator System

The interactive graphic calculator

Math Power Graphics

Keyboard Versatility

Plotting Software

The 31/10 system consists of two components: the 31 Programmable Calculator and the 4010-1 Display Terminal. Linked by an interface, the terminal provides the calculator with the display capability of presenting your data in alphanumeric and graphic form. Displays include graphs, charts, vectors, histograms, or any other information better understood graphically.

Keyboard Versatility—Using the calculator's remote key enables the user to send commands to the terminal such as • erase screen • accept X or Y coordinate data • plot X-Y coordinates • enable or disable graphics • make hard copies • start or stop alpha and print • continue alpha only.

The optional 4610 Hard Copy Unit will easily provide hard copies of your display for less than 6¢ per copy and is directly compatible with the 31/10.

SOFTWARE

Function Plot—Designed to enable the user to plot any user-definable single variable function. Automatic scaling routines assure good representation of data and optimum screen area usage. Interactive operation will, however, allow the user to specify minimum and maximum values for X and Y coordinates, the coordinate of axis intersection, and the independent variable increment.

Optional Function Plot—Used with memory option 04, this package provides not only the above, but also automatic scaling with axis labeling.

Histogram Plot—This package allows users to specify the minimum and maximum values and establish cell width. The program will use consecutively entered values to establish mean, standard deviations, and percentage of occurrences per cell.

Optional Histogram Package—In addition to the above, this includes automatic scaling and labeling. Additionally, it allows cell plotting three ways: occurrences per cell, percentages per cell, and pie charts. Needs 31 memory option 4 package.

Standard Accessories— 31/10 Systems Manual • 31 Operator's Manual • 4010 User's Manual • 31/10 Graphic Software Package (includes Function, Data and Histogram Plot Programs on mag tape cartridge with overlays.) • blank Mag Tape Cartridge • 2 blank User-Definable Overlays • Interface Cable • Power Cord • Termination Pack • Cable Guide.

ORDERING INFORMATION

31/10 Graphic Calculator System $7500

31 Options—See 31 Programmable Calculator, page 313

31/10 System Software ordered separately (062-1644-10) $150

Modularity

Versatility

Natural Programming Ease

Low Cost High Performance

Introducing Tektronix's calculator world of instrumentation systems. 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.

SOFTWARE

With the standard 31/53 software tapes you have automatic data acquisition and processing. The software will pick out the number of samples you specify along with the rate, data limits, and automatic termination.

31/53 components and accessories include: • 31 Programmable Calculator • 153 Instrumentation Interface • 31/53 System Operation Manual • 31 Manual and Verification Program • 153 Manual • Standard Software • Interface Cable • Power Cord • Two User-Definable 31 Overlays.

See 31 Calculator description and options on page 313.

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, $\leq$.8 V low • Calculator display flashed by interface with a momentary short or pulldown to .8 V or less.

PATCH PLUG INFORMATION

A Type I 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 I as standard equipment. For a system with two counters, option 31 should be ordered (no charge). It replaces the Type I as standard equipment. When ordering subsequent instrumentation, all additional patch plugs are available as optional accessories.

Optional Plug-in Modules—The choice of counters, multimeter or combinations can be selected from the TM 500 Series DC 501, 502 or 503. Counters and DM 501 Multimeters. For a detailed description of these modules please refer to pages 256, 258 and 262 respectively.

COUNTERS

DC 501 Option 4—Direct counting to 110 MHz • Seven digit LED display • Manual start/stop (totalize) • Time Base Option (1) • Auto Range Option (2).

DC 502 Option 4—Same as DC 501, but counts to 550 MHz with 10X prescale, with 50 ohm input • Time Base Option.

DC 503 Option 4—Same as DC 501, but has period and ratio averaging • Six functions: period, ratio, frequency, Time A-B, time manual and totalizing.

A 5 MHz Time Base, option 1, is available for DC 501/502/503. The required option 4 may be field-installed in standard counters.

MULTIMETER

DM 501— 0.1% DC voltage accuracy • 4½ digit LED display • Auto-polarity • Measures voltage, current, resistance and temperature • Fully isolated serial BCD output.

ORDERING INFORMATION

31/53 Calculator Instrumentation System **$3995**
31 Options and Accessories—See pages 312-313.

153 Instrumentation Interface ..... **$ 995**

Optional Accessories

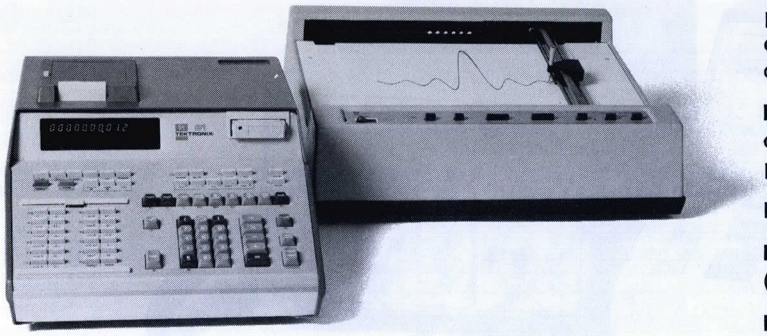
Type I Patch Plug, order 013-0153-00 ..... **$ 44**
Type II Patch Plug, order 013-0153-01 ..... **$ 44**
Type III Patch Plug, order 013-0153-02 ..... **$ 44**

31/53 Choice of Multimeter and Counter modules.
Refer to pages 256, 258, and 262 respectively, for ordering information. Specify Option 4 Counters.

NEW
4661

Digital Plotter

The graphic XY plotter



Repeatability: Pen will return to any previously plotted point, ± .0025 inch.

Accuracy: ±0.0025 inch and ± .4% of vector length.

The low cost 4661 can provide graphic displays of statistical data, histograms, sales curves, production rates.

Speed—Once a plot is started, your calculator can get busy computing the 4661's next plot. Vectors are drawn at speeds up to 22 inches per second. Combined, these two factors add up to the fastest calculator plotter on the market.

Accuracy—Because the 4661 operates digitally there's no drift due to analog variations.

Versatility—Scale controls and electrostatic hold-down allow either full or half size plots on paper size to 11 x 17 inches maximum.

Plotting Area— 10 x 15 inches, on Y and X axis respectively (approximately 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 inches of Y data and 15 inches of X data. In half scale mode, the plotter accepts 20 inches of Y data, and 30 inches of X data.

Motor Drive— ± .005 inch (.127 mm)

Resolution—Numerical—(a) At full scale, resolution is .010 inch (.254 mm). (b) At half scale, resolution is .005 inch (.127 mm).

Manual Pen Positioning—Front panel switches allow movement of the nylon-tipped pen at a fast rate or slow rate in each axis.

Paper Size— 11 x 17 inches maximum (28 x 43 cm).

Standard Accessories—Operator's Manual • Power Cord • Calculator Interface Cable • Terminator Pack • 3 each: Black, Red, Green and Blue Pens • 100 sheets paper, 10 x 15 inches (25 x 38 cm).

ORDERING INFORMATION

4661 Digital Plotter		**$2550**
Optional Accessories:		
Paper:	**100 sheets/package (11 x 16½ inches), 10 x 15 inches linear, 10 div/inch (006-1698-00)**	**$ 6.60**
	25 x 38 cm linear, 10 div/cm (006-1699-00)	**$ 6.60**
	15 inches x 3 cycles (006-1700-00)	**$ 6.60**
	Semi-log: 15 inches x 2 cycles (006-1701-00)	**$ 6.60**
	Log-log: 2 cycles x 3 cycles (006-1702-00)	**$ 6.60**
Pens:	**(package of 3 each)**	**$ 5.00**
	Red (016-0589-00) **Black (016-0589-02)**	
	Green (016-0589-01) **Blue (016-0589-03)**	
Cables:	**2.5 ft. Type 2 interface (012-0499-00)**	**$185.00**
	7 ft. Type 1 interface (012-0498-01)	**$200.00**
	7 ft. Type 2 interface (012-0499-01)	**$200.00**

NEW

Interfaces

152 Calculator General BCD Interface—The 152 can be used to combine your 31 or 21 with counters, DVM's, in fact, with most programmable instruments or peripherals. Data acquired through the 64 bit-parallel inputs may be logged, stored or processed. When used with the 31, it can enter data directly into memory at a rate up to 15,000 sample/sec. There are 56 programmable outputs to provide system control along with six addressable triggers.

All input/outputs are strap selectable which enables the user to define the desired polarity.

152 Calculator Interface—Option 1 (128 inputs, 112 outputs); Option 2 (192 inputs, 168 outputs).

Standard Accessories—Calculator Cable (7 ft.) (012-0499-01) • Terminator Pack (016-0567-00) • Connector Guide (016-0579-00).

153 Calculator Instrumentation Package—See 31/53 specifications, page 315.

153 Calculator Interface Standard Accessories—Calculator Cable (7 ft.) (012-0499-01) • Terminator Pack (016-0567-00) • Connector Guide (016-0578-00). • Connector Adapter (013-0153-00) • Fuse Fast 6 Amp. (159-0013-00) • Fuse Slow .8 Amp. (159-0018-00).

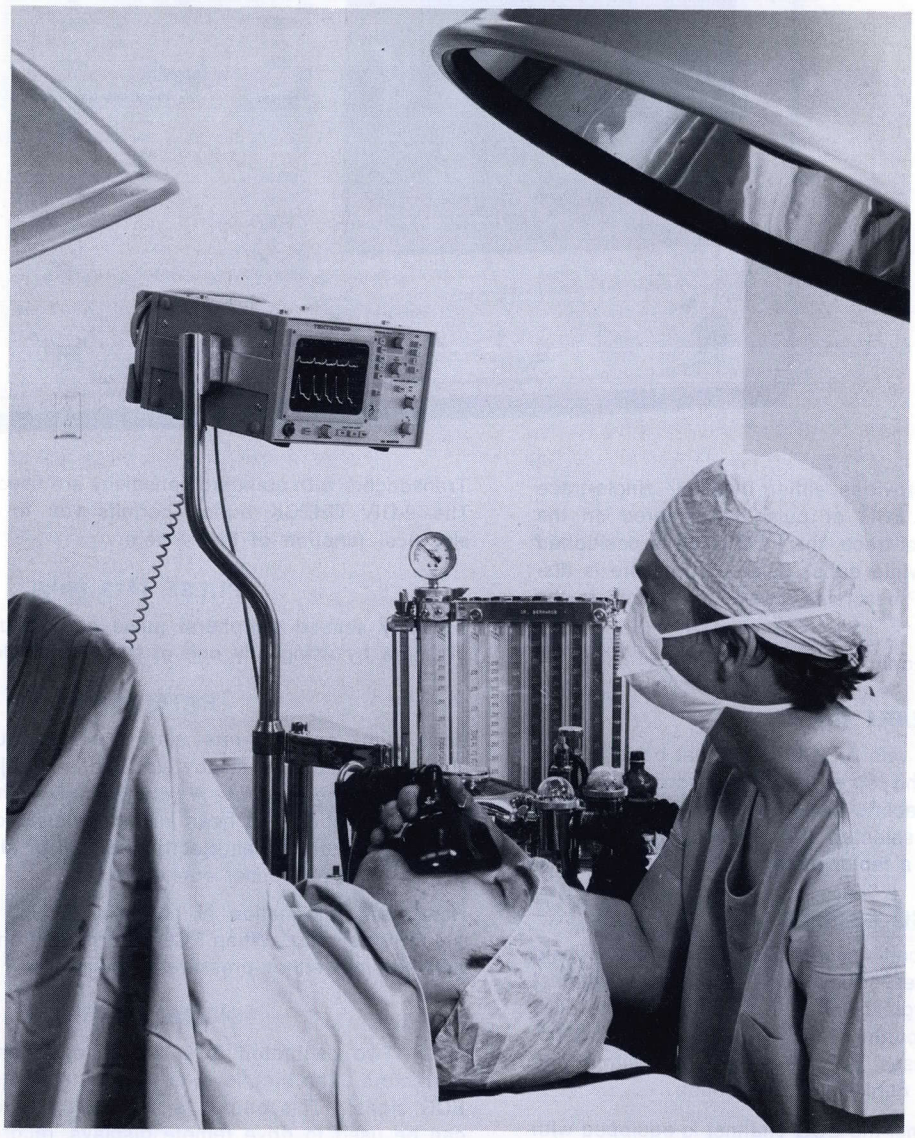
154 Calculator RS-232-C Interface—The 154 provides calculator communication with a wide range of computer peripherals such as teletypes, data cassettes, line printers. This means by combining the 31, the 154 and the equipment of your choice, a variety of systems are possible. This two-way, bit serial, ASCII character interface is appropriate to many instrumentation and teleprocessing applications.

154 Calculator Interface Standard Accessories—Calculator Cable (7 ft.) (012-0498-01) • Terminator Pack (016-0567-00) • Connector Guide. (016-0579-00.)

ORDERING INFORMATION

Contact your local sales engineer or write to Tektronix, Inc., P. O. Box 500, Beaverton, Oregon 97005.

Medical Monitors



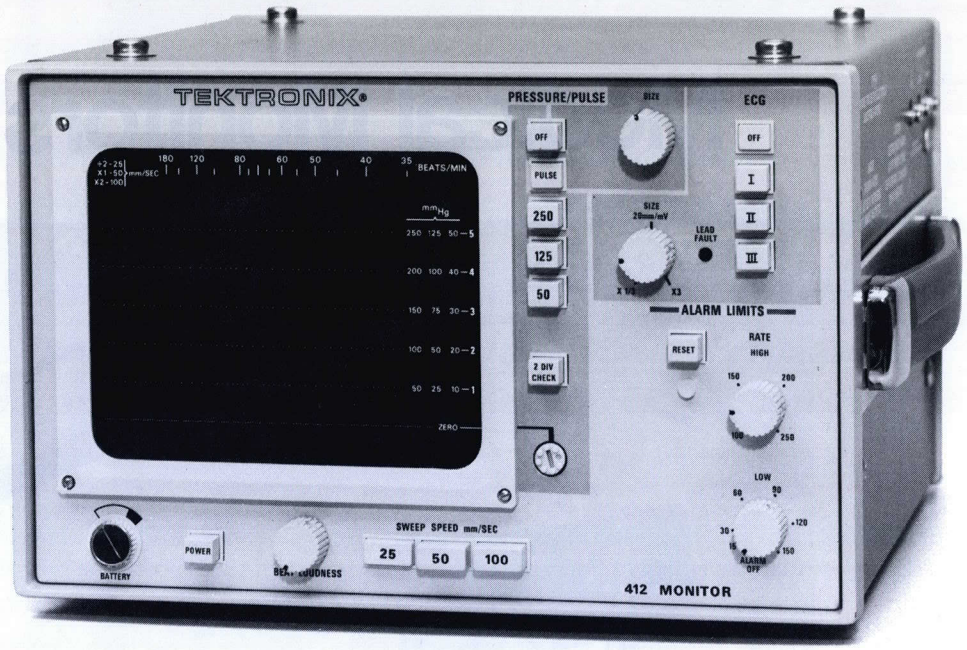
Two new products this year—the 408 and 412 patient monitors—provide real-time electrocardiograms (ECG) in truly portable instruments. Furthermore, the 412 simultaneously monitors blood pressure or peripheral pulse. These specialized oscilloscopes combine Tektronix technology and craftsmanship to provide safe, reliable instruments for intensive care units, operating rooms, cardiac crash carts and ambulances.

Dual-trace, 412
ECG
Pressure or Pulse

Single-trace, 408
ECG

Battery or Ac

Rate Alarm



The 412 patient monitor provides either dual- or single-trace operation. In single-trace, ECG or pulse is centered on the large display screen. In dual-trace, the ECG trace is positioned in the upper display area while either pulse or pressure is displayed in the lower area. Pressure is always referenced to the ZERO line.

The 408 is a single-trace monitor for ECG only.

HEART RATE

A direct indication of heart rate on a beat-by-beat basis is read from the rate scale across the top of the display screen. It reads directly when the 50 mm/second sweep rate is selected; when alternative sweep rates are selected, the rate-scale reading must be multiplied or divided by a factor of two.

ECG SAFETY

A fully-isolated patient circuit assures leakage current is held to less than 5 microamperes. The circuit is protected against defibrillators and electrosurgical units. In many cases, the ECG can be monitored during cutting or coagulation with an electrosurgical unit. In all cases, the trace recovers within one second after defibrillation, cutting or coagulation.

To minimize false rate alarms, the ECG channel is equipped with a fully automatic QRS detector. It can pick out R-waves in the presence of considerable muscle artifact. Pacer pulses are also rejected. While many detectors work with a normal ECG, the TEKTRONIX QRS detector works also with an abnormal ECG.

Lead faults are indicated by a front-panel lamp in order to provide constant assurance of cable and electrode integrity.

PRESSURE (412 only)

The 412 provides three ranges of direct-indicating pressure: 250, 125 and 50 mm_{Hg}. The monitor will actually indicate pressure and vacuum over ranges of —50 to +300, —25 to +150 and —10 to +60 mm_{Hg}.

Zeroing is the only adjustment required for setup. The control is flush with the front panel and is easily turned with a fingertip to cancel imbalance of individual transducers.

Transducers with standard sensitivity are used (see accessories). The 2-DIV CHECK button permits you to quickly check the electrical function of the system.

PULSE (412 only)

Optically sensed peripheral pulse can be displayed in lieu of pressure by using any one of three available sensors.

RATE ALARM

Both high- and low-rate alarms are announced audibly and visibly. The audible, steady alarm tone is adjustable in loudness by a rear-panel control. A yellow lamp on the front panel gives visible indication that heart rate has deviated from the selected limits. Additionally, an electrical signal of alarm status is available from a rear-panel connector.

Heart rate information is normally derived from the ECG by the QRS detector. When ECG is turned off on the 412, the rate is derived from either pressure or pulse.

SIGNAL OUTPUTS

ECG—Two calibrated ECG signal levels are provided at rear correctors. The high-level is 1000X the amplitude of the applied ECG signal. This output is fully isolated from the patient and can be used to drive remote displays, recorders, etc. The low-level signal is equal to the input signal, and also is isolated from the patient. This output is intended to drive devices which might normally be connected directly to the patient, such as ECG recorders, telemetry transmitters, etc.

Pressure/Pulse (412 only)—Two output levels are provided, equivalent to those for ECG.

Alarm—The alarm output connector provides two functions: alarm indication and remote reset of alarm.

POWER

TEKTRONIX patient monitors incorporate versatile power systems for full internal battery operation or ac line operation. The ac power supply operates over a wide range of voltages so that line fluctuations, such as "brown outs", will not impair operation. Battery and ac systems are independent so that

failure of batteries will not impair normal ac operation. Two battery systems are available for different battery-operation requirements.

Battery Operating Time Available From Full Charge	Standard Battery Operating Time		Option 3 Battery Operating Time	
	Typical	Minimum	Typical	Minimum
412*	3 hours	2 hours	5.3 hours	3.5 hours
408	5 hours	3.3 hours	8.8 hours	5.8 hours

*With both channels operating

SAFETY

Patient and operator safety is an inherent goal in Tektronix engineering and design of patient monitors. The ECG channel is fully isolated from the remainder of the monitor. Leakage current (also known as hazard current or risk current) is less than five microamperes. The isolation will with stand 2500 V ac at 60 Hz and more than 5000 V dc. Chassis or ground leakage current in the monitors is less than one-half the 50 microamperes normally allowed by most safety standards.

MOUNTING

A mounting adaptor is supplied as standard with each monitor. This device attaches to the left side of the instrument. An optional mounting pole is available which can be attached to most anesthesia machines (see accessories).

CHARACTERISTICS

All characteristics apply to both the 408 and 412 except where indicated.

ECG

ECG patient circuits are fully isolated for maximum patient safety.

Monitoring Bandwidth— 0.2 Hz to 50 Hz.

Recovery after Defibrillation—Within 1 second.

Outputs—Two calibrated output levels, X 1000 gain and X 1 gain. X 1 Gain permits direct recording on a standard ECG machine.

Patient Input Leakage Current—Less than 5 μA rms at 120 V 60 Hz ac.

Lead Check— 0.5 mV for Lead I and III, I.0 mV for Lead II.

Lead Fault—Front-panel lamp lights with loss of connection to patient.

PRESSURE (412 only)

Uses pressure transducer that has been standardized to 50 μV/volt/cm_{Hg}.

Ranges— —50 to +300 m_{Hg}, —25 to +150 mm_{Hg} and —10 to +60 mm_{Hg}.

Output— —0.5 V to +3.0 V full scale on each range and —0.5 mV to +3.0 mV full scale on each range.

Calibration Check— 2 cm on display. Confirms electrical system function.

Drift—Chopper stabilized for drift-free operation resulting in minimum operating controls.

Pulse Output (412 only)— ±2.5 V full scale and ±2.5 mV full scale.

OTHER CHARACTERISTICS

Rate Limits Alarm—Rate limits are for ECG signal. When ECG channel is off, the limits are for PULSE or PRESSURE in the 412. HIGH RATE sets the upper limit between 100 and 250 beats/minute. High limits must be continuous for 2 to 5 seconds for alarm. LOW RATE sets the lower limit between 15 and 150 beats/minute. For low-limit alarm, there must be two R-R intervals for excessive duration within 5 to 10 seconds of each other. Arrest alarm results when no beat is detected for approximately 6 seconds. Alarm may be reset by pressing the RESET push-button or turning off the low-rate control to the alarm-off position.

408

Audio—Alarm is a continuous tone. Alarm and beat loudness are independently controlled.

Light—Yellow lamp on front panel is on during alarm.

Output—Rear-panel connector provides 12 mA output at up to +5.5 volts (compliance) during alarm. Contact closure between two lines permits remote reset of alarm.

Cathode-Ray Tube— 5-inch rectangular 8 x 10-cm viewing area. 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.

Sweep Rates— 25, 50 or 100 mm/sec. Crt graticule is marked in beats/min for use with all sweep rates.

Power—Ac: 115 V ac or 230 V ac, 48 to 440 Hz. Battery pack provides at least 2 hours (412) or 3⅓ hours (408) operation. Battery recharge time is approximately 16 hours.

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); shipping— 19.0 lb (8.6 kg).

Included Accessories—Patient cable, torso *(012-0445-00); (2) Electrode wire packages (Each contains one white, RA; black, LA; and red, LL) *(012-0502-00); Electrodes, disposable, three packs of three (119-0305-00); Accessory pouch (016-0560-00); Mounting adapter (014-0050-00); Operators manual (070-1522-00); Service manual (408: 070-1525-00, 412: 070-1523-00).

ORDERING INFORMATION

408 Patient Monitor, single-trace, ECG only **$1200**

412 Patient Monitor, dual-trace, ECG & pressure or pulse **$1600**

INSTRUMENT OPTIONS (Options apply to both 408 and 412)

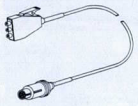
Option 1 Without battery pack and meter ..... **Subtract $65**

Option 3 "F" Cell battery pack instead of "D" Cell .. **Add $50**

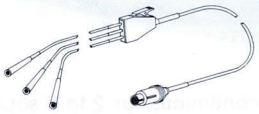
Option 13 Includes Patient cable, limb (012-0459-00), and (3) Electrode adapters, snap (103-0110-00) in lieu of accessories marked* ..... **Add $10**

Option 15 Deletes all included accessories except manuals ..... **Subtract $50**

PATIENT CABLES



TORSO CABLE
(012-0445-00) **$25**



LIMB CABLE
With #4-40 Tapped Fittings
(012-0459-00) **$38.50**

ELECTRODE WIRES FOR TORSO CABLES

18-inch wires with snap fittings for disposable electrodes, set of three
(012-0502-00) **$3**

18-inch wires with #4-40 tapped fittings
White (RA) (012-0449-00) **$3**
Black (LA) (012-0450-00) **$3**
Red (LL) (012-0451-00) **$3**

ELECTRODE ADAPTERS

All equipped with #4-40 thread to mate with limb cable or related electrode wires

Snap Adapter
(103-0110-00) **$1.65**

Needle Adapter
(103-0108-00) **$1.40**

Plate Adapter
(103-0079-00) ..... **$ .85**

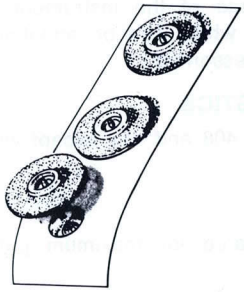
ELECTRODES

Electrode, re-usable, Ag/AgCl, with #4-40 thread
(119-0197-00) **$4.50**

Attachment rings (006-1099-00) **$4.05**

Electrode paste (006-1098-00) ..... **$ .75**

Other attachment methods—
MICROPORE tape or pads cut from RESTON #1360 or #1561.



Pre-gelled disposable Ag/AgCl electrodes. GEL-PAD and other compatible brands of disposable electrodes can be purchased from local hospital supply outlets. American Hospital Supply Corp. number 65375-030.

Three electrodes per pack. Sold only in boxes of ten packs.

Order 10 ea. (119-0353-00) **$2.50**
(Total cost per box $25.00)

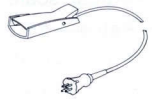
TRANSDUCERS

STATHAM P23 Ia
(015-0233-00) **$425**

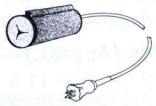
TRANTEC 800
(015-0234-00) **$375**

BELL & HOWELL
4-327-0109
(015-0235-00) **$425**

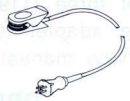
PULSE SENSORS



FINGER
(015-0236-00) **$60**



RADIAL
for finger, toe, etc.
(015-0237-00) **$60**



LOBE, for ear or nose
(015-0238-00) **$60**

MOUNTING FIXTURES

MOUNTING KIT
Mounts monitor at five-foot level. Attaches to vertical pipes or surfaces of anesthesia machines or similar devices.
(016-0110-00) **$60**

BRACKET
The upper-most portion of the mounting stand is available separately.
(407-0393-01) **$6**

MOUNTING FIXTURE
Attaches to instrument.
(014-0050-00) **$5**

MISCELLANEOUS

Replacement "D"-Cell Battery Pack
(119-0441-00) **$55**

Replacement "F"-Cell Battery Pack
(119-0443-00) **$120**

Accessory Pouch
(016-0560-00) **$12**

Servicing Extender Set
(020-0078-00) **$22**

Repair kit for #4-40 ends on limb cables and electrode wires
(040-0696-00) **$10.50**

The instruments described on these pages are in limited demand, but represent a desirable choice in a few specialized cases. As such, they are available for you who have a need for them.

MODULAR INSTRUMENT SYSTEM

2600 Series

The 2600 Series is a modular instrumentation system of signal generators and signal conditioners. Plug-In Modules permit a building-block approach to specialized systems.

These major components comprise the system:

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

26A1 Operational Amplifier Plug-In, easily adapted for many uses, including processing of signals generated by other plug-ins.

26A2 Differential Amplifier Plug-in, capable of amplifying low-level signals up to 100,000 times with up to 50,000:1 cmrr.

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

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

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

2620 Stimulus Isolator, allowing true differential stimulation for biophysical applications.

The interconnection system stresses flexibility and ease of set-up change. The plug-in unit front-panel pin connectors are duplicated at the rear connector, permitting interconnection through the pull-out interconnection board system. An optional interconnection board is available which, in addition, has integrated circuit sockets to permit the easy addition of logic gates, buffers, amplifiers, etc. Spare connectors, lines, and power sources are available in anticipation of future and specialized requirements.

2620 Stimulus Isolator

The 2620 Stimulus Isolator is a tristable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from ground-referenced generators connected to the input, thus permitting true differential tissue stimulation.

Pulse polarity and timing are determined by the input signal via an optical coupler and may be supplied from a 2600-Series pulse generator or other suitable source. The output pulse amplitudes are controlled independently at the isolator control panel.

Power is provided by two nickel-cadmium "D" cells, operating a dc-to-dc converter.

Order 2620 Stimulus Isolator **$520**

2601 Power Supply

The 2601 Mainframe is a power supply and interconnection system for 2600-Series plug-in units. Its electronically-preregulated power supplies require no fan or vent holes for cooling.

Interconnection between the six plug-ins and the front- and rear-panel connectors can be made on the pull-out interconnection board, which improves appearance, reduces accidental removal, and improves control accessibility. It also allows each plug-in to be removed without interference. Additional boards may be ordered to permit different interconnection formats to suit various requirements.

Order 2601 Mainframe **$570**

Order R2601 Mainframe (rackmount) **$570**

26A1 Operational Amplifier

The 26A1 is an operational amplifier with a wide output voltage swing, wide common-mode range, and high slewing rates suited to a broad range of applications, including final processing of signals generated in the 2600-Series system.

Order 26A1 Operational Amplifier **$320**

26A2 Differential Amplifier

The 26A2 is a dc-coupled differential amplifier. Excellent common-mode rejection, high gain, and selectable high- and low-frequency —3 dB points, make the 26A2 suitable for low-frequency, low-level applications.

A guard signal derived from the common-mode signal within the amplifier is available on the front panel for driving cable shields. ±15 volts dc is also available to permit use of special active probes, transducer adapters, etc.

Order 26A2 Differential Amplifier **$630**

26G1 Rate/Ramp Generator

26G2 Ramp Generator

The 26G1 and 26G2 Generators produce a ramp voltage well suited to analog timing applications such as delayed triggering of pulse generators. The ramp can be triggered or gated, or both. In the 26G1 the ramp can be triggered externally, manually, or from its rate generator; the 26G2 does not have the rate generator and can be triggered externally or manually.

Order 26G1 Rate/Ramp Generator **$495**

Order 26G2 Ramp Generator **$345**

26G3 Pulse Generator

The 26G3 generates precise rectangular pulses whose duration and amplitude are selected by the calibrated front-panel controls. The generator has accurately-controlled voltage level selection of the triggering point; when a 10-V ramp is used as a triggering source, the 26G3 can pick off a voltage proportional to time, thus providing a calibrated time delay.

Order 26G3 Pulse Generator **$560**

Limited-Demand Products

7403N Oscilloscope

For replacement see 7000-Series Oscilloscopes

Bandwidth is dc to 60 MHz and it accepts 7000-Series Plug-ins. Features include trigger source selection and a large crt with illuminated graticule.

Order 7403N Oscilloscope, without Plug-ins **$1,050**
Order R7403N Oscilloscope, (Rackmount), without Plug-ins **$1,150**

7A14 Current Probe Amplifier

For replacement see 7000-Series

Bandwidth is 25 Hz to 120 MHz (7900 Family) and may be limited to 20 MHz with a front panel push button. Deflection factors range from 1 mA/div to 1A/div in 10 calibrated steps.

Order 7A14 Amplifier **$800**

422 Portable Oscilloscope

For replacement see 400 & 300 Series Portable Oscilloscopes.

The dual trace 422 at 15 MHz bandwidth, has calibrated deflection factors from 1 mV to 20 V/div. Sweep speeds range from 0.5 s to 50 ns/div. Ac or dc versions are available, the dc version operates up to 5 hours from an internal battery pack.

Order 422 Oscilloscope **$1,600**
Order R422 Oscilloscope (Rackmount) **$1,675**

432 Portable Oscilloscope

For replacement see 400 & 300 Series Portable Oscilloscopes.

The dual trace 432 at 25 MHz bandwidth, has calibrated deflection factors from 1 mV to 10 V/div. Sweep speeds range from 5 s to 20 ns/div.

Order 432 Oscilloscope **$1,720**
Order R432 Oscilloscope (Rackmount) **$1,760**

D54 Oscilloscope

The D61 Dual Trace Oscilloscope is recommended as a replacement for the D54.

The TELEQUIPMENT D54 is a low-priced 10 MHz, dual trace oscilloscope of solid-state design. Features include 10 mV sensitivity, 200 ns/cm maximum sweep rate and 6 x 10 cm viewing area. Tv field and line triggering probe calibration output, and an illuminated graticule are also provided.

D54 Oscilloscope **$665**
D54R Oscilloscope (Rackmount) **$710**

S54A Oscilloscope

The D61 Dual Trace Oscilloscope is recommended as a replacement for the S54A.

The TELEQUIPMENT S54A is a low-priced, 10 MHz, single trace oscilloscope of solid-state design. Features include 10 mV sensitivity, 200 ns/cm maximum sweep rate and 6 x 10 cm viewing area. Tv field and line triggering, probe calibration output and an illuminated graticule are also provided.

S54A Oscilloscope **$520**
S54AR Oscilloscope (Rackmount) **$565**

410 Physiological Monitor

The 408 and 412 Patient Monitors are recommended replacements for the 410.

The 410 provides dynamic displays of patient electrocardiogram, electroencephalogram or pulse. Battery operation allows its continuous use as the patient is transported, for example from surgery into recovery or special care facilities. Features include heart rate beep, arrest alarm, 4-second recovery after defibrillator or cauterizer overdrive, output for strip-chart recorder and a durable, washable cabinet finish.

Order 410 Physiological Monitor **$1,125**

507 Oscilloscope

The TEKTRONIX 507 is a specialized oscilloscope, designed primarily for high-voltage surge testing of power transformers, high-voltage insulators, lightning arrestors, etc. Careful design of circuitry grounding points ensures minimum sensitivity to extraneous disturbances caused by large voltage transients often introduced into the grounding system.

Order 507 Oscilloscope **$4,425**

106 Squarewave Generator

The PG 506 is recommended as a replacement.

This general-purpose generator provides simultaneous positive- and negative-going output transitions with 1 ns or less risetime into 50 Ω, or positive-going, hi-amplitude output with 12 ns or less risetime into 50 Ω. Features include: High amplitude or fast rise outputs; 10 Hz to 1 MHz repetition rate; sync input and trigger out.

Order 106 Squarewave Generator **$825**

115 Pulse Generator

For replacement see TM 500-Series Generators

The 115 is a 10 MHz, 10 V general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude, and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, and shapes are required. Features include: Variable dc offset; 100 Hz to 10 MHz repetition rate and short proof output.

Order 115 Pulse Generator **$1,175**

3S2 Dual-Trace Sampling Unit

The 5S14/7S14 Samplers are recommended as replacements.

The Type 3S2 Dual-Trace Sampling Unit is designed for use in the Type 561B, 564B or 568 Oscilloscope. In the 568 Oscilloscope, information can be presented in digital as well as analog form.

The Type 3S2 accepts two Sampling Heads that can be inserted directly or located remotely with an optional extender. Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs.

Five display modes provide for a variety of single-trace, dual-trace or X-Y displays.

Order 3S2 Dual-Trace Sampling Unit, without sampling heads **$770**

3T2 Random Sampling Sweep Unit

The 5S14/7S14 Samplers are recommended as replacements.

The 3T2 Random Sampling Sweep Unit provides a unique advancement in measurement capabilities. This unit may be used in a 561B, 564B or 568 Oscilloscope.

Random sampling permits observation of the leading edge (or other portions) of signals even when used with vertical units that have no delay lines and without a pretrigger.

SWEEP TIME/DIV— 100 μs/div to 200 ps/div. 20 ps/div with X10 display magnifier. Accurate within 3% from 100 μs/div to 2 ns/div, within 5% from 1 ns/div to 200 ps/div. Time/div is a resultant of the combined settings of time position range, time magnifier, and display mag.

Order 3T2 Random Sampling Sweep Unit **$880**

2101 Pulse Generator

For replacement see TM 500-Series Generators

The 2101 is a compact, 2.5 Hz to 25 MHz, 10 V general-purpose pulse generator with simultaneous positive- and negative-going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration, and delay. Ranges may be extended by user-supplied capacitors to reduce the repetition rate and to increase the duration and delay.

Order 2101 Pulse Generator **$900**

3A10 Transducer Amplifier

The 3A10 can be used with any 560 Series oscilloscope. It is especially designed for transducer measurements and can be used with voltage probes.

Order 3A10 Amplifier **$880**

191 Constant-Amplitude Signal Generator

The SG 503 is recommended as a replacement.

The 191 is a variable-frequency, sinewave generator with a constant-amplitude output over the entire frequency range. Both output amplitude and frequency and calibrated. Frequency is variable from 350 kHz to 100 MHz; amplitude is adjustable from 5 mV to 5.5 V.

Order 191 Constant Amplitude Signal Generator **$775**

2901 Time Mark Generator

The TG 501 is recommended as a replacement.

The 2901 is a compact, wide-range, time-mark generator. It is crystal-controlled and provides 16 marker intervals, 4 sinewave frequencies, and 8 trigger-pulse intervals. Time mark outputs range from 1 μs to 5 s in 16 steps. Sinewave outputs are: 2 ns; 5 ns; 10 ns and 50 ns. Trigger output and external clock input are also provided.

Order 2901 Time Mark Generator **$845**

Engine Analyzer System

The TEKTRONIX Engine Analyzer is designed to locate and identify engine malfunctions by displaying engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer consists of a Type 564B Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crankshaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Polaroid Trace-Recording Camera, SCOPE-MOBILE® Cart and a tripod for easy mounting of the Rotational Function Generator.

For complete details and specifications on the TEKTRONIX Engine Analyzer, contact your local Tektronix Field Office.

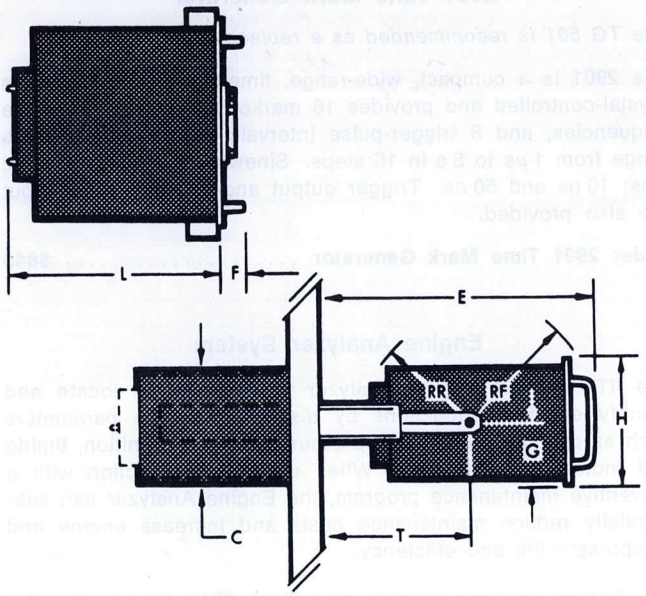
Order 564B Mod 121N Storage Oscilloscope **$1485**

Order 2B67 Mod 730A Time Base ..... **$ 515**

Order 3A74 Mod 730A Amplifier **$1045**

Order Engine Analyzer Accessory Package **$1189**

Instrument Dimensions



RACK MOUNT INSTRUMENTS

EXCLUSIVE OF PLUG-IN UNITS AND PROBES

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

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

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

MOUNTING DIMENSIONS

PRODUCT	H		L		F		G		E		RF		RR		T		C	
	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm	in	cm
D54R	5.3	13.3	17.8	45.1	1.8	4.5	—	—	—	—	—	—	—	—	—	—	5.3	13.3
R140, R141A, R142 R144, R146, R147A, R148, R149A, 145	3.5	8.8	18.5	47.1	1.6	4.1	—	—	24.1	61.3	—	—	—	—	—	—	3.0	7.6
R230, R241 R287, R288	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
R422	7.0	17.8	12.5	31.8	1.8	4.6	3.5	8.9	16.6	42.3	—	—	—	—	—	—	6.8	17.2
R432, R434	5.3	13.3	18.0	45.7	1.6	4.1	—	—	—	—	—	—	—	—	—	—	5.3	13.2
R465, R475	7.0	17.8	16.3	41.4	1.8	4.6	3.5	8.9	20.4	51.8	11.0	27.9	7.9	20.0	9.6	24.4	6.8	17.3
R485	7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	50.6	10.9	27.6	7.9	20.2	9.3	23.7	6.8	17.2
R491	7.0	17.8	17.4	44.2	2.1	5.2	3.5	8.9	21.1	53.5	11.9	30.4	8.5	21.6	9.3	23.7	6.8	17.3
R520A, R521A, R522A	7.0	17.8	18.0	45.8	2.0	5.1	—	—	23.0	58.4	—	—	—	—	—	—	7.0	17.8
R568	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
632	10.5	26.7	18.5	46.9	1.9	4.8	1.2	2.3	23.4	59.5	—	—	—	—	—	—	10.5	26.7
1140A, R1340	7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
R2601	7.0	17.8	15.5	39.4	2.1	5.2	—	—	—	—	—	—	—	—	—	—	7.0	17.8
R5103N, R5403	5.3	13.3	19.0	48.3	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
R7403N	5.3	13.3	22.2	55.5	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3
R7704	7.0	17.8	22.4	56.0	2.3	5.8	1.8	4.4	33.3	84.6	15.3	38.9	10.7	27.2	18.5	47.0	7.0	17.8
R7313, R7603, R7613, R7623	5.3	13.3	22.3	55.6	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3
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
S54AR	5.3	13.3	17.8	45.1	—	—	—	—	—	—	—	—	—	—	—	—	5.3	13.3
650 Series	10.5	26.7	12.2	31.0	1.7	4.9	4.9	12.7	21.5	54.7	—	—	—	—	—	—	10.5	26.7
670	15.7	39.9	19.6	49.8	2.1	5.3	8.1	20.6	27.7	70.4	—	—	—	—	—	—	15.8	40.1
1440	3.5	8.9	18.0	45.7	2.1	5.3	—	—	17.4	44.2	—	—	—	—	—	—	3.5	8.9
1441, 1478	1.7	4.3	18.1	45.9	1.3	3.3	—	—	17.4	44.2	—	—	—	—	—	—	1.7	4.3
016-0115-02	5.3	13.3	16.3	41.4	0.3	0.9	—	—	—	—	—	—	—	—	—	—	5.3	13.3
016-0268-00	5.3	13.3	19.8	50.2	1.8	4.6	—	—	—	—	—	—	—	—	—	—	5.2	13.2
016-0525-00	12.3	31.1	21.4	54.3	1.0	2.6	—	—	26.0	66.1	—	—	—	—	—	—	—	—
040-0551-00	14.0	35.6	22.4	57.1	0.6	1.5	—	—	30.9	78.6	—	—	—	—	—	—	—	—
040-0554-00	15.8	40.0	21.5	54.7	1.9	4.9	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0555-00	15.8	40.0	22.6	57.6	1.9	4.9	—	—	31.3	79.5	—	—	—	—	—	—	—	—
040-0616-00	5.3	13.3	16.5	41.9	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
040-0617-00	5.3	13.3	16.5	41.9	1.1	2.7	1.8	4.5	24.6	62.5	—	—	—	—	—	—	5.3	13.3
437-0031-00	8.8	22.2	9.5	24.2	0.3	0.7	—	—	—	—	—	—	—	—	—	—	7.1	18.0
437-0071-00	7.0	17.8	13.4	34.0	1.4	4.0	—	—	—	—	—	—	—	—	—	—	6.6	16.8
437-0126-00	5.3	13.3	22.3	55.6	2.0	5.1	—	—	25.2	63.0	—	—	—	—	—	—	5.3	13.3

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

COMMUNICATIONS

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

ORDERING

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

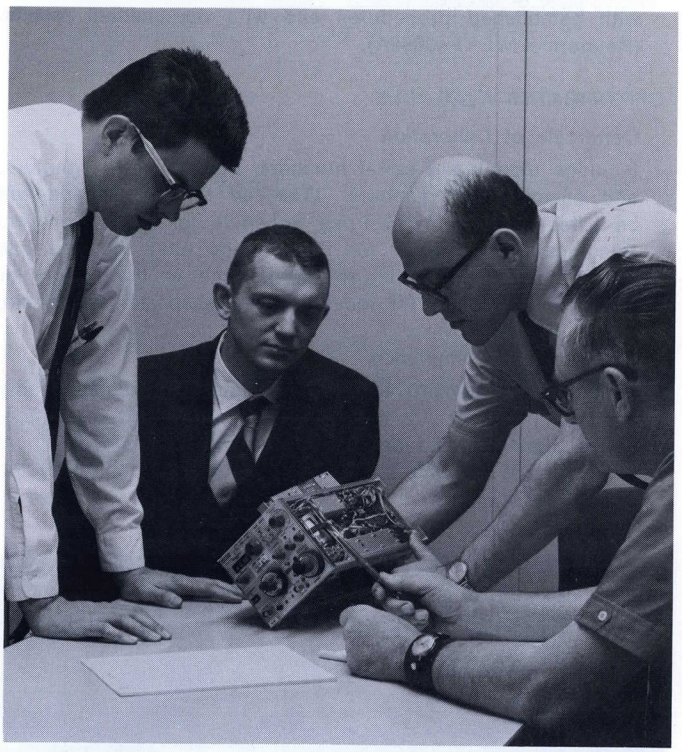
If you are a Purchasing Agent or Buyer, your Field Engineer *or his secretary* can provide information on prices, terms, shipping estimates, and best method of transportation on instruments, accessories, and replacement parts.

OPERATION

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

FACTORY TRAINING

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



APPLICATIONS

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

CALIBRATION & CERTIFICATION

Services furnished are provided in accordance with all applicable Tektronix specifications. Actual test data can be made available when required.

Tektronix' calibration measurements are traceable to the National Bureau of Standards to the extent allowed by the Bureau's calibration facilities.

Tektronix Service Quality Program satisfies the requirements of MIL-I-45208A, and MIL-C-45662A.

TRACEABILITY

The reference standards of measurement of Tektronix, Inc., are compared with the U.S. National Standards through frequent tests by the U.S. National Bureau of Standards. The Tektronix working standards and testing apparatus used are calibrated against the reference standards in a rigorously maintained program of measurement control.

The manufacture and final calibration of TEKTRONIX instruments are controlled by the use of Tektronix reference and working standards and testing apparatus in accordance with established procedures and with documented results. (Reference MIL-C-45662A).

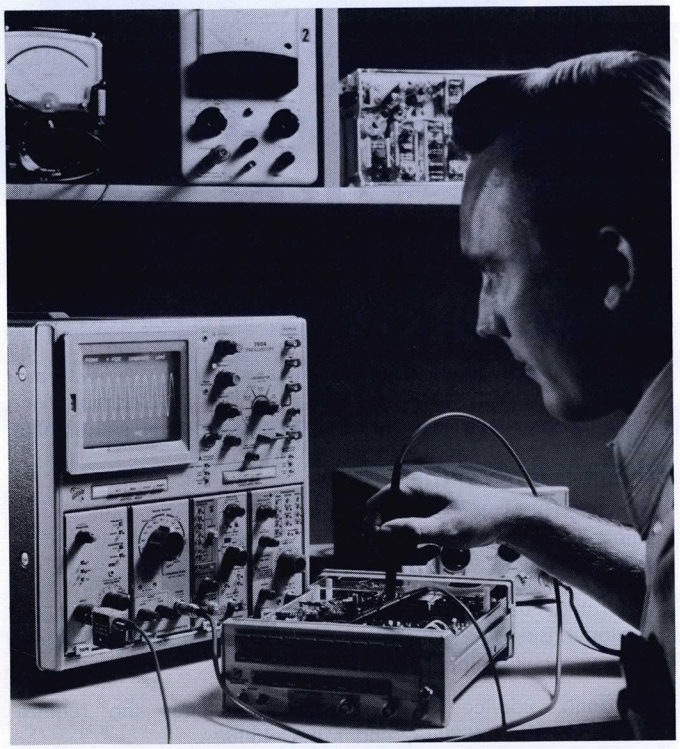
CERTIFICATES AVAILABLE

Certificate of Calibration

Includes model and serial numbers, date of test, signature, and current NBS numbers. (The fee for this service will be listed in the current Price Schedule for Calibration and Readings.) If you ask for this service after the unit has been shipped, you must return the unit to the factory or local service center for recalibration, transportation prepaid.

Certificate of Compliance

Includes a statement that the particular instrument being shipped conforms to its published (or quoted) specifications. Signature and date will normally be provided. There is no charge for this service when requests accompany the order.



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.

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From Oakland, Berkeley, Richmond, Albany and San Leandro: 254-5353

***Irvine** 92705
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(213)778-5225, 6

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2133B Leghorn Street
Mountain View 94043
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***San Diego** 92111
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Phone (714)292-7330

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***Van Nuys** 91406
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Phone (213)987-2600
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From Harrisburg, Lancaster and York Area call: ENterprise 1-0631

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†**Service Center**

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Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands
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Tektronix Limited maintains a warehouse of United States-made instruments, accessories and parts on the Island of Guernsey to quickly support these distributors in filling customer orders. Technical support of customers and distributors is also available from this facility. In addition, Tektronix has manufacturing facilities within the European Economic Community and European Free Trade Association.

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GENERAL TERMS OF SALE AND WARRANTY

Orders should be placed with your Tektronix Field Engineering Office listed on page 327.

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.

Certain Information Display Products are available under an operating lease program. The minimum fixed term of this lease is 12 months. Equipment leased on this program is maintained by Tektronix, Inc. during the term of the agreement.

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.

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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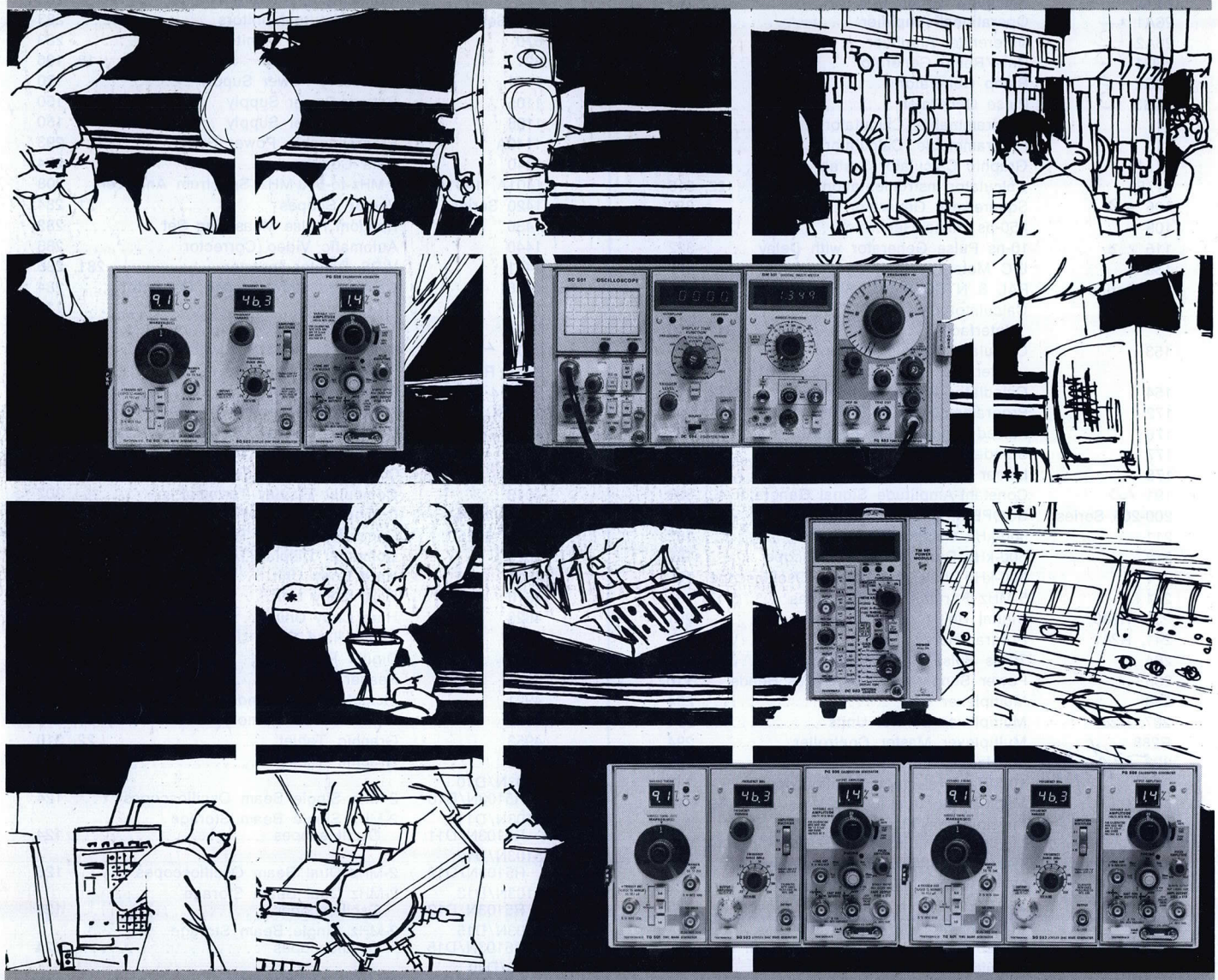
Many ways to think of Tektronix



The TM 500 Series

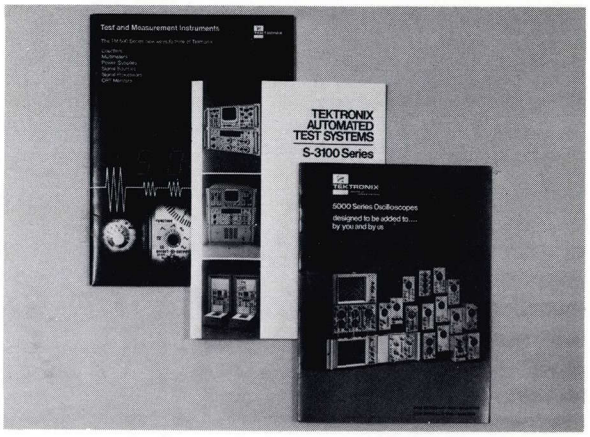
- Counters
- Function Generators
- Pulse Generators
- Ramp Generators
- Signal Generators
- Time Mark Generators
- Signal Processors
- Digital Multimeter
- Power Supplies
- CRT Monitors

TEKSCOPE

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

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.



NEW PRODUCTS and LITERATURE SUPPLEMENT

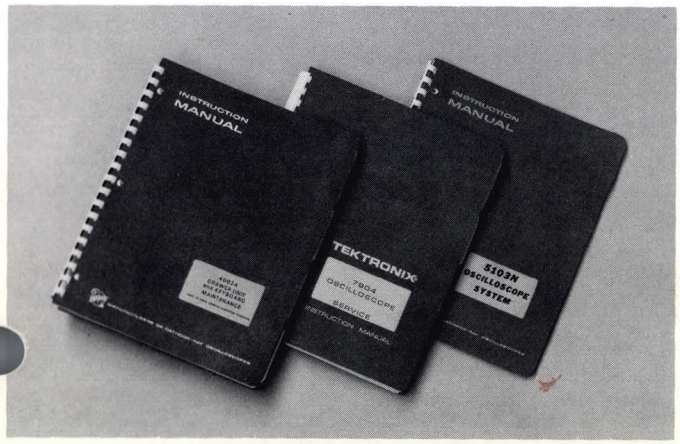
A bimonthly publication which serves to update the long-form catalog on a regular and frequent basis. The supplement contains information on new products including a photo of the product, a brief description of unique features, major specifications and price. The new literature section gives a brief description of new brochures, application notes and catalogs available from Tektronix.

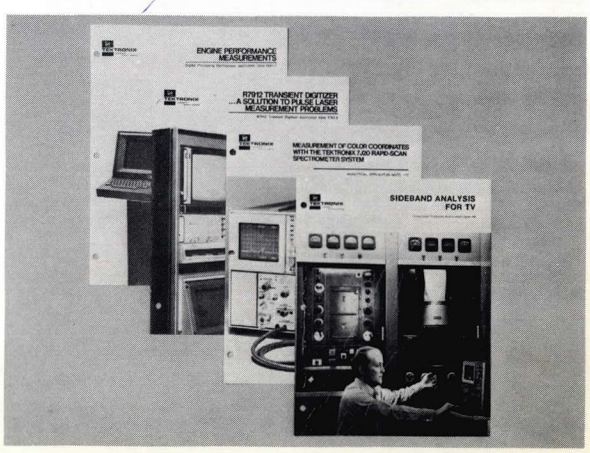
APPLICATION NOTES

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.

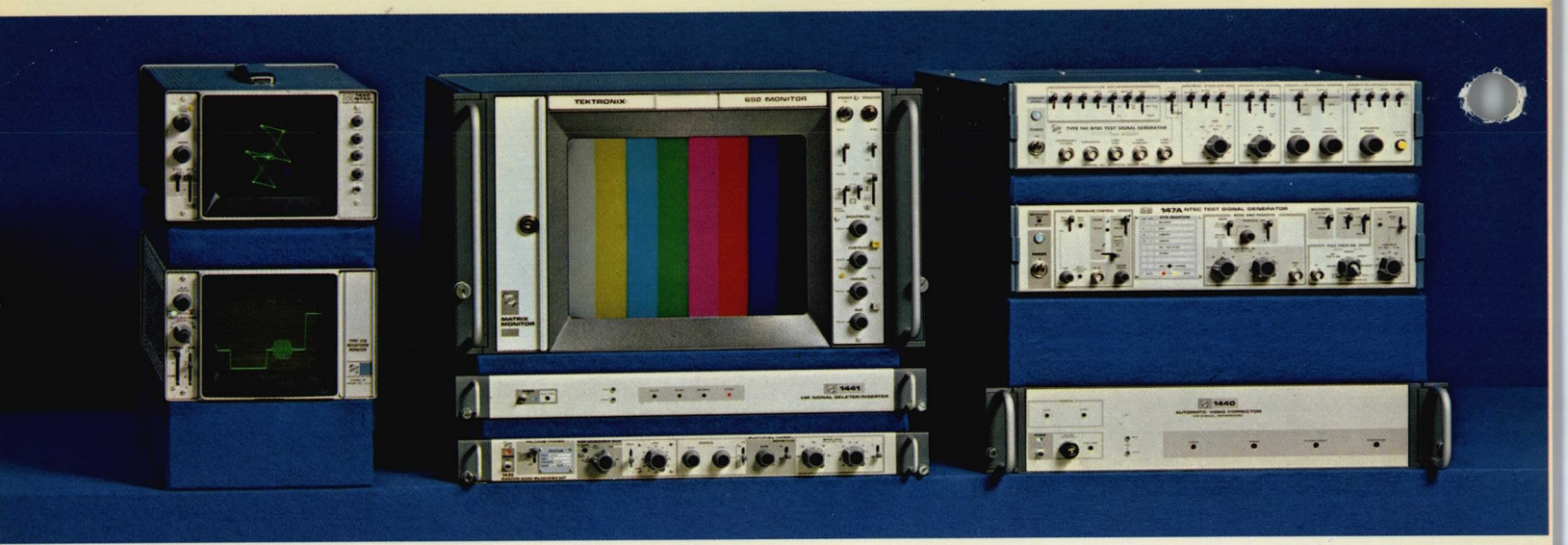
INSTRUCTION MANUALS

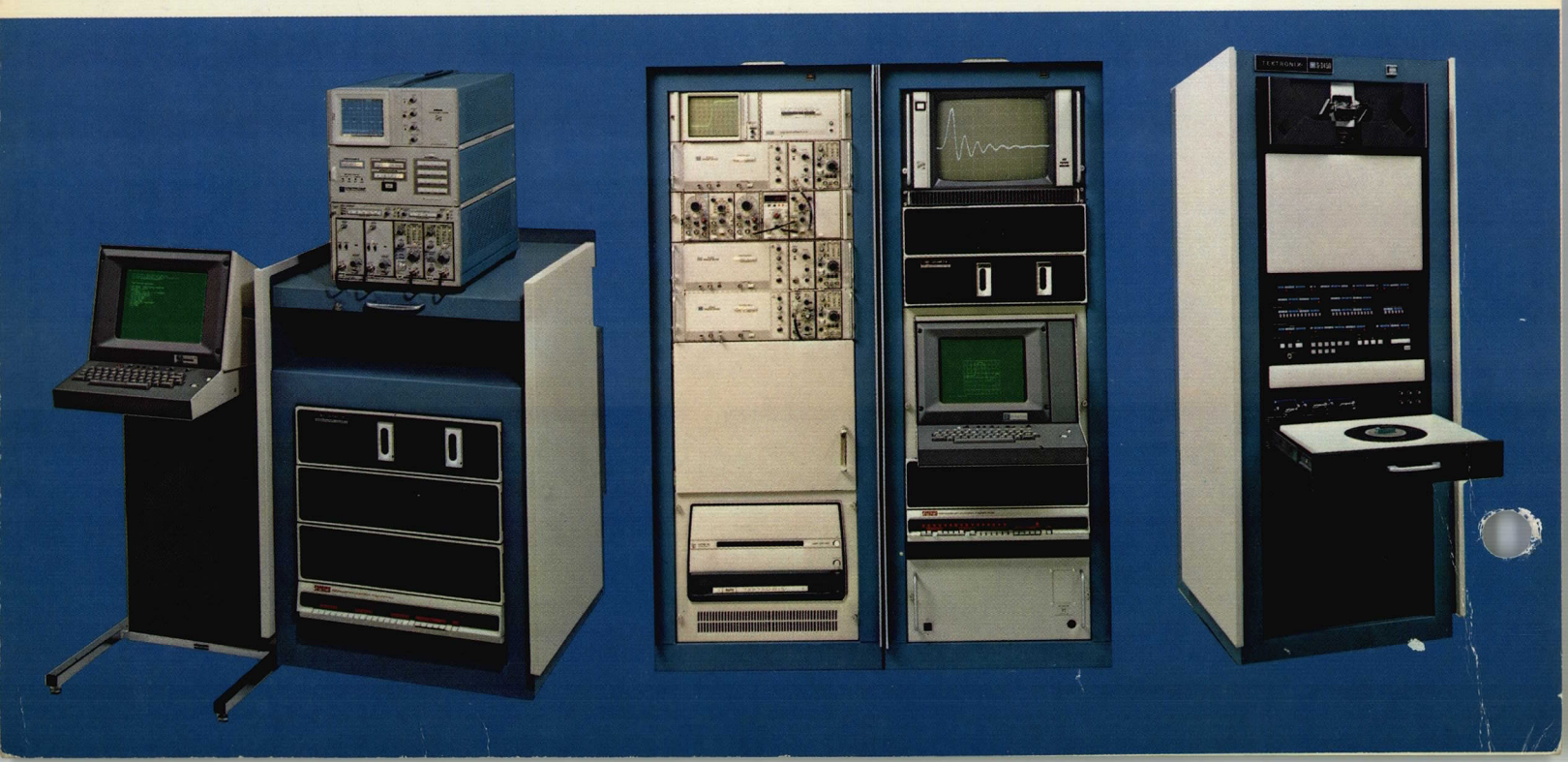
TEKTRONIX instruction manuals are written for both the user and maintenance personnel. Shipped with each instrument, instruction manuals contain instrument specifications, operating instructions, circuit descriptions, maintenance information and calibration instructions as well as complete schematics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





TEKTRONIX PRODUCTS 1975



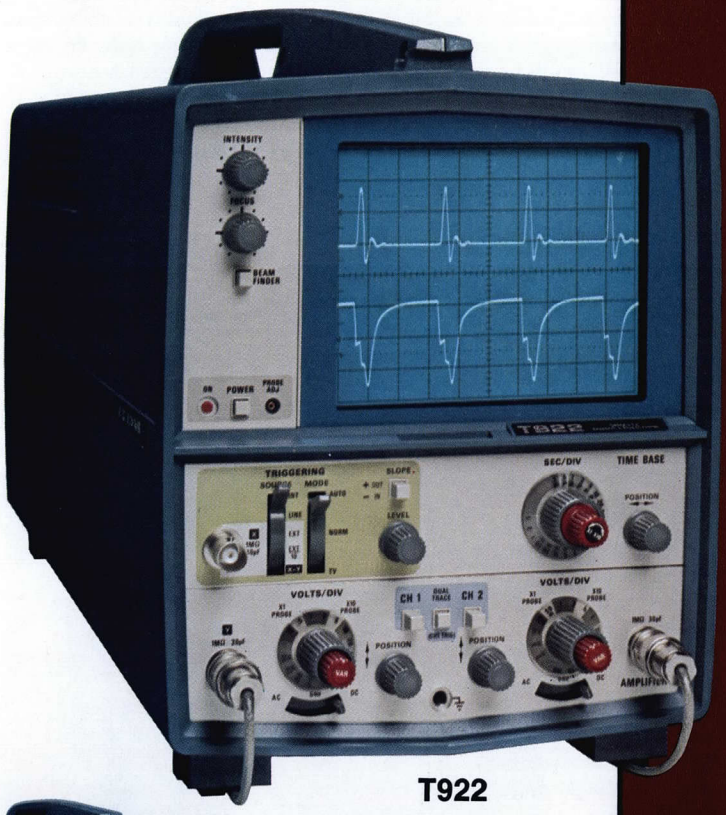


TEKTRONIX®

committed to technical excellence

T921

T912



T922

T932

T935

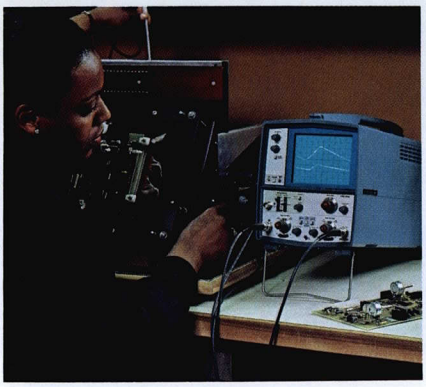
new

T900

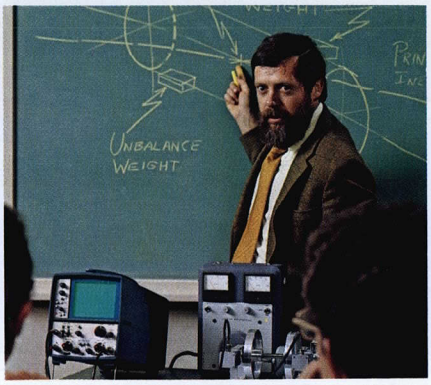
Series Oscilloscopes by Tektronix, Inc.

Reliable Performance
Small and Light
Easy to Use
Moderately Priced

The story behind the T900 series



T900's are economical answers to production-line testing requirements.



T900's enhance classroom demonstrations.

T900's are good travelers—even under an airplane seat.

A tradition of leadership

An independent product preference poll noted that TEKTRONIX Oscilloscopes are preferred over all others by most users in the electronics industry.* This leadership has been achieved by consistently designing and producing high-value oscilloscopes, using the latest engineering and manufacturing technology.

The new T900 Oscilloscopes series continues this tradition. The growth of electronics technology and its expansion into new branches of industry has created an increasing need for a basic performance, relatively low-cost, general purpose oscilloscope . . . one that is highly reliable, easy to operate and maintain, and well suited for service, production line and classroom applications.

**Electronics* Magazine Product Preference Poll, November 1974. Of those responding to the poll, 98.9% listed Tektronix as a preferred supplier of oscilloscopes. 82.6% named Tektronix oscilloscopes as their "first choice."

Designing for economy

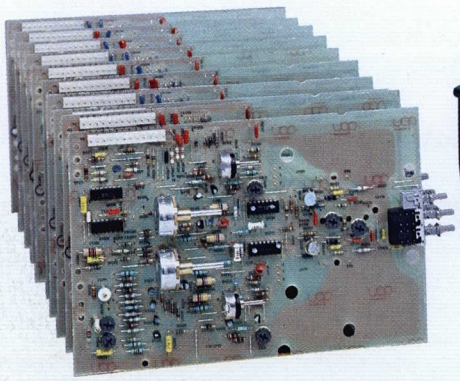
In meeting these requirements Tektronix did not compromise on the principles that have led to its preference: performance, reliability and support. But by carefully considering the functions, performance, and characteristics most needed for the intended applications, our designers identified cost savings that could be passed on to you.

For instance, special attention was devoted to developing circuits with fewer components, to increase reliability and lower component costs. Also by making maximum use of machine-insertable components, we are able to reduce labor costs. Off-the-shelf IC's, transistors and other components were used whenever possible. Tektronix-made components were specified when better cost/performance ratios could be achieved. For example, because crt quality and performance are considered so important, we selected the most widely used TEKTRONIX crt and featured it in the T900 series. Also, because this crt requires only a fraction of the deflection voltage required by crt's used in most other low-cost instruments, savings in deflection amplifier components, power consumption and heat-dissipation hardware were also gained.

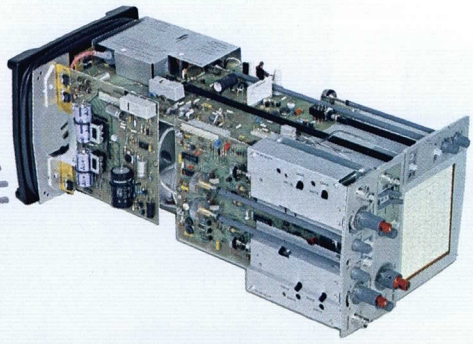
Engineering for commonality

Another effective economy measure was the achievement of commonality of subassemblies. This practice further reduced design, engineering and production costs. As a result, all instruments in the line have identical structural cores, outer cases and, with the exception of the storage model (T912), identical power supply modules.

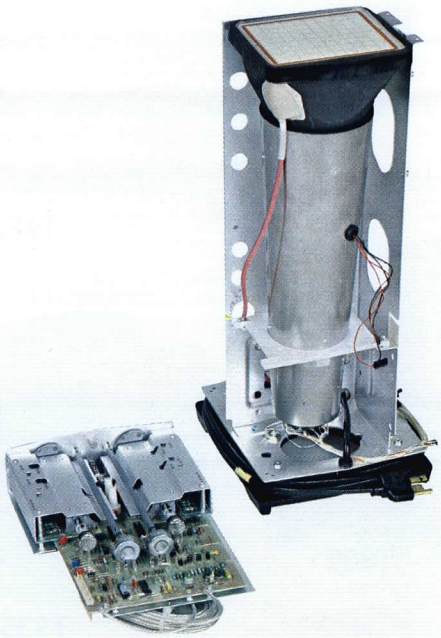
Further savings resulted from the elimination of almost all hand-wired connections, by generous use of harmonica and EC board connectors.



① *Low-density, single-sided circuit boards simplify maintenance.*



② *Switches and potentiometers are mounted on circuit boards for easy access.*



③ *12KV post-accelerator crt and vertical system with delay line show high quality components and workmanship.*

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Reducing costs of ownership

Part of the cost of owning an instrument comes after its purchase . . . Here again, we've found ways to help save you money.

New circuit designs included fewer calibration adjustments, reducing both production costs, and cost of ownership.

Use of fewer components, means fewer chances of failures, and all active components are pre-tested to ensure greater reliability. All instruments can be disassembled into their component modules in just a few minutes. No switches, potentiometers or other items of hardware are mounted on the rear face of the front-panel, but are installed on circuit boards. There is no wiring to unsolder when removing the front panel. When a component needs replacing, it can in almost all cases be purchased at a local electronic supply house. This helps minimize downtime, component and labor costs.

Five new instruments

These and other measures made it possible to give extra value to you in your anticipated applications. The result is a new line of oscilloscopes that offers basic performance and traditional Tektronix reliability at surprisingly low cost.

Five completely new instruments make up the T900 Series.*

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**
T912—(Storage model) Dc to 10 MHz, dual trace, mono time base $1195**

(NOTE: Prices include probes).

All T900 models offer large (8 x 10 cm) display areas. The four non-storage models use a 12 kV accelerating voltage in a post-accelerator crt, providing the added brightness required at low rep-rates and fast sweep speeds. Stored writing speed of the T912 storage crt extends up to 250 cm/ms. An internal graticule eliminates parallax errors on all T900 models.

Measuring only 7″ x 10″ x 19″, the T900 Series oscilloscopes take little space on the production line or work bench. Light weight (15-18 lbs.), compact, with a protective front panel cover and impact-resistant plastic case, T900 instruments can be carried or shipped with little effort or care. Carefully selected controls and color-coded control panels contribute to quick, confident use of all T900 Series oscilloscopes.

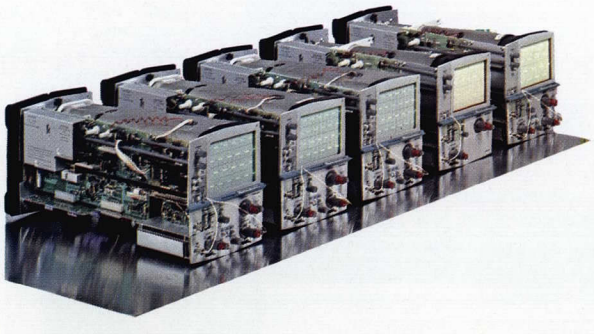
Switching between alternate and chopped sweep modes and tv line or frame triggering is performed automatically for optimum display presentation. A delay line in the vertical system allows you to see the leading edge of fast-rise time signals. Accessories also contribute to ease-of-use, and include 10X probes as standard equipment. Optional accessories include scope stand, camera, protective front-panel cover, rain/dust jacket and more . . .

Measurement accuracy of the T900 oscilloscopes is 3% or better, achieved in part by use of regulated power supplies. A detent position on variable controls gives you positive identification of the calibrated position.

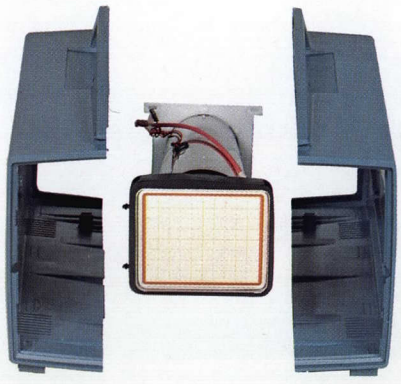
Easier maintenance

Calibration circuits have been given a wide adjustment margin to reduce sensitivity and thus speed up calibration procedures. Circuits are also designed to preserve calibration over a wide range of temperature fluctuation. The T900 Series oscilloscopes are warranted against defective materials and workmanship for one year, and backed by thirty-seven national service centers and fifty U.S. Tektronix Field Offices. They have also been engineered for fast, simple maintenance. Users who wish to perform their own maintenance will appreciate the T900's modular construction, uncrowded circuit boards and thorough instructions in T900 service manuals.

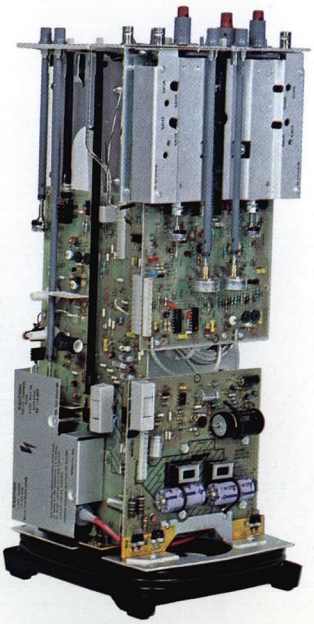
*Available presently in U.S.A. only.
**U.S.A. price FOB Beaverton, Oregon.



④ *All T900's get a 7-day break-in cycling at 122°F.*

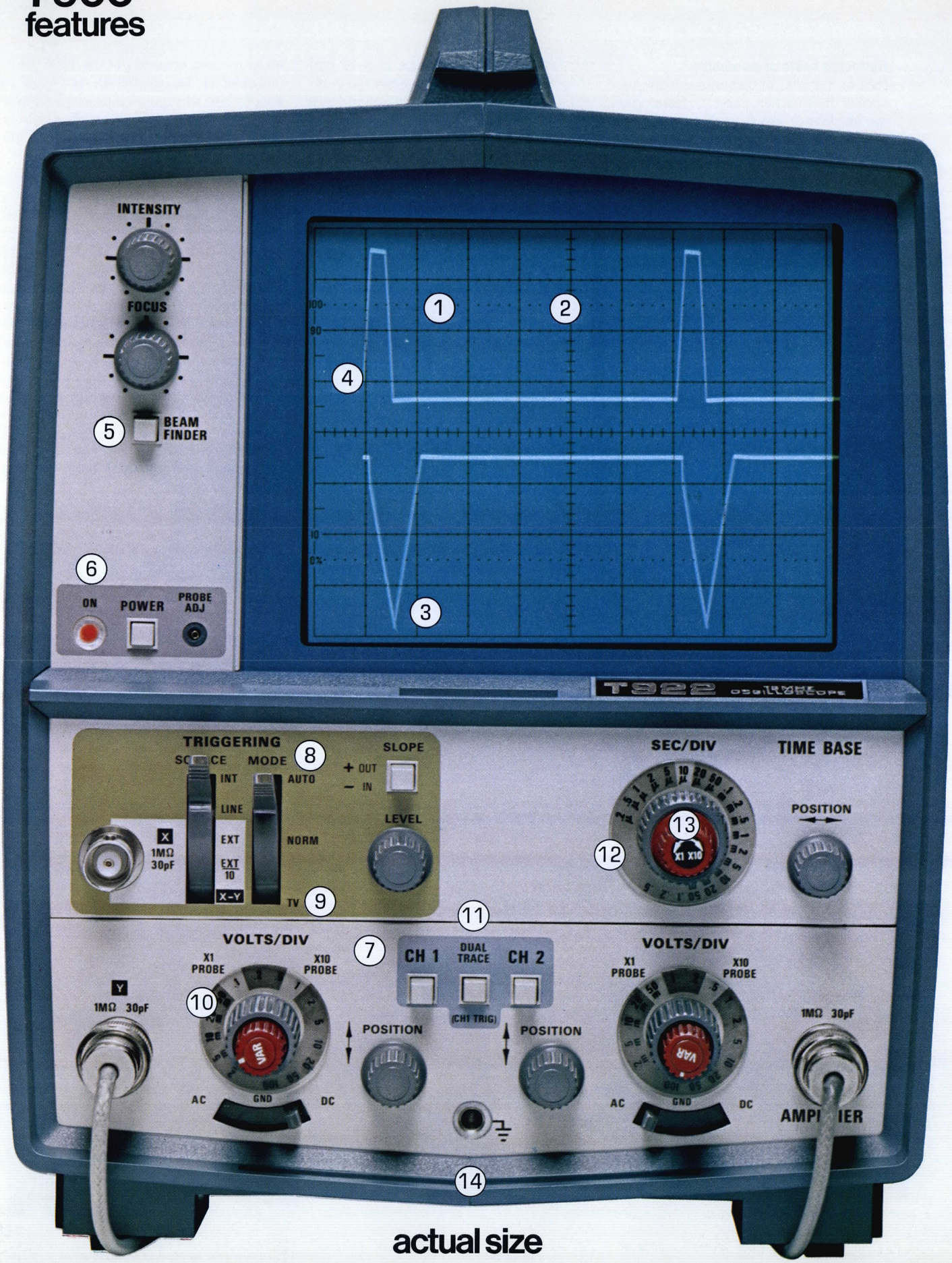


⑤ *Structural core and outer case are common to all T900's.*



⑥ *Edgeboard and harmonica connectors eliminate most wiring and soldered joints.*

T900 features



actual size

T900 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.

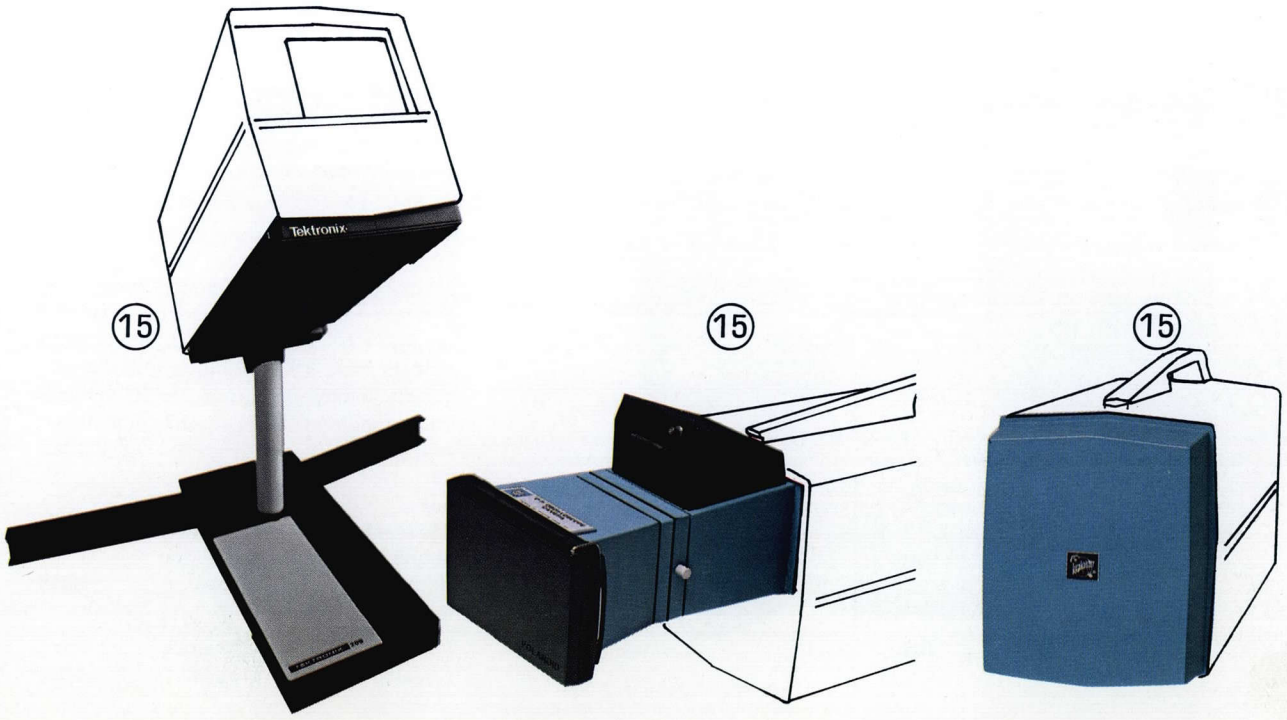
(11) **Display mode switching.** Dual-trace mode (not provided for T921) provides automatic selection of alternate or chopped-sweep displays for best viewing, depending on selected sweep rate.

(12) **Sweep rate selector.** Provides sweep rates from 200 ns to 0.5 s/div in 18 steps. (See pages 8 and 10 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 8 and 10 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.

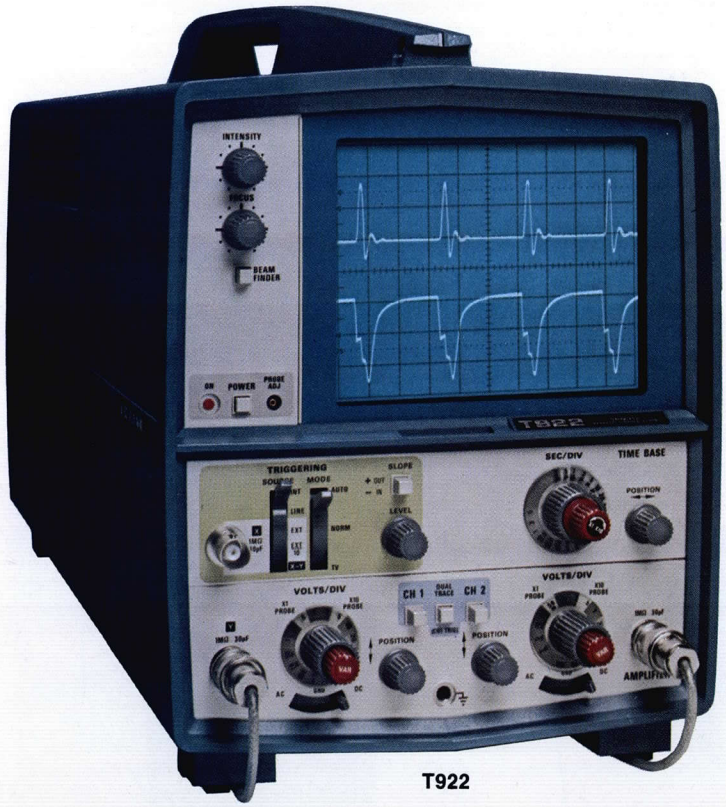
(14) **Impact-resistant case.** Molded from tough, durable Cycoloy KHP. Provides additional structural strength and attractive finish that doesn't wear off.

(15) **Specially designed** T900 accessories add to convenience of use, and protection in transport or storage.



T921/T922
15 MHz oscilloscopes

T921



T922

Dc to 15 MHz at 2mV/cm

20 ns/cm Sweep Rate (With 10X Sweep Expander)

Bright (12kV) Display

Easy to Use

Small and Light Weight

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″ x 10″ x 19″), 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.

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**

T921/T922 specifications

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) — ≈ 250 kHz.

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

Maximum Input Voltage —
Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.
Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

HORIZONTAL SYSTEM

Calibrated Range — 0.5 s/div to 0.2 μs/div in 20 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 20 ns/div.

Accuracy —	**Unmagnified**	**Magnified**
+20°C to +30°C	Within 3%	Within 5%
0°C to +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

Maximum Input — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

X-Y OPERATION

Sensitivity, Variable Magnifier — ≈ 100/mV/div (X10 mag) ≈ 1 V/div X1 mag).

X-Axis bandwidth — Dc to at least 1 MHz (measured at − 3 dB).

Input Resistance — ≈ 1 megohm.

Input Capacitance — ≈ 30 picofarads.

Phase Difference Between X and Y Axis Amplifiers — Within 5° from dc to 50 kHz.

CRT DISPLAY

Display area — 8 x 10 cm, internal graticule.

Standard Phosphor — P31.

Beam Finder — Locates off screen display.

Nominal Accelerating Potential — ≈ 12 kV.

PROBE ADJUST

Output Voltage — ≈ 0.5 V.

Repetition Rate — ≈ 1 kHz.

Z AXIS INPUT

Sensitivity — 5 V causes noticeable modulation.

Useable 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. Maximum operating temperature decreased 1°C/1,000 ft. above 5,000 ft.

PHYSICAL

Weight

With Panel Cover and Accessories — 15.5 lbs (7.0 kg).

Without Panel Cover and Accessories — 15.0 lbs. (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 10 times voltage probe for each channel. Provides full bandwidth capabilities for either the T921 or the T922.

T932/T935
35 MHz oscilloscopes

T932

T935

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″ x 10″ x 19″), 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.

T935—Dc to 35 MHz, dual trace, single time base oscilloscope (includes two 10X probes) **$1,050**

T935—Dc to 35 MHz, dual trace, dual time base (with delayed sweep) oscilloscope (includes two 10X probes) **$1,250**

T932/T935 specifications

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°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 — $\approx$ 250 kHz.

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 30 picofarads.

Maximum Input Voltage —
Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.
Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac 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 maximum 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 maximum 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

Maximum 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 2 MHz (measured at −3 dB).

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 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 — $\approx$ 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. Maximum operating temperature decreased 1°C/ 1,000 ft. above 5,000 ft.

PHYSICAL

Weight

With Panel Cover and Accessories — 15.5 lbs. (7.0 kg)

Without Panel Cover and Accessories — 15.0 lbs. (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.

T912
10 MHz oscilloscope with storage

250 cm/ms Stored Writing Rate

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.

The T912 may be used in the bistable-storage mode or the nonstorage mode. Bistable storage, a proprietary technique of Tektronix, Inc., gives you simple operation and long retention time at a low cost. In the nonstorage mode, the T912 offers all the advantages of a conventional 10-MHz dual-trace oscilloscope.

Like the other T900-Series oscilloscopes, the T912 is engineered for simple operation and basic performance at a moderate price. Functionally related controls are grouped together by color coding and proximity. Convenience controls like the beam finder and probe-calibrate output signal also add to ease of use. Chopped or alternate sweep modes are selected automatically to yield the best display for the selected sweep rate.

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.

T912—Dc to 10MHz, dual-trace, single time-base storage oscilloscope (includes two 10X probes) . . **$1195**

T912 specifications

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 — $\approx$ 250 kHz.

Input Resistance — $\approx$ 1 megohm.

Input Capacitance — $\approx$ 30 picofarads.

Maximum Input Voltage —

Dc Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

Ac Coupled — 400 V (dc + peak ac) 800 V p-p ac at 1 kHz or less.

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 maximum sweep rate to 50 ns/div.

Accuracy —	**Unmagnified**	**Magnified**
+20° 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

Maximum 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) $\approx$ 1V/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 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 — $\approx$ 2.76 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) 65, amps (max) 0.6, 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. Maximum operating temperature decreased 1°C/1,000 ft. above 5,000 ft.

PHYSICAL

Weight

With Panel Cover and Accessories — 18.0 lbs. (8.2 kg).

Without Panel Cover and Accessories — 17.5 lbs. (7.9 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)

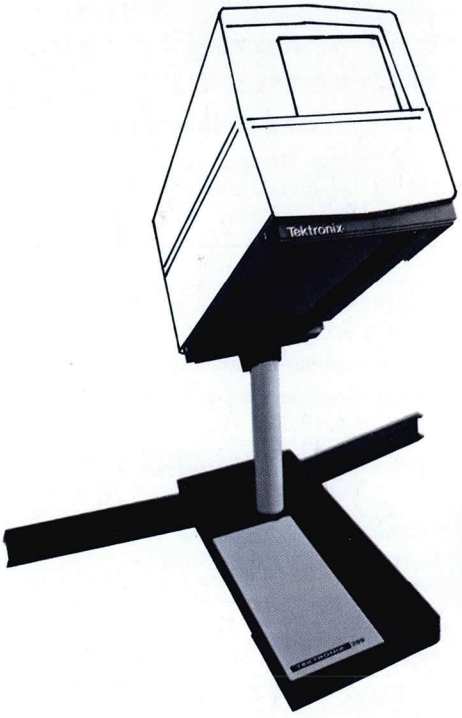
Probes — 2 each. P6006 general purpose 10 times voltage probes. Provides full bandwidth capabilities for the T912.

Optional Accessories

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″ aluminum support column.

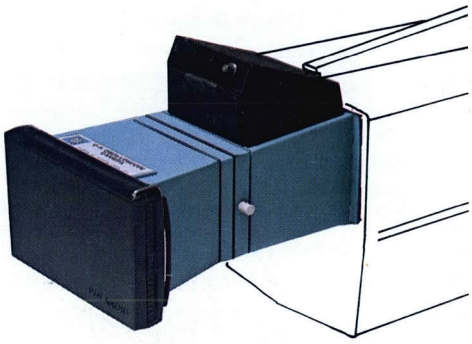
Order: Accessory Stand (016-0347-00)*



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.

(Available January 1976)



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.

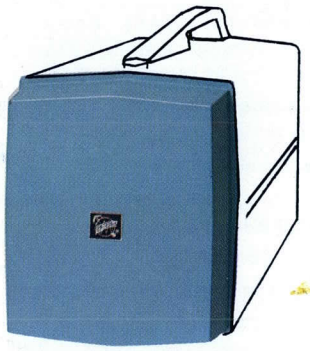
Order: Protective front cover (016-0340-00)*

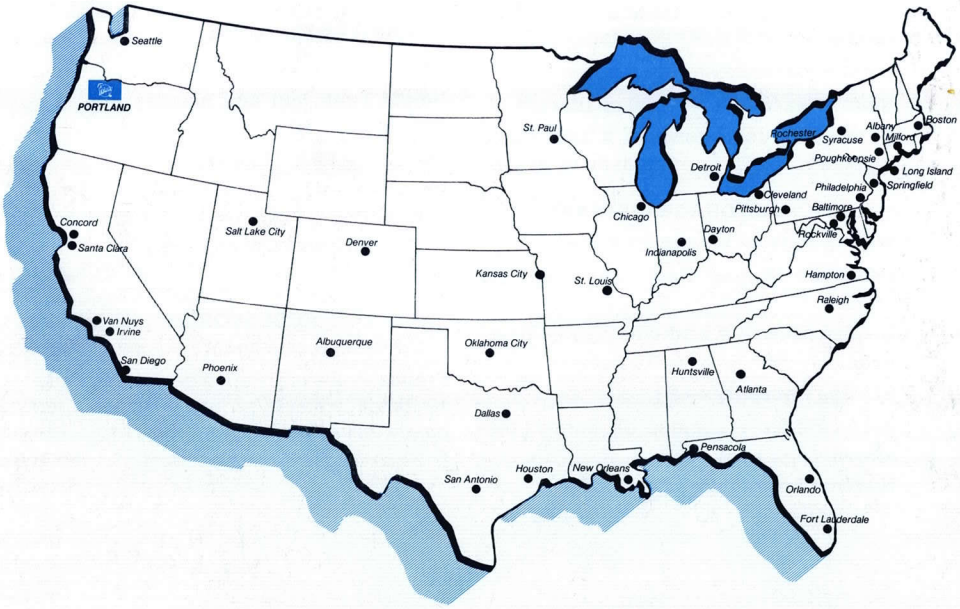
Dust Cover/Rain Jacket (not shown)

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 (010-0361-00)*

*Contact your local Tektronix Field Engineer for ordering information.





Service and Support

Your local Tektronix Field Engineer is trained to help you in the selection, operation, application and maintenance of all T900 Series oscilloscopes . . . another extra value you should consider. Consult your local Tektronix Field Office, or write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97077, Phone: (Area Code 503) 644-0161.

TEKTRONIX®

committed to technical excellence

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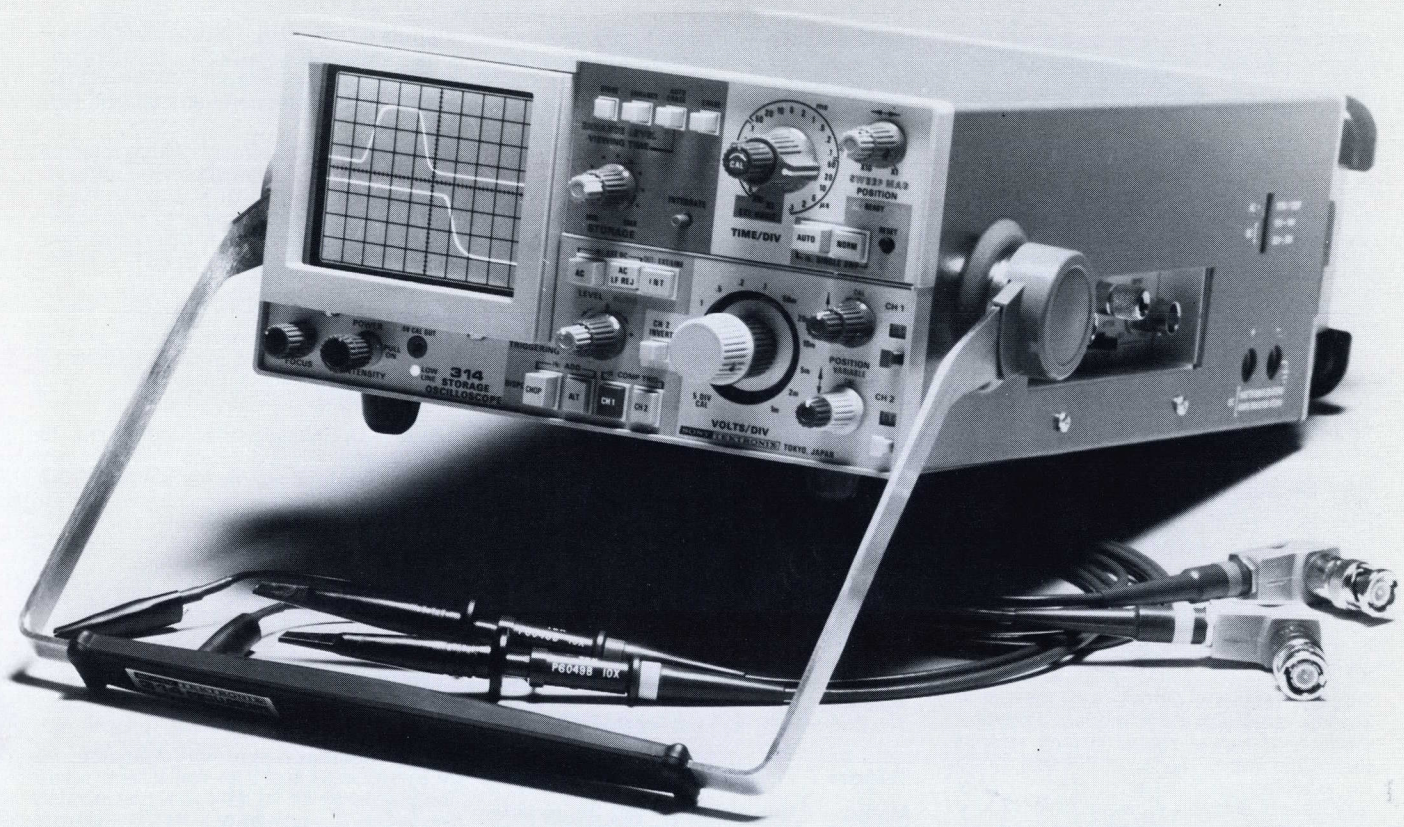
TEKTRONIX®
committed to technical excellence

314 Portable Storage Oscilloscope



Stored viewing time to 4 hrs.

10.5 lb. portable package

Integrate mode for intensifying fast risetime, 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 risetime, low repetition rate signals an integrate mode increases the intensity of the stored trace.

Light weight (10.5 lbs.), 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 autoerase mode, with variable erase period from 1 to 5 seconds, enhances the ability of the 314 to make measurements on slowly changing analog signals such as those from a pressure transducer.

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.

This lightweight, cost-effective servicing tool joins a comprehensive line of Portable Storage Oscilloscopes from Tektronix. Capabilities in this family range from dual-trace, 500 kHz storage in a 3.5 lb., handheld package to a dual-trace, delayed sweep model which can store single-shot events at its full 100 MHz bandwidth.

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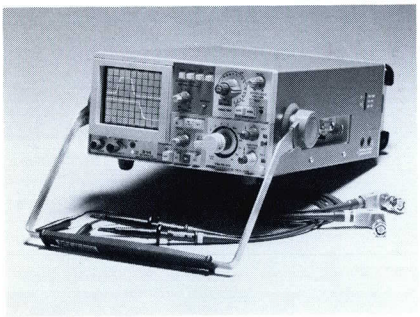
TEKTRONIX®
committed to technical excellence

314 Portable Storage Oscilloscope



Specifications

CRT Display and Storage

CRT—8 x 10 div display area (0.25 in/div). Phosphor is type P43.2 kV accelerating potential.

Graticule—Internal, non-illuminated. Vertical and horizontal center-lines marked in 5 minor divisions per major ¼ inch division.

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 Deflection

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.

Risetime—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.

Maximum 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 absence 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. Maximum 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. Non-operating: −40°C to +75°C.

Altitude—Operating: 20,000 feet maximum, decrease maximum temperature by 1°C/1000 feet from 5,000 feet to 20,000 feet. Non-operating: 50,000 feet maximum.

Humidity—Non-operating: 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 peak-to-peak (4 g's at 55 cps). 10 to 55 to 10 cps in 1 minute cycles.

Shock—Operating and non-operating: 30 g's, ½ sine, 11 ms duration. 2 shocks per axis in each direction for a total of 12 shocks.

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. Maximum 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. Maximum power dissipation 29 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a maximum current drain of 1.6 A at +12 V or 0.8 A at +24 V.

Dimensions and Weights

Height	4.4 in	11.2 cm
Width with handle	9.3 in	23.6 cm
Depth, handle not extended	13.6 in	34.7 cm
Depth, handle extended	17.6 in	44.8 cm
Net weight without accessories	10.5 lb.	4.7 kg
Shipping weight	17.0 lb.	7.6 kg

Included Accessories—Two P6049B X10 probes (010-6049-01), carrying case (016-0612-00), external dc cable assembly (012-0406-00), viewing hood (016-0297-00), light blue CRT filter (378-2016-00).

Order 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.

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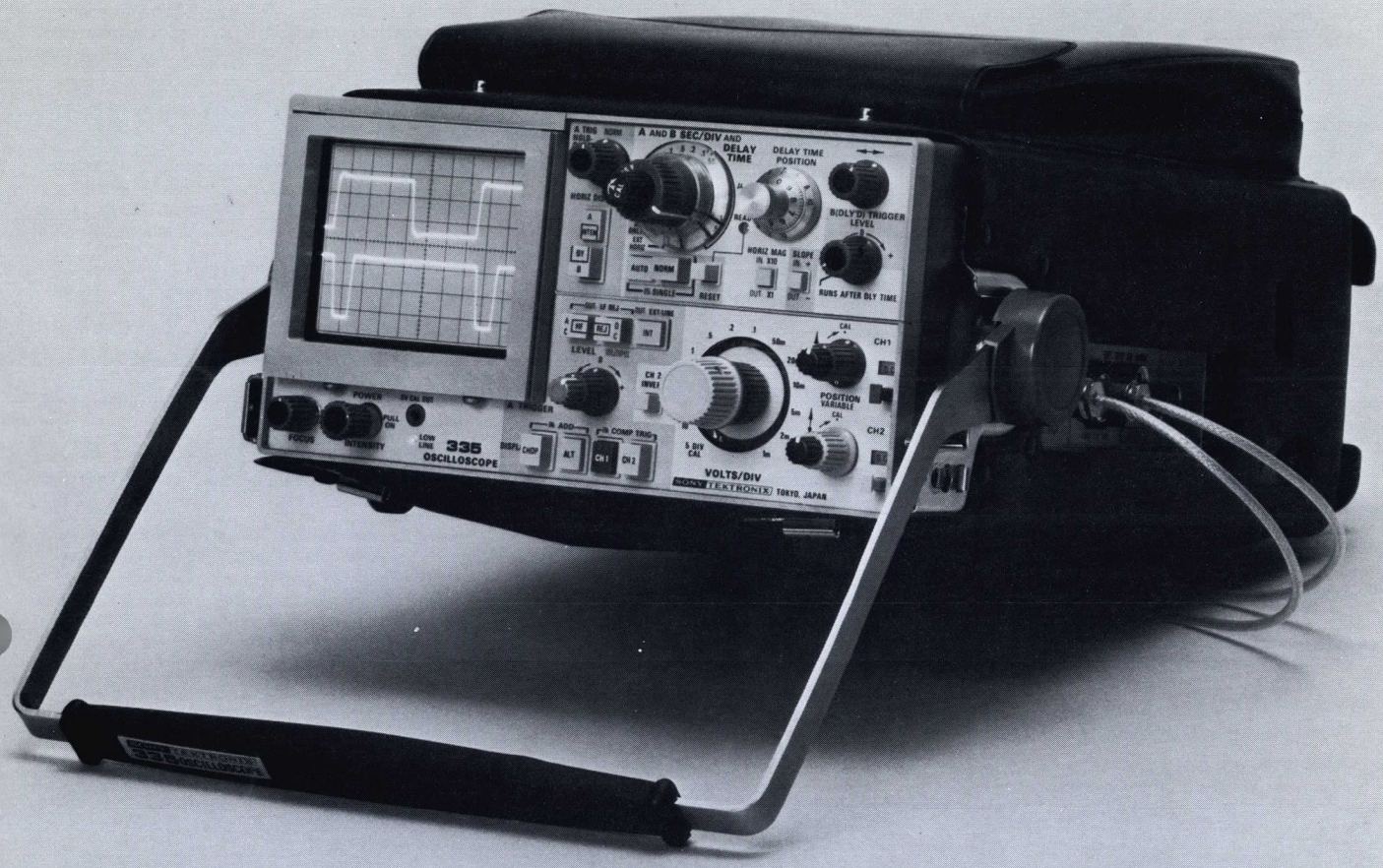
committed to technical excellence

335 Portable Oscilloscope



335 PORTABLE OSCILLOSCOPE

35 MHz, Dual-Trace, Delayed Sweep

Compact (11.2 x 23.6 x 34.7 cm, 4.7 kg)

1 mV/div Vertical Sensitivity

Delay Line Inputs

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. Delay line inputs provide 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.

Pg 1 of 9

TEKTRONIX®

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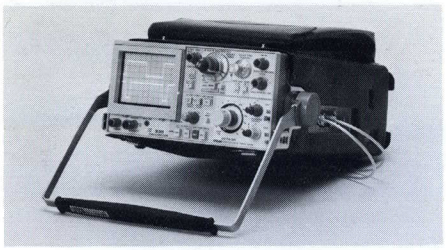
335 Portable Oscilloscope



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 1 X probe and 1 Hz or less with a 10 X 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.

Maximum 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 divisions).

	+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 10 X.

CALIBRATED SWEEP DELAY

Delay Time Range—Continuously variable from 0.2 μs to at least 5 sec after the start of the delaying (A) sweep.

Differential Time Measurement Accuracy— ± 2% for measurements of 1 or more major dial divisions or ± 0.02 major dial division for measurements of less than one major dial division (for delay time dial settings between 1.0 and 9.0).

Jitter— 1 part or less in 20,000 (0.005%) of 10X 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—Approximately 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 Lf 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 Hf 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	

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 — Approximately 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 inch increments.

ENVIRONMENTAL CAPABILITIES

Temperature—Operating. −15°C to +55°C. Non-operating: −40°C to +75°C.

Altitude—Operating: 15,000 feet maximum, decrease maximum temperature by 1°C/1000 feet from 5,000 feet to 15,000 feet. Non-operating: 50,000 feet maximum.

Humidity—5 cycles (120 hours) referenced to MIL-E-16400 F.

Vibration—Operating and non-operating 15 minutes along each of the three major axes at a total displacement of 0.025 in peak-to-peak (4 g's at 55 cps) 10 to 55 to 10 cps in 1 minute cycles.

Shock—Operating and non-operating: 30 g's, ½ sine, 11 ms duration. 2 shocks per axis in each direction for a total of 12 shocks.

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. Maximum power dissipation 24 W at 115 V. External dc source: +11 V to +14 V or +22 V to +28 V with a maximum current drain of 2.0 A at +12 V or 1.0 A at +24 V.

DIMENSIONS AND WEIGHT

Height	4.4 in	11.2 cm
Width With Handle	9.3 in	23.6 cm
Depth, Handle Not Extended	13.6 in	34.7 cm
Depth, Handle Extended	17.6 in	44.8 cm
Net Weight Without Accessories	10.5 lb.	4.7 kg
Shipping Weight	17.0 lb.	7.6 kg

INCLUDED ACCESSORIES

2 probe packages (010-6065-13), carrying case (016-0612-00), external dc cable assembly (012-0460-00).

ORDERING INFORMATION

Order 335 Portable Oscilloscope $1825

OPTIONAL ACCESSORIES

Viewing Hood.—Order 016-0297-00

Crt Filter—Light blue. **Order 378-2016-00**

Crt Filter—Light amber. **Order 378-0843-00**

Crt Mesh Filter—With frame and holder. **Order 378-0063-00**

Camera Adapter—Adapts C-30A camera to 335. **Order 016-0327-00**

C-30A-P Camera—General purpose camera with pack film back. **Order C-30A-P Camera**

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.

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A-3164

MARKETING SALES RELEASE

FILE #641

DATE March 15, 1977

RECEIVED
MAR 18 1977
CLEVELAND OFFICE
TEKTRONIX, INC.

607 Opt. 08
Fast Writing Speed Option
Replacement For Instrument Type 605

When the 607 was developed, it was intended to be a replacement for the 605. However, resolution requirements could only be met at a sacrifice to writing speed. Since several users needed the higher writing speed, it was decided to leave the 605 in the product line at that time.

The 607 Opt. 08 will be the replacement for the 605. It will utilize the 605 CRT and have all of the 605 specifications. It will not have the resolution of the standard 607.

	Writing Speed	Half Tone Resolution
605	1 div/μsec	≃ 10 dots/div
607	.8 div/μsec	18 dots/div
607 Opt. 08	1 div/μsec	≃ 10 dots/div

The mechanical configuration of the 607 Opt. 08 and the 605 is identical.

Public Announcement. AP711

Price Information:

607. . . . . $1,800
Option 01 internal graticule. . . . . N/C
Option 03 without handle and feet. . . . . -10
(not available with Opt 07)
Option 04 time base. . . . . +150
Option 06 U.L. listed. . . . . +50
Option 07 without handle, feet and all dust covers. . . . . -20
(not available with Opt 03)
Option 08 fast writing speed CRT (reduced resolution). . . . . -100

Customer Availability. AP801

Beaverton Responsibility:

Marketing. . . . . .Mike Kondrat

Service Support. . . . . .Lynn Porter

2007557
MARY LEWIS
CLEVELAND

COMPANY CONFIDENTIAL

MARKETING
SALES RELEASE

FILE

DATE March 15, 1972

507 Opt. 06

Fast Writing Speed Option

Replacement For Instrument Type 606

MARKETING SALES RELEASE

FILE

DATE March 14, 1977

5000/7000 READOUT CONVERSION KIT PRICE

(To Add Readout)

As stated in the FEN, dated February 4, 1977, we are rolling back the price of the 5000/7000 Conversion Kits. Listed below is the part number, the old price, the new price and instruments affected. This supersedes the '77 catalog and is effective Monday, March 14, 1977.

Part Number	Old Price	New Price	Instruments Affected
	7000 SERIES		
040-0533-01	$600	$480	R7704
040-0605-03	$600	$480	R7903/7904
040-0613-00	$600	$480	7704A
040-0654-02	$550	$480	7603
040-0655-02	$550	$480	7313
040-0656-02	$550	$480	7613
040-0674-02	$550	$480	R7603
040-0675-02	$550	$480	R7313
040-0676-02	$550	$480	R7613
040-0748-01	$550	$480	7623A/7633
040-0759-01	$550	$480	R7623A/R7633
	5000 SERIES		
040-0691-00	$455	$436	5440/R5440 5441/R5441

2007573
MARILYN IREY
CLEVELAND

Vince Lutheran
Lab Scope Marketing
Marketing Program Manager

COMPANY CONFIDENTIAL

MARKETING SALES RELEASE

FILE #637

DATE March 14, 1977

J6523 Opt 05

The J6523 1 degree luminance probe for the J16 is now available with an actual spectral curve as are all other J16 probes. To obtain this curve, specify J6523 Option 05 on the initial order. The price is an additional $55.

Order:

J6523	$ 980.00
Option 05	55.00

Pete Keller
Access. Mktg.
58/129 x7769

COMPANY CONFIDENTIAL

MARKETING SALES RELEASE

FILE #638

DATE March 14, 1977

DM44 OPTION KITS

In MSR #621, dated January 7, 1977, there was no mention made of the temperature probe as an included accessory. This probe (P6430 P/N 010-6430-00) should be included in the Kit. The probe can also be ordered separately.

Order:

P6430.....(010-6430-00).....$110.00

Milt Ringe
SID Marketing
50/438 x6410

COMPANY CONFIDENTIAL

MARKETING SALES RELEASE

FILE #639

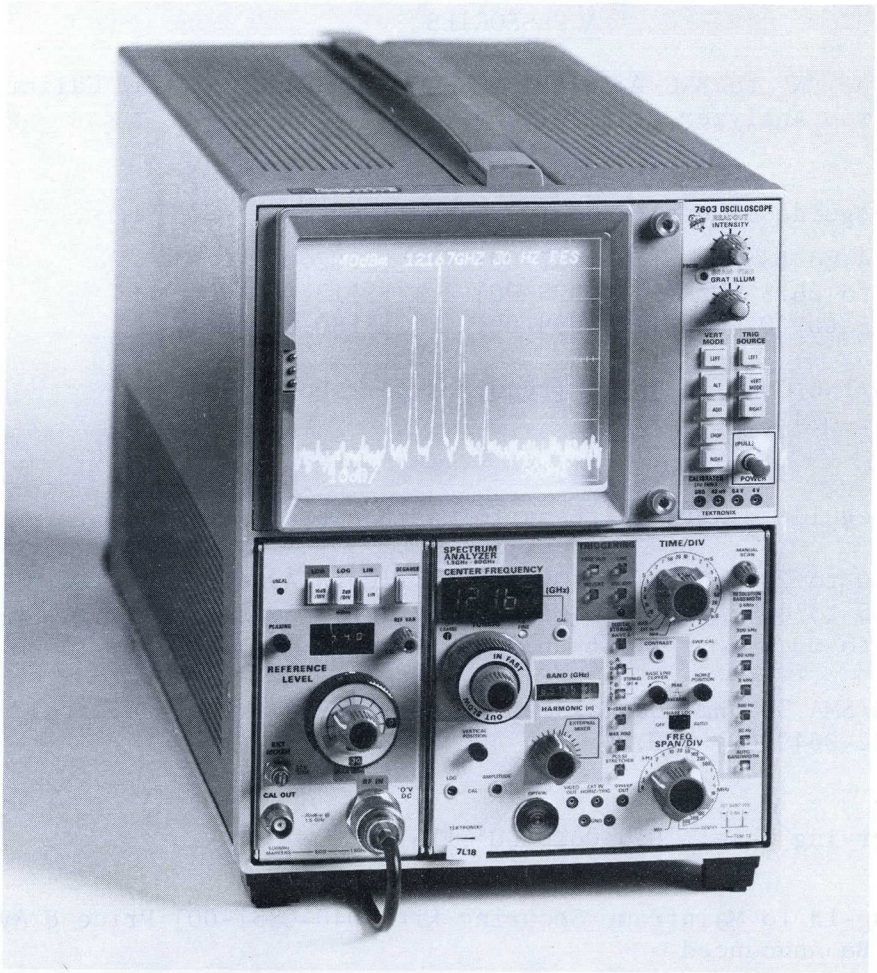
DATE March 14, 1977

7L18 MICROWAVE SPECTRUM ANALYZER

1.5 TO 60 GHz

"WE'RE TUNED TO YOUR FREQUENCY"

(U. S. DISTRIBUTION ONLY)



- 30 Hz RESOLUTION TO 12 GHz
- 80dB DYNAMIC RANGE
- BUILT-IN AUTOMATIC PRESELECTOR FOR SPURIOUS FREE DISPLAY
- DIGITAL STORAGE AND SIGNAL PROCESSING
- 7000 SERIES COMPATIBILITY

COMPANY CONFIDENTIAL

7L18 MARKETS

- Microwave Relay Equipment Manufacturers and End Users
- Military Systems Support Test Equipment
- Satellite Communications
- Microwave Systems Manufacturers (Prime Contractors)
- Frequency Management (Regulatory Agencies)
- Microwave Navigation
- Microwave Research & Development
- Space Exploration
- Microwave Hardware Manufacturers
- Surveillance
- EMI, EMC Testing
- Microwave Semiconductor Manufacturers

ACCESSORIES

INCLUDED: Type "N" to BNC ADAPTER, BNC TO BNC 50 ohm Coaxial Calibrator Cable Manual, Spectrum Analyzer Graticule.

OPTIONAL: Waveguide mixers (economy general purpose)

12.4 to 18 GHz	(119-0097-00)	$102.00
18 to 26.5 GHz	(119-0098-00)	$117.00
26.5 to 40 GHz	(119-0099-00)	$180.00

SMA/TNC Coaxial Cable (required for above mixers)
(012-0748-00) $15.00

Waveguide mixers (high performance ultra flat)

18.0 to 26.5 GHz	(016-0631-00)	Price & Availability To Be Announced
26.5 to 40 GHz	(016-0632-00)	Price & Availability To Be Announced
40 to 60 GHz	(016-0634-00)	Price & Availability To Be Announced

SMA/SMA 50 ohm Coaxial Cable (required for above mixers)
(012-0649-00) $20.00

Carrying Case: 016-0626-00 $175.00

Plug-In To Mainframe Securing Kit (040-0831-00) Price & Availability To Be Announced

Shippable Luggage Case (Accepts 7603 OPT 8 with 7L18 secured)
(016-0628-00) $225.00

50 ohm Coaxial Cable 6 Foot Type "N" Male Fittings
(012-0114-00) $15.00

PRICE

7L18 - $12,000.00
7603 - 1,850.00 (recommended mainframe)

TOTAL $13,850.00

COMPETITION

Hewlett Packard 141T/8555A/8552B/8554B	$16,625.00
AILTECH 727	$17,100.00
Systron Donner 4809/4701/2311/4745	$17,100.00
Nelson Ross (Polarad) 640	$11,150.00

INTRODUCTION SCHEDULE

PUBLIC ANNOUNCEMENT: IEEE ELECTRO WEEK April 17, 1977 (week 16)

CUSTOMER AVAILABILITY: October 1977 (week 40)

DEMO AVAILABILITY: 2 B-Phase instruments (East and West FDI RSM's) provided at IEEE ELECTRO WEEK. Prioritized Demo's to FDI RSM's AP 801/802.

MEDIA COVERAGE: Front cover Electronic Design APRIL. Feature article Microwave System News MAY. Editorial Coverage: 125 National Publications including Electronics, EDN, Microwave Journal, Electronic Warfare. Press tour at IEEE.

LITERATURE: Four color brochure and specification sheet available at IEEE ELECTRO mailed to all F.E.'s (week 17).

F.E. SUPPORT: A product program will be mailed to each F.E. in June (AP 801).

TRAINING: Introductory videotape at IEEE ELECTRO, FDI Specialist Microwave Seminar in Beaverton week of April 4, 1977.

GSA LISTING: July

Len Garrett
Spectrum Analyzer
Product Manager
58/741

Tektronix®
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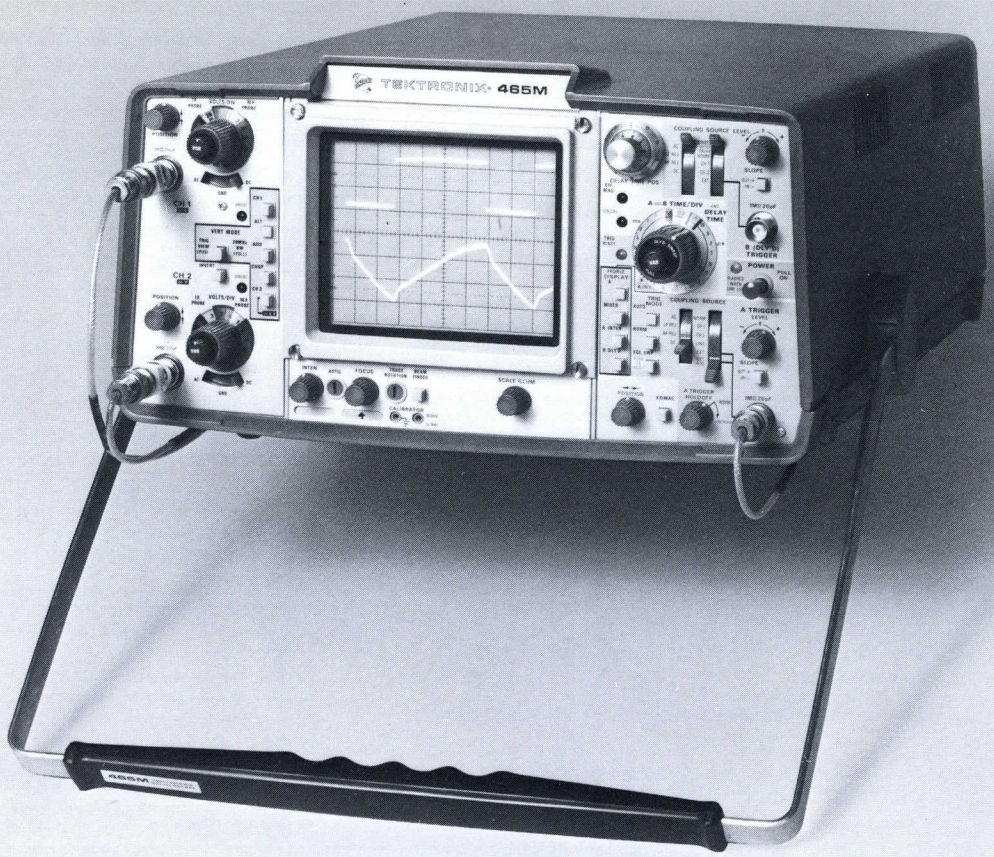
465M Oscilloscope



Military Designator AN/USM 425

Meets Mil-T-28800A, Type II, Class 4, Style C

Triservice Standard 100 MHz Oscilloscope

Full Military Provisioning

2007557
MARY LEWIS
CLEVELAND

The 465M Oscilloscope is the commercially available AN/USM 425, the triservice 100 MHz standard oscilloscope. Both the 465M and the AN/USM 425 are designed to meet the Mil-T-28800A, Type II, Class 4, Style C requirements.

The 465M dual-trace oscilloscope features 100 MHz bandwidth, 5 mV/div vertical sensitivity and delayed sweep . . . all in a rugged portable. And there's more to the value leading 465M. Trigger signal presence and timing can be checked by pushing a button without moving the probes. Variable trigger holdoff provides stable displays of complex digital signals.

With clearly labeled controls, color coding and functional group arrangements, operator training time is minimized in addition to easier, faster, more error-free measurements. All this translates into savings in time and money.

Modular design means easy serviceability. Vertical amplifier and time-base modules can be quickly removed for ready access to all components, making repairs faster and less costly. Lower parts count means a less expensive spare parts inventory. Since the military catalogs all parts for the military version (AN/USM 425), parts provisioning and logistics support is not a problem when specifying the 465M as test equipment in military applications.

Calibration time is reduced with the 465M. A minimum number of adjustments, made possible by actively trimmed networks, saves the time and money associated with elaborate calibration procedures.

For protection against adverse environmental and operating conditions, the unit is housed in a rugged, attractive, reinforced plastic case and comes complete with a drip-proof front cover.

Tektronix®
COMMITTED TO EXCELLENCE

465M Oscilloscope

465M Specifications

VERTICAL SYSTEM

Bandwidth and Rise Time—Dc to at least 100 MHz (−3 dB) and rise time 3.5 ns or less for dc coupling and −15°C to +55°C. For ac coupling the lower 3 dB point is 10 Hz or less with a 1X probe and 1 Hz or less with a 10X probe.

Bandwidth Limit Mode—Bandwidth limited to 20 MHz.

Deflection Factor—5 mV/div to 5 V/div in 10 steps (1-2-5 sequence). Dc accuracy: ±2% 0°C to 40°C; ±3% −15°C to 0°C, 40°C to 55°C. Uncalibrated, continously variable between settings, and to at least 12.5 V/div.

Common-Mode Rejection Ratio—25:1 to 10 MHz; 10:1 from 10 to 50 MHz, 6 cm sinewave. (ADD Mode with Ch 2 inverted.)

Display Modes—Ch 1, Ch 2 (normal or inverted), alternate, chopped (250 kHz rate), added, X-Y.

Input R and C—1 MΩ ±2%, approx 20 pF.

Max Input Voltage—Dc or ac coupled: ±250 V dc + peak ac at 50 kHz, derated above 50 kHz.

Cascaded Operation—(Ch 2 Out into Ch 1) Bandwidth, dc to at least 40 MHz. Sensitivity, approx 1 mV/div when terminated in 50 Ω at Ch 1 input with both Ch 1 and Ch 2 V/div switches set to 5 mV/div.

HORIZONTAL DEFLECTION

Time Base A—0.5 s/div to 0.05 μs/div in 22 steps (1-2-5 sequence). 10X mag extends fastest sweep rate to 5 ns/div.

Time Base B—50 ms/div to 0.05 μs/div in 19 steps (1-2-5 sequence). 10X mag extends maximum sweep rate to 5 ns/div.

Accuracy—

	Unmagnified	Magnified
+20°C to +30°C	±2%	±3%
−15°C to +55°C	±3%	±4%

Mixed Sweep Accuracy—A Portion—±4%
B portion—±2%.

Horizontal Display Modes—A, A intensified by B, B delayed by A, and mixed.

CALIBRATED SWEEP DELAY

Calibrated Delay Time—Continuous from 0.1 μs to at least 5 s after the start of the delaying A sweep.

Differential Time Measurement Accuracy—for measurements of two or more major dial divisions:
+15°C to +35°C 1% + .1% of full scale
0°C to +55°C additional 1% allowed

Jitter—1 part or less in 20,000 (0.005%) of 10X the A TIME/DIV switch setting.

TRIGGERING A AND B

A Trigger Modes—Normal Sweep is triggered by an internal vertical amplifier signal, external signal, or internal power line signal. A bright baseline is provided only in presence of trigger signal. Automatic: A bright baseline is displayed in the absence of input signals. Triggering is the same as normal mode above 40 Hz. Single: (Main time base only). The sweep occurs once with the same triggering as normal. The capability to re-arm the sweep and illuminate the reset lamp is provided. The sweep activates when the next trigger is applied for re-arming.

A Trigger Holdoff—Increases A sweep holdoff time to at least 10X the TIME/DIV settings, except at .2 s and .5 s.

Trigger Sensitivity and Coupling—

Coupling		From 30 Hz to 25 MHz	At 100 MHz
Dc	Internal	0.3 div	1.0 div
	External	50 mV	150 mV
Ac	Attenuates signals below		30 Hz
Ac Lf Reject	Attenuates signals below		15 kHz
Ac Hf Reject	Attenuates signals above		50 kHz

Jitter—0.5 ns or less at 100 MHz and 5 ns/div, −15°C to +55°C.

Trigger View—View external and internal trigger signals; Ext X1 100 mV/div, Ext÷10 1 V/div.

Level and Slope—Internal, permits triggering at any point on the positive or negative slopes of the displayed waveform. External, permits continuously variable triggering on any level between +1.0 V to −1.0 V on either slope of the trigger signal.

A Sources—Ch 1, Ch 2, NORM (all display modes triggered by the combined waveforms from Ch 1 and 2), LINE, EXT, EXT ÷ 10.

B Sources—B starts after delay time; Ch 1, Ch 2, NORM, EXT, EXT ÷ 10.

X-Y OPERATION

Sensitivity—5 mV/div to 5V/div in 10 steps (1-2-5 sequence) through the vertical system. Continuously variable between steps and to at least 12.5 V/div.

X Axis Bandwidth—Dc to at least 4 MHz.

Y Axis Bandwidth—Dc to 100 MHz.

X-Y Phase—Less than 3° from dc to 50 kHz.

SIGNAL OUTPUTS

A Gate—Approx 5.0 V positive-going pulse.
B Gate—Approx 5.0 V positive.

DISPLAY

Crt—5 in, rectangular tube; 8x10 cm display; P31 phosphor.

Graticule—Internal, non-parallax; illuminated. 8x10 cm markings with horizontal and vertical centerlines further marked in 0.2 cm increments. 10% and 90% markings for rise time measurements.

Graticule Illumination—Provides variable illumination from 0 to greater than optimum illumination.

Beam Finder—Limits the display to within the graticule area and provides a visible display when pushed.

Z-axis Input—A female BNC connector is provided to permit intensity modulation over the dc to 15 MHz range. At optimum intensity, intensity modulation is accomplished with a Z axis input of from −5 V (to intensify) to +5 V (to blank). Continuous operation maximum input shall be ±50 V (dc + peak ac).

ENVIRONMENTAL

EMI—complies with the following limits as specified in MIL-T-28800A: CE01 (10 kHz to 20 kHz only), CE03, CS01, CS02, CS06, RE01 (relaxed 10 db at fundamental, third harmonic, and fifth harmonic of the power source frequency), RE02 (limited to 1 GHz), RS01 and RS03 (limited to 1 GHz).

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −62°C to +85°C.

Altitude—Operating: to 15,000 feet. Max operating temperature decreased 1°C/1,000 ft above 5,000 ft. Non-operating: to 50,000 ft.

Vibration—Operating: along each of the three major axes:
a. cycling 5 to 25 to 5 Hz for 10 min at 0.025 in p-p;
b. cycling 25 to 55 to 25 Hz for 5 min at 0.020 in p-p;
c. dwelled at 55 Hz for 10 min at 0.020 in p-p.
Total vibration time 75 min.

Humidity—5 cycles (120 hours) referenced to MI... E-16400F (operating and non-operating).

Shock—Operating: 30 g's, ½ sine, 11 ms duration, 3 shocks each direction per axis for a total of 18 shocks.

OTHER CHARACTERISTICS

Calibrator Output Voltage—1.0 V ±1.0% −15°C to +55°C. Frequency approx 1 kHz.

Channel 2 Signal Output—Through main module Ch 2 OUT connector. Output voltage: approx 50 mV/div into 1 MΩ, approx 25 mV/div into 50 Ω. Output resistance: approx 50 Ω. Bandwidth: dc to at least 40 MHz into 50 Ω.

Power Requirements—100 V to 132 V rms, 200 V to 264 V rms. 48 Hz to 440 Hz. Maximum power consumption 60 watts at 115 V, 60 Hz.

Dimensions—	in	cm
Height (with feet)	7.05	17.91
Width (with handle)	13.65	34.67
Width (without handle)	12.50	31.75
Depth (including panel cover)	24.45	54.58
Depth (handle extended)	24.10	61.10
Weight (approx)	**lbs**	**kg**
Net (without cover and accessories)	24.0	10.9
Net (with panel cover, modules, and accessories)	27.0	12.2
Shipping	34.2	15.5

Transportation—Meets the limits of National Safe Transit Committee test procedure 1A with a 30-in drop.

Included Accessories—One 1X Probe (010-6101-00), two 10X probes (010-6104-00), three pincer tips (013-0107-03), two UHF male to BNC female adapters (103-0015-00), two BNC male to UHF female adapters (103-0032-00), one T connector (103-0030-00), one BNC male to dual binding post adapter (103-0035-00), three probe tip adapters (103-0051-01), three banana tips (134-0013-00), three 6″ lead with spring clips (175-0124-01), three hooked probe tips (206-0105-00), one blue filter (337-2122-00), one clear filter (337-2122-01), three miniature alligator clips (344-0046-00), one power cord (161-0118-00).

ORDERING INFORMATION

465M Portable Oscilloscope **$2195**

OPTIONAL ACCESSORIES

Probe—P6022 Current Probe, 5 ft cable with termination.
Order 015-0135-00 ..... **$205**

C-30AP Compact Camera—Variable magnification, optional electric shutter, interchangeable film backs.
Order C30AP Camera **$690**

Camera Adapter and Corrector Lens—Adapts to C-30A to 465M.
Order 016-0601-00 ..... **$ 55**

Folding Polarized Viewing Head—
Order 016-0180-00 ..... **$ 17**

Mesh Filter—Improves contrast and emi filtering.
Order 378-0726-01 ..... **$ 28**

SCOPE-MOBILE Cart—Occupies less than 18 in of aisle space.
Order 200-C **$160**

1105 Battery Power Supply—Provides 1.8 hours of battery operation.
Order 1105 Battery Power Supply **$795**

Rack Adapter (Cradle Mount) Kit— Rack height 7 in, depth 18¾ in, width 19 in.
Order 040-0825-00 ..... **$200**

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1/77

A-3528

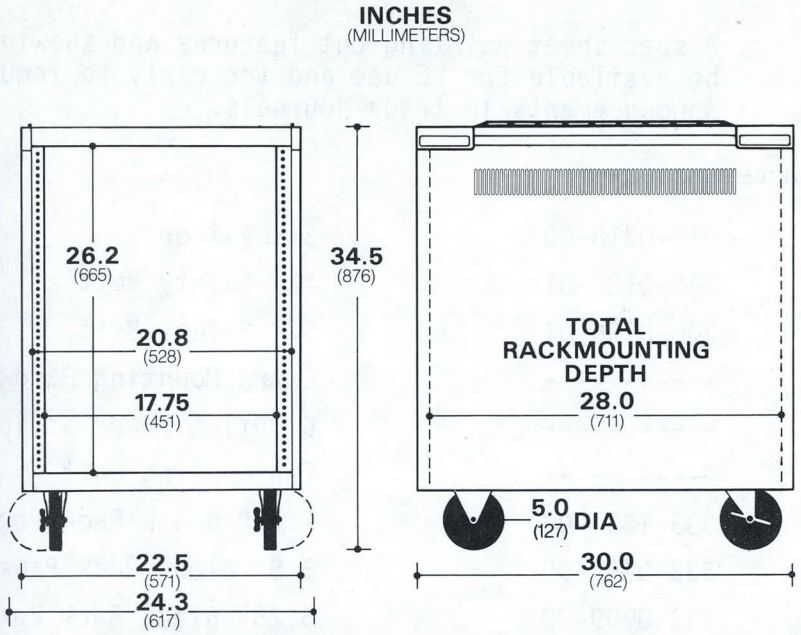
MARKETING SALES RELEASE

#632

FILE

DATE February 22, 1977

Model 7 Rack Cart



Model 7

The Model 7 Rack Cart is for small systems consisting of rack mounted equipment and is designed for shipment with up to 300 lbs. of instruments mounted in place. This feature combined with its UL listing makes it an attrative product for OEM applications.

Accessories include the 015-0318-00 Stabilizer which is required to meet UL requirements when slide mounted equipment is installed in the Model 7, safety belts for securing oscilloscopes or other instruments to the top surface of the cart and several blank rack panels of various sizes.

Let us know about any potential OEM applications that you encounter. We can arrange the loan of a Model 7 or make a customer visit if the potential sales quantity is sufficient.

U.S. Price	$450 ($382.50 with 15% OEM Discount)
Product Announcement	1977 Tek Catalog (April)
Available	Wk 10
Demos	None are expected
Initial PAL	2 weeks

COMPANY CONFIDENTIAL

Advertising Support--

A spec sheet pointing out features and showing the Model 7 in use will be available for FE use and for reply to inquiries from new product announcements in trade journals.

Accessories--

015-0318-00	Stabilizer	$85.00
346-0136-01	42" Safety Belt	15.00
346-0156-01	57" Safety Belt	15.00
----------	Extra Mounting Hardware Kit	*
----------	6 Outlet Power Strip w/15 ft. Cord	*
----------	Fan Cooling Unit	*
333-1351-00	1.75" Blank Rack Panel	3.00
333-0997-00	3.5" Blank Rack Panel	6.00
333-0999-00	5.25" Blank Rack Panel	8.50
333-1352-00	7.0" Blank Rack Panel	10.50
333-0998-00	8.75" Blank Rack Panel	11.50
333-0996-00	10.5" Blank Rack Panel	11.50

* Part numbers and prices to be announced at a later date.

2007599
BOB PADGETT
CLEVELAND

Pete Keller
Accessories Marketing
Del. Sta. 58-129
Extension 7769

MARKETING SALES RELEASE

FILE #623

DATE January 13, 1977

T922R Option 01

Option 01, which provides differential capability between channels 1 and 2, will be available for the T922R effective January 31, 1977.

T922R Options:

Option 01 (channel 1 and 2 differential).....Add $50.

John C. Behdjet
T900 Marketing
50-442
ext. 6364

2007557
MARY LEWIS
CLEVELAND

COMPANY CONFIDENTIAL

MARKETING SALES RELEASE

FILE #619

DATE January 5, 1977

PRICES FOR 7L5 OPTIONS 21, 28, 32, 33

All options for the 7L5 Spectrum Analyzer have now been priced. The options were introduced via MSR #582, dated September 17, 1976. Option 25 (tracking generator) was the only one priced at that time. The following options now have prices:

Option 21 with Logarithmic Frequency Display.....$750

Option 28 Front Panel Readout.....$500

Option 32 combines Options 25 and 28.....$1300

Option 33 combines Options 21, 25, and 28.....$1800

Options 30 and 31 have been deleted and will be available only as custom mods. See 7L5 Data Sheet (A-3209-1) for details on all 7L5 options.

Gary Mott
FDI Marketing
58/741 X5667

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MARKETING SALES RELEASE

FILE #618

DATE January 5, 1977

7L5 INSTRUCTION MANUALS AVAILABLE

7L5 manuals to replace the 7L5 interim manual are now available. If you need one, the following are available:

070-2184-00	7L5 Service Manual
070-1734-00	7L5 Operators Manual
070-2155-00	7L5 Options Manual

The 7L5 options manual now contains information on Option 25 only, but will be updated to include information on Options 21, 28, 32, and 33.

Gary Mott
FDI Marketing
58/741 X5667

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MARKETING SALES RELEASE

FILE #612

DATE December 7, 1976

DETECTORS FOR SW 503 SWEEP GENERATOR

A 50 Ω detector (118-0070-00) and 75 Ω detector (118-0071-00 are available as recommended accessories to the SW 503 Sweep Generator. The price of the detectors is $55.00 each.

118-0070-00 50 Ω Precision Detector for SW 503 . . . . . $55.00
118-0071-00 75 Ω Precision Detector for SW 503 Opt. 1 . . $55.00

These detectors are listed under suggested accessories on the attached updated SW 503 data sheet (A-3328-1).

Gary Mott
FDI Marketing
58/741 ext. 5667

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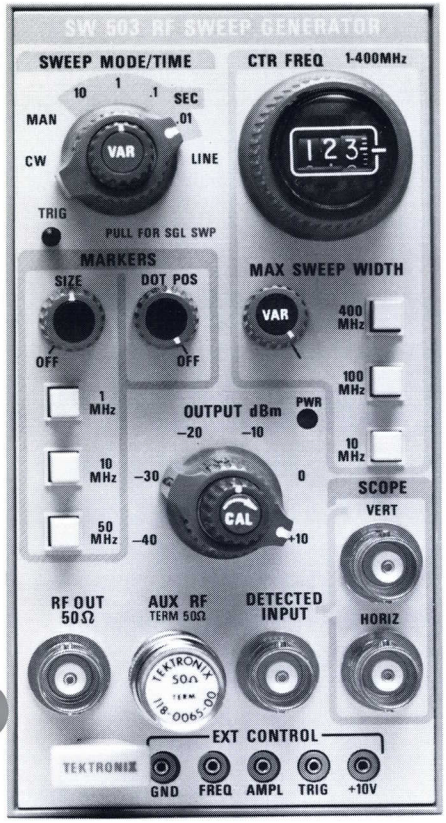
TEKTRONIX®

committed to technical excellence

RF SWEEP GENERATOR SW 503



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

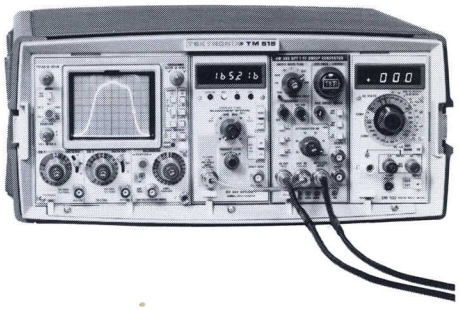
The SW 503 Sweep Generator covers a frequency range of 1 to 400 MHz. It has a variable sweep rate, step attenuator, 20 dB vernier attenuator, and a crystal controlled marker generator which provides comb type markers at 1, 10, and 50 MHz.

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.

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.



The Sweep System shown in the photograph includes SW 503 Option 1 Sweep Generator, DC 502 Option 7 Counter, SC 502 Oscilloscope, and DM 502 DMM in a TM 515 Power Module.

CHARACTERISTICS

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% @ 400 MHz position, ≤3% @ 100 MHz and 10 MHz positions.

Signal Purity — Residual fm: ≤10 KHz. Harmonic Spurious: ≥30 dB below output from 10 to 400 MHz, ≥25 dB below output from 3 to 10 MHz ≥15 dB below output from 1 to 3 MHz. Non-harmonic Spurious: ≥40 db below output.

Output — Impedance: Model SW 503 50 Ω, Model SW 503, Option 1 75 Ω. Level: 0.7 VRMS MAX, SW 503 CALIBRATED −40 to +10 dBm 50 Ω, SW 503, Option 1 CALIBRATED 0 to +50 dBmV 75 Ω. Attenuation: Step 50 dB in 10 dB steps, absolute accuracy 0.2 dB/step referred to zero attenuation, vernier ≥20 dB. Flatness: ±0.25 dB (measured at maximum output using precision detector ≤1.15 vswr).

Blanking — Retrace blanking of the rf output provided for sweep operation, removed for cw operation.

Aux Rf Output — −2 dBm min. into 50Ω.

Operating Modes — Repetitive sweep, single sweep, externally triggered sweep, line-lock sweep, manual sweep, cw.

Sweep Time — Continuously variable from 10 ms to 100 s in 4 decade steps, plus vernier.

Horizontal Output — 0.5 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 detector's 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, i.e.: 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/V. 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.

Included Accessory — 50 Ω Termination 118-0065-00.

ORDERING INFORMATION

SW 503 RF Sweep Generator (50 Ω) $1450

SW 503 Option 1 RF Sweep Generator (75 Ω)...$1450

Note: a power module is required for either sweep generator. See TM 500 catalog for power module information. Needs external detector.

SUGGESTED ACCESSORIES

TM 515 Option 7 Power Module $350

DC 502 Option 7 550 MHz Freq Counter.....$1195

DM 502 Digital Multimeter $375

SC 502 15 MHz Dual Trace Oscilloscope.....$1200

50 Ω Precision Detector for SW 503 (118-0070-00) $55

75 Ω Precision Detector for SW 503 Opt 1 (118-0071-00) $55

Specification and price change privileges reserved.

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MARKETING SALES RELEASE

#609

FILE

DATE November 16, 1976

C-32 SERIES CAMERAS DISCONTINUED

The C-32 Series cameras, originally designed to fit the 453A and 454A, has been discontinued. The C-30A opt 1 will replace the C-32 Series in most cases (at a cost savings to the customer). The C-31 Series is recommended where maximum photographic writing speed is required.

A few C-32 Series remain in inventory and will be available for a short time. See the PAL for availability.

The long term support product support program will be effective AP 706.

Pete Keller
Accessories Marketing
58-129
Ext. 7769

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MARKETING SALES RELEASE

FILE #608

DATE November 16, 1976

203 & Opts, 204 & Opts SCOPEMOBILES DISCONTINUED

The models 203 & opts and 204 & opts scopemobiles have been discontinued. The Model 3 Lab Cart is the recommended replacement for both the 203 & opts and 204 & opts. Stock is depleted for both models. Long term product support program will be effective AP 706.

Pete Keller
Accessories Marketing
58-129
Ext. 7769

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MARKETING SALES RELEASE

FILE

DATE November 11, 1976

TELEQUIPMENT S51B - DM64 - D67 BEING DISCONTINUED IN THE U.S.

Effective AP707 the TLS51B, TLDM64 and Option 01 and TLD67 and Option 01 will be discontinued from the Tektronix product line, IN THE U.S. ONLY.

All, if any, remaining inventory of these instruments is being transferred to the Reconditioned and Discontinued Instrument List (the Pink Sheet).

Replacement products for these discontinued instruments are as follows:

Instrument	Replaced By
TLDM64	T912
TLD67	T935
TLS51B	*TLS61

*TLS61 to be introduced in the U.S. Week 49

MSR will follow in the very near future.

Please contact Bill Glaze on any questions/problems this action may create.

Bill Glaze
50-442
Ext. 7163

COMPANY CONFIDENTIAL

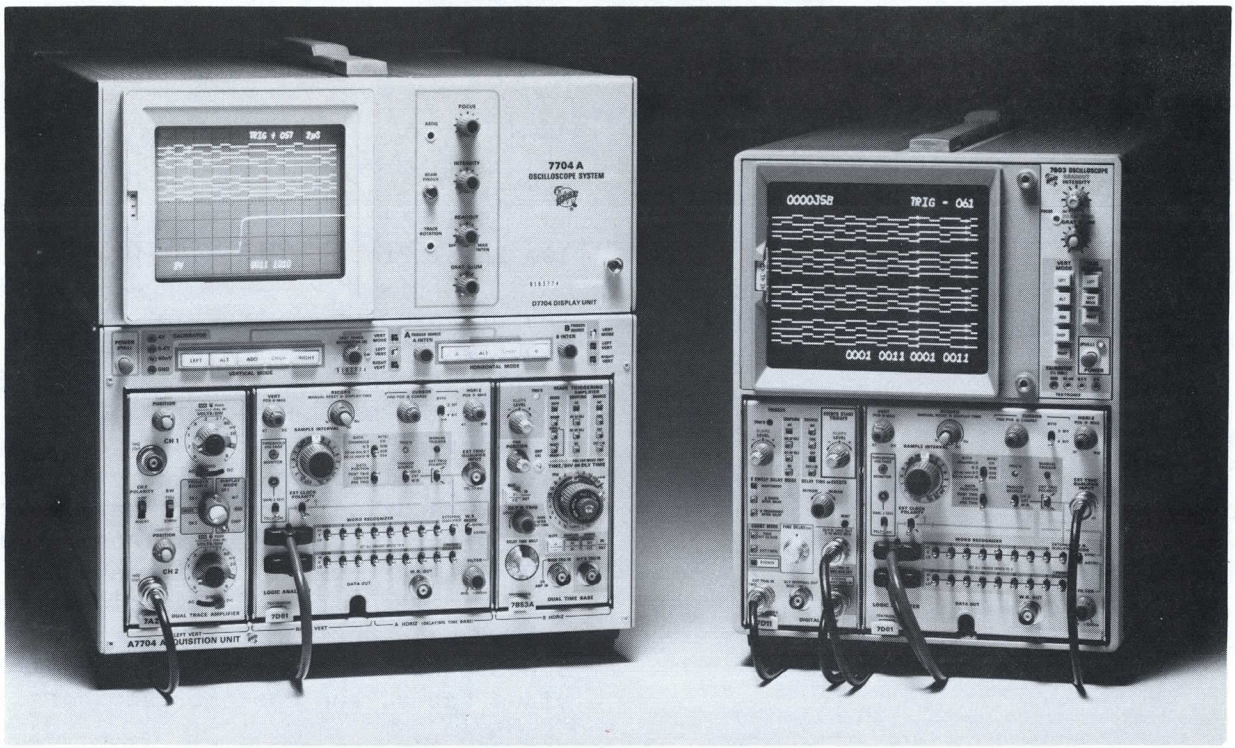
MARKETING SALES RELEASE

FILE #525

DATE April 28, 1976

7D01 LOGIC ANALYZER PLUG-IN

(Domestic Distribution Only)



Any 7000-Series Mainframe becomes a high-performance logic analyzer when the 7D01 Logic Analyzer plug-in is added.

The 7D01 provides 7000-Series with the basic capabilities offered in the LA501 Logic Analyzer--timing diagram readout; selection of 4 channel x 1024 bit, 8 channel x 516 bit, or 16 channel x 256 bit formats; pre-, center-, or post-triggering; synchronous or asynchronous sampling; and sample rate to 100 MHz (10 ns sample interval).

In addition it includes a 16 bit Word Recognizer for trigger generation, an intensified trigger position marker on the crt, an intensified display cursor for selecting a parallel word on the display, crt readout of the number of sample intervals between trigger and cursor, and crt readout (1's and 0's) of the parallel word selected by the cursor.

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Domestic Announcement	5/11/76 (Electro)
International Announcement	AP 706
Initial PAL quote	10 weeks
Demo Availability	25 demos (probably B phase non-salable) will be available initially. Shipping schedule to field managers by week 17.

U.S. Prices

7D01	$3195
7D01 Option 49 (Delete one P6451 probe)	Sub.$300
P6451 Probe (010-6451-01)	$ 375

Included accessories for 7D01	Two P6451 Probes (010-6451-01)
Advertising Support	Feature product coverage of the LA501/WR501 and 7D01 Logic Analyzers is planned for the April 29 issue of Electronics magazine. A brochure covering all Tektronix Logic Analyzers (A-3341) will be available by announcement. Magazine and direct mail advertising for Tektronix Logic Analyzers (7D01, LA501, WR501) will start in May. At least four application notes are planned during FY 700. Further support will include tutorial booklets, video tapes, and customer seminars.
Sales Guide	Available by week 702.

Beaverton Responsibilities

Advertising	Bob Down
Marketing	Dave McCullough
Service Support	Vern Johnson

MARKETING SALES RELEASE

FILE #524

DATE April 23, 1976

(Domestic Distribution Only)

7D10

General Product Description

The 7D10 is a delay-by-events plug-in for the 7000 Series. This 7½ digit events delay unit is usable with signals up to at least 50 MHz. The basic instrument is identical to the 7D11 except that it does not have delay-by-time and it costs much less.

Intended Markets

This product was initiated to quickly address the digital market with a competitively priced instrument. The 7D10 will provide a very convenient and easy to use delay system when used with a storage or nonstorage mainframe. Because of the lower price, we are looking for a better penetration into the more price sensitive areas; i.e., 7603 users. Approximately, 30% of these 7603 users are working with digital logic, therefore, the 7D10 delay unit should be an asset to them since it can identify transient and logic fault locations.

Another major market is the customer using our 7D01 logic analyzer, where the user is involved with I/O design or large complex system work. These users, when using the 7D10, can delay their entire logic analyzer so that the analyzer can effectively cover more data. A delay up to 10^7 bits can be obtained. We could also use the 7D10 to delay the analyzer by words. This will provide a way to combat the competitor's logic analyzers that have digital delay.

Public Announcement

May 11, 1976 (ELECTRO) in the U.S. only.

Customer Availability

Week 29

Demo Availability

No 7D10 demos should be required. Suggest that you use the 7D11 for demonstrating the 7D10's capability.

Advertising

A low profile advertising campaign will occur. Besides having it shown at ELECTRO and WESCON, we plan to have it appear during June in the first 7D01 product ad.

COMPANY CONFIDENTIAL

Literature

A combined 7D10/7D11 data sheet (AX-3343) will be available at announcement. This data sheet will also be in the 7D01 brochure (A-3341).

U.S. Price

7D10 . . . . . $925. F.O.B. Beaverton, OR

Mike Kondrat
7000 Series Marketing
Ext. 7489

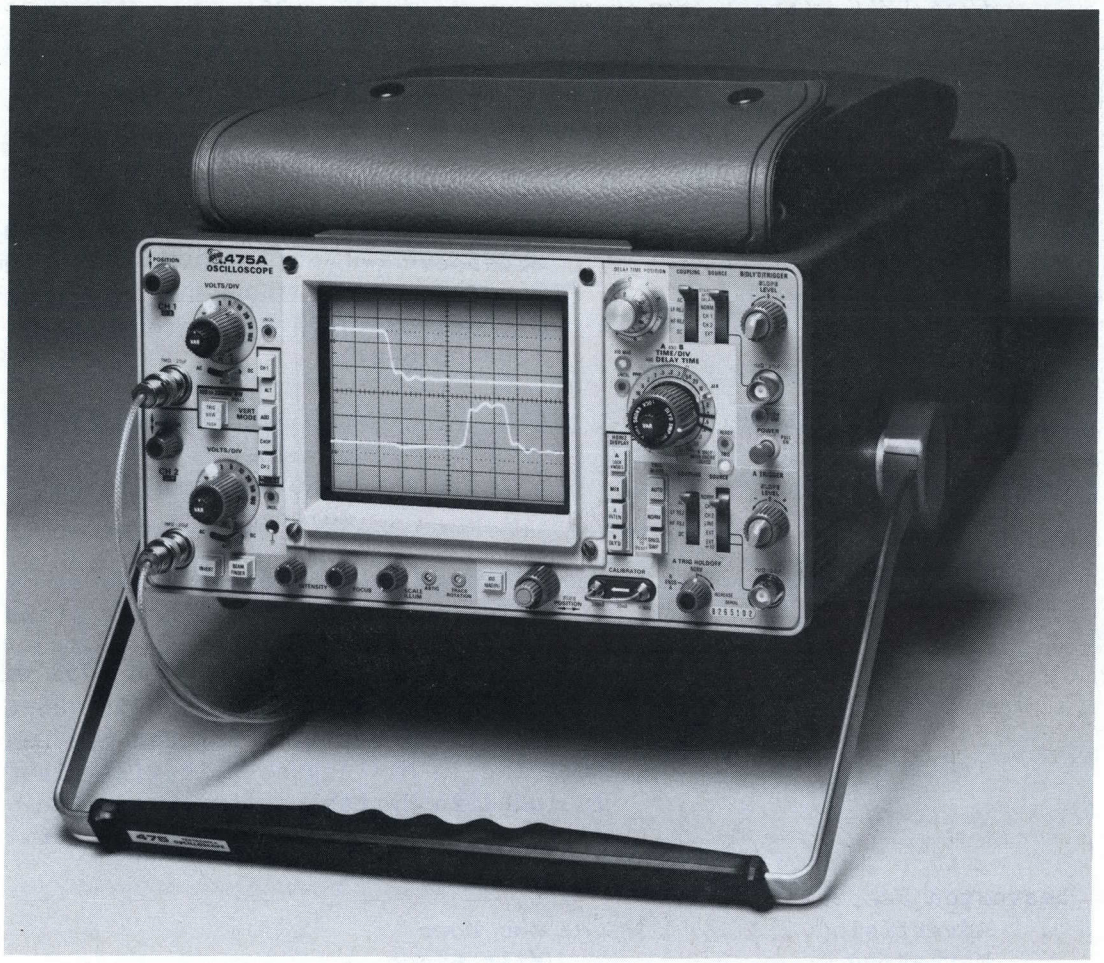
MARKETING SALES RELEASE

#548

FILE

DATE July 16, 1976

475A Portable Oscilloscope



The 475A is an improved performance version of the 475 Portable Oscilloscope. It provides 250 MHz at 5 mV/div and a reduced spot size.

It is intended to be marketed in a performance dollar gap that is currently being exploited by the HP1720A. The 250MHz 475A, priced at $3300, and the 200MHz 475, priced at $3000, will be extremely competitive with the 200MHz HP1710B at $2900 and the 275 MHz HP1720A at $3750. With the DM44, the 475A will have a considerable price performance advantage over the HP1722A. The 475A DM44 will have essentially the same features as the HP1722A and will cost $3710 versus $4900 for the HP1722A.

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Announcement (Domestic & International) 8/16/76

U.S. Prices

475	$3000
475A	$3300
R475A	**$3425**
475A DM44 (Order 475A Option 44)	$3710
475A DM44 without temperature probe (order 475A option 45)	$3625
Option 04-Emc Environmental	Add $ 125
Option 07-External dc operation (not available on 475A DM44)	Add $ 125
Option 78-P11 Phosphor	No charge

Included Accessories . . . . . Two 6 ft P6075 Probes (010-6075-13), accessory pouch (016-0535-02), blue crt filter (337-1674-00), clear crt filter (337-1674-01), ground post (134-0016-01)

Customer Availability . . . . . 4 weeks from receipt of order

Demo availability. . . . . 60 U.S. demos to be shipped week 33.

Advertising Support . . . . News Release on 475A distributed to domestic and international trade press. 2 page, 4 color data sheet (AX-3389) available before announcement. The 475A will be covered (together with 465, 475, 466 & 464), in ads and direct mail for the new DM44 starting in mid August. It will also be included in Portables family ads and direct mail planned to start in 9/76.

Beaverton Responsibilities

Advertising	Bob Down
Marketing	Milt Ringe
Service Support	Don Wilson

475A Portable Oscilloscope

SPECIFICATIONS

VERTICAL DEFLECTION
(2 identical channels)

Bandwidth* and risetime (at all deflection factors from 50Ω terminated source)--

-15°C to +40°C	+40°C to +55°C
Dc to 250 MHz, 1.4 ns	Dc to 250 MHz, 1.4 ns

*Measured at -3dB down. Bandwidth may be limited to 20 MHz or 100 MHz by bandwidth limit switch.

Lower-3 dB point	(ac coupling from 50Ω 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%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Display Modes-Channel 1; Channel 2 (normal and inverted); Alternate; Chopped (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-CH 2 vertical signal is dc to at least 50 MHz (-3 dB), and approx 20 mV/div terminated into 1 MΩ.

Delay Line-Permits viewing leading edge of displayed waveform.

Probe Power-Connectors provide correct voltages for two optional P6201 FET Probes.

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-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
Unmagnified	±1%	±2%
Magnified	±2%	±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. Cumulative accuracy within 3%.

CALIBRATED SWEEP DELAY

Delay Time Range-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-

	Trigger Mode	To 40 MHz	At 250 MHz
Dc	Internal	0.3 cm deflection	2.0 cm deflection
	External	50mV	250mV
	External ÷ 10	500mV	2.5V
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	

Jitter-0.2 ns or less at 250 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 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 ± 20V 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

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)- 5 mV/div to 10 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 rectangular tube; 8 x 10 cm display area. Horizontal and vertical centerlines further marked in 0.2 cm increments. P31 phosphor normally supplied; P11 optional without extra charge. 18 kV accelerating potential.

Z Axis Input-Dc coupled to crt cathode; noticeable modulation at normal intensity 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: $-15^{\circ}C$ to $+55^{\circ}C$. Nonoperating: $-55^{\circ}C$ to $+75^{\circ}C$. Filtered forced air ventilation is provided.

Altitude-Operating: to 15,000 ft; max allowable ambient temperature decreased by $1^{\circ}C$/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 04 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	0.3V	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. 100 watts (475) max at 115 V and 60 Hz. Operation from 12 or 24 V dc is available with Option 07

Dimensions	Cabinet in	Cabinet cm	Rackmount in	Rackmount cm
Height	6.2	15.7	7.0	17.7
Width (with Handle)	12.9	32.8	19.0	48.3
Depth (with Panel Cover)	18.1	46.0	18.0	45.7
Depth (Handle Extended)	20.3	51.6		
Weights (Approx)	**lb**	**kg**	**lb**	**kg**
Net (without Panel Cover)	22.8	10.3	29.4	13.3
Net (with Panel Cover and Accessories)	25.3	11.5		
Shipping	37.0	16.7	58.0	26.3

Included Accessories=Two 6 ft P6075A Probes with accessories (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 04-Includes the features of the 475A, in addition meets electromagnetic compatibility requirements of MIL-Std-461A.

External Dc Operation, Option 07-In addition to the standard ac line operation, Option 07 permits the 475A to be powered from 12 V dc or a 24 V dc source. For battery operation, Option 07 makes these scopes compatible with the 1106 Battery pack.

ORDERING INFORMATION

475A Oscilloscope . . . . . $ 3300

INSTRUMENT OPTIONS

Option 04 Emc Environmental . . . . . Add $125
Option 07 Ext Dc Operation . . . . . Add $125
Option 44 ΔTime and DMM . . . . . Add $410
Option 45 ΔTime and DMM, but without temperature probe . . . . . Add $325
Option 78 P11 Phosphor . . . . . .No charge
Note: Option 07 cannot be ordered with DM44.

OPTIONAL ACCESSORIES

Probes-The probes provided as standard accessories to the 475A 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*
P6063A	1X Switchable 10X	1 MΩ- 105 pF 10 MΩ- 14 pF	6 MHz 145 MHz
P6202 FET Probe 2 Meter	10X	10MΩ- 2 pF	185 MHz
	100X Head	10MΩ- 2 pF	185 MHz
	AC Head	10 MΩ- 4 pF	185 MHz

Current Probe	Calibration	Insertion	Bandwidth*
P6022	1mA/mV 10 mA/mV (Selectable)	.03Ω @ 1 MHz Increasing to 0.2Ω @ 120 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 01 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 01

Camera Adapter and Corrector Lens-Adapts C-30A to 475A, Order 016-0301-00.

Protective Cover-Waterproof, blue vinyl, Order 016-0554-00.

Folding Polarized Viewing Hood, Order 016-0180-00.

Mesh Filter-Improves contrast and emc filtering, Order 378-0726-01.

SCOPE-MOBILE Cart-Occupies less than 18 in aisle space, has storage area in base, Order 200C.

1106 Battery Pack (for use with Option 07)

1105 Battery Power Supply

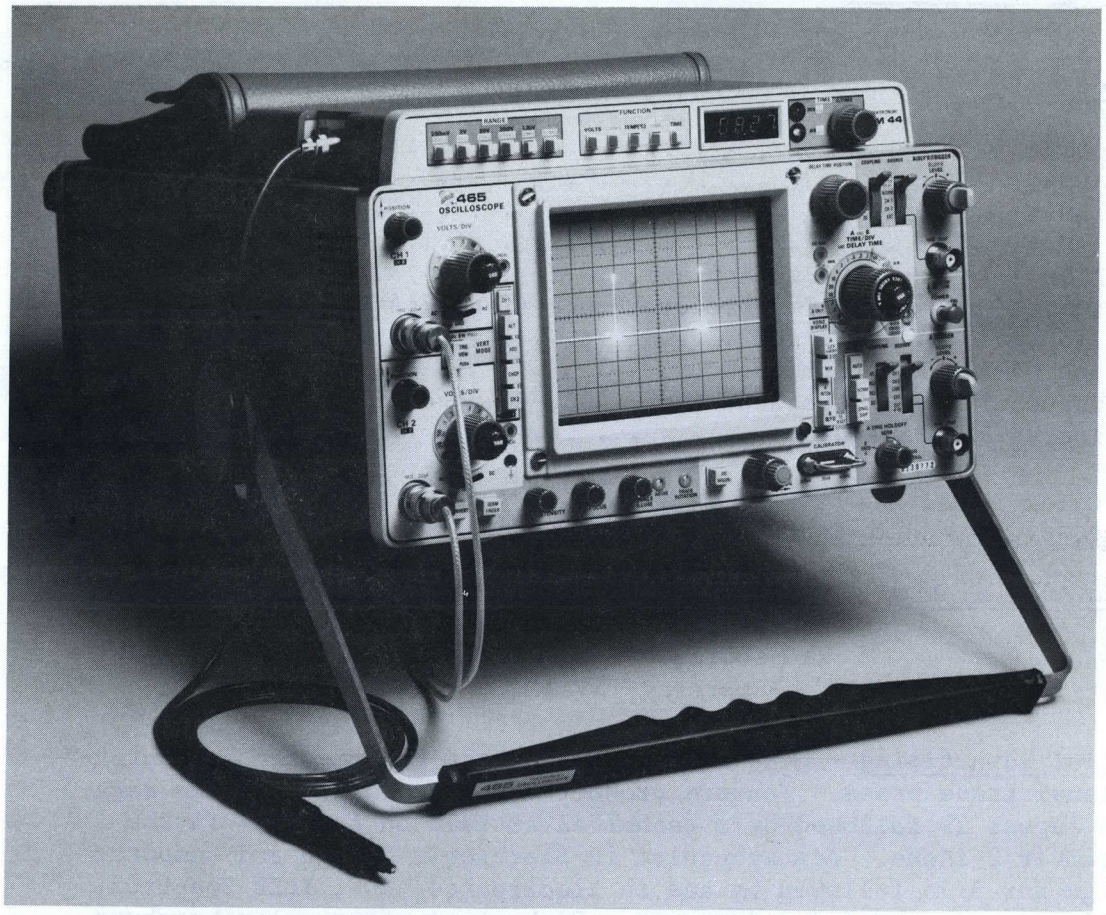
#549

MARKETING SALES RELEASE

FILE

DATE July 16, 1976

DM44 TIME INTERVAL READOUT AND MULTIMETER



The optional DM44 adds Delta Delayed Sweep, direct numerical readout of time intervals, and a DMM (dc voltage, ohms, and temperature) to the 464, 465, 466, 475, and 475A* Portable Oscilloscopes. It replaces the DM40 and DM43 with a single improved unit (Delta Delayed Sweep and 1/Time added).

All DM44's have temperature measurement circuitry built in. The P6430 temperature probe is included in the standard package. As an option, the probe can be omitted for a lower price.

The DM44 differentiates TEKTRONIX Portables from the competition on the basis of performance. It gives us the only 100 MHz, 200 MHz, and storage portables with Delta Delayed Sweep and direct readout of time intervals. Value compared with HP is excellent. The 475A DM44 is more than a match for the HP 1722A and underprices it by $ 1190 .

*475A (250 MHz 5mV/div) being announced simultaneously with DM44.

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Public Announcement . . . . . August 16, 1976

Price

464 DM44	$4260
465 DM44	$2555
466 DM44	$5010
475 DM44	$3410
475A DM44 (order 475A option 44)	$3710
Option 01-Omit P6430 Temperature Probe (for 475A DM44 order option 45)	Subtract $ 85
Option 04-Emc Environmental	Add$ 125
Option 05-TV Sync Separator (465, 466, & 464 only)	Add$ 185
Option 78-P11 Phosphor	No charge

Customer Availability - 4 weeks from receipt of order

Demo Availability - 160 U.S. demos to be shipped wk 33
160 international demos to be shipped wk 33
210 sourced from U S, 55 sourced from Guernsey, 55 sourced from Herenveen.

Initial Advertising - News release to be sent to domestic and international trade press. Feature product coverage in Electronics magazine August 19 followed by a technical article on the DM44 in the September 2 issue. Ads scheduled in Electronic Design and Computer Design for 9/76 followed by ads in Electronics, EDN, IEEE Spectrum, EE Times, and Industrial Research. Eight-page, four-color brochure (A-3373) available before announcement. Direct mail (starting 8/76) via TIDS (Technical Information Distribution Service), Mailman, Electronic Design, IEEE Spectrum and Electronics.

Beaverton Responsibilities

Marketing	Milt Ringe	X5824
Advertising	Bob Down	X6974
Service Support	Sherm Feetham	X5764

DM44 Specifications

Timing Measurements

Differential Time Delay Accuracy-

+15°C to +35°C	-15°C to +55°C	
used with 464, 465, 466, 475, and 475A	used with 464, 465, and 466	used with 475 and 475A
within 1% of reading ± 1 count	within 2.5% of reading ± 1 count	within 1.5% of reading ± 1 count

1/Time Accuracy -

+15°C to +35°C	-15°C to +55°C	
used with 464, 465, 466, 475, and 475A	used with 464, 465, and 466	used with 475 and 475A
within 2% of reading ± 1 count	within 3.5% of reading ± 1 count	within 2.5% of reading ± 1 count

Common Mode Accuracy-

As the delayed time position is moved, the displayed time change is accurate within 1 count for 1 div or more separation between the intensified spots (2 sec range over full screen).

Dc Voltage

Ranges- 0-200mV, 0-2V, 0-20V, 0-200V, 0-1.2KV

Resolution- 100 μV

Accuracy- Within 0.1% of reading ± 1 count

Input Resistance - 10 MΩ for all ranges. Removal of an internal strap increases resistance to approximately 1000 MΩ on 200 mV and 2V ranges.

Normal Mode Rejection Ratio- At least 60 dB at 50 Hz and 60 Hz

Common Mode Rejection Ratio- At least 100 dB at dc, 80 dB at 50 Hz and 60 Hz

Recycle Rate- Approximately 3.3 measurements/second

Response Time- Within 0.5 second

Temperature Dependence - Within 45 ppm/^{o}C

Maximum Safe Input Voltage- ± 1200 V(dc + peak ac) between + and common inputs or between + and chassis. ± 500 V(dc + peak ac) common floating voltage between common and chassis.

Resistance

Ranges- 0-200 Ω, 0-2k Ω, 0-20k Ω, 0-200k Ω, 0-2 M Ω, and 0-20 M Ω

Resolution- 0.1 Ω

Accuracy-

Range	Accuracy
200 Ω	within 0.25% ± 1 count + probe resistance
2k Ω, 20k Ω, 200k Ω, 2 MΩ	within 0.25% ± 1 count
20 M Ω	within 0.3% ± 1 count

Recycle Rate- Approximately 3.3 measurements/second

Response Time-

200 Ω through 200k Ω ranges	within 1 sec.
2 M Ω and 20 M Ω ranges	within 5 sec.

Maximum Safe Input Voltage- 120 V rms between + and common inputs

Temperature Using P6430 Probe

Range - -55°C to +150°C

Accuracy -

DM44 Temp	P6430 Tip Temp	Accuracy	
		probe calibrated to DM44	probe not calibrated to DM44
+15°C to +35°C	-55°C to +150°C	± 2°C	± 6°C
	-55°C to +125°C	± 3°C	± 8°C
-15°C to +55°C	+125°C to +150°C	± 4°C	± 8°C

MARKETING SALES RELEASE

FILE: PRB 200C Scope-Mobile

DATE: May 9, 1975

200C Scope-Mobile

The 200C Scope-Mobile Cart, which will eventually replace the 200 Cart, accepts the same instruments as the 200 Scope-Mobile and because the tray is wider, it also accepts the new 455 Oscilloscope.

When the 200 Scope-Mobile supply is depleted, the 200C will be automatically shipped for a 200 order. And the 200 Scope-Mobile will be dropped.

When ordering a 200 Scope-Mobile, specify the 200C for the 455.

Price

200C Scope-Mobile. $130

Beaverton Contacts:

Marketing. . . . . Denton Bramwell

Advertising. . . . Bob Payne

455 – (CART 200C)

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MARKETING
SALES RELEASE

FILE

DATE

2000 Scope-Mobile

The 2000 Scope-Mobile Cart, which will eventually replace the 200 Cart, accepts the same instruments as the 200 Scope-Mobile and because the tray is wider, it also accepts the new 455 Oscilloscope.

When the 200 Scope-Mobile supply is depleted, the 2000 will be automatically shipped for a 200 order. And the 200 Scope-Mobile will be dropped.

When ordering a 200 Scope-Mobile, specify the 2000 for the 455.

Price

2000 Scope-Mobile. $130

Reverton Contacts:

Marketing. . . . Denton Pramwell

Advertising. . . Bob Payne

Cart
2 per C

455

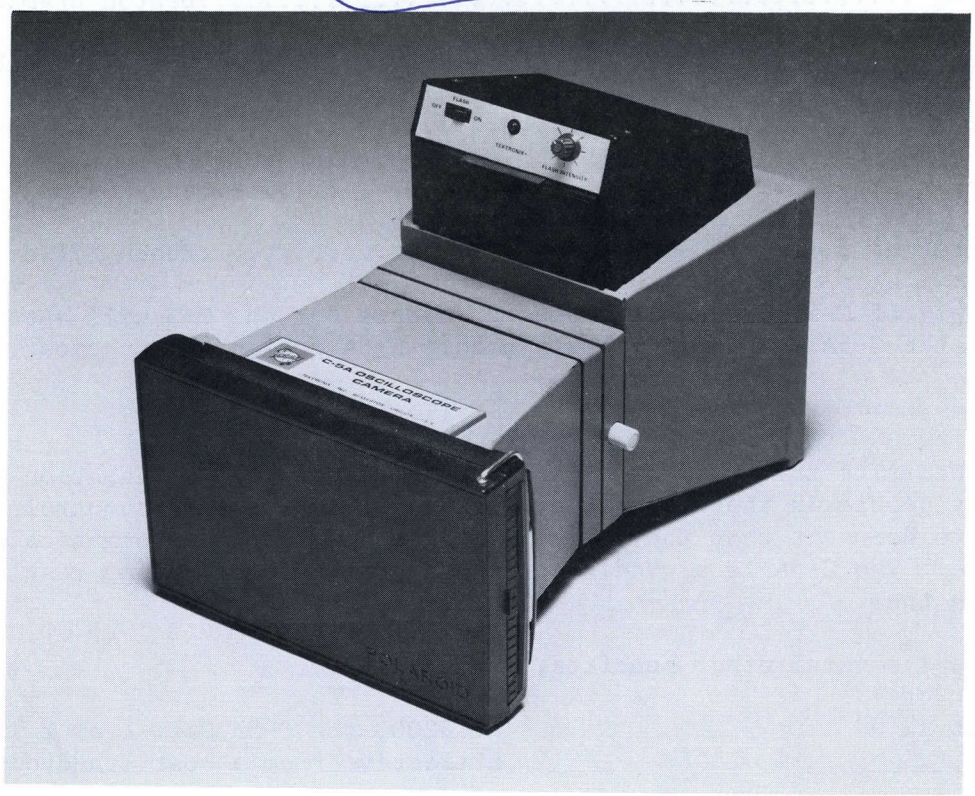
#467

MARKETING SALES RELEASE

FILE

DATE Nov. 19, 1975

C-5A Camera



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

The f16 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.

Public Announcement .....Week 1

Prices Standard model fits 7000, 5000, 600 Series with flash	$235
Option 1 fits 7000, 5000, 600 Series without flash	$200
Option 2 fits 465 size bezel without flash	$200
Option 3 fits T900 with flash	$235

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Demo Availability .....Week 49

Customer Availability .....Week 2

Beaverton Responsibilities:

Marketing .....Denton Bramwell

Service .....Sherwin Feetham

Advertising .....Lew Loebe/Abe Taghioff

Engineering .....Andy Burns

Manufacturing .....Ruben Miller

When the supply of C-5 Cameras is depleted, orders for the C-5 will automatically be converted to the C-5A. This will begin before C-5A public announcement.

Benefits:

Two general benefits that you can offer with the C-5A are documentation and communication. Many people in the field of production, R + D, quality control and medicine have a need to document what they measure. They also need to communicate the results of their work. The C-5A is a good tool for accurately documenting results and clearly communicating them.

The C-5A offers several other benefits, including:

Low Cost	At $200, the C-5A Opt. 1 or 2 is very attractive from a cost standpoint.
Versatility	The changeable 0.67/0.85 magnification and various options to fit 7000/5000/600/T900 and some 400 Series instruments make the C-5A one of our most versatile cameras.
Reliability	The improved Xenon graticule illumination system is more reliable than the "blink light" system used in the C-5.

Competition:

Comparison with the Polaroid CR-9

The Polaroid CR-9 is the only competing camera that might have a noticeable impact on the C-5A. The following chart shows our products' strengths and weaknesses compared to the CR-9.

Feature	C-5A	CR-9	Which Has The Advantage
Lens Aperture	f/16 fixed	f/5.6 variable	CR-9
Lens Magnification	0.67 or 0.85	0.85 mag only	C-5A
Shutter	1/5 - 1/30 s	1/30 - 1/125 s	C-5A
Scope Fit	7000/5000/600 Series; T-900 and some 400	Older Scopes only	C-5A
Graticule Flash	yes	no	C-5A
Price	$235 w/flash $200 w/o flash	$179.95	CR-9

Recommendations:

There are a number of oscilloscopes that are "natural" to demo the C-5A with. For example:

1. 5100 and T-900 Series are very cost compatible with the C-5A.

2. 7613, 7633 and 5441 oscilloscopes have their own built-in method of capturing fast events. The C-5A adds the ability to permanently document the displays they capture.

3. 455, 465, 475 etc. have not had a lightweight camera available before the C-5A. Someone concerned with oscilloscope weight would be attracted to the C-5A.

Taking the C-5A along on a camera demo gives two advantages:

1. It allows you to generate a reminder of the oscilloscope sales call.

2. It draws attention to the C-5A as part of the total measurement/recording system.

With its low cost and general usefulness, the C-5A should produce extra revenue on a good percentage of sales calls.

Specifications:

LENS Fixed focus, fixed aperture f16, 0.67 or 0.85 (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.

WEIGHTS AND DIMENSIONS

	in	cm
Height	5.5	14
Width	6.6	16.8
Length	10.1	25.7
	lb	kg
Weights (approx)	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

OPT. 1

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. Order C-5A Opt. 1.....$200

OPT. 2

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. Order C-5A Opt. 2.....$200

OPT. 3

Opt. 3 has graticule illumination and is molded to fit T-900-Series Oscilloscopes. Recommended for all T-900-Series Oscilloscopes. Order C-5A Opt. 3.....$235

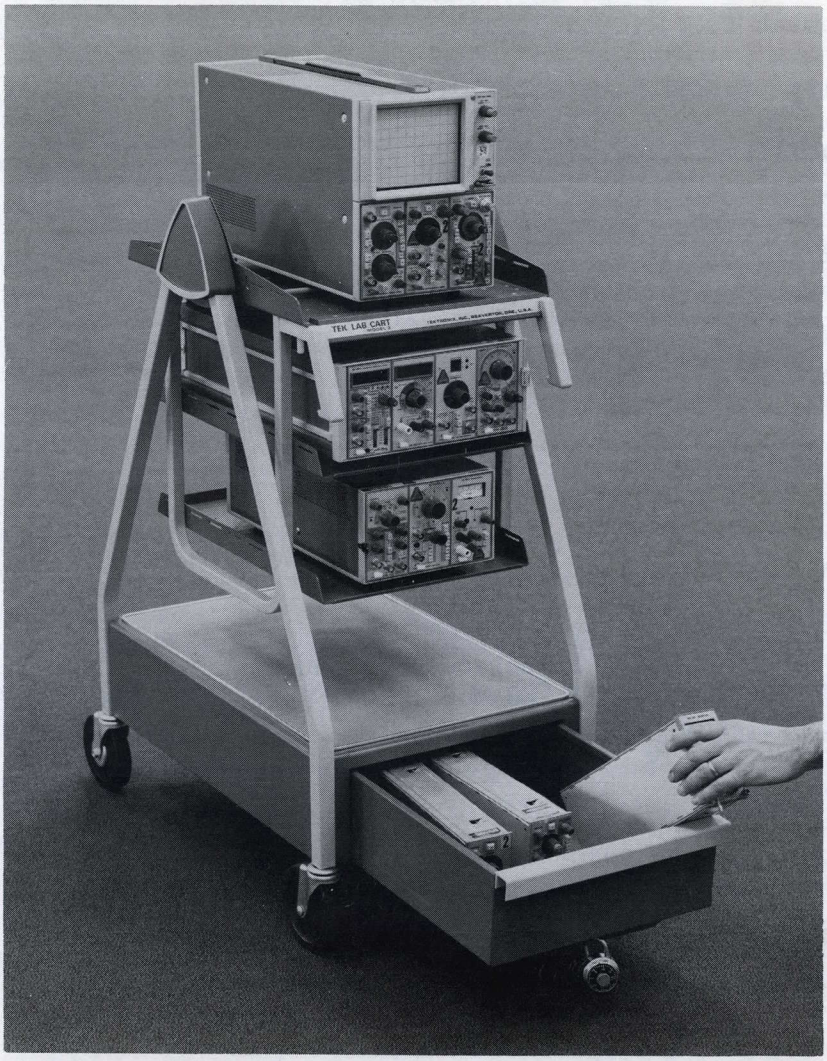
#483

MARKETING SALES RELEASE

FILE

DATE Jan. 9, 1976

TEK LAB CART MODEL 3



The Tek Lab Cart Model 3 introduces a new line of versatile, general purpose oscilloscope carts. Its tilting top tray with removable scope lock-down bar accomodates all three and four plug-in mainframes of 5100, 5400 and 7000 Series Oscilloscopes. It can also accomodate TM 503 or TM 504 mainframes, portable scopes, 576, and 577 curve tracer instruments. A framework on the underside of the top tray accepts one

COMPANY CONFIDENTIAL

or more shelves (one of which is standard) at any one of ten positions. This permits the use of various configurations of instruments such as the TM 500 Series. A safety belt is provided to secure instruments to the top tray, shelves or base platform.

The cart has a blue vinyl finish. It contains a large drawer in its base with provision for a padlock. This drawer can hold up to 4 single width plug-ins and miscellaneous accessories. There is an ac plug strip with four sockets, circuit breaker, and 15 foot attached power cord. Front casters are provided with brakes.

Public Announcement ..... AP 611

Demo Availability ..... AP 612

Customer Availability ..... AP 612

Beaverton Responsibilities

Marketing ..... Denton Bramwell

Service ..... Sherwin Feetham

Advertising ..... Lew Loebe/Abe Taghioff

Engineering ..... Gale Morris

Manufacturing ..... Don Verley

In AP 612, the Lab Cart Model 3 replaces 5 products: Model 203; Model 203, Option 1; Model 204; Model 204, Option 1; and Model 204, Option 2. Long term support program will begin in AP 612 for replaced products.

Specifications

Top Tilting Tray -- can be adjusted from 9° below horizontal to 27° above horizontal in 4¼° increments. It has a load limit of 40 lb.

Power Strip -- has four ac outlets, circuit breaker and 15 foot power cord. Current rating is 15 A at 125 V ac.

Cart Load Limit -- 125 lb

Weights

Net	57 lb	25.8 kg
Shipping	75 lb	34 kg

Ordering Information

Order Lab Cart Model 3 . . . . . $285

/International Version/ Option 1 deletes the ac Power Strip for shipment outside USA.

Option 1 . . . . . NC

Standard Accessories

Adjustable shelf with four mounting screws, 436-0132-01

Safety Belt, 346-0136-01

Optional Accessories

Adjustable shelf with four mounting screws,

Order 436-0132-01 . . . . . $25

Safety Belt, Order 346-0136-01 . . . . . $15