

TEKTRONIX PRODUCTS 1973



USING THIS PUBLICATION

NEW PRODUCT SUMMARY

New Products Summary Section beginning on page 2 gives you a quick look at the latest features and characteristics of each new TEKTRONIX product.

PRODUCT REFERENCE INFORMATION

Product Reference Section describes the subjects of oscilloscope characteristics such as Common-Mode Rejection, Writing Rate and Differential Input in terms of measurement capability. This section also includes CRT Phosphor Data.

INDEXES

TEKTRONIX products are indexed alphanumerically by type numbers and by functional use on the last 5 pages of this publication. For those not familiar with the identifying alphanumeric symbol for each instrument, the products are grouped according to common family characteristics on the CONTENTS page. Each product division has reference information to allow comparison of performance of a group of instruments.

General-purpose oscilloscopes and special-purpose test instruments are completely described in this publication. Telequipment Products, Television Products, Automated Test Systems, Computer Display Terminals and Machine Control Products are summarized. Complete information on these products can be obtained by filling out the Information Request Card located at the rear of this book.

PURCHASING, SERVICE and GENERAL INFORMATION

Ordering Information—This section contains information on what to contact and how to place your order as well as shipment anwarranty details. (Reference pages 314, 315 and 316).

Field Office Assistance—TEKTRONIX maintains 78 domestic and international field offices as well as 56 distributors and representatives throughout the world. These offices are staffed with qualified personnel who specialize in solving measurement problems. They provide a communication link between you and the factory and are the people to contact for assistance. Call or visit your nearest field office for details on applications, maintenance, instrument selection or instrument orders. You'll find these offices listed on pages 315 through 318.

Instrument Dimensions—Charts of dimensions of rackmounted instruments and shipping volume of all instruments are listed on pages 320 and 321.

Electrical and Mechanical Considerations—Information about ventilation, power requirements and construction is found on page 323.

Publications Available—Page 323 contains a list of technical publications available through your Tektronix Field Engineer, Representative and Distributor.

Symbols and Abbreviations—A table of symbols and abbreviations as used in this catalog is presented on page 322.

Economic Stabilization Act—TEKTRONIX prices are controlled by the Price Commission as a prenotification firm. Information regarding the lawful base price or other queries concerning our prices can be directed to Tektronix, Inc. The information regarding this Act only applies to instruments manufactured an sold in the United States.

Tektronix, Inc.
An Oregon Corporation

MAILING ADDRESS:

P.O. BOX 500, BEAVERTON, OREGON 97005

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

Telephone: (503) 644-0161

Telex: 36-0485

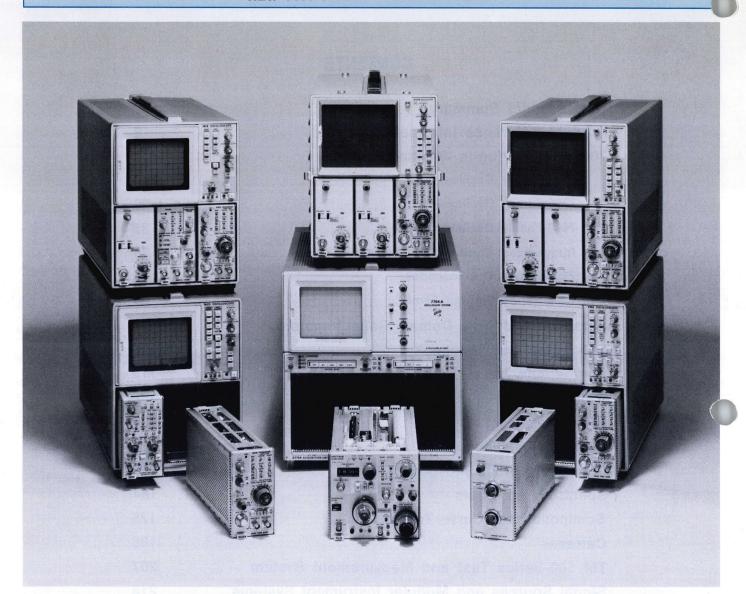
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NEW 7000-SERIES OSCILLOSCOPES



We've expanded the 7000-Series Oscilloscope product line. There are 10 new mainframes and 14 new plug-ins. The 7000 Series provides you with a broader instrument selection and more measurement solutions than any other oscilloscope series.

New 7000-Series Storage Family (7623, 7613, and 7313)—These storage oscilloscopes and their $5\frac{1}{4}$ -inch rackmount versions bring three types of storage, bistable phosphor, variable persistence and fast bistable. A breakthrough in fast storage is offered with the 7623 Option 12 providing $200 \text{ cm}/\mu\text{s}$ stored writing speed and a long viewing time (until erased).

See Pages 41 to 49 for complete descriptions.

7600 Family (7603 and R7603)—These three-plug-in oscilloscopes (the R7603 is a 5¼-inch rackmount) provide 100-MHz performance and, with CRT READOUT Option, low price.

See pages 32 to 34 for complete description.

7603N Option 11S (50-MHz Ruggedized Oscilloscope System)— This system meets the rigid environmental and electrical specifications required by the military. The complete system is qualified under MIL-O-24311 (EC) and appears on U.S. Navy QPL-24311.

See pages 35 to 37 for complete description.

7704A (7700 Family)—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.

See pages 29 to 31 for complete description.

7000-Series Plug-Ins—New single-trace amplifiers, time-based digital counter/timer, digital delay unit, direct access unit, as spectrum analyzer plug-in provide more flexibility to the growing 7000 Series.

See pages 50 to 72 for complete descriptions.



NEW PORTABLE TDR SYSTEM



The 1501 Time Domain Reflectometer (TDR) is a portable, battery-operated system, used to detect and locate faults and to measure impedance variations in transmission cables out to 10,000 feet through the use of test pulses. Resultant reflections from any discon-

tinuities indicate the seriousness and character of the faults.

The chart recorder in the 1501 can also be driven by the 1401A or 1401A-1 Spectrum Analyzer.

See pages 89 and 90 for complete description.

NEW LOW FREQUENCY PLUG-IN



5A19N Amplifier—The 5A19N is a low-cost differential amplifier for the 5103N Oscilloscope System. Featuring low cost and simplicity of controls, it is ideal for monitor and systems applications.

See page 124 for complete description.

NEW PORTABLE OSCILLOSCOPES



485 Oscilloscope—The 485 is a 350-MHz, 1-ns/div, 20.5-lb portable dual-trace oscilloscope. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, trigger holdoff, external trigger display, alternate delayed sweep with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control.

The 485 can be operated from either a free-standing battery pack or one which attaches directly to the oscilloscope. Accurate measurements can now be made in difficult environments or remote locations.

See pages 139 to 142 for complete description.

NEW PORTABLE OSCILLOSCOPES



475 and 465 Oscilloscopes—The exceptionally low cost of the 465 with 100 MHz at 5 mV/div and the 475 with 200 MHz at 2 mV/div represents a price/performance breakthrough for portables and insures top value for the future.

A big 8 x 10-cm CRT display, new versatile trigger selection, trigger view, and automatic volts/div readout are just a few of the many features designed into the lightweight 465 and 475 portable oscilloscopes.

The 475 and 465 can be operated from either a free-standing battery pack or one which attaches directly to the oscilloscope. This means accurate measurements can be made at remote locations or in difficult environments.

See pages 143 to 146 for complete descriptions.



326 Oscilloscope—The 326 is the latest addition to the SONY®/TEKTRONIX® series of portable oscilloscopes. Using the proven design of its single-trace predecessors, the new 326 combines portability and dual-trace convenience in a small, rugged battery-operated package. Measuring only 4.0

x 8.7 x 15 inches, and weighing less than 13 pounds, the 326 offers bandwidth to 10 MHz at 10 mV/div or 5 MHz at 1 mV/div. Sweep rates extend from 1 s/div to 1 μ s/div (0.1 μ s/div with X10 magnifier). Triggering is accomplished with a single control.

See pages 154 and 155 for complete description.



211 Oscilloscope — The 211 weighs only three pounds, measures only 3 x 5.3 x 9 inches. Yet it is a complete measurement tool for field maintenance and other applications where space and portability are primary considerations. The 211 is the first quality miniscope to offer 500

kHz at a low price with unmatched portability and carrying convenience.

In many industrial applications, it's frequently necessary to "float" an oscilloscope. The 211 may be elevated to 700 V (DC + peak AC) above ground when operated from batteries, and 250 V RMS when operated from AC.

See pages 160 and 161 for complete description.



NEW TELEQUIPMENT PRODUCTS



D83 Oscilloscope — 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. Sweep rates extend from 2 s/div to 100 ns/div (to 10 ns/div with X10 magnifier).



D66 Oscilloscope — 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 s/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.



DM64 Storage Oscilloscope—

The DM64 is the world's least expensive bistable storage oscilloscope. 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. Bandwidth is 10 MHz at 10 mV/cm and using the X10 gain will extend the deflection factor to 1 mV/cm. Sweep rates extend from 2 s/div to 100 ns/div.

Summary information on these products will be found on page 162. Complete information will be found in the TELEQUIP-MENT PRODUCTS CATALOG.

NEW SPECTRUM ANALYZER SYSTEM



1401A (50 Ω)/1401A-1 (75 Ω) 1 MHz to 500 MHz Spectrum Analyzer Modules—Spectrum analysis in the 1-MHz to 500-MHz frequency range is easily performed anywhere with the 1401A or 1401A-1 when combined with the SONY/TEKTRONIX 323 or 324. Amplitude

and frequency calibration with intermodulation distortion of less than 60 dB full screen is featured. AC line, 6 to 16 VDC, or internal rechargeable batteries can be used for power.

See pages 167 and 168 for complete description.

NEW ELECTRO-OPTIC PRODUCTS



The TEKTRONIX J16 is a portable digital photometer/radiometer designed for use in the laboratory, or in the field. Illuminance, irradiance, and luminance measurements can be accurately made by selecting the appropriate probe. A choice of five probes is available. Each uses a silicon photodiode which has excellent long-term stability and reliability. Easy-to-read 2½-digit LED readout reduces measurement error, particularly in low ambient light conditions.

At least two hours of continuous operation are provided by the internal rechargeable batteries. A shoulder strap is provided for carrying ease. The bottom of the case and probe have a standard threaded socket (1/4 inch x 20) for tripod or optical bench use.

See pages 186 and 187 for complete description.

NEW CAMERAS AND ACCESSORIES



The C-53, C-58 and C-59 Cameras are the latest members of the C-50 Series Cameras. They are designed primarily for the 7000-Series Oscilloscopes, however, they may be used with most other full-size oscilloscopes and display units.

See pages 192 to 197 for complete descriptions.

The Writing Speed Enhancer (WSEN) is a camera accessory for accurately controlling film fogging. Writing speed increases up to four times are possible.

See page 206 for a complete description.



NEW TM500-SERIES TEST AND MEASUREMENT SYSTEM

Never before has one compact plug-in test and measurement system offered such a variety of measurement capabilities and at such a favorable cost per function. 14 plug-ins are initially offered with more to be announced soon.



The TM 503 Power Module is a three-compartment mainframe for any combination of up to three plug-in modules. For example, a counter, digital multimeter and function generator can be operated together, occupying less bench space and costing less than three monolithic instruments. Intra-compartment interface connections and rear panel outputs may be added for specific applications, such as connecting the output of the ramp generator to the VCF input of the function generator for frequency sweeps, or monitoring the output of a signal source with the digital counter or digital voltmeter. Two TM 503's provide space for up to six plug-in modules in only 51/4 inches of rack space. The TM 503 is also available in a SCOPE-MOBILE® cart for mobile use.

The TM 501 Power Module is a single compartment mainframe for one plug-in module.

Power Supplies are available in five versions, each with a floating supply adjustable to 20 VDC, and a fixed +5 VDC supply at 1A.

The PS 501 is a single 0-20 VDC supply, with current limit adjustable for 0 to 400 mA. Voltage is set and read by means of a single-turn control (plus vernier) with panel markings. The PS 501-1 output voltage is set and read by a 10-turn precision potentiometer with 3-digit in-line dial plus range switch. Accuracy is within 0.5%. The PS 501-2 output voltage or current is read from a dual-range panel meter.

The **PS 502** is a dual tracking supply with + and - outputs varied by a single control. Current limit is fixed at greater than 400 mA. Output is 10 to 20 VDC with respect to the common terminal, or 20 to 40 VDC across the + and - terminals. Voltage is set and read by means of a single-turn control with panel markings.

The **PS 503** is a dual or dual-tracking supply providing 0-20 VDC with respect to the common terminal, or 0-40 VDC across the + and - terminals. Outputs can be independently varied, or varied at a constant ratio. Current limit is adjustable from 0 to 400 mA on each supply.

Digital Products include a digital multimeter, two frequency counters and a universal counter, each with a 7-digit LED display and leading zero blanking.

The **DM 501** 4.5-digit multimeter measures AC and DC volts and current; resistance; and temperature.

The **DC 501** measures frequency to 100 MHz: auto-ranging available; Option 2. The **DC 502** measures frequency to 550 MHz. The **DC 503** measures frequency to 100 MHz, and also performs PERIOD, RATIO, TIME INTERVAL, TOTALIZE and TIME MANUAL functions. Standard time base of each counter accurate to 1 part in 10⁵. Optional time base available accurate to 5 parts in 10⁷; Option 1.

Signal Sources include a function generator, ramp generator, pulse generator and oscillator.

The **FG 501** is a general purpose function generator providing low-distortion sinewaves, squarewaves, triangle and ramp waveforms from 0.001 Hz to 1 MHz. Frequency is adjustable by a front panel control or external VCF input.

The **RG** 501 is a ramp generator with outputs of selectable polarity, amplitude, and duration. Complete trigger controls and gate outputs suit the RG 501 for use as a time base for a monitor oscilloscope, as well as providing gating and sweeping signals for the function generator.

The **PG 501** is a 5-volt, 50-MHz general-purpose pulse generator with simultaneous + and — outputs with $t_{\rm r}$ and $t_{\rm f}$ of 5 ns or less. Duration is 10 ns to 0.1 s; period is 20 ns to 0.2 s. A "locked on" mode allows use of the generator as a power supply furnishing both + and — voltages. Output is adjustable from approximately 0.25 V to 5 V into 50 Ω .

The **SG** 502 is a low-frequency sinewave oscillator covering the range from 5 Hz to 500 kHz. Output level is within 0.1 dB from 5 Hz to 50 kHz; within 0.3 dB from 50 kHz to 500 kHz. Amplitude is 2.5 V RMS into 600 Ω or 5 V RMS open circuit. 0 to 70 dB attenuation may be selected. Squarewave output also provided.



NEW TELEVISION PRODUCTS

137 Chrominance/Luminance Gain Normalizer

138 Chrominance/Luminance Gain Normalizer

147 NTSC Signal Generator

148 PAL Signal Generator

149 NTSC Signal Generator

520A NTSC Vectorscope

521A PAL Vectorscope

522A PAL M Vectorscope

602 MOD 174V X-Y Monitor

604 MOD 174V X-Y Monitor

631 Monochrome Picture Monitor

632 Monochrome Picture Monitor

633 Monochrome Picture Monitor

650 NTSC Color Picture Monitor

650-1 NTSC plus RGB Color Picture Monitor

651 PAL Color Picture Monitor

651-1 PAL plus RGB Color Picture Monitor

652 PAL M Color Picture Monitor

652-1 PAL M plus RGB Color Picture Monitor

654 RGB Color Picture Monitor

654-1 RGB plus RGB Color Picture Monitor

655 NTSC plus PAL Color Picture Monitor

655-1 NTSC plus PAL plus RGB Color Picture Monitor

658 PAL M plus NTSC Color Picture Monitor

658-1 PAL M plus NTSC plus RGB Color Picture Monitor

659 PAL M plus PAL Color Picture Monitor

659-1 PAL M plus PAL plus RGB Color Picture Monitor

1430 Random Noise Measuring Set

Tektronix, Inc. is very active in designing and introducing products used to operate and maintain broadcast, closed circuit and cable television systems. Summary information on these products will be found starting on page 238. Complete information will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.

NEW AUTOMATED TEST SYSTEMS PRODUCTS

S-3003 Waveform Digitizer S-3260 Automatic Test System

1140A Programmable Power Supply

Tektronix, Inc. is very active in designing and introducing complete Automated Test Systems and products used in systems. A summary of TEKTRONIX Automated Test Systems capability begins on page 242.

NEW DISPLAY PRODUCTS

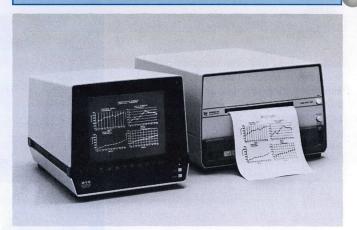


603 and 604 Display Monitors
—The 603 is an X-Y monitor
for displaying alphanumeric
and graphic data in either a
refreshed or stored mode on a
6½-inch CRT. The 604 is similar to the 603 but is not a storage monitor. These display
monitors are now available

with the optional, horizontal time base. With these calibrated sweep rates, conventional Y-T measurement capability is a valuable addition to these high performance monitors.

See pages 257 to 259 for complete description.

NEW DISPLAY PRODUCTS



613 Storage Display Unit—A four-fold increase in large screen storage display brightness is now available with the 613 Storage Display. As many as twelve 613's can be multiplexed to the 4010-Series Computer Display Terminals as remote displays. Four 613's can also be multiplexed to one 4610 Hard Copy Unit thus affecting a considerable saving in copy costs.

See pages 262 and 263 for complete description.



4610 Hard Copy Unit—The 4610, used in conjunction with the 4010-1 Computer Display Terminal and 613 Storage Display, provides a convenient means for permanently copying alphanumeric and graphic displays.

See pages 272 and 273 for complete description.

NEW COMPUTER DISPLAY TERMINALS



4010 Computer Display Terminal—The 4010 is the first low-cost large-screen terminal able to support alphanumeric and complex graphics. Equally adaptable to business, scientific, and academic environments, the 4010 is capable of portraying 2500 characters in alphanumerics, or complex graphics.

See page 275 for complete description.



NEW COMPUTER DISPLAY TERMINALS

4012 Computer Display Terminal—The 4012 offers full upper and lower case ASCII character plus the proven advantage of large-screen storage interactive graphics.

See page 275 for complete description.



4013 Computer Display Terminal—One of the most exciting recent developments in computer technology has been the availability of a new programming technique called APL—A Programming Language. The TEKTRONIX 4013 Computer Display Terminal supports the full APL character

set and also has full upper and lower case ASCII capability. The storage display of the 4013 also enhances full-screen complex graphics and alphanumerics.

See page 276 for complete description.

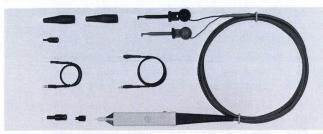


4911 Reader/Perforator and 4912 Digital Cassette Tape Unit—Cost reductions in data storage are realized by off-line recording of program and data files for subsequent reloading into computer storage for processing. Both the 4911 and the 4912, used in conjunction with the 4010, 4012 and 4013

Computer Display Terminals, provide this cost reduction.

See page 277 for complete description.

NEW PROBES



P6401 Logic Probe is a device to extend and improve your capability to analyze and troubleshoot TTL and DTL circuitry. The P6401 detects and positively identifies logic states or conditions at the point checked. Just touch and see, no control usage is involved. The 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 TEKTRONIX probe accessories that extend the usefulness of TEKTRONIX scopes.

See page 284 for complete description.

P6056, General-purpose 10X Voltage Probe; see page 291.

P6057, General-purpose 100X Voltage Probe; see page 291.

P6060, General-purpose 10X Voltage Probe; see page 292.

P6061, General-purpose 10X Voltage Probe; see page 292. P6065, General-purpose 10X Voltage Probe; see page 292.

P6075, General-purpose 10X Voltage Probe; see page 292.

P6201, FET 1X Voltage Probe; see page 285.

NEW MACHINE CONTROL PRODUCTS



N/C Editor System—On-the-spot tape program modifications, insertions and deletions are quickly and easily carried out using the TEKTRONIX N/C Editor System. The N/C Editor System keeps production machines producing parts. And, for the first time, tool path and program errors can be instantly viewed and corrected without a computer, on the system's storage cathode-ray tube display unit. N/C tape preparation time is notably reduced by eliminating transcription errors and turn-around delays normally occurring in computer facilities. Thus, productivity is increased and N/C tape preparation costs are significantly reduced.

This stand-alone, mobile N/C Editor System provides: graphic displays of complex N/C tool paths in seconds; visual displays of N/C program data in seconds; fast, simple N/C tape error corrections; convenient N/C tape code conversion and duplication; permanent copies of N/C tool path, data and program listing in seconds.

The TEKTRONIX N/C Editor System consists of a 1781 Editor, a 1791 N/C Program Verifier, and a 4601 Hard Copy Unit, all housed in a 207-1 mobile cart.

See page 279 for complete description.











The Tektronix home office is located near Beaverton, Oregon, a few miles west of Portland, on a campus-like 300-acre Tektronix Industrial Park. This complex provides over 2 million square feet for the design and manufacturing of: • oscilloscopes • cameras • accessories • automated measurement systems • calculators • digital systems • electro-optic products • information display products • machine control products • spectrum analyzers • signal sources • television products. The four-level Technical Center, shown in the two left pictures, houses corporate offices and engineering.

In order to supply products with state-of-the-art performance, Tektronix, Inc. designs and manufactures many of its own electrical and mechanical components. Some of these are CRT's, chassis, circuit boards, knobs, integrated circuits, semiconductors, and transformers. This approach brings to our customers maximum value at a reasonable price.

Our ceramics facility, shown at upper right, manufactures thick film attenuators and voltage dividers along with other devices requiring ceramic substrates. Ceramic CRT parts, including our unique funnels also originate here.

Engineering facilities along with component manufacturing and product assembly plants are located in Beaverton, Oregon ● Guernsey, Channel Islands ● Heerenveen, The Netherlands ● Tokyo, Japan.

Product sales and service is accomplished through a worldwide marketing organization with a network of Domestic and International Field Offices and Service Centers, supplemented internationally by Distributors and Representatives.

Tektronix, Inc.An Oregon Corporation

MAILING ADDRESS:

P.O. BOX 500, BEAVERTON, OREGON 97005

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

Telephone: (503) 644-0161

Telex: 36-0485

Cable: TEKTRONIX



The following two pages contain a synopsis of all the oscilloscopes in this catalog. The intent of this brief overview is to direct you to the series which best meets your measurement requirements. For a detailed description of that series, go to the indicated page number. If more information is required, or time is not available for you to appraise the specifications to make a choice, call your nearby field engineer or representative. He will quickly recommend the right oscilloscope for your application. Please consult pages 315 to 318 for the location of the field office nearest you. Oscilloscope reference information is located on pages 11 to 18.

7000 SERIES

Page 19

The growing 7000 Series with its versatile plug-ins and flexible three- and four-channel mainframes, provides the world's largest selection of oscilloscope systems.

The mainframes and plug-ins are grouped into FAM-ILIES by bandwidth and application to simplify selection.

The mainframe FAMILIES are:

7900 FAMILY

1-GHz Direct CRT Access Oscilloscope — 7904 500-MHz Oscilloscope System — 7904

7700 FAMILY

250-MHz Oscilloscope System — 7704A Option 9 200-MHz Oscilloscope System — 7704A 175-MHz Oscilloscope System — R7704

7600 FAMILY

100-MHz Oscilloscope System — 7603/R7603/ 7603N Option 11

50-MHz Ruggedized

Oscilloscope System — 7603N Option 11S

7400 FAMILY

60-MHz Oscilloscope System - 7403N/R7403N

STORAGE FAMILY

Fast Stored Writing Speed — 7623/R7623 Variable Persistence — 7613/R7613 Split-Screen Bistable — 7313/R7313

The plug-ins are cataloged alphanumerically. There are Amplifiers, Time Bases, Curve Tracer, Digital Delay Unit, Digital Multimeter, Digital Counters, Spectrum Analyzer and Samplers.

The 7000-Series three- and four-plug-in mainframes provide measurement options not available in any other single-beam oscilloscope. Vertical- and horizontal-mode switching in the four-plug-in mainframes, provides 20 possible combinations of operating modes. CRT READOUT, exclusive to TEKTRONIX Oscilloscopes, labels the CRT with correct parameters in frequency, time, voltage, current, resistance, temperature or events, depending on the plug-in used. CRT READOUT has a character set of 50 symbols for present and future applications.

There is a complete line of probes, accessories, cameras and SCOPE-MOBILE® Carts to enhance all 7000-Series Oscilloscope Systems.

5100 SERIES

Page 116

Many oscilloscope users do not require wide-bandwidth instruments. Frequently, however, they do require plug-in versatility. Until now, this combination has not been available. The 5100 Series meets this need as it offers 2-MHz bandwidth in a three-compartment mainframe that accepts any of 15 plug-ins.

Choose any of these large 6½-inch displays: single-beam, dual-beam, single-beam or dual-beam bistable

storage, available in cabinet or rackmount configuration. When your applications change, you can select a different display or configuration at minimum cost. Plug-ins provide Y-T or X-Y displays. Select from these amplifiers: $10-\mu V$ differential, $50-\mu V$ differential with current input, 1-mV differential comparator, 2-MHz single-trace, dual-trace and four-trace. Select a single or dual time base. A characteristic curve tracer plots power levels to 0.5 watts.

MORE -



550 SERIES

Page 129

This series offers the user proven performance in one of the most respected, flexible, versatile oscilloscope systems presently available.

The 50-MHz Type 556 is the widest bandwidth, dualbeam oscilloscope available from Tektronix, Inc. Operational amplifier, transducer and strain-gage amplifier plug-ins are also offered (they are also available in the 560 Series).

560 SERIES

Page 91

The 560 Series offers 22 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical- and horizontal-deflection systems (Type 565), a bistable storage oscilloscope (Type 564B) with and without auto-erase, and a conventional oscilloscope (Type 561B). The dual plug-in unit features of the Type 564B and 561B allow conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling, spectrum analyzer, operational amplifier, transducer and strain-gage amplifier plug-ins are also available.

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

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

PORTABLE OSCILLOSCOPES

Page 137

TEKTRONIX portable oscilloscopes are designed to solve a wide range of measurements with laboratory precision — in the field or in the lab.

The portable family offers complete measurement capability (including storage). Performance ranges from

350 MHz at 201/2 lb to a pocket-size 500 kHz at 3 lb.

These oscilloscopes are ruggedized to withstand the shock, vibration and other extremes of environment associated with portability.

TELEQUIPMENT OSCILLOSCOPES

Page 162

When price is of prime importance, TELEQUIPMENT products warrant serious consideration. TELEQUIPMENT oscilloscopes combine low price with a number of features not usually found in this price range. Product support is the same as for TEKTRONIX oscilloscopes.

Among the notable features of this line are bistable storage, delayed sweep, 50-MHz bandwidth, X-Y capability and TV field or line triggering.



BEHIND THE FRONT PANEL . . .

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

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

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

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

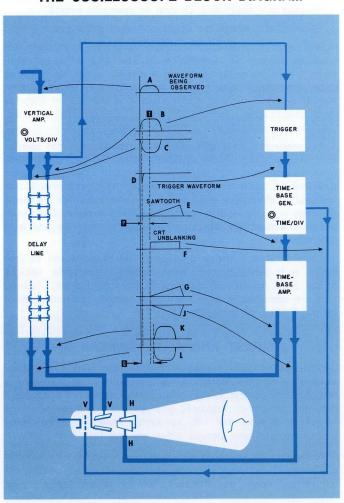
In order to maintain a stable display on the cathode-ray-tube screen, each horizontal sweep must start at the same point on the waveform being displayed. To maintain a stable display, we feed a sample of the displayed waveform to a "trigger" circuit that gives a negative output voltage spike (D) at some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

A rectangular "unblanking" wave (F) derived from the timebase generator is applied to the grid of the cathode-ray tube. The duration of the positive part of this rectangular wave corresponds to the duration of the positive-going or run-up part of the time-base output, so that the beam is switched on during its left-to-right travel and is switched off during its right-to-left retrace. In the case shown, the leading edge of the waveform being displayed is used to actuate the trigger circuit. Yet we may want to observe this leading edge on the screen—and the triggering and unblanking operations require a measurable time interval (P), often about 0.15 microsecond. To permit us to see the leading edge, a delay (Q) of about 0.25 microsecond is introduced by the delay line in the vertical-deflection channel, after the point where the sample of the vertical signal is tapped off and fed to the trigger circuit.

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

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

THE OSCILLOSCOPE BLOCK DIAGRAM



Oscilloscope Reference Information



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

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

SCALES AND SWEEPS

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

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

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

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

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

FAST AND SLOW SWEEPS

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

To measure risetime as accurately as *possible*, a step-signal (squarewave, rectangular pulse, etc.) should occupy almost the full vertical scale, and the rising portion of the signal should

be displayed at nearly a 45-deg slope. This requirement can be met only if the fastest sweep is able to move the beam a horizontal distance nearly equal to the full vertical scale in a time interval equal to the risetime of the vertical deflection system. Because of the compounding difficulties and costs of providing extremely fast sweeps which are both linear and accurate, the requirement is seldom met by scopes having very good vertical deflection risetime capabilities.

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

SINGLE-SWEEP OPERATION

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

SWEEP MAGNIFICATION AND SWEEP DELAY

Sometimes it is desirable to display parts of waveforms which occur considerably later than suitable sweep triggering signals occur. Such waveforms, can always be displayed on sweeps which last long enough, but if the duration of the waveform is short compared to the duration of a full sweep, an accurate examination may not be possible. The need to magnify (expand) the display for the time interval during which a particular event occurs is apparent. Portions of sweeps may be magnified by increasing the gain of the horizontal amplifier (allowing either or both ends of the sweeps to go off-screen) and positioning the display so that the desired portion is onscreen. 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.
- Elimination of "time jitter" or "time drift" of displayed waveforms.
- Greater accuracy of time-interval measurements between waveforms.
- 4. Better long-term accuracy of the displayed time base.



DELAYING SWEEP

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

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

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

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

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

SWEEP SWITCHING

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

RISETIME AND HIGH-FREQUENCY RESPONSE

The first qualification generally sought in a scope is adequate risetime or adequate high-frequency sinewave response. Risetime is the more important specification for "faster" scopes, and passband (bandwidth) the more frequently used specifica-

tion for "slower" scopes. The two will be closely related mathematically, however, when fast step-signals produce little or no overshoot or ringing. The product of risetime and frequency response should produce a factor whose value lies between 0.33 and 0.35, when transient response is optimum. For example, the product of 0.023-microsecond risetime (0.023 \times 10 $^{-6}$ second) and 15 MHz (15 \times 10 6 Hz) equals 0.345. Factors larger than 0.35 probably indicate overshoot in excess of 2 percent, while those larger than 0.4 probably indicate overshoot in excess of 5 percent.

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

$$T_{\mathrm{s}}=\sqrt{T_{\mathrm{i}}^{2}-T_{\mathrm{a}}^{2}}$$

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

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

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

SWITCHED INPUTS AND DUAL-BEAM SCOPES

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

Oscilloscope Reference Information



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

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

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

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

DIFFERENTIAL, BALANCED OR PUSH-PULL INPUTS

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

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

COMMON-MODE REJECTION

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

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

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

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

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

FACTORS WHICH AFFECT CMRR

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

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

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

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



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

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

"SUMMING" INPUTS

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

SAMPLING OSCILLOSCOPES

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

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

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

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

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

TIME-DOMAIN REFLECTOMETRY

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

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

STORAGE OSCILLOSCOPES

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

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

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

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

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

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

Oscilloscope Reference Information



Applications for variable persistence storage are with real time, spectrum analysis, time-domain reflectometry, sampling and other measurements which require slow sweep displays. For fast repetitive sweeps, the storage persistence can be set so multiple traces are displayed before the first trace fades from view. Then you can view changes in signal response with changes in circuit conditions, time or adjustments. This method can also be used to provide display integration so only those portions of a repetitive signal which are coincident are displayed. Any aberration or jitter which is not common to all repetitive traces will not be stored or displayed. Low repetition rate, fast risetime signals that are not discernible on conventional CRT's can be easily viewed. This type of storage provides the best display when storing displays which have varying intensities, such as delayed sweep or with Z-axis intensity modulation. Variable persistence provides very good photographs due to the contrast of dark background and bright waveforms when in the stored mode.

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

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

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

SPECTRUM ANALYZERS

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

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

PLUG-IN OR NON-PLUG-IN

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

The plug-in type consists of a mainframe containing, at the least, the low-voltage and high-voltage power supplies and the CRT and its associated circuitry. With this type of mainframe, the entire vertical amplifier is a plug-in unit, and the time base

and horizontal-sweep amplifier comprise another plug-in unit. The 561B and 564B utilize this type of design.

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

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

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

Turn to pages 9 and 10 for a brief description of the outstanding features offered by each oscilloscope series.

ENVIRONMENTAL CHARACTERISTICS

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

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

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

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

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



CATHODE-RAY TUBE PHOSPHOR DATA

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

Human Eye Response

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

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

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

Phosphor Burning

When a phosphor is excited by an electron beam having an excessively high current density, a permanent loss of phosphor

efficiency may occur. The light output of the damaged phosphor will be reduced and in extreme cases complete destruction of the phosphor may result. Darkening or burning occurs when the heat developed by electron bombardment cannot be dissipated rapidly enough by the phosphor.

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

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

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

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

PHOSPHOR DATA CHART

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

- (A) Taken with a Spectra Brightness Spot Meter which incorporates a CIE standard eye filter. Representative of 10 kV aluminized screens. P31 as reference.
- (B) P11 as reference with Polaroid 410 film. Representative of 10 kV aluminized screens.
- * Low level lasts over one minute under conditions of low ambient illumination.



accelerating voltage—The cathode-toviewing-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 cathoderay 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 cathoderay tube electron gun which traps the electron beam inside the gun to extinguish the spot, permitting blanking during retrace and between sweeps regardless of intensity setting.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

unblanking—Turning on of the cathoderay-tube beam.



BANDWIDTH FAMILIES

FAMILY	MAINFRAME	PAGE	BANDWIDTH
7900	7904	26	DC to 500 MHz*
7700	7704A Opt 9	29	DC to 250 MHz
	7704A	29	DC to 200 MHz
	R7704	29	DC to 175 MHz
7600	7603/R7603 7603N Opt 11**	32	DC to 100 MHz
7400	7403N/R7403N	38	DC to 60 MHz

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

SPECIAL APPLICATION OSCILLOSCOPE FAMILIES

FAMILY	MAINFRAME	PAGE	APPLICATION
	7623/R7623	45	200 cm/µs Stored Writing Speed, Multi- mode Storage
STORAGE	7613/R7613	47	Variable Persistence Storage
	7313/R7313	48	Split-Screen Bistable Storage
50-MHz Ruggedized Oscilloscope System	7603N Opt 11S	35	Qualified under MIL-O- 24311(EC) and appears on U.S. Navy QPL- 24311.

7000-SERIES VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN A	MPLIFIER		7A11	7A12	7A13	7A14	7A15A 7A15AN	7A16A	7A17	7A18 7A18N	7A19	7A21N	7A22
PAGE	T		50	51	51	53	54	54	55	55	56	56	57
FEATURE		Low-Capaci- tance FET Probe Amplifier	Dual- Channel Amplifier	Differential DC Offset, High-Freq CMRR Ampli- fier	AC Current Probe Ampli- fier (2 cur- rent probes)	Low-Cost Conven- tional Input Amplifier	Wide-Band width Con- ventional Input Amplifier	Low Cost, Easy to Customize Amplifier	Dual- Channel Amplifier	Wide-Band- width 50- ohm Input Amplifier	Direct CRT Access	DC-Coupleo, High-Gain Differential Amplifier	
MIN DEFL FACTOR		5 mV/div	5 mV/div	1 mV/div	1 mA/div	5 mV/div (0.5 mV/div) ²	5 mV/div	50 mV/div	5 mV/div	10 mV/div	<4 V/div	10 μV/div	
ACCURACY ¹ WITHOUT PROBE		2% (Integral)	2%	1.5%	- A 1 17	2%	2%	Adjustable	2%	3%		2%	
		BW	250 MHz	120 MHz	105 MHz P6053A 65 MHz P6055	120 MHz P6022 55 MHz P6021	80 MHz	225 MHz	150 MHz	80 MHz	500 MHz ⁴	1 GHz	1 MHz ±10%
7900 FAMILY 7904	7904	Tr	1.4 ns	2.9 ns	3.4 ns P6053A 5.4 ns P6055	2.9 ns P6022 6.4 ns P6021	4.4 ns	1.6 ns	2.4 ns	4.4 ns	0.8 ns	350 ps	350 ns ±9%
		SIG OUT BW	140 MHz	110 MHz	100 MHz P6053A 65 MHz P6055	100 MHz P6022 50 MHz P6021	70 MHz	140 MHz	15 MHz	70 MHz	300 MHz	<u>arenak</u> e	1 MHz ±10%
		BW	180 MHz ³	105 MHz	100 MHz P6053A 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	170 MHz ³	150 MHz	80 MHz	250 MHz ³		1 MHz ±10%
	7704A Opt. 9	Tr	2.0 ns	3.4 ns	3.5 ns P6053A 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.1 ns	2.4 ns	4.4 ns	1.5 ns		350 ns ±9%
		SIG OUT BW	70 MHz	60 MHz	60 MHz P6053A 50 MHz P6055	55 MHz P6022 40 MHz P6021	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz		1 MHz ±10%
7700 FAMILY		BW	170 MHz	105 MHz	100 MHz P6053A 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	160 MHz	150 MHz	80 MHz	200 MHz		1 MHz ±10%
	7704A	Tr	2.1 ns	3.4 ns	3.5 ns P6053A 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.2 ns	2.4 ns	4.4 ns	1.8 ns	-	350 ns ±9%
		SIG OUT BW	70 MHz	60 MHz	60 MHz P6053A 50 MHz P6055	55 MHz P6022 40 MHz P6021	55 MHz	70 MHz	15 MHz	55 MHz	80 MHz	THERE	1 MHz ±10%
		BW	150 MHz	105 MHz	100 MHz P6053A 65 MHz P6055	105 MHz P6022 50 MHz P6021	75 MHz	150 MHz	150 MHz	75 MHz	175 MHz	TRIBUTE	1 MHz ±10%
	R7704	Tr	2.4 ns	3.4 ns	3.5 ns P6053A 5.4 ns P6055	3.4 ns P6022 7.0 ns P6021	4.7 ns	2.4 ns	2.4 ns	4.7 ns	2.0 ns	Total In	350 ns ±9%
		SIG OUT BW	60 MHz	55 MHz	55 MHz P6053A 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz		1 MHz ±10%
	7603 R7603	BW	100 MHz	80 MHz	75 MHz P6065 55 MHz P6055	80 MHz P6022 50 MHz P6021	65 MHz	100 MHz	100 MHz	75 MHz	105 MHz	0000	1 MHz ±10%
	7603N Opt. 11 ⁶ 7613 ⁵	Tr	3.5 ns	4.4 ns	5.0 ns P6065 6.4 ns P6055	4.4 ns P6022 7.0 ns P6021	5.4 ns	3.5 ns	3.5 ns	4.7 ns	3.4 ns		350 ns ±9%
7600 FAMILY	R7613 ⁵ 7623 ⁵ R7623 ⁵	SIG OUT BW	60 MHz	55 MHz	55 MHz P6065 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz		1 MHz ±10%
and STORAGE FAMILY		BW	25 MHz	25 MHz	25 MHz P6052 24 MHz P6055	25 MHz P6022 24 MHz P6021	25 MHz	25 MHz	25 MHz	25 MHz	25 MHz	J ohn I	1 MHz ±10%
7313 R7313	7313 R7313	Tr	14 ns	14 ns	14 ns P6052 15 ns P6055	14 ns P6022 15 ns P6021	14 ns	14 ns	14 ns	14 ns	14 ns	A ANSTE	350 ns ±9%
	12	SIG OUT BW	60 MHz	55 MHz	55 MHz P6052 45 MHz P6055	50 MHz P6022 40 MHz P6021	50 MHz	60 MHz	15 MHz	50 MHz	65 MHz	Q MAY	1 MHz ±10%
7400	7403N	BW	60 MHz	55 MHz	55 MHz P6065 45 MHz P6055	55 MHz P6022 40 MHz P6021	50 MHz	60 MHz	50 MHz	50 MHz	65 MHz		1 MHz ±10%
FAMILY	R7403N	Tr	5.9 ns	6.4 ns	6.4 ns P6065 7.8 ns P6055	6.4 ns P6022 8.8 ns P6021	7.0 ns	5.9 ns	7.0 ns	7.0 ns	5.4 ns		350 ns ±9%

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.

¹Accuracy 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%.

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

 3 System temperature range from $+20\,^{\circ}\text{C}$ to $+30\,^{\circ}\text{C}$. Over the temperature range of 0 $^{\circ}\text{C}$ to $+50\,^{\circ}\text{C}$, 7704A specifications apply.

 4 System bandwidth is 500 MHz from $+20\,^{\circ}\mathrm{C}$ to $+30\,^{\circ}\mathrm{C}$, 400 MHz from $0\,^{\circ}\mathrm{C}$ to $+20\,^{\circ}\mathrm{C}$ and $+30\,^{\circ}\mathrm{C}$ to $+50\,^{\circ}\mathrm{C}$.

 5 System temperature range from 0°C to $+35^{\circ}$ C. Refer to Storage FAMILY System specification for $+35^{\circ}$ C to $+50^{\circ}$ C.

⁶Refer to 50-MHz Ruggedized Oscilloscope System.

^{**}Refer to 50-MHz Ruggedized Oscilloscope System.

7000-SERIES OSCILLOSCOPES

Reference



SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE		
Curve Tracing	7CT1N	63	Low Power Semiconductor Curve Tracer		
Digital Delay Unit	7D11	65	Digital Time Delay Echo Time Delay Count by Events mode		
Digital Multimeter	7D13	67	Digital Multimeter Plus a unique Temperature Probe		
Digital Counting	7D14	68	Directly Gated Counter to 525 MHz		
Universal Counter-Timer	7D15	69	DC to 225 MHz Direct Count 8 Basic Modes		
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer		
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line		
Sampling	7811	74	Accepts Plug-In Sampling Heads		
TDR and Sampling	7812	74	TDR and Sampling Applications		
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Real- Time Sampling		

- MAINFRAME AND PLUG-IN SELECTION BY BANDWIDTH AND APPLICATION FAMILIES
- SELECT FROM 16 MAINFRAME MODELS: CABINET, RACKMOUNT, CONVENTIONAL, STORAGE, THREE PLUG-IN, FOUR-PLUG-IN
- MAINFRAME OPTION-PLUG-IN MODULARITY ALLOWS COST SAVINGS
- OVER 30 PLUG-INS PROVIDE MEASUREMENT VERSATILITY
- CRT READOUT
- CONVENTIONAL AND STORAGE CRT's
- ADVANCED PHOTOGRAPHIC TRACE-RECORDING CAPABILITIES
- AUTO FOCUS
- PLUG-IN FLEXIBILITY
- MAINFRAME MODE SWITCHING
- EXPANDED TRIGGER SOURCE SELECTION
- PEAK-TO-PEAK AUTO TRIGGERING
- COLOR-KEYED PANELS
- LOW-TORQUE CAM SWITCHES

TIME BASES

TIME BASE	PAGE	PERFOR- MANCE FEATURE	MAX SWEEP RATE	RECOM- MENDED FAMILY	TRIGGERING FREQUENCY RANGE
7B50	58	Delayed Sweep & Ext Amplifier	5 ns/div	Storage 7400 7500 7600	DC to 100 MHz
7B51	58	Delaying Sweep	5 ns/div	7500	DC to 100 MHz
7B53A 7B53AN	59	Dual and Calibrated Mixed Sweep	5 ns/div	Storage 7400 7500 7600	DC to 100 MHz
7B53A Opt 5 7B53AN Opt 5	59	TV SYNC Separator Triggering	5 ns/div	Storage 7400 7500 7600	DC to 100 MHz
7B70	61	Delayed Sweep & Ext Amplifier	2 ns/div	7700 7900	DC to 200 MHz
7B71	61	Delaying Sweep	2 ns/div	7700 7900	DC to 200 MHz
7B92	62	Dual Sweep, Display Switching	2 ns/div 0.5 ns/div	7700 7900	DC to 250 MHz DC to 500 MHz

NEW CONCEPTS IN PLUG-IN AND MAINFRAME VERSATILITY

Throughout its history of product development, Tektronix, Inc. has provided measurement solutions and sought to safeguard the customer's investment. The TEKTRONIX 7000-Series Oscilloscope Systems represent an ongoing effort devoted to achieving this goal.

The 7000-Series three- and four-plug-in mainframes provide measurement options not available in any other single-beam oscilloscope. Vertical and horizontal mode switching in the four-plug-in mainframes, provides 20 possible combinations of operating modes. CRT READOUT, exclusive to TEKTRONIX Oscilloscopes, labels the CRT with correct parameters in frequency, time, voltage, current, resistance, temperature or events, depending on the plug-in used. CRT READOUT has a character set of 50 symbols for present and future applications.

The growing 7000 Series with its versatile plug-ins and flexible three- and four-channel mainframes, provides the world's largest selection of oscilloscope systems. There are plug-in Amplifiers, Time Bases, Curve Tracer, Digital Delay Unit, Digital Multimeter, Digital Counters, Spectrum Analyzer and Samplers.

There is a complete line of probes, accessories, cameras and SCOPE-MOBILE[®] Carts to enhance all 7000-Series Oscilloscope Systems.



SELECT FROM 16 MAINFRAME MODELS

he mainframes and plug-ins are grouped into FAMILIES by bandwidth and application to simplify selection.

The mainframe FAMILIES are:

7900 FAMILY

1-GHz Direct CRT Access

Oscilloscope — 7904 500-MHz Oscilloscope System — 7904

7700 FAMILY

250-MHz Oscilloscope System - 7704A Option 9

200-MHz Oscilloscope System — 7704A 175-MHz Oscilloscope System — R7704

7600 FAMILY

100-MHz Oscilloscope System — 7603/R7603/7603N Option 11

50-MHz Ruggedized

Oscilloscope System — 7603N Option 11S

7400 FAMILY

60-MHz Oscilloscope System - 7403N/R7403N

STORAGE FAMILY

Fast Stored Writing Speed- - 7623/R7623

Multimode CRT

Variable Persistence — 7613/R7613 Split-Screen Bistable — 7313/R7313

7900 FAMILY WIDEST REAL-TIME BANDWIDTH OSCILLOSCOPE

For DC to 500 MHz real time applications. The 7904 mainframe ith the 7A19 vertical amplifier and 7B92 dual time base units gives you 10 mV/div sensitivity and a 500 ps/div sweep speed. Choose from the other 7000-Series plug-ins for virtually any measurement.

For 1 GHz applications use the 7904 mainframe with the 7A21N direct access unit and a 7B92 dual time base. The deflection factor is less than 4 V/div. Fastest sweep speed is 500 ps/div. Triggers from DC to 500 MHz. The direct access connection to the CRT bypasses the vertical amplifier, disconnecting the CRT READOUT and the second vertical channel.

7700 FAMILY GENERAL PURPOSE MODULAR SYSTEM, DC TO 250 MHz

The 7704A Oscilloscope System offers you the choice of either 250 MHz and optimized bandwidth or 200 MHz and optimized transient response. The R7704 mainframe and 7A19 deliver 175 MHz bandwidth. Choose from the other 7000-Series plug-ins for virtually any measurement.

7600 FAMILY GENERAL PURPOSE LABORATORY AND SERVICING OSCILLOSCOPE SYSTEM, DC TO 100 MHz

The 7603, 7603N Opt 11 and R7603 give three-plug-in flexibility for use of all 7000-Series plug-ins. They feature a large CRT (6½ inches). The rackmount version requires only $5\frac{1}{4}$ inches of vertical rack space. Mainframes weigh only 30 pounds.

50-MHz RUGGEDIZED OSCILLOSCOPE SYSTEM

The 7603N Opt 11S is a ruggedized three-plug-in system for DC-to-50 MHz applications. It meets the rigid environmental and electrical specifications required by the military.

7400 FAMILY GENERAL PURPOSE LABORATORY AND SERVICING OSCILLOSCOPE SYSTEM, DC TO 60 MHz

The 7403N and R7403N give three-plug-in flexibility and feature large (6½ inch) CRT's. The rackmount version requires only 5¼ inches of vertical rack space. Mainframes weigh only 30 lbs. These systems deliver high performance and allow cost savings by not providing for CRT READOUT. See 7400-FAMILY System Chart for recommended plug-ins.

STORAGE FAMILY STORAGE OSCILLOSCOPE SYSTEMS, DC TO 100 MHz

7623/R7623—For applications requiring stored writing speeds, up to $200 \text{ cm}/\mu\text{s}$ and bandwidths from DC to 100 MHz, use the 7623 (Option 12) storage oscilloscope with a 7A16A amplifier and 7B53A time base.

The 7623 has four modes of operation:

FAST—which gives writing speeds of $200 \text{ cm}/\mu\text{s}$ for 7623 Opt. 12 or 100 div/ μs for 7623, both with a long view time (until erased).

VARIABLE PERSISTENCE—with writing speeds up to 0.5 div/ μs and viewing times varying from 15 seconds at maximum writing speed to one minute or longer at 100 div/ms.

BISTABLE—with writing speeds up to 30 div/ms and a long view time (until erased).

NONSTORE-for conventional, nonstorage operation.

7613/R7613—For applications requiring Variable Persistence Storage such as fast risetime, low-rep-rate pulse work, Sampling or Spectrum Analysis.

The 7613 has two modes of operation:

VARIABLE PERSISTENCE—with stored writing speed of greater than 5 div/µs and a view time ranging from 15 seconds to 60 minutes (stored writing speed dependent).

NONSTORE-for conventional nonstorage operation.

STORAGE FAMILY STORAGE OSCILLOSCOPES DC TO 25 MHz

7313/R7313—For applications requiring split-screen Bistable Storage or conventional (nonstorage) operation. Stored writing speeds up to $5 \text{ cm}/\mu\text{s}$ with a viewing time up to four hours on an 8×10 div (0.98 cm/div) CRT with auto erase.

All Storage FAMILY CRT's are extremely burn resistant and do not require any special operating precautions. Each mainframe accepts all 7000-Series Plug-Ins allowing virtually any measurement.

MAINFRAME-OPTION-PLUG-IN CONCEPT PROVIDES COST SAVINGS

By utilizing modular electrical and mechanical design concepts, offering instrument and plug-in options and conversion kits, the customer may choose the instrumentation package most suited to his requirement. Compare the TEKTRONIX MAINFRAME-OPTION-PLUG-IN concept with others. You'll realize immediate cost savings by purchasing only those options and plug-ins you presently require. The 7000-Series modular, electrical and mechanical design concepts bring you all this, plus the capacity for system upgrading.

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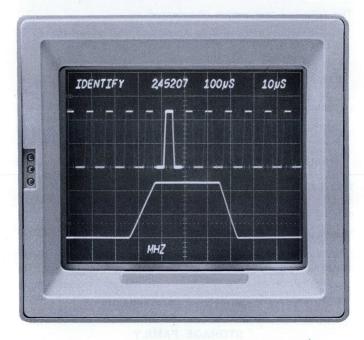
OVER 30 PLUG-INS PROVIDE MEASUREMENT VERSATILITY

There are 32 plug-ins presently for the 7000-Series, thirteen Amplifiers, nine Time Bases, and ten Specialized Units. The Specialized Units consist of four sampling units (including a Time Domain Reflectometer unit and a high quality Delay Line unit), one Spectrum Analyzer, two Digital Counters, one Digital Multimeter, one Digital Delay unit and one Curve Tracer.

There are more plug-ins coming . . .

CRT READOUT

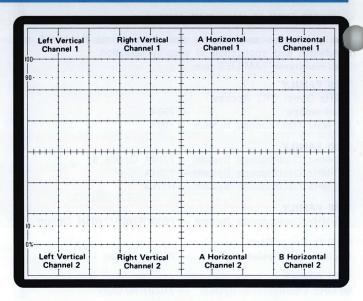
The CRT is the focal point on all oscilloscopes. CRT READOUT displays the measurement parameters right on the CRT where you make the measurements. It provides you with increased operator accuracy and speed. It decreases the measurement set-up time plus operator errors due to overlooked probe attenuation and amplifier gain factors.



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

CRT READOUT changes the conventional oscilloscope into an integrated test system by reading out the measurement parameters from plug-ins working in the frequency, time, voltage, current, resistance and temperature domains . . . and there are more coming.

CRT READOUT functions in all 7000-Series mainframes and plug-ins except those having a suffix N (7403N, 7A21N, etc.).



CONVENTIONAL AND STORAGE CRT'S

The greater than 1 gigahertz bandwidth of the 7904 CRT is achieved by employing a helical traveling wave structure. The vertical sensitivity of less than 4 V/div and the 8 x 10 cm scan are achieved by using a dome shaped mesh electrode between the deflection-plate structure and post-accelerator field. The 7704A uses a similar CRT.

The CRT in the R7704 is a single-beam, 5-inch rectangular display device. Its internal, parallax free graticule is 8 x 10 cm The 7600 and 7400 FAMILY use a 6½ inch CRT with an internal parallax-free graticule of 8 x 10 div (each division is 1.22 cm).

The Storage CRT's used in the 7000-Series Storage FAMILY are of three types; Fast Transfer, Multimode (7623/R7623), Variable Persistence (7613/R7613), and Split-Screen Bistable (7313/R7313). A very fast stored writing speed (200 cm/ μ s, 7623 option 12) is achieved by using a TEKTRONIX proprietary Mesh-to-Mesh transfer CRT. All the CRT's are extremely burn resistant, and require no special operating precautions. Please refer to the 7000-Series Storage FAMILY for more information.

ADVANCED PHOTOGRAPHIC AND TRACE-RECORDING CAPABILITIES

The CRT used in the 7904 and 7704A provides an excellent visual brightness and photographic writing speed by being operated at a 24 kV accelerating potential. Typical writing speeds of greater than 5 cm/ns are achieved (using C-51-R Camera, P11 phosphor and 10,000 ASA film). The 7600 and 7400 FAMILY CRT's are operated at 15 kV; for writing speeds, refer to the catalog specification pages.

The 7904, 7704A, 7603 and 7403N offer, as an option, a CRT with additional trace brightness for higher photographic and information writing speeds than the standard CRT. The photographic writing speed of the 7904 optional CRT (with P11 phosphor using C-51-R Camera, and 10,000 ASA film) is 10 cm/ns.

The TEKTRONIX Writing Speed Enhancer, a camera accessory for increasing photographic writing speed by precise fill fogging, will increase writing speeds to greater than 2 times for 10,000 ASA film and 4 times for 3000 ASA film.



AUTO-FOCUS

to-Focus is provided in all the 7000-Series mainframes (except 7403N and 7313). Once set, it reduces the need for additional manual adjustments assuring a focused trace with changes in intensity. A Beam Finder is also provided on all 7000-Series mainframes, when activated it will limit the deflection to the display area, allowing the operator to make necessary gain and position adjustments.

PLUG-IN FLEXIBILITY

Amplifier Combinations

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

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

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

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

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

Time-Base Plug-Ins

Different time-base units are available for each 7000-Series mainframe. The difference in the plug-ins are the maximum sweep speeds available and the triggering frequency range they are designed to cover. Please refer to the Time Base chart in the beginning of this reference section for mainframe compatibility.

Sampling Units

The 7S11 Sampling Unit, 7M11 Delay Line, and 7T11 Sampling Time Base are the building blocks for utilizing the sampling technique with the 7000-Series mainframes. In conjunction with the six plug-in sampling heads and the mainframe switching capability, they offer an extremely versatile combination of operational modes.

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

The 7T11 features 10 ps/div to 5 ms/div calibrated sweep rates and random or sequential operations. To cover that wide range of TIME/DIV settings, the 7T11 automatically crosses from EQUIVALENT time to REAL time displays at an appropriate sweep range. The triggering range of the unit is from \simeq 10 Hz to above 12.4 GHz which precludes the requirement an internal trigger countdown unit.

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

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

Sampling Unit Combinations

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

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

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

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

Spectrum Analyzer Plug-In

Spectrum analysis is possible with the 7L12 Spectrum Analyzer Plug-in. In one display a spectrum range from 0 Hz to 1800 MHz can be viewed. In addition to waveforms, all parameters are displayed on the CRT via CRT READOUT, for viewing and photographing.

Digital Family

The Digital FAMILY has four plug-ins to offer: 7D11 Digital Delay Unit, 7D13 Digital Multimeter, 7D14 Digital Counter and 7D15 Universal Counter/Timer. The Digital plug-ins display is via CRT READOUT. They will function in any compartment of a 7000-Series mainframe incorporating CRT READOUT. Please refer to the Digital Plug-in catalog pages for more information.

2600 Series

The 2600-Series plug-in modules can be operated in all 7000-Series Oscilloscope mainframes. An adapter is required to provide power to the plug-in and to extend the plug-in length for mechanical compatibility. Please refer to the Modular Instrument systems section of the catalog for more information.

MAINFRAME MODE SWITCHING

By electronically switching between vertical and horizontal plug-ins, the 7000-Series four-plug-in mainframe provides measurement options which are not available in any other single-beam oscilloscope. In the past, a second or third vertical plug-in was not always usable in combination with another plug-in in a single-beam oscilloscope. Now, different kinds of

7000-SERIES OSCILLOSCOPES

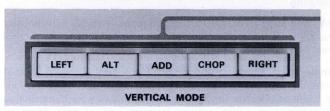
Reference



plug-ins may be used simultaneously in a single mainframe. To realize the maximum benefits from this new option, the user needs electronic plug-in switching at his disposal; the mainframe is the logical place for this switching to be done. Vertical and horizontal switching in the 7000-Series mainframes provide 20 possible combinations of operating modes in the four plug-in oscilloscopes. A wide selection of multi-trace options is provided even in applications where performance parameters vary considerably. Thus, the user can select the two vertical plug-ins most appropriate for his measurement, and still have multi-trace performance.

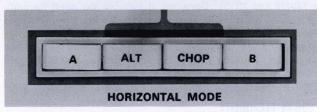
A second important benefit of vertical and horizontal mode switching in the mainframe is the simulation of dual-beam capabilities. Many users have found themselves faced with having to purchase a dual-beam oscilloscope for applications where horizontal chopping or alternating between two time bases would have solved the measurement problem. The 7000-Series horizontal mode switching provides this capability.

Vertical Switching Modes (Three- and Four-Plug-In Mainframes)



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

Horizontal Switching Modes and Logic (Four-Plug-In Mainframes)



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

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

EXPANDED TRIGGER SOURCE SELECTION

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

There will be times, of course, when the measurement will require different triggering modes. In anticipation of these requirements, the 7000 Series is designed with a wide range of mainframe and plug-in trigger selection options. Mainframe trigger selection options include the VERT MODE, LEFT

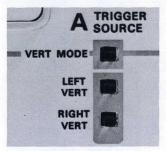
The chart shows 20 possible combinations of vertical and horizontal operating modes for four-plug-in mainframes.

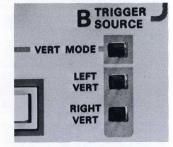
VERT MODE	HORIZ MODE	DISPLAY			
1913 <u>1913 19</u> 13 1931 1	A, B	Single-trace			
LEFT	ALT, CHOP	(A) independent dual time base (B) simultaneous DELAYING and DELAYED-sweep display			
edite2	A, B	Dual-trace Dual-trace			
ALT	ALT, CHOP	 (A) independent "dual-beam" display (B) X-Y, X-Y display (CHOP ONLY) (C) X-Y, Y-T display (D) "dual-trace" delaying-sweep display 			
ADD	A, ALT, CHOP, B	Algebraic addition of vertical channels with: (A) single-trace (B) dual time base (C) "dual-trace" delaying-sweep display			
CHOP	A, B	Dual-trace Dual-trace			
CHOP	ALT, CHOP	"dual-trace" delaying-sweep display			
RIGHT	A, B ALT, CHOP	Same display capability as with LEFT above			



VERT, and RIGHT VERT modes. Both the A and B time-base igger signal can be selected individually from either of these sources. To complete the selection options, the trigger signal may be selected from Channel 1 or 2, or a composite of Channels 1 and 2, in multi-trace plug-ins. All trigger source controls are color-keyed for ease of operational understanding.

Internal Trigger Selection





7000 Series

7000 Series (Four-Plug-In Mainframes)

The trigger signal to the time base is selected by lighted pushbutton switches for LEFT, RIGHT, or VERT MODE. The vertical signal from both LEFT and RIGHT plug-ins is coupled through the trigger logic circuitry and made available to the time-base units for triggering purposes, and to a SIGNAL OUT jack for external use. The VERT MODE eliminates the need to continually select the trigger source. Activating the VERT MODE trigger switch slaves the trigger signal source to the displayed signal in the LEFT VERT, RIGHT VERT and ALT position of the VERTICAL MODE display switch. In the ADD or CHOP positions of the VERTICAL MODE display switch, the internal trigger signal is the algebraic sum of the signals applied to the vertical plug-ins (7904 excepted). This prevents the time base from triggering on the chopped signal. When a 7D14 Digital Counter is used in a horizontal plug-in compartment, signals can be internally routed to it from the vertical plug-ins by the trigger source switches.

COLOR-KEYED PANELS

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

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

Blue-identifies controls affecting the CRT display mode.

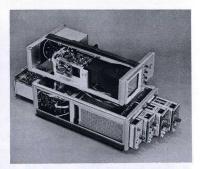
Green-identifies all trigger controls.

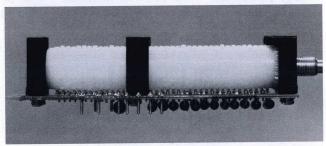
Gray—has no functional meaning, used to group or combine certain controls such as CRT beam controls.

ELECTRO-MECHANICAL CONSIDERATIONS

The increased measurement capabilities of the 7000-Series instruments have placed previously unencountered demands upon electro-mechanical design. Many of the capabilities of this new series of oscilloscopes would not have been possible without advances in mechanical designs. Wafer type switches and conventional attenuators impose definite limitations upon instrument design. To overcome these limitations, Tektronix, Inc. has designed and incorporated into these instruments new low-torque cam switches to reduce wiring problems, increase switch life, reduce congestion, and to improve maintenance and ease of operation. Miniature push-button switches are used to conserve space and increase operator speed. Modularity started with the plug-in concept, and now is used extensively in many oscilloscopes. The 7704A modular construction carries the plug-in concept many steps farther. The 7704A consists of two main units; the A7704 Acquisition Unit and the D7704 Display Unit. These units in turn are constructed of plug-in modules that are easily removed for faster servicing.



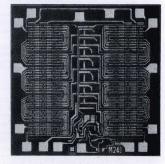




Some of the new TEKTRONIX designs used in the 7000-Series Oscilloscopes. Clockwise from upper left: miniature push button, 7704A modular design, rotary cam switch.

INTEGRATED CIRCUITS

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

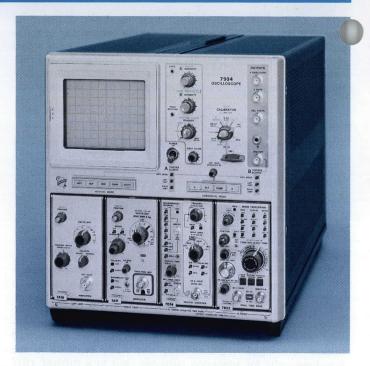


7900-FAMILY OSCILLOSCOPES 7904 500-MHz Oscilloscope



- 500 MHz at 10 mV/DIV
- 1-GHz DIRECT ACCESS PLUG-IN (LESS THAN 4 V/DIV)
- 500 ps/DIV DELAYED SWEEP
- 8 x 10 cm DISPLAY
- GREATER THAN 12 cm/ns ENHANCED WRITING SPEED
- CHOOSE FROM 24 COMPATIBLE PLUG-INS
- CRT READOUT
- VERTICAL AND HORIZONTAL MODE SWITCHING
- VERSATILE TRIGGER SOURCE SELECTION
- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING

The TEKTRONIX 7904 Oscilloscope and its recommended plugins are called the TEKTRONIX 7900 FAMILY.



PLUG-IN VERSATILITY

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

45-ps Risetime TDR

- 525-MHz Direct Counter
 1.8 GHz Spectrum Analyzer
 Sampling to 14 GHz
- Dual Time Base
- Single Trace

- **Digital Multimeter**
- 10 μV/Div Differential
- 1 mA/Div Current Amplifier
 Differential Comparator
 500-ps Dual Time Base
 Dual Trace Curve Tracer
 - Single Time Base

- **Digital Delay**
- Universal Counter/Timer
- Delay Line
- Mixed Sweep
- Multi-Trace Combinations

500 MHz — 7900 FAMILY — VERTICAL SYSTEMS SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	SIG OUT BW	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	250 MHz	1.4 ns	140 MHz	2%	\$950
7A12	Dual-Channel Amplifier	5 mV/div	120 MHz	2.9 ns	110 MHz	2%	\$900
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053A 105 MHz	3.4 ns	100 MHz	1.5%	\$1250
2 8003 ent n	heau expless XIVORTX11	van sat to ke	P6055 65 MHz	5.4 ns	65, MHz		oreon, and or
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 55 MHz	6.4 ns	50 MHz		\$700
			P6022 120 MHz	2.9 ns	. 100 MHz	Totalian	
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	22 5 MHz	1.6 ns	140 MHz	2%	\$475
7A17	Low-Cost, Easy to Customize Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	Adjustable	\$95
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	80 MHz	4.4 ns	70 MHz	2%	\$535 (7A18) \$500 (7A18N)
7 A 19	Wide-Bandwidth 50-ohm Input Amplifier	10 mV/div	500 MHz	0.8 ns	300 MHz	3%	\$500
7A21N	Direct CRT Access	<4 V/div	1 GHz	350 ps			\$350
7A22	DC-Coupled, High Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	\$575

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

+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%.





SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	64	Low Power Semiconductor Curve Tracer	\$ 400
Digital Delay Unit	7D11	65	Digital Time Delay Echo Time Delay Count by Events mode	\$1475
Digital Multimeter	7D13	67	Digital Multimeter Plus a unique Temperature Probe	\$ 560
Digital Counting	7D14	68	Directly Gated Counter to 525 MHz	\$1400
Universal Counter/ Timer	7D15	69	DC - 225 MHz Direct Count 8 Basic Modes	\$1475
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer	\$4850
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line	\$ 325
Sampling	7S11	74	Accepts Plug-In Sampling Heads	\$ 575
TDR and Sampling	7S12	74	TDR and Sampling Applications	\$1200
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Real- Time Sampling	\$1625

The 7900 FAMILY is the world's most advanced oscilloscope measurement system. Coupled with the broad functional versatility of the established 7000-Series plug-ins, it offers the highest mainframe and CRT bandwidth available today in a general-purpose oscilloscope system. You may also select from 10 additional specialized plug-ins that will make virtually any measurement possible.

he 7904 CRT has a full 8 x 10 cm viewing area and offers excellent visual brightness and photographic writing speed. 24-kV accelerating potential and a new CRT design provide a writing speed of 6.1 cm/ns with C-51-R Camera, P11 phosphor and 10,000 ASA film (12.2 cm/ns with the optional writing speed enhancer). An optional CRT (4 x 5 cm display area) and the writing speed enhancement of TEKTRONIX' new film fogging technique extends writing speed to 20 cm/ns and beyond. Most photographic requirements can now be met with 3000 ASA film. The writing speed reserve means reduced intensity settings and improved trace definition. With P31 phosphor, the optional CRT provides an outstanding method of viewing low rep rate signals even in high ambient light.

VERTICAL SYSTEM

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

Vertical Plug-Ins

PLUG-IN	BW	Tr	SIG OUT BW
7A11	250 MHz	1.4 ns	140 MHz
7A17	150 MHz	2.4 ns	15 MHz
7A19	500 MHz	0.8 ns	300 MHz
7A21N	1 GHz	350 ps	N/A

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

Chopped Mode—Repetition rate is approximately 1 MHz.

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

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

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	TRIGGERING FREQUENCY RANGE	PRICE
7B70	60	Delayed Sweep	2 ns/div	DC to 200 MHz	\$625
7B71	60	Delaying Sweep	2 ns/div	DC to 200 MHz	\$725
7B92	62	Display Switching	0.5 ns/div	DC to 500 MHz	\$1400

HORIZONTAL SYSTEM

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

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

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

X-Y Mode—PHASE SHIFT is within 2° from DC to 35 kHz without phase correction (DC to 1 MHz with phase correction opt 2) between vertical and horizontal channels. Bandwidth is DC to at least 1 MHz.

CRT AND DISPLAY FEATURES

Standard—Internal 8 x 10 cm graticule with variable illumination.

Option 4, Maximum Brightness CRT—Internal 4 x 5-cm graticule with variable illumination. Provides extremely high photographic and information writing speed and increases the visibility of low-rep-rate high-speed signals.

Phosphor—P31 standard.

Option 8, Phosphor Change (P11)—Specify P11 when ordering.

Accelerating Potential-24 kV.

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	V	VRITING S	CAMERA	LENS		
	P3	31	P-	11		
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA	7	
Standard 8 X 10 cm	2.8	1.4	6.1	3.1	C-51-R	f/1.2 1:0.5
	1.1	0.6	2.6	1.3	C-52-R	f/1.4 1.1
Option 4 4 X 5 cm	5.0	2.5	10.0	5.0	C-51-R	f/1.2 1:0.5
	2.0	1.0	4.3	2.2	C-52-R	f/1.4 1:1

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.

CALIBRATOR

Output Waveshape-Rectangular, positive-going from ground.

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

^{*}Registered Trademark Polaroid Corporation

7900-FAMILY OSCILLOSCOPES 7904 500-MHz Oscilloscope



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

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

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

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

OUTPUTS

+Sawtooth-Sawtooth starts 1 V or less from ground (into an open circuit). Internally selectable from A or B horizontal. Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω within 2%.

+Gate-Positive-going rectangular waveform derived from A, B, or DELAYED gate, internally selectable. Output voltage is $0.5\,\mathrm{V}$ ($\pm\,10\%$) into $50\,\Omega$, $10\,\mathrm{V}$ ($\pm\,10\%$) into an open circuit. Risetime is 5 ns or less into 50 Ω , output R is 950 Ω within 2%.

Sig Out-Selected by B TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into an open circuit. The bandwidth depends upon vertical plug-in. See the 7900 Family Vertical System Specification Chart. Output R is 950 Ω within 2%.

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

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

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

DIMENSIONS AND WEIGHTS

TRANSPORT TO WARRANT										
DIMENSIONS	HEI	GHT	WI	WIDTH		LENGTH				
	in	cm	in	cm	in	cm				
7904	13.5	34.2	12.0	30.5	23.3	59.0				
SINGLE-WIDTH PLUG-INS	5.0	12.7	2.8	7.1	14.5	36.9				
DOUBLE-WIDTH PLUG-INS	5.0	12.7	5.5	14.0	14.5	36.9				
WEIGHTS (Approx)	NET		DOMESTIC SHIPPING							
	lb	kg	Ib	kg	Ib	kg				
7904	32.0	14.5	52.0	23.5	63.0	28.6				
SINGLE-WIDTH PLUG-INS	2.0	0.9	5.0	2.3	10.0	4.5				
DOUBLE-WIDTH PLUG-INS	9.0	4.1	12.0	5.4	17.0	7.7				

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

ORDERING INFORMATION

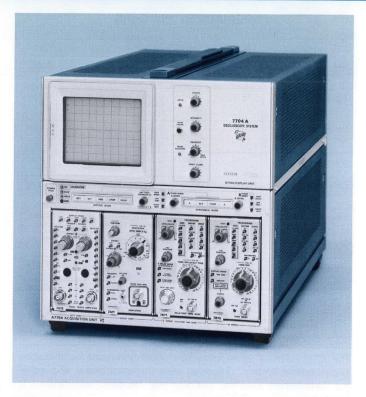
	(Plug-ins n	ot included)	
7904 OSC	LLOSCOPE		\$2900
	7904 C	PTIONS	
Option 1	W/O CRT READOUT	1158-000-1	. Sub \$400
Option 2	X-Y HORIZ COMP		. Add \$75
Option 3	EMI MODIFICATION .		Add \$75
Option 4	MAX BRIGHTNESS C	RT	Add \$350
Option 8	PHOSPHOR CHANGE	(P11)	No Charg
	7904 CONV	ERSION KITS	managar
040-0605-0	O CRT READOUT		\$400
040-0606-0	O X-Y HORIZ COMP .		\$75
040-0570-0	0 EMI MODIFICATION		\$95

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



- DC-to-200 MHz OPTIMUM PULSE RESPONSE
- DC-to-250 MHz BANDWIDTH OPTION
- 8 x 10 cm DISPLAY
- GREATER THAN 5 cm/ns WRITING SPEED
- FOUR-PLUG-IN FLEXIBILITY
- VERTICAL AND HORIZONTAL MODE SWITCHING
- VERSATILE TRIGGER SOURCE SELECTION
- CRT READOUT
- SIMPLIFIED DESIGN FOR GREATER RELIABILITY
- MODULAR
- PUSH-BUTTON SWITCHING
- COLOR-KEYED PANELS

The TEKTRONIX 7704A Oscilloscope System, R7704 Rackmount Oscilloscope, and their recommended plug-ins are called the TEKTRONIX 7700 FAMILY.



PLUG-IN VERSATILITY

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

- Digital Multimeter
- 45-ps Risetime TDR
- Digital Delay
- 525-MHz Direct Counter 1.8 GHz Spectrum Analyzer Sampling to 14 GHz

 - 10 μV/Div Differential
 - Universal Counter/Timer
- Curve Tracer
- Delay Line
- Dual Time Base
- 1 mA/Div Current Amplifier
 Differential Comparator
 Delayed Sweep
 - Mixed Sweep
- Single Trace Dual Trace
- Single Time Base
 Multi-Trace Combinations

250 MHz-7700 FAMILY-

VERTICAL SYSTEMS SPECIFICATIONS

				7704A			R7704			
PLUG-IN PERFORMANCE FE AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	SIG OUT BW	BW	Tr	SIG OUT BW	ACCURACY* WITHOUT PROBE	PRICE
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	170 MHz 180 MHz**	2.1 ns 2.0 ns	70 MHz	150 MHz	2.4 ns	60 MHz	2%	\$950
7A12	Dual-Channel Amplifier with DC Offset	5 mV/div	105 MHz	3.4 ns	60 MHz	105 MHz	3.4 ns	55 MHz	2%	\$900
7A13	Differential DC Offset	1 mV/div	P6053A 100 MHz	3.5 ns	60 MHz	100 MHz	3.5 ns	55 MHz	1.5%	\$1250
is mil si	High-Freq CMRR Amplifier	1 mv/div	P6055 65 MHz	5.4 ns	50 MHz	65 MHz	5.4 ns	45 MHz	1.0 70	ψ1230
7A14	AC Current Probe Amplifier	ug Can be	P6021 50 MHz	7.0 ns	40 MHz	50 MHz	7.0 ns	40 MHz		\$700
, Alt	(2 current probes)	1 mA/div	P6022 105 MHz	3.4 ns	55 MHz	105 MHz	3.4 ns	50 MHz	Bearling	
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	Adjustable	\$95
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	80 MHz	4.4 ns	55 MHz	75 MHz	4.7 ns	50 MHz	2%	\$535 (7A18) \$500 (7A18N)
7A19	Wide-Bandwidth 50-Ohm Input Amplifier	10 mV/div 20 mV/div	200 MHz 250 MHz**	1.8 ns 1.5 ns	80 MHz	175 MHz	2.0 ns	65 MHz	3%	\$500
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	\$575

System Environmental Specifications—Operating temperature range is from 0°C to $+50^{\circ}\text{C}$. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

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

*Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. 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%.

^{**}Obtained with 7704A Option 9 (\pm 20°C to \pm 30°C).

250-MHz Oscilloscope System 7704A



SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	64	Low Power Semiconductor Curve Tracer	\$ 400
Digital Delay Unit	7D11	65	Digital Time Delay Echo Time Delay Count by Events mode	\$1475
Digital Multimeter	7D13	67	Digital Multimeter Plus a unique Temperature Probe	\$ 560
Digital Counting	7D14	68	Directly Gated Counter to 525 MHz	\$1400
Universal Counter/ Timer	7D15	69	DC - 225 MHz Direct Count 8 Basic Modes	\$1475
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer	\$4850
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line	\$ 325
Sampling	7S11	74	Accepts Plug-In Sampling Heads	\$ 575
TDR and Sampling	7S12	74	TDR and Sampling Applications	\$1200
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Realtime Sampling	\$1625

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.

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

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 10.6 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 20 cm/ns. This writing speed reserve means reduced intensity setting for improved trace definition.

Characteristics are common to all mainframes unless noted.

VERTICAL SYSTEM

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

Option 9 Bandwidth Change (250 MHz) - 7704A vertical circuit performance is adjusted to extend frequency response to 250 MHz (upper -3 dB) when 7A19 is used. Provides additional performance for those working in the frequency domain.

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

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

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	TRIGGERING FREQ RANGE	PRICE
7B70	60	Delayed Sweep & Ext Amplifier	2 ns/div	DC to 200 MHz "	\$625
7B71	60	Delaying Sweep	2 ns/div	DC to 200 MHz	\$725
7B92	62	Display Switching	2 ns/div*	DC to 250 MHz*	\$1400

*Two faster calibrated sweep speeds (0.5 ns/div and 1 ns/div) and internal triggering to 500 MHz are available when used with the 7900-FAMILY main-

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

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

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.

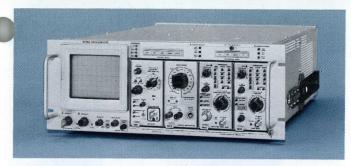
Option 4, Maximum Brightness CRT (7704A only)—Internal 4 x 5-cm graticule with variable illumination. Accelerating potential is 24 kV with P31 phosphor standard. This provides extremely high photographic and information writing speed and increases the visibility of low rep rate high speed signals.

Option 8, Phosphor Change (P11)—Specify P11 when ordering.

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	٧	RITING S	CAMERA	LENS		
enje licevijen en	P3	31	P1	11	MAG	
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA	A.O	
7704A	2.8	1.4	5.3	2.7	C-51-R	f/1.2 1:0.5
R7704 8 x 10 cm	1.1	0.6	2.2	1.1	C-52-R	f/1.4 1:1
7704A	5.0	2.5	10.0	5.0	C-51-R	f/1.1 1:0.5
Option 4 4 x 5 cm	2.0	1.0	4.3	2.2	C-52-R	f/1.4 1:1

¹Registered Trademark Polaroid Corporation.



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

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

Beam Finder-Limits display within graticule area.

External Z-Axis Input (7704A only)—2 V P-P for full intensity range. A positive signal blanks the trace. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC. Input is DC coupled.

External Z-Axis Inputs (R7704 only)—High Sensitivity Input: Minimum pulse width to blank trace is 30 ns at 2 V; 2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace, input R is 500 Ω within 10%. Maximum input voltage is 15 V (DC + Peak AC) and P-P AC. High Speed Input: 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 planks the trace; input R is $18 \text{ k}\Omega$ 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 $\text{M}\Omega).$ Internally selectable from A or B horizontal. Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω nominal.

+Gate—Positive-going rectangular waveform derived from A. B, or DELAYED gate, internally selectable. Output voltage is $0.5\,\mathrm{V}$ ($\pm\,10\%$) into $50\,\Omega$, $10\,\mathrm{V}$ ($\pm\,10\%$) into $1\,\mathrm{M}\Omega$. 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 (\pm 10%) into 50 Ω , 0.5 V/div (\pm 10%) into 1 $M\Omega$. The bandwidth depends upon vertical plug-in; see 7700-FAMILY Vertical System Specification Chart. Output R is 950 Ω nominal.

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

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

Camera Power-Three-contact 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 P6051 FET 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 M Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (+15°C to $+35^{\circ}$ C); within 2% (0°C to $+50^{\circ}$ C). Repetition rate is approx 1 kHz.

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

POWER REQUIREMENTS

Line Voltage Ranges—90 to 132 V AC and 180 to 264 V AC. Line Frequency— 48 to 440 Hz (7704A), 48 to 66 Hz (R7704).

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

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

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

Included Accessories—(For 7704A) 20-inch cable (two-pin-to-BNC) (175-1178-00). (For R7704) 42-inch BNC 50-Ω cable (012-0057-01); 20-inch cable (two-pin-to-BNC) (175-1178-00); current probe-to-oscilloscope cable (current-loop adapter) (012-0259-00); rackmounting hardware.

ORDERING INFORMATION

\$2400 \$2650
\$400
\$75
\$350
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\$75
\$75
\$50
400
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\$400
\$95
\$50
\$400
\$75
\$100

7600-FAMILY OSCILLOSCOPES

100-MHz Oscilloscope 7603

DC-to-100 MHz BANDWIDTH

CRT READOUT

NEW

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

The TEKTRONIX 7603 Oscilloscope, R7603 Rackmount Oscilloscope and their recommended plug-ins are called the TEK-TRONIX 7600 FAMILY.

The TEKTRONIX 7600 FAMILY provides a wide performance range through plug-in and mainframe versatility. The family is also compatible with 10 additional specialized plug-ins, expanding it beyond a general purpose measurement system.

Other 100-MHz mainframes are available, the TEKTRONIX 7613 and 7623 Storage Oscilloscopes, described in the Storage FAMILY and the TEKTRONIX 7603N Option 11 Ruggedized Oscilloscope described in the 50-MHz Ruggedized Oscilloscope System.



PLUG-IN VERSATILITY

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

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

Single Trace

- Single Time Base
- Multi-Trace Combinations
- 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
7A12	Dual-Channel Amplifier with DC Offset	5 mV/div	80 MHz	4.4 ns	55 MHz	2%	\$900
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053A 75 MHz	5.0 ns	55 MHz	1.5%	\$1250
	(XIII) OCE) SURANA EMPLOYA SATVA	in university	P6055 55 MHz	6.4 ns	45 MHz	geis rübiwonst	
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 50 MHz	7.0 ns	40 MHz		\$700
	MUD 1917	DINUNCT T-X	P6022 80 MHz	4.4 ns	50 MHz	A-TOKON GOON	
7A15A 7A15AN	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	65 MHz	5.4 ns	50 MHz	2%	\$280 (7A15A) \$250 (7A15AN
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	100 MHz	3.5 ns	60 MHz	2%	\$475
7A17	Low-Cost, Easy to Customize 50 Ω Input Amplifier	50 mV/div	100 MHz	3.5 ns	15 MHz	Adjustable	\$95
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	75 MHz	4.7 ns	50 MHz	2%	\$535 (7A18) \$500 (7A18N)
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	\$575

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.

*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	64	Low Power Semiconductor Curve Tracer	\$ 400
Digital Delay Unit	7D11	65	Digital Time Delay Echo Time Delay Count by Events mode	\$1475
Digital Multimeter	7D13	67	Digital Multimeter Plus a unique Temperature Probe	\$ 560
Digital Counting	7D14	68	Directly Gated Counter to 525 MHz	\$1400
Universal Counter/Timer	7D15	69	DC-225 MHz Direct Count 8 Basic Modes	\$1475
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer	\$4850
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line	\$ 325
Sampling	7S11	74	Accepts Plug-In Sampling Heads	\$ 575
TDR and Sampling	7S12	74	TDR and Sampling Applications	\$1200
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Real- Time Sampling	\$1625

VERTICAL SYSTEM

Channels—Two left-hand plug-in compartments; compatible with all 7000-Series plug-ins. Bandwidth determined by mainrame and plug-in unit, see 7600 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 with the 7B53A or 7B53AN.

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

Option 4, Maximum Brightness CRT—Internal 8 x 10-cm graticule with variable illumination. Accelerating potential is 18 kV with P31 phosphor standard, P11 optional.

Ption 8, Phosphor Change (Specify)—Standard CRT: P1, P2, P7, P11, P7SA (Phosphor/Spectrum Analyzer graticule combination); Maximum Brightness CRT: P11.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	TRIGGERING FREQUENCY RANGE	PRICE
7B50	58	Calibrated Time Base	5 ns/div	DC to 100 MHz	\$450
7B53A	59	Calibrated Mixed Sweep	5 ns/div	DC to 100 MHz	\$850
7B53AN	59 Low Cost, 5 ns/ Calibrated Mixed Sweep	5 ns/div	DC to 100 MHz	\$750	
7B53A Opt 5	59	TV Sync Separator Triggering	5 ns/div	DC to 100 MHz	\$910
7B53AN Opt 5	59	Low Cost, TV Sync Separator Triggering	5 ns/div	DC to 100 MHz	\$810

Minimum Photographic Writing Speed—Using Polaroid* film without film fogging. Can be increased by using the TEK-TRONIX Writing Speed Enhancer (see Camera Section for more information).

MAINFRAME	V	RITING S	CAMERA	LENS		
	P31		P1	11		
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA	- III 189,1	
Standard 8 X 10 div (1.22 cm/div)	980	490	1320	660	C-51-R	f/1.2 1:0.5
	180	90	245	125	C-59-R	f/2.8 1:0.67
Option 4 8 X 10 cm	1500	750	2000	1000	C-51-R	f/1.2 1:0.5
	300	150	400	200	C-59-R	f/2.8 1:0.67

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 M Ω). Output voltage is 50 mV/div (±15%) into 50 Ω , 1 V/div (±10%) into 1 M Ω . Output R is 950 Ω within 2%.

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

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm\,10\%$) into 50 $\Omega,~0.5$ V/div ($\pm\,10\%$) into 1 M $\Omega.$ 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.

^{*}Registered Trademark Polaroid Corporation

7600-FAMILY OSCILLOSCOPES

7603 100-MHz Oscilloscope



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 M Ω ; 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 \pm 10%; internally selectable with quick-change jumpers.

Line Frequency-50 Hz to 400 Hz (7603), 50 Hz to 66 Hz (R7603).

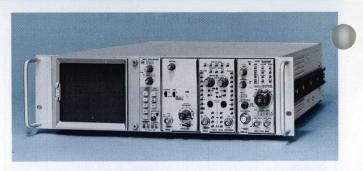
Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7603 to 50 - 400 Hz operation (not required for 7603).

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

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



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

ORDERING INFORMATION

(Plug-ins not included)

	(riag mo not moraca)	
7603 OSC	LLOSCOPE	\$1600
R7603 OS	CILLOSCOPE	\$1700
	7603 OPTIONS	
Option 1	W/O CRT READOUT	Sub \$400
Option 3	EMI MODIFICATION	Add \$75
Option 4	MAX BRIGHTNESS CRT	Add \$75
Option 7	W/O SIG OUT/IN	Sub \$50
Option 8	PHOSPHOR CHANGE (Specify) (P1, P2, P7, P7/SA, P11 Available)	No Charge
		uig bal-lame
Ontion 1	W/O COT DEADOUT	Cub 6400

	R/603 OPTIONS
Option 1	W/O CRT READOUT Sub \$400
Option 3	EMI MODIFICATION Add \$50
Option 4	MAX BRIGHTNESS CRT Add \$75
Option 5	LINE FREQ CHANGE (50 - 400 Hz) Add \$100 (Not required for 7603)
Option 7	W/O SIG OUT/IN Sub \$50
Option 8	PHOSPHOR CHANGE (Specify) No Charge (P1, P2, P7/SA, P11 Available)

	7603 CONVERSION KITS		
040-0630-00	CRT READOUT	\$4	400
040-0631-00	EMI MODIFICATION	\$	100
040-0629-00	SIG OUT/IN		\$50

	R7603 CONVERSION KITS	
040-0630-00	CRT READOUT	\$400
	EMI MODIFICATION	
040-0633-00	SIG OUT/IN	\$50

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





- 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 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 7603N Option 11S Ruggedized 50-MHz Oscilloscope System meets rigid environmental and electrical specifications required by the military. The complete system is qualified unler MIL-O-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.

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

CHARACTERISTICS ENVIRONMENTAL

Temperature—Nonoperating -62° C to $+75^{\circ}$ C, operating -28° C to $+65^{\circ}$ C.

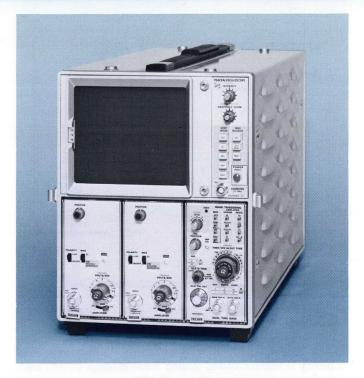
 ${f Humidity}{=}0$ to 95% RH over entire temperature range, operating or nonoperating.

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 \pm 0.012 inches P-P amplitude, 16 to 25 Hz at 0.040 inches \pm 0.008 inches P-P amplitude, 26 to 33 Hz at 0.020 inches \pm 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 nigitudinal axis as per MIL-S-901 for Grade A, Class 1, Type A for lightweight equipment.

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



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

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

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

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

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

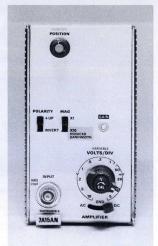
Reliability—Optimum performance and reliable service is provided during continuous or interrupted operation. The MIL-0-24311(EC) MTBF requirement of greater than 600 hours is met as tested under the following conditions: Temperature $+40^{\circ}$ C $\pm 2^{\circ}$ C; Relative Humidity 70% $\pm 5\%$; 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.

RUGGEDIZED OSCILLOSCOPE SYSTEM NEW 7603N Option 11S



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 50 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 7 ns with less than 2% aberrations.

Input R and C— 1 M Ω 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 READ-OUT).

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 a 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 ($\pm 10\%$) are available. Input R and C for 7B53AN Option 11 is 1 M Ω 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— $0.05 \,\mu\text{s/div}$ to $5 \,\text{s/div}$ in 25 steps (1-2-5 sequence). $5 \,\text{ns/div}$ fastest calibrated sweep rate, obtained with X10 magnifier. The uncalibrated variable is continuous between steps and to $12.5 \,\text{s/div}$.

Sweep Accuracy—Within 3% from 0.05 μ s/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 μ s/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 \div 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 M Ω 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 M Ω 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 $0.5\,\mu\text{s}/\text{div}$, within 4% for all other sweep rates except the magnified X10 sweep rate of 5 ns/div which is within 6%.

CRT

Accelerating Potential—15 kV.

Phosphor—P31.

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



Graticule—Internal 8 x 10 cm with variable illumination. The 1/2-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. Internal controls are Astigmatism and Trace Rotation.

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%.

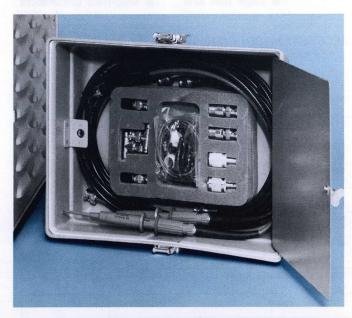
Horizontal—Main Sweep +5 V, Delayed Sweep +5 V, Main Sweep Gate +2 V, Delayed Sweep Gate +2 V, Delayed Trigger +1 V with pulse width of greater than 50 ns. All amplitudes are minimum and measured when working into at least 100 k Ω and 15 pF.

POWER REQUIREMENTS

Input Voltage— 100, 110, 120, 220 and 240 \pm 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 NC cables (012-0366-00); two BNC female to UHF male adapters (103-0015-00); two BNC male to UHF female adapters (103-0032-00); two BNC male to binding post adapters (103-0033-00); two BNC T connectors (103-0030-00). One set of technical manuals (not packaged in cover).

DIMENSIONS AND WEIGHTS

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

ORDERING INFORMATION

7603N Option 11S OSCILLOSCOPE SYSTEM (AN/USM-281C) ... \$3025 System Includes—One each 7603N Option 11 Oscilloscope, Two each 7A15AN Option 11 Amplifier Plug-ins, One each 7B53AN Option 11 Time Base, and One each C281 Cover with Accessories.

To Order Separately:

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

System Without MIL-Nomenclature

7603N Option 11SA OSCILLOSCOPE SYSTEM \$3025 System Includes—One each 7603N Option 11A Oscilloscope, Two each 7A15AN Option 11A Amplifier Plug-ins, One each 7B53AN Option 11A Time Base, and One each C281A Cover with Accessories.

To Order Separately:

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

Blue shading quirements

indicates the specification exceeds MIL-0-24311(EC) re-

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

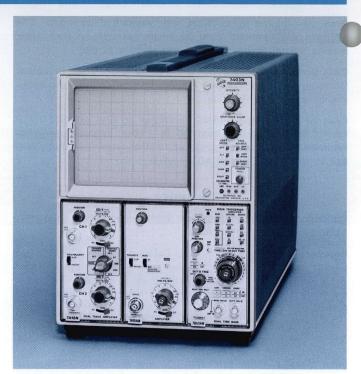
7400-FAMILY OSCILLOSCOPES 7403N 60-MHz Oscilloscope



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

The TEKTRONIX 7403N Oscilloscope, R7403N Rackmount Oscilloscope and their recommended plug-ins are called the TEKTRONIX 7400 FAMILY.

The TEKTRONIX 7400 FAMILY provides a wide performance range through plug-in and mainframe versatility. The family is also compatible with 6 additional specialized plug-ins, expanding it beyond a general purpose measurement system.



PLUG-IN VERSATILITY

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

- Sampling to 14 GHz
- 1.8-GHz Spectrum Analyzer
- Differential Comparator
- Dual Time Base
- Single Trace

- Delay Line
- 1 mA/Div Current Amplifier Curve Tracer
- Delayed Sweep
- Dual Trace

- 45-ps Risetime TDR 10 μ V/DIV Differential
- Mixed Sweep
- Single Time Base
- Multi-Trace Combinations

60 MHz — 7400 FAMILY — VERTICAL SYSTEM SPECIFICATIONS

PLUG-IN AMPLIFIER	PERFORMANCE FEATURE	MIN DEFL FACTOR	BW	Tr	ACCURACY* WITHOUT PROBE	PRICE	
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	60 MHz	5.9 ns	2%	\$950	
7A12	Dual-Channel Amplifier with DC Offset	5 mV/div	55 MHz	6.4 ns	2%	\$900	
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6053A 55 MHz	6.4 ns	4.50/	\$1250	
	340320111320	tt weiten Wither	P6055 45 MHz	7.8 ns	1.5%		
7A14	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 40 MHz	8.8 ns		\$700	
	TUNE BASE PENICHN	I nongo MACCH	P6022 55 MHz	6.4 ns			
7A15A 7A15AN	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	50 MHz	7.0 ns	2%	\$280 (7A15A) \$250 (7A15AN	
7A16A	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	60 MHz	5.9 ns	2%	\$475	
7A17	Low-Cost, Easy to Customize 50 Ω Input Amplifier	50 mV/div	50 MHz	7.0 ns	Adjustable	\$95	
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	50 MHz	7.0 ns	2%	\$535 (7A18) \$500 (7A18N)	
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1.0 MHz ±10%	350 ns ±9%	2%	\$575	

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

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

*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%.

7400-FAMILY OSCILLOSCOPES 60-MHz Oscilloscope 7403N

SPECIALIZED PLUG-INS

MEASUREMENT REQUIREMENT	PLUG-IN	PAGE	PERFORMANCE FEATURE	PRICE
Curve Tracing	7CT1N	64	Low Power Semiconductor Curve Tracer	\$400
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer	\$4850
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line	\$325
Sampling	7S11	74	Accepts Plug-In Sampling Heads	\$575
TDR and Sampling	7S12	74	TDR and Sampling Applications	\$1200
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Real- Time Sampling	\$1625

CHARACTERISTICS VERTICAL SYSTEM

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

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

Chopped Mode-Repetition rate is approximately 1 MHz.

Delay Line—Permits viewing leading edge of displayed waveform.

HORIZONTAL SYSTEM

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

Internal Trigger Modes—LEFT VERT, VERT MODE, RIGHT

Fastest Calibrated Sweep Rate-5 ns/div with the 7B53AN.

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

CRT

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

Option 4, Maximum Brightness CRT—Internal 8 x 10-cm graticule with variable illumination. Accelerating potential is 18 kV with P31 phosphor standard, P11 optional.

Option 8, Phosphor Change (Specify)—Standard CRT: P1, P2, P7, P11, P7/SA (Phosphor/Spectrum Analyzer graticule combination); Maximum Brightness CRT: P11.

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	TRIGGERING FREQUENCY RANGE	PRICE	
7B50	58	Calibrated Time Base	5 ns/div	DC to 100 MHz	\$450	
7B53AN 59 Low Cost, Calibrated Mixed Swee			5 ns/div	DC to 100 MHz		
7B53AN Opt. 5	59	Low Cost, TV Sync Separator Triggering	5 ns/div	DC to 100 MHz	\$810	

Minimum Photographic Writing Speed—Using Polaroid¹ film without film fogging. Can be increased by using the TEKTRONIX Writing Speed Enhancer (see Camera Section for more information).

MAINFRAME	V	RITING S	CAMERA	LENS		
	P31		P1	1		
	10,000 ASA	3000 ASA	10,000 ASA	3000 ASA		
8 x 10 div Standard	980	490	1320	660	C-51-R	f/1.2 1:0.5
(1.22 cm/ div)	180	90	245	125	C-59-R	f/2.8 1:0.6
Option 4 8 x 10 cm	1500	750	2000	1000	C-51-R	f/1.2 1:0.5
	300	150	400	200	C-59-R	f/2.8 1:0.6

Beam Finder-Limits display within graticule area.

EXTERNAL Z-AXIS INPUT

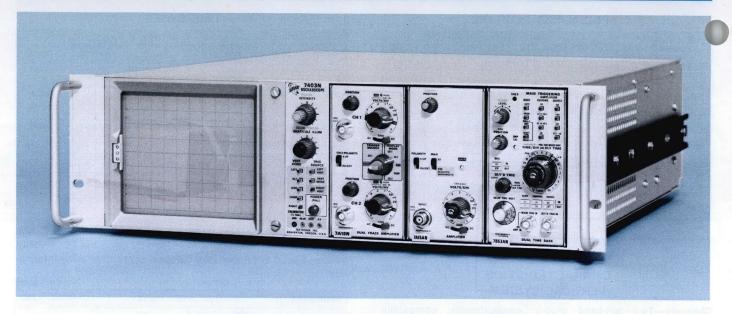
2 V P-P for full intensity range from DC to 2 MHz, intensity range diminishes to 20% of full range at 10 MHz. A positive signal blanks the trace. Maximum input voltage is 10 V (DC + Peak AC) and P-P AC.

CAMERA POWER OUTPUT

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

¹Registered Trademark Polaroid Corporation





The R7403N requires only 5-1/4 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

	74	103N	R7	403N
	in in	cm	in	cm
HEIGHT	11.4	28.9	5.25	13.3
WIDTH	8.7	22.1	19.0	48.2
LENGTH	24.0	60.9	24.7	62.9
	lb	kg	lb .	kg
NET WEIGHT	30.0	13.6	30.0	13.6
DOMESTIC SHIPPING WEIGHT	≈42.0	≈19.0	≈42.0	≈19.0
EXPORT- PACKED WEIGHT	≈55.0	≈25.0	≈55.0	≈25.0

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 M Ω ; 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 $\pm\,$ 10%; internally selectable with quick-change jumpers.

Line Frequency— 48 Hz to 440 Hz (7403N), 48 Hz to 66 Hz (R7403N).

Option 5, Line Frequency Change (48 - 440 Hz)—Converts the R7403N to 48 - 440 Hz operation (not required for 7403N).

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

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

ORDERING INFORMATION (Plug-ins not included)

7403N OS	CILLOSCOPE \$950
	SCILLOSCOPE \$1050
	7403N OPTIONS
Option 4	MAX BRIGHTNESS CRT Add \$75
Option 8	PHOSPHOR CHANGE (Specify) No Charge (P1, P2, P7, P7/SA, P11 Available)
	R7403N OPTIONS
Option 4	MAX BRIGHTNESS CRT Add \$75
Option 5	LINE FREQ CHANGE (48 - 440 Hz) Add \$50 (Not required for 7403N)
Ontion 8	PHOSPHOR CHANCE (Specify) No Charge

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(P1, P2, P7/SA, P11 Available)





- STORAGE FEATURES
 - PRINCIPLES OF OPERATION
 - GLOSSARY
 - APPLICATIONS
 - STORAGE OSCILLOSCOPE SELECTION CHART

STORAGE FEATURES

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

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

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

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

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

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

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

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

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

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

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

PRINCIPLES OF OPERATION

7623/R7623: Multimode Storage—Multimode Storage provides four modes of operation in one instrument: a FAST mode for fast stored writing speed requirements; a VARIABLE PERSISTENCE (HALFTONE) mode for bright, high contrast or halftone displays; a BISTABLE mode for slow stored writing speed requirements; and a NONSTORE mode for conventional oscilloscope applications. The FAST and BISTABLE modes give long stored viewing times.

Fast Bistable Storage is an industry first. With it come: a fast stored writing speed and a long viewing time. (Previous storage oscilloscopes had to compromise between writing speed and viewing time).

The Fast Bistable operation is possible through a TEKTRONIX proprietary mesh-to-mesh transfer storage CRT. In this CRT, the image is first briefly stored on a high-speed, short retention target/mesh. It then is transferred to a low-speed, long retention Bistable Storage target/mesh. This target/mesh, in turn, modulates the flow of flood (viewing) electrons maintaining the image on the CRT until it is erased.

A second mode of operation in the 7623/R7623 is Variable Persistence (Halftone Storage). Whereas, Fast Bistable Storage and Bistable Storage give only one level of brightness for the written image, Variable Persistence Storage stores data with several levels of brightness. The display can be made to gradually fade away with a Variable Persistence control; this results from operating the CRT at different potentials than with the two Bistable functions.

This Variable Persistence feature comes about from a characteristic of Halftone Storage CRT's: namely, unwritten areas of the storage target/mesh begin to fade positive (become written) due to positive ion generation in the flood electron system of the CRT. This causes the entire screen to reach a stored condition within just a few minutes, making the desired stored image no longer visible.

7000-SERIES STORAGE FAMILY

Reference



To prevent this fade positive action and to provide for optimum viewing of the stored image, the entire storage target/mesh is slowly erased during operation. The amount of erasure can be controlled with a front-panel "Persistence" control—hence the term Variable Persistence.

Bistable Storage, also featured in the 7623 and R7623, uses the low-speed, long retention storage target/mesh as in the previous type. The high-speed, short retention target/mesh, however, is not used.

7613/R7613: Variable Persistence Storage (Halftone Storage)—Technology in Variable Persistence Storage developed in the 7623/R7623 is available in the 7613/R7613. Its storage CRT, however, has been optimized for a faster stored writing speed than in the Multimode CRT. Variable Persistence Storage stores data with varying levels of brightness. Trace persistence can be varied with a front-panel "Persistence" control. This feature permits one waveform to be faded out while another appears. Or, the trace may be stored for as long as 60 minutes.

Inherent with Variable Persistence Storage is the ability to see

a trace build up while integrating low repetition rate, fast risetime signals.

Variable Persistence gives a bright, high contrast display of fast risetime, low repetition rate signals; it is ideal for spectrum analysis. Conventional nonstore operation is possible with push-button ease.

7313/R7313: Bistable Phosphor Storage—Using already proven designs, the CRT's in these oscilloscopes use a common medium for both storing and viewing functions. This affords an efficient and economical storage instrument. Split-screen Storage is featured; the storage target consists of two screens which are electrically insulated from each other. This means that either half of the CRT can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half (or both halves). For example, a stored display can be compared simultaneously with a conventional display. Or a test or standard signal can be stored on one half of the screen and compared in detail with successive signals displayed on the other half.

Bistable Phosphor Storage adds a lower cost, high performance instrument to the storage selection list.

GLOSSARY

The following glossary of storage terms is provided to aid your understanding of TEKTRONIX 7000-Series Storage Oscilloscopes.

auto erase—An operating mode for automatically restoring a Bistable or Bistable Phosphor Storage target to its unwritten state. Auto erase circuitry provides adjustable stored viewing times, automatic display erasure and subsequent sweep arming.

bistable phosphor storage—A directly viewed storage display whose phosphor has two stable states, written and unwritten. The written portion is brighter than the background (unwritten portion). Bistable Phosphor Storage is a TEKTRONIX innovation developed in 1962.

bistable storage—The slow writing speed mode of the TEK-TRONIX Multimode Storage tube. This type of storage has only two stable states—written and unwritten. When viewed, the written portion is brighter than the background (unwritten portion).

direct-view storage—A display with one storage medium serving two purposes; i.e., storing and displaying. The Bistable Phosphor Storage CRT is an example of a Direct-View Storage device. Its phosphor stores (written and unwritten) and is directly viewed (written = bright), (unwritten = background).

enhance mode—An operating mode which momentarily changes the CRT electrode potentials in a storage tube to increase stored writing performance.

erase mode—An operating mode which momentarily changes the CRT electrode potentials in a storage tube in such a manner that previously stored information is removed. There are two steps in a complete erasure: (1) remove the previously written trace; and (2) return the storage target to a ready-to-write state.

erase time—The time needed for the stored display to be erased.

fast bistable storage—The fast writing speed mode of the TEK-TRONIX Multimode Storage tube. Fast waveforms (up to 200 cm/ μ s) are written and stored on a high-speed, short retention

target/mesh and then immediately transferred (mesh-to-mesh transfer) to a low-speed, long retention Bistable target. This target, in turn, modulates the transmission of flood (viewing) electrons maintaining the image on the CRT.

flood electrons—Electrons emitted by flood guns in a storage CRT; flood electrons are necessary for storage operation.

halftone storage (variable persistence storage)—The storing of data with several levels of brightness. This is one of four operating modes of the TEKTRONIX Multimode Storage tube (7623/R7623). This is the only storage mode of the Variable Persistence Storage tube (7613/R7613). Note: The terms "Halftone Storage," "Variable Persistence Storage," and "Variable Persistence" may sometimes be used interchangeably.

integrate—An operating mode used with repetitive sweeps to increase the effective stored writing speed. Integration interrupts flooding of the storage target and permits the writing gun electrodes to sum over several sweeps.

level—A control for changing effective storage sensitivity of the Variable Persistence Storage tube; e.g., adjusting the level control will increase or decrease the time required for developing the viewed, stored image. A faster image development is accomplished with only a slight increase in CRT background brightness.

split-screen storage—A horizontal division of the Bistable Phosphor Storage target into separate sections, each one with independent drive circuitry and controls. Split-screen Storage allows both stored and conventional operation at the same time.

stored writing speed—The upper speed (centimeters or divisions per millisecond or microsecond) at which the writing beam will register stored information when scanning on the storage target, under stated conditions of operation.

TEKTRONIX multimode storage—Three modes of storage (Fast Bistable, Variable Persistence and Bistable) plus one conventional mode (nonstorage) available in the 7623/R7623 Storage Oscilloscopes.





variable persistence—A control for increasing or decreasing stored image retention time in Variable Persistence Storage tubes (7623/R7623 and 7613/R7613). Note: The terms "Variable Persistence," "Variable Persistence Storage," and "Halftone Storage" may sometimes be used interchangeably.

variable persistence storage (halftone storage)—The storing of data with several levels of brightness; the display can be

made to gradually fade away with a variable persistence control. This is one of four operating modes of the TEKTRONIX Multimode Storage tube (7623/R7623). This is the only storage mode of the Variable Persistence Storage tube (7613/R7613). Note: The terms "Variable Persistence Storage," "Variable Persistence," and "Halftone Storage" may sometimes be used interchangeably.

APPLICATIONS

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

- (1) Observing changes in a signal: making circuit adjustments; setting up a circuit or system where many set ups are needed before arriving at the final configuration; recording tests of near yield limits where repeated testing would change the characteristics of the tested device; checking for repeatability of a signal; noting the effects of jitter, drift, etc. on a signal versus time or environment.
- (2) Comparing two or more signals: checking out design or production components against a standard; comparing a complex digital waveform with a reference; comparing X-Y plots over long viewing times; and (sometimes) replacing X-Y recorders, strip chart or other graphic recorders.
- (3) Reducing annoying flicker on low repetition rate signals, such as power line signals, TV field signals, and low duty cycle digital signals.

- (4) Observing the entire display of a slowly occurring signal, such as the slowly moving trace of a spectrum analyzer, a sampling system, or a digital waveform.
- (5) Increasing the brightness of a repetitive signal, such as very fast risetime, low repetition rate pulses.
- (6) Reducing the brightness of noise on a signal when the noise occurs randomly, and the signal, periodically.
- (7) Unattended oscilloscope monitoring when waiting for transients to occur, mechanical stress, or other unpredictable signals in nuclear, medical, mechanical, or electronic fields.
- (8) Photographing a display when many set ups are needed or for a multitrace display; the storage oscilloscope helps reduce film costs expended during the set up and positioning of the different traces.
- (9) Troubleshooting intermittents and looking for cause-andeffect relationships; a dual-trace storage oscilloscope can be used to monitor the equipment unattended and record the trouble as it occurs.

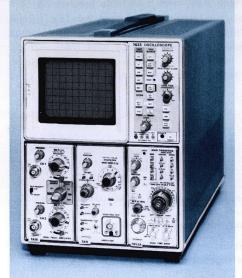
STORAGE OSCILLOSCOPE SELECTION CHART

OSCILLOSCOPE	PAGE	PERFORMANCE FEATURES	MEASUREMENT REQUIREMENTS AND APPLICATIONS (Refer to above applications)				
7623/R7623	45	Multimode Storage 200 cm/ μ s stored writing speed	4-in-1 operation: Fast Bistable, Variable Persistence, Bistable and nonstore				
		Long viewing time	Applications: all				
		A PART OF THE PROPERTY OF THE PART OF THE	Captures high-speed single-shot events				
	12.7	DC-to-100 MHz bandwidth	Stores for long viewing time				
7613/R7613	47	Variable Persistence	Variable Persistence and nonstore operation				
	- 1 - 4	DC-to-100 MHz bandwidth	Applications: 1, 2, 3, 4, 5, 6				
			Especially useful when a high contrast is needed betweer stored image and CRT background				
7313/R7313	48	Split-screen Bistable Storage	Split-screen Bistable and nonstore operation				
		DC-to-25 MHz bandwidth	Applications: all except number 6				

NEW









7623

- 200 cm/µs STORED WRITING SPEED
- MULTIMODE STORAGE
- DC-to-100 MHz BANDWIDTH

- 7613
- VARIABLE PERSISTENCE STORAGE
- DC-to-100 MHz BANDWIDTH

7313

- SPLIT-SCREEN BISTABLE STORAGE
- DC-to-25 MHz BANDWIDTH

FAMILY FEATURES

- VERSATILE TRIGGER SOURCE SELECTION
- **VERTICAL MODE SWITCHING**
- THREE-PLUG-IN FLEXIBILITY

- COLOR-KEYED PANELS
- PUSH-BUTTON SWITCHING
- LIGHTWEIGHT

EXTREMELY BURN RESISTANT CRT

- LONG VIEW TIME
- 51/4-INCH RACKMOUNT
- CRT READOUT

PLUG-IN VERSATILITY

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

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

STORAGE FAMILY — VERTICAL SYSTEM SPECIFICATIONS

AMPLIFIER PLUG-IN	PERFORMANCE FEATURE	MIN DEFL	73	13	7613 and 7623					ACCURACY*	
		FACTOR	BW (MHz)	Tr (ns)	BW (MHz)	Tr (ns)	BW (MHz)	Tr (ns)	SIG OUT BW (MHz)	WITHOUT	PRICE
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	25	14	0° C to	+35° C 3.5	+35° C to	+50° C	60	2%	\$950
7A12	Dual-Channel Amplifler with DC Offset	5 mV/div	25	14	80	4.4	75	4.7	55	2%	\$900
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	P6065 25	14	75	4.8	70	5.0	55	1.5%	\$1250
		ank patwork	P6055 24	15	55	6.4	55	6.4	45		
	AC Current Probe Amplifier (2 current probes)	1 mA/div	P6021 24	15	50	7.0	45	7.8	40	61	\$700
		2 4 4 5	P6022 25	14	80	4.4	75	4.7	50		
7A15A 7A15AN	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)†	25	14	65	5.4	60	5.9	50	2%	\$280 (7A15A) \$250 (7A15AN
7A16A	Wide-Bandwldth Conventional Input Amplifier	5 mV/div	25	14	100	3.5	90	3.9	60	2%	\$475
7A17	Low-Cost, Easy to Customize 50 Ω Amplifier	50 mV/div	25	14	100	3.5	90	3.9	15	Adjustable	\$95
7A18 7A18N	Dual-Channel Amplifier	5 mV/div	25	14	75	4.7	70	5.0	50	2%	\$535 (7A18) \$500 (7A18N)
7A22	DC-Coupled, High Gain Differential Amplifier	10 μV/div	1 ± 10%	350 ns ±9%	1 MHz ±10%	350 ns ±9%	1 ± 10%	350 ± 9%	1 ± 10%	2%	\$575

System Environmental Specifications-Operating temperature range is from 0°C to $+50^{\circ}\text{C}$ (except where noted). Operating altitude to 15,000 feet. Non-operating to 50,000 feet.

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

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

NEW

TIME BASES

TIME BASE	PAGE	PERFORMANCE FEATURE	MAX SWEEP RATE	FREQUENCY TRIGGERING RANGE	PRICE
7B50	58	Calibrated Time Base	5 ns/div	DC - 100 MHz	\$450
7B53A	59	Calibrated Mixed Sweep	5 ns/div	DC - 100 MHz	\$850
7B53AN	59	Low cost, Calibrated Mixed Sweep	5 ns/div	DC - 100 MHz	\$750
7B53A Opt 5	59	TV Sync Separator Triggering	5 ns/div	DC - 100 MHz	\$910
7B53AN Opt 5	59	Low cost, TV Sync Separator Triggering	5 ns/div	DC - 100 MHz	\$810

7000-SERIES STORAGE FAMILY

There are six models to choose from in the TEKTRONIX 7000-Series Storage FAMILY: three cabinet models and three 5¼-inch rackmount versions. Each mainframe has three-plug-in versatility and is compatible with the 27 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	64	Low Power Semiconductor Curve Tracer	\$ 400
Digital Delay Unit	7D11	65	Digital Time Delay Echo Time Delay Count by Events mode	\$1475
Digital Multimeter	7D13	67	Digital Multimeter Plus a unique Temperature Probe	\$ 560
Digital Counting	7D14	68	Directly Gated Counter to 525 MHz	\$1400
Universal Counter/Timer	7D15	69	DC-225 MHz Direct Count 8 Basic Modes	\$1475
Spectrum Analysis	7L12	71	100 kHz to 1.8 GHz Spectrum Analyzer	\$4850
Delay Line	7M11	77	High Quality Dual 50-Ω Delay Line	\$ 325
Sampling	7811	74	Accepts Plug-In Sampling Heads	\$ 575
TDR and Sampling	7S12	74	TDR and Sampling Applications	\$1200
Sampling Sweep	7T11	76	Random or Sequential, Equivalent or Real- Time Sampling	\$1625

Transfer Storage Oscilloscope 7623 NEW

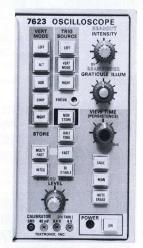
 $200 \text{ cm}/\mu\text{s}$ STORED WRITING SPEED

LONG VIEW TIME

MULTIMODE STORAGE

DC-to-100 MHz BANDWIDTH

EXTREMELY BURN RESISTANT CRT



The TEKTRONIX 7623 (Option 12) Storage Oscilloscope de-

livers $200\,\mathrm{cm}/\mu\mathrm{s}$ Stored Writing Speed. The standard 7623 performs at $100\,\mathrm{div}/\mu\mathrm{s}$ (0.9 cm/div). A new proprietary TEK-TRONIX storage CRT is used to achieve these fast stored writing speeds. The CRT incorporates a special high-speed target and uses a unique mesh-to-mesh transfer technique. This unparalleled design and operation provides the extremely fast wrting speed without compromising viewing time. This means stored traces can be viewed for hours or even days, without fading. The CRT is extremely burn resistant. This means that there are no special operating precautions to be observed.

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

VERTICAL SYSTEM

hannels—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 with the 7B53A or 7B53AN.

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

CRT AND DISPLAY FEATURES

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

Option 12, Fast Writing Speed CRT—Offers $200~{\rm cm}/\mu{\rm s}$ stored writing speed. Internal 8 x 10-div (0.9 cm/div) graticule with variable illumination.

Accelerating Potential-8.5 kV.

Phosphor—P31.

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

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

^{*}Measured over center 4 x 5 div area, derated towards display edges.

**May be extended by selecting SAVE mode.

NEW

7623 Transfer Storage Oscilloscope

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C.L CANO

Persistence—(Variable Persistence mode only) Continuously variable, persistence may be turned off when not needed.

Auto Erase—Viewing time continuously variable up to 12 s. The sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep, the stored display is retained and further sweeps are locked out for the viewing interval selected by the VIEW TIME control. Then, the display is erased and the time base is enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MANUAL control.

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

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

External Z-Axis Input—2 V P-P for 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 M Ω). Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω within 2%.

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

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . The bandwidth depends upon vertical plug-in, see Storage 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.

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 M Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% ($+15^{\circ}$ C to $+35^{\circ}$ C); within 2% (0°C to $+50^{\circ}$ 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 \pm 10%; internally selectable with quick-change jumpers.

Line Frequency-50 Hz to 66 Hz.

Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7623 to 50 - 400 Hz operation (not available for 7623).

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

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

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

ORDERING INFORMATION

(Plug-ins not included)

7623 STORAGE OSCILLOSCOPE	 \$2850
R7623 STORAGE OSCILLOSCOPE	\$2950

7623 OPTIONS

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

R7623 OPTIONS

W/O COT DEADOUT

Option 1	W/U CRI KEADUUI	2np	\$400	
Option 3	EMI MODIFICATION	Add	\$50	
Option 5	LINE FREQ CHANGE (50 - 400 Hz)(Not available for 7623)	Add	\$100	
Option 7	W/O SIG OUT/IN	Sub	\$50	
Option 12	FAST WRITING SPEED CRT	Add	\$500	

7623 CONVERSION KITS

040-0630-00	CRT	READOUT	. \$400
040-0631-00	EMI	MODIFICATION	. \$100
040-0629-00	SIG		\$50

R7623 CONVERSION KITS

040-0630-00	CRT	READOUT	\$400
040-0632-00	EMI	MODIFICATION	\$7
040-0633-00	SIG	OUT/IN	\$50

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



Variable Persistence Storage Oscilloscope 7613 NEW



- DC-to-100 MHz BANDWIDTH
- EXTREMELY BURN RESISTANT CRT



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

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 with the 7B53A or 7B53AN.

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 \times 10 div (0.9 cm/div) graticule with variable illumination.

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

Accelerating Potential-8.5 kV.

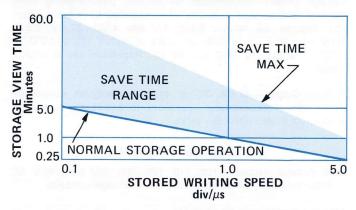
Phosphor—P31.

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

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

Stored Writing Speed—Greater than $5 \text{ div}/\mu s$.

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



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.

External Z-Axis Input— $2\,\text{V}$ P-P for full intensity range from DC to $2\,\text{MHz}$, intensity range diminishes to 20% of full range at $10\,\text{MHz}$. A positive signal blanks the trace. Maximum input voltage is $10\,\text{V}$ (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 M Ω). Output voltage is 50 mV/div (\pm 15%) into 50 Ω , 1 V/div (\pm 10%) into 1 M Ω . Output R is 950 Ω within 2%.

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

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 Ω , 0.5 V/div ($\pm 10\%$) into 1 M Ω . The bandwidth depends upon vertical plug-in, see Storage 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.

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 M Ω ; 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 \pm 10%; internally selectable with quick-change jumpers.

Line Frequency-50 Hz to 66 Hz.

Option 5, Line Frequency Change (50 - 400 Hz)—Converts the R7613 to 50 - 400 Hz operation (not available for 7613).

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

DIMENSIONS AND WEIGHTS

Please refer to the 7623 dimensions and weights chart.

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.

(Plug-ins not included)	4
7613 STORAGE OSCILLOSCOPE	. \$2500
R7613 STORAGE OSCILLOSCOPE	
7613 OPTIONS	
Option 1 W/O CRT READOUT S	ub \$400
Option 3 EMI MODIFICATION A	dd \$75
Option 6 SPECIAL INT GRATICULE (Spectrum Analyzer) No	Charge
Option 7 W/O SIG OUT/IN	ub \$50
R7613 OPTIONS	
Option 1 W/O CRT READOUT S	ub \$400
Option 3 EMI MODIFICATION A	dd \$50
Option 5 LINE FREQ CHANGE (50 - 400 Hz) A (Not available for 7613)	dd \$100
Option 6 SPECIAL INT GRATICULE (Spectrum Analyzer) No	o Charge
Option 7 W/O SIG OUT/IN	Sub \$50
7613 CONVERSION KITS	
040-0630-00 CRT READOUT	\$400
040-0631-00 EMI MODIFICATION	\$100
040-0629-00 SIG OUT/IN	\$50
R7613 CONVERSION KITS	
040-0630-00 CRT READOUT	\$400

ORDERING INFORMATION

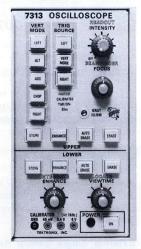
U.S. Sales Prices FOB Beaverton, Oregon Please refer to General Information page

040-0632-00 EMI MODIFICATION

040-0633-00 SIG OUT/IN

NEW 7313 Bistable Storage Oscilloscope

- SPLIT-SCREEN BISTABLE STORAGE
- DC-to-25 MHz BANDWIDTH
- EXTREMELY BURN RESISTANT CRT



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

The split-screen storage CRT provides the convenience of storage and conventional displays on the same CRT at the same time. This capability is useful in many applications. For instance, the operator may wish to store a reference trace and then view the change in waveform characteristics as he varies

circuit components. He does this easily by operating half of the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

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 with the 7B53A/AN. 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) nonilluminated graticule. 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.

Bistable Storage Oscilloscope 7313 NEW

Phosphor-P1.

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

Storage View Time-Up to 4 hours.

Auto Erase View Time Range— 0.5 or less to at least 12 s after end of sweep.

Erase Time-300 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 12 s. The sequence begins with the arrival of the signal. The signal initiates a sweep. After each sweep, the stored display is retained and further sweeps are locked out for the viewing interval selected by the VIEW TIME Control. Then, the display is erased and the time-base is enabled for the next sweep. This cycle will automatically repeat itself as long as a signal is available. The stored display may also be erased by the MAN-UAL control.

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

Beam Finder-Limits display within graticule area.

OUTPUTS/INPUTS

+Sawtooth—Sawtooth starts 1 V or less from ground (into 1 M Ω). Output voltage is 50 mV/div (±15%) into 50 Ω , 1 V/div (±10%) into 1 M Ω . 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 M Ω . Risetime is 20 ns or less into 50 Ω , output R is 950 Ω within 2%. Source is selectable from Main, Delayed or Auxiliary Gate.

Sig Out—Selected by TRIGGER SOURCE switch. Output voltage is 25 mV/div ($\pm 10\%$) into 50 $\Omega,~0.5$ V/div ($\pm 10\%$) into 1 M $\Omega.$ The bandwidth depends upon vertical plug-in, see Storage 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.

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-eries 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 M Ω ; 20 mV, 0.2 V, 0.4 V into 50 Ω . Amplitude accuracy is within 1% (\pm 15°C to \pm 35°C); within 2% (0°C to \pm 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 \pm 10%; internally selectable with quick-change jumpers.

Line Frequency-50 Hz to 400 Hz (7313), 50 Hz to 66 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.

DIMENSIONS AND WEIGHTS

Please refer to the 7623 dimensions and weights chart.

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

ORDERING INFORMATION (Plug-ins not included)

7313 STORAGE OSCILLOSCOPE	\$2000
R7313 STORAGE OSCILLOSCOPE	\$2100
7313 OPTIONS	
Option 1 W/O CRT READOUT	Sub \$400
Option 3 EMI MODIFICATION	Add \$75
Option 7 W/O SIG OUT/IN	. Sub \$50
R7313 OPTIONS	
Option 1 W/O CRT READOUT	Sub \$400
Option 3 EMI MODIFICATION	. Add \$50
Option 5 LINE FREQ CHANGE (50 - 400 Hz) (Not required for 7313)	
Option 7 W/O SIG OUT/IN	Sub \$50
7313 CONVERSION KITS	
040-0630-00 CRT READOUT	\$400
040-0631-00 EMI MODIFICATION	
040-0629-00 SIG OUT/IN	\$50
R7313 CONVERSION KITS	
040-0630-00 CRT READOUT	
040-0632-00 EMI MODIFICATION	\$75
040-0633-00 SIG OUT/IN	

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

7000-SERIES OSCILLOSCOPES

7A11 Single-Trace Amplifier

M

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

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904	250 MHz	1.4 ns
7700 FAMILY	7704A Opt 9	180 MHz*	2.0 ns
PID SALE	7704A	170 MHz	2.1 ns
	R7704	150 MHz	2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11**	100 MHz	3.5 ns
7500 FAMILY	7504	90 MHz	3.9 ns
	7503	90 MHz	3.9 ns
	7514	90 MHz	3.9 ns
7400 FAMILY	7403N/R7403N	60 MHz	5.9 ns
STORAGE	7623/R7623	100 MHz	3.5 ns
FAMILY	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 $-3~\mathrm{dB}$).

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

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

Signal and Offset Range

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

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

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

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

^{**}Refer to 50-MHz Ruggedized Oscilloscope System.



7000-SERIES OSCILLOSCOPES Dual-Trace Amplifier 7A12

- DC-to-120 MHz BANDWIDTH (7900 FAMILY)
- 5 mV/DIV to 5 V/DIV CALIBRATED DEFLECTION FACTORS
- DC OFFSET

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



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

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904	120 MHz	2.9 ns
7700 FAMILY	7704A Opt 9	105 MHz	3.4 ns
	7704A	105 MHz	3.4 ns
	R7704	105 MHz	3.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	80 MHz	4.4 ns
7500 FAMILY	7504	75 MHz	4.7 ns
	7503	75 MHz	4.7 ns
	7514	75 MHz	4.7 ns
7400 FAMILY	7403N/R7403N	55 MHz	6.4 ns
STORAGE	7623/R7623	80 MHz	4.4 ns
FAMILY	7613/R7613	80 MHz	4.4 ns
	7313/R7313	25 MHz	14 ns

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

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

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

Max Input Voltage

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

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

Input R and C— 1 M Ω within 2%; \approx 24 pF.

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

DC Stability—Drift with ambient temperature (constant line voltage) $100 \,\mu\text{V}/^{\circ}\text{C}$ or 0.01 div/ $^{\circ}\text{C}$ or less, whichever is greater.

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
407	P6053A	3%	7600 7700, 7900
10X	P6065	2%	7313, 7400
100X	P6009	3%	All
1X FET	P6201	5%	7500, 7700, 7900

Order 7A12 AMPLIFIER

\$900

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

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



Differential Comparator Amplifier 7A13

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 plugins. 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. The + or - inputs allow normal or inverted displays.

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

^{*}Refer to 50-MHz Ruggedized Oscilloscope System.

7000-SERIES OSCILLOSCOPES

7A13 Differential Comparator Amplifier



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 $\pm 10\,\mathrm{V}$ 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	RISETIME	RISETIME
7900 FAMILY	7904	105 MHz	3.4 ns
7700 FAMILY	7704A Opt 9	100 MHz	3.5 ns
	7704A	100 MHz	3.5 ns
	R7704	100 MHz	3.5 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	75 MHz	5.0 ns
7500 FAMILY	7504	75 MHz	4.7 ns
	7503	75 MHz	4.7 ns
	7514	75 MHz	4.7 ns
7400 FAMILY	7403N/R7403N	55 MHz	6.4 ns
STORAGE	7623/R7623	75 MHz	5.0 ns
FAMILY	7613/R7613	75 MHz	5.0 ns
	7313/R7313	25 MHz	14 ns

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

*Refer to 50-MHz Ruggedized Oscilloscope System.

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

Input R and C— 1 $M\Omega$ within 0.15%; $\approx\!20$ pF. R in $\simeq _{\infty},$ is available in the 1 mV to 50 mV/div range, selectable by an internal switch.

Signal Range

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

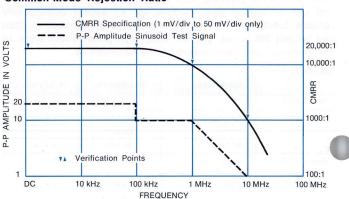
DC Stability—Drift with Time (constant ambient temperature and line voltage): Short Term; 1 mV P-P or 0.1 div, or les (whichever is greater) over any 1-minute interval after 20 minutes warm-up. Long-Term; 1 mV P-P or 0.1 div, or less (whichever is greater) during any 1-hour interval after 20 minutes 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 μ V (200 μ V 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 μ s to recover to within 1.5 mV and 0.1 ms to recover to within 0.5 mV after the removal of an overdrive signal between +10 V and -10 V, regardless of overdrive signal duration.

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

Common-Mode Rejection Ratio



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

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
1X	P6011	1.5%	All
	P6065	1.5%	7313, 7400
10X	P6053A	1.5%	7600 7700, 7900
	P6055	1.5%	All
100X	P6009	1.5%	All

Order 7A13 AMPLIFIER

\$1250

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



7000-SERIES OSCILLOSCOPES Current Probe Amplifier 7A14

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



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

Probes are not supplied with the 7A14 and are ordered separately to fit the application. The P6021 and P6022 AC current probes are recommended for use with the 7A14.

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

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

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

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

20 MHz within 3 MHz, 20 MHz bandwith mode. 25 Hz or less (+20°C to +75°C) 30 Hz or less (0°C to +20°C). With P6021 (lower -3 dB). 250 Hz or less with P6022 (lower -3 dB).

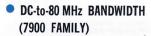
Input Characteristics

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

Order 7A14 A	MPI IFIFR	\$700

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

Single-Trace Amplifiers 7A15A and 7A15AN NEW



- 5 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS
- 500 μV/DIV at 10 MHz
 (X10 GAIN)



The 7A15A and 7A15AN are wideband plug-in amplifiers for all 7000-Series mainframes. They feature constant bandwidth over all the deflection factor settings. The two vertical mainframe channels allow the 7A15A/AN to be used alone, or with another vertical unit for dual-trace operation. Polarity of the display is

selectable. The 7A15A/AN can also be used in the horizontal channels for X-Y operation. The 7A15AN does not incorporate CRT READOUT; all other specifications are identical.

Bandwidth

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

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

^{*}Refer to 50 MHz Ruggedized Oscilloscope System.

^{*}Refer to 50-MHz Ruggedized Oscilloscope System.

7000-SERIES OSCILLOSCOPES

7A15A and 7A15AN Single-Trace Amplifiers



Deflection Factor—5 mV/div to 10 V/div in 11 calibrated steps (1-2-5 sequence). X1 GAIN accuracy is within 2% with X1 GAIN adjusted at 10 mV/div. X10 GAIN (increases sensitivity to 500 μ V) 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 M Ω within 2%; \simeq 20 pF.

NEW

Max Input Voltage—DC coupled 250 V (DC + Peak AC), AC component 500 V P-P max, 1 kHz or less. AC coupled 500 V (DC + Peak AC), AC component 500 V P-P max, 1 kHz or less.

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
	P6065 (7A15A)	2%	7313, 7400
10X	P6053A (7A15A)	3%	7600
	P6061 (7A15AN)	3%	All
100X	P6009	3%	All
1X FET	P6201	5%	7500, 7700, 7900

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

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

NEW 7A16A Single-Trace Amplifier

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



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

Bandwidth

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

DC to 20 MHz within 3 MHz, 20 MHz bandwidth mode. 10 Hz or less, AC coupled (lower $-3~\mathrm{dB}).$

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

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 M Ω within 2%; \approx 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 time (ambient temperature and line voltage constant) 0.02 div in any one minute after 1 hour warm-up.

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
	P6053A	3%	7600 7700, 7900
10X	P6065	2%	7313, 7400
100X	P6009	3%	All
1X FET	P6201	5%	7500, 7700, 7900

Order 7A16A AMPLIFIER

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

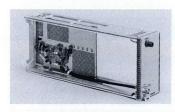
^{**}Refer to 50-MHz Ruggedized Oscilloscope System.





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 conjectors, switches, indicators, etc.

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

Bandwidth

	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904	150 MHz	2.4 ns
7700 FAMILY	7704A Opt 9	150 MHz	2.4 ns
	7704A	150 MHz	2.4 ns
	R7704	150 MHz	2.4 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	100 MHz	3.5 ns
7500 FAMILY	7504	75 MHz	5.0 ns
	7503	75 MHz	5.0 ns
	7514	75 MHz	5.0 ns
7400 FAMILY	7403N/R7403N	50 MHz	7.0 ns
	7623/R7623	100 MHz	3.5 ns
STORAGE FAMILY	7613/R7613	100 MHz	3.5 ns
· /	7313/R7313	25 MHz	14 ns

^{*}Refer to 50-MHz Ruggedized Oscilloscope System.

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

Input Z-50 Ω .

Max Input Voltage-5 V RMS.

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
10X	P6056	Adjustable	All
100X	P6057	Adjustable	All
1X FET	P6201	Adjustable	7500, 7700, 7900

Order 7A17 AMPLIFIER

209

Dual-Trace Amplifiers 7A18 and 7A18N

Bandwidth

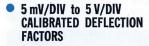
	MAINFRAME	BANDWIDTH	RISETIME
7900 FAMILY	7904	80 MHz	4.4 ns
7700 FAMILY	7704A Opt 9	80 MHz	4.4 ns
	7704A	80 MHz	4.4 ns
	R7704	75 MHz	4.7 ns
7600 FAMILY	7603/R7603 7603N Opt 11*	75 MHz	4.7 ns
7500 FAMILY	7504	60 MHz	5.9 ns
	7503	60 MHz	5.9 ns
	7514	60 MHz	5.9 ns
7400 FAMILY	7403N/R7403N	50 MHz	7.0 ns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

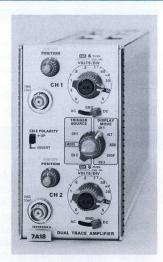
¹⁰ Hz or less, AC coupled (lower -3 dB).

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 M Ω within 2%; \approx 20 pF.

DC-to-80 MHz BANDWIDTH (7900 FAMILY)





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, HOP, 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.

^{*}Refer to 50-MHz Ruggedized Oscilloscope System.



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

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

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

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
1X	P6011	2%	All
10X	P6065 (7A18)	2%	7313, 7400
	P6053A (7A18)	3%	7600
	P6061 (7A18N)	3%	All
100X	P6009	3%	All
1X FET	P6201	5%	7500, 7700, 7900

Order 7A18 AMPLIFIER	THE PROPERTY OF THE PROPERTY O	\$535
Order 7A18N AMPLIFIER		\$500

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

7A19 Single-Trace Amplifier

- DC-to-500 MHz BANDWIDTH (7900 FAMILY)
- 10 mV/DIV to 1 V/DIV CALIBRATED DEFLECTION FACTORS
- OPTIONAL ± 500 ps
 VARIABLE DELAY LINE



The 7A19 is a high performance, wide bandwidth, single-trace plug-in amplifier designed primarily for use with the 7900 and 7700-FAMILY mainframes, but is compatible with all 7000-Series mainframes. The polarity of the display is selectable, either normal or inverted.

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

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.

Bandwidth

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

- 1 kHz, AC coupled (lower -3 dB).
- *System bandwidth temperature range from +20 °C to +30 °C.
- **Refer to 50-MHz Ruggedized Oscilloscope System.

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

ATTENUATION	RECOMMENDED TYPE	SYSTEM ACCURACY	RECOMMENDED FAMILY
10X	P6056	4%	All
100X	P6057	4%	All
1X FET	P6201	6%	7500, 7700, 7900

Order 7A19 AMPLIFIER

7A19 OPTION

Order Option 4 VAR SIG DELAY Add \$200

7A21N Direct Access Unit

- BANDWIDTH TO 1 GHz (7900 FAMILY ONLY)
- LESS THAN 4 V/DIV DEFLECTION FACTOR
- SINGLE AND DIFFERENTIAL INPUTS
- POSITIONING CONTROL

The 7A21N plug-in is designed specifically for the AC coupling of high frequency or fast risetime signals directly into wide bandwidth CRT of the 7904 Oscilloscope. Two front panel input connectors allow either single-end-



ed 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 7904 vertical amplifier. Hence the vertical mode switching is inoperative and the use of the other preamps in the vertical channel adjacent to the 7A21N is not possible. Small interconnection boards with coupling cables to accomplish this are supplied with each 7A21N. CRT READOUT is inoperative when the 7A21N is installed. The 7A21N is compatible only with the 7900-Family Oscilloscopes.

Bandwidth—20 kHz to 1 GHz.

Deflection Factor-Less than 4 V/div.

Input Z-50 Ω .

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

Order 7A21N DIRECT ACCESS

\$350

\$500

Included Accessories-Interconnecting board assembly.





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 $10~\mu\text{V}/\text{div}$ 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 $10~\mu\text{V}/\text{div}$, DC coupled, differential signal range $\pm 1~\text{V}$ at $10~\mu\text{V}/\text{div}$, and a DC OFFSET feature with $\pm 1~\text{V}$ range $\pm 100,000~\text{div}$ at $10~\mu\text{V}/\text{div}$.

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 μ V at 10 μ V/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 $5 \mu V$ per minute and $10 \mu V$ per hour at 10 μ V/div. Drift with temperature is 50 μ V/°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 $\mu V/div$. 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 \pm 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 μ V/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 M Ω within 1%; \approx 47 pF.

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

*With constant temperature. See DC STABILITY specifications.

Signal and Offset Range

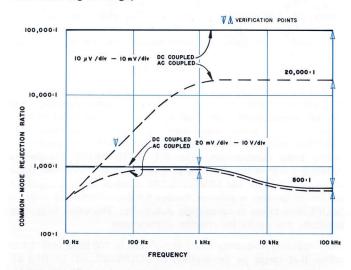
DEFLECTION FACTOR SETTINGS	10 μV to 10 mV/div	20 mV to 0.1 V/div	0.2 V to 1 V/div	2 V to 10 V/div
COMMON-MODE SIGNAL RANGE	±10 V	<u>+</u> 100 V	<u>+</u> 5	00 V
MAX DC COUPLED INPUT (DC + PEAK AC AT 1 kHz OR LESS)	± 15 V	± 200 V	<u>±</u> 5	00 V
MAX AC COUPLED INPUT (DC VOLTAGE)	±500 V DC rejection, at least 4 x 10 ⁵ :1			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; $5 \,\mu V$ (P-P) or 0.1 div whichever is greater in any minute after 1 hour warm-up. Long Term; $10 \,\mu V$ (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 $50 \,\mu V/\,^{\circ} C$ or less.

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

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

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



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

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

Order 7A22 AMPLIFIER

. \$575

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

7000-SERIES OSCILLOSCOPES 7B50 and 7B51 Time Bases







7B50

7B51

FEATURES OF BOTH TIME BASES

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

The 7B50 and 7B51 Times Base units are recommended for use with the 7400, 7500, 7600 and Storage FAMILIES to provide bandwidth/sweep speed compatibility. However, the 7B50 and 7B51 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode in operation; the 7B51 being the DELAYING SWEEP and the 7B50 the DELAYED SWEEP. The 7B50 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source. The calibrated TIME/DIV range is from 5 ns/div to 5 s/div. The 5 ns/div rate 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 upper-most push-button switches: INT SOURCE, AC COUPLING, and P-P AUTO MODE—the most commonly used combination. The P-P AUTO MODE provides a baseline trace in the absence of a signal and a triggered trace at any position of the LEVEL/SLOPE control when a signal of 0.5 div or greater is present. Except for the selection of $+\mbox{ or }-$ SLOPE this mode is completely automatic. The other triggering positions are useful for specific applications.

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

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

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

Characteristics are common to both units unless otherwise noted.

Sweep Rate— $0.05\,\mu\text{s}/\text{div}$ to $5\,\text{s}/\text{div}$ in 25 steps (1-2-5 sequence). $5\,\text{ns}/\text{div}$ 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
$5 \mathrm{s/div}$ to $0.1 \mathrm{s/div}$ and $0.2 \mu \mathrm{s/div}$ to $0.05 \mu \mathrm{s/div}$	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP (7B51 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— $5\,\mathrm{s/div}$ to 1 s/div: $\pm\,(1.5\%)$ of measurement $+\,0.3\%$ of full scale); 0.5 s/div to 1 $\mu\mathrm{s/div}$: $\pm\,(1\%)$ 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 $+15\,\mathrm{^{\circ}C}$ to $+35\,\mathrm{^{\circ}C}$.

Jitter— 1 part or less in 50,000 of X10 the main TIME/DIV set ting.



COUPLING	TRIGGERING	MIN SIGNAL REQUIRED		
	FREQUENCY RANGE	INT	EXT	
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV	
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV	
AC HF REJ	30 Hz - 50 kHz	0.3 div	150 mV	
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	150 mV 750 mV	

*Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

P-P Auto Operation— 0.5 div INT, 250 mV EXT from 200 Hz to 10 MHz; 1.5 div INT, 750 mV EXT from 10 MHz to 100 MHz.

Single Sweep—Triggering requirements are the same as normal sweep. When triggered, sweep generator produces one sweep only until manually or remotely reset.

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

Ext Trigger Input—Max input voltage is 500 V (DC + peak AC), 500 V (P-P AC) at 1 kHz or less. Input R and C is 1 M Ω within 2%, 20 pF within 2 pF. The level range (excluding P-P AUTO) is at least +3.5 V to -3.5 V in EXT, at least +3.5 V to -3.5 V in EXT. \div 10.

EXT HORIZONTAL INPUT (7B50 ONLY)

Deflection Factor—Minimum deflection factor is 90 mV/di 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 \div 10 source position with variable fully CW. The VARIABLE is continuous between steps and to at least 9 V.



7000-SERIES OSCILLOSCOPES Time Bases 7B50 and 7B51

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 kHz	75 kHz
AC HF REJ	16 Hz	120 kHz
DC	DC	500 kHz

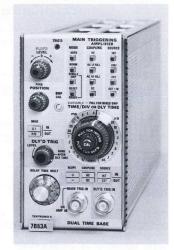
Order 7B50	TIME	BASE	\$450
Order 7B51	TIME		

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

Dual Time Bases 7B53A and 7B53AN NEW

5 ns/DIV to 5 s/DIV CALIBRATED TIME BASE

- CALIBRATED MIXED SWEEP
- TRIGGERING to 100 MHz
- SINGLE-SWEEP OPERATION
- OPTIONAL TV SYNC-SEPARATOR TRIGGERING



The 7B53A and 7B53AN Dual Time Bases are recommended for use with the 7400, 7500, 7600 and Storage FAMILIES to provide bandwidth/sweep speed compatibility. Both time bases have identical characteristics except the 7B53AN does not incorporate CRT READOUT.

These Dual Time Bases feature four sweep display modes: normal, intensified delaying, delayed and mixed.

Normal Sweep (nondelayed) is selected when the DLY'D TIME/DIV switch is pushed in and set to the same sweep rate as the TIME/DIV switch. The switches will latch in this mode.

Intensified Delaying Sweep is accomplished by pulling out the DELAYED SWEEP TIME/DIV knob. The delaying (main) sweep is intensified for a period of time determined by the delayed sweep setting. The intensified zone may be initiated at any point on the delaying sweep determined by the DELAY TIME MULT (DTM). The DELAYING and DELAYED TIME/DIV controls can be independently set. MAIN TRIGGERING controls are used to control the delaying sweep.

Delayed Sweep is selected by pushing in the DELAYED SWEEP TIME/DIV knob. The intensified segment of the delaying sweep is now displayed over the full 10 div of the CRT. The delayed sweep may be operated in either a "triggered" or "runs-after-delay" mode.

Mixed Sweep is accomplished by pulling the VARIABLE knob out, combining the slower and faster sweep speeds into one display. The main sweep is displayed at the slower speed from the beginning of 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— $0.05\,\mu s/div$ 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.

	UNMAGNIFIED		MAGNIFIED	
TIME/DIV	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
$5 \text{ s/div to } 0.1 \text{ s/}$ div and $0.2 \mu\text{s/}$ div to $0.05 \mu\text{s/}$ 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 $5 \, \text{s/div}$ to $1 \, \mu \text{s/div}$.

Differential Delay Time Measurement Accuracy— $5\,\mathrm{s/div}$ to 1 s/div: $\pm\,(1.4\%$ of measurement $+\,0.3\%$ of full scale); 0.5 s/div to 1 $\mu\mathrm{s/div}$: $\pm\,(0.7\%$ 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 $+15\,\mathrm{^\circ C}$ to $+35\,\mathrm{^\circ C}$.

Jitter— 1 part or less in 20,000 of X10 the TIME/DIV setting.

Triggering

COUPLING	TRIGGERING	MIN SIGNAL REQUIRED		
	FREQUENCY RANGE	INT	EXT	
AC	30 Hz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV	
AC LF REJ*	30 kHz - 10 MHz 150 kHz - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV	
AC HF REJ	30 Hz - 50 kHz	0.3 div	100 mV	
DC	DC - 10 MHz 10 MHz - 100 MHz	0.3 div 1.5 div	100 mV 500 mV	

^{*}Will not trigger on sinewaves of 3 div or less INT or 1.5 V EXT below 120 Hz.

7000-SERIES OSCILLOSCOPES



7B53A and 7B53AN Dual Time Bases



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 M Ω 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 -1.5 V in EXT \div 10.

DELAYED SWEEP

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

Sweep Accuracy—Measured over the center 8 div.

	UNMAGNIFIED		MAGNIFIED	
TIME/DIV	+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 $0.2 \mu \text{s/div}$ to $0.05 \mu \text{s/div}$	4%	5%	4.5%	6%
$50 \text{ ms/div to } 0.5 \ \mu\text{s/div}$	3%	4%	3.5%	5%

Delayed Sweep Gate—Output voltage is approximately $+3.5\,\text{V}$ into at least 10 k Ω shunted by 100 pF or less. Risetime is 50 ns or less, output R is 1 k Ω within 10%. Gate is available at the DLY'D TRIG IN connector when the delayed sweep source switch is set to INT.

Triggering

	TRIGGERING	MIN SIGNAL REQUIRED	
COUPLING	FREQUENCY RANGE	INT	EXT
AC	30 Hz - 10 MHz	0.3 div	100 mV
	10 MHz - 100 MHz	1.5 div	500 mV
DC	DC - 10 MHz	0.3 div	100 mV
	10 MHz - 100 MHz	1.5 div	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 M Ω 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 μ s (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 \div 10.

Frequency Response

COUPLING	LOWER —3 dB	UPPER —3 dE
AC	40 Hz	2 MHz
AC LF REJ	16 kHz	2 MHz
AC HF REJ	40 Hz	100 kHz
DC	DC	2 MHz

Order 7B53A TIME BASE	\$850
Order 7B53AN TIME BASE	\$750

7B53A/AN OPTION

Order Option 5 TV TRIGGERING Add \$60



7B70 and 7B71 Time Bases





7B70

7B71

FEATURES OF BOTH TIME BASES

- 2 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- TRIGGERING TO 200 MHz
- PEAK-TO-PEAK AUTO TRIGGERING
- SINGLE-SWEEP OPERATION

The 7B70 and 7B71 are horizontal TIME-BASE units intended primarily for use with the 7700-FAMILY mainframes to provide bandwidth/sweep speed compatibility. However, the 7B70 and 7B71 may be used in any 7000-Series mainframe. They are identical units except in two particulars. In combination, they provide a delaying-sweep mode of operation; the 7B71 being the DELAYING SWEEP and the 7B70 the DELAYED SWEEP. The 7B70 also has a horizontal amplifier input for uncalibrated X-axis deflection from an external source.



The calibrated TIME/DIV range is from 2 ns/div to 5 s/div. The ns/div rate, obtained with the X10 MAGNIFIER, complements the risetime capability of the 7700-FAMILY vertical systems.

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

The triggering frequency range is from DC to 200 MHz, selectable within that range by the method of COUPLING. AC LF REJ attenuates undesirable trigger components below 30 kHz (60 Hz would be almost totally rejected); AC HF REJ attenuates high-frequency components (above 50 kHz) which can cause triggering problems during low-frequency applications. SINGLE-SWEEP functions with lighted READY indicators and manual reset are associated with the trigger MODE controls.

For delaying-sweep operation, the 7B71 (occupying the A horizontal channel) contains the DELAY TIME MULTIPLIER and control circuitry to release the 7B70 DELAYED SWEEP (B horizontal channel) at a predetermined point during the delaying sweep. After release, the delayed sweep can be programmed to begin immediately or wait for the next trigger event.

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

Characteristics are common to both units unless otherwise noted.

Sweep Rate— $0.02~\mu s/div$ to 5~s/div in 26 steps (1-2-5 sequence). 2 ns/div is the fastest calibrated sweep rate, obtained with the X10 MAGNIFIER. The uncalibrated VARIABLE is continuous between steps and to 12.5 s/div.

Sweep Accuracy—Measured over the center 8 div, with the 7704A mainframe calibrator.

TIME/DIV	UNMAGNIFIED		MAGNIFIED	
	+15°C to +35°C	0°C to +50°C	+15°C to +35°C	0°C to +50°C
5 s/div to 0.1 s/ div and 0.2 μs/ div to 0.02 μs/ div	3%	4%	3.5%	5%
50 ms/div to 0.5 μs/div	2%	3%	2.5%	4%

DELAYING SWEEP CHARACTERISTICS (7B71 ONLY)

Delay Time Multiplier Range— 0 to 10 times the TIME/DIV setting from 5 s/div to $1 \mu \text{s/div}$.

Differential Delay Time Measurement Accuracy— 5 s/div to 1 s/div: \pm (1.5% of measurement + 0.3% of full scale); 0.5 s/div to 1 $\mu s/\text{div}$: \pm (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 $+15^{\circ}\text{C}$ to $+35^{\circ}\text{C}$.

Jitter-1 part or less in 50,000 of X10 the TIME/DIV setting.

TRIGGERING

COUPLING	TRIGGERING	MIN SIGNAL REQUIRED		
	FREQUENCY RANGE	INT	EXT	
AC	30 Hz - 20 MHz 20 MHz - 200 MHz	0.3 div 1.5 div 0.3 div 1.5 div	75 mV 375 mV	
AC LF REJ*	30 kHz - 20 MHz 20 MHz - 200 MHz		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 M Ω 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 \div 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 \div 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	16 Hz	100 kHz
DC	DC	100 kHz

 Order 7B70 TIME BASE
 \$625

 Order 7B71 TIME BASE
 \$725

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- 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

Normal Sweep (nondelayed) is selected when the DLY'D TIME/DIV switch is pushed in and is set to the same sweep rate as the TIME/DIV switch. The switches will latch in this mode and the delayed sweep time base automatically goes to a zero delay mode.

Intensified Delaying Sweep is accomplished by pulling out the DELAYED SWEEP TIME/DIV knob. The delaying sweep is intensified for a period of time determined by the delayed sweep setting. Intensity of the delaying sweep is set with the INTENSITY control, concentric with the POSITION control on the plug-in. Intensity of the delayed sweep (intensified portion) is controlled by the mainframe intensity. 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 cm of the CRT. Intensity of the delayed sweep is controlled by the mainframe intensity. The triggering event can be displayed with the delayed sweep by setting the DTM at or near zero. When the two TIME/DIV controls are latched together, zero delay is automatically selected and the MAIN TRIGGERING controls initiate the delayed sweep.

Alternate mode is accomplished by pressing the TRACE SEP-ARATION control. Pressing the control causes it to unlatch and the display to alternate between Intensified Delaying Sweep and Delayed Sweep. The repetition rate is determined by the duration of the delaying sweep. When unlatched, the TRACE SEPARATION control is used to move the delaying sweep upward from 0 to 4 divisions.

 $^{\star}\text{The two fastest}$ 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.

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: $\pm (1.4\% \text{ of measurement} + 0.3\% \text{ of full scale})$; 0.1 s/div: $\pm (0.7\% \text{ of measurement} + 0.3\% \text{ of full scale})$; 50 ns/div to 10 ns/div: $\pm (1.5\% \text{ of measurement} + 0.5\% \text{ of full scale})$.

Absolute Time Measurement Accuracy—(Measurement from start of Delaying Sweep.) 0.2 s/div to 1 μ s/div: Within 1% of full scale plus differential time measurement accuracy; 0.5 μ s/div to 0.1 μ s/div: Within 1% of full scale plus differential time measurement accuracy plus 0.1 μ s; 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 $+15^{\circ}$ C to $+35^{\circ}$ C.

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	MIN SIGNAL REQUIRED	
	FREQUENCY RANGE	INT	EXT
AC	30 Hz - 20 MHz	0.5 div	100 mV
AC	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 - 20 MHz	0.5 div	100 mV
DC	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 M Ω inputs. Max input voltage 250 V (DC + peak AC) for 1 M Ω input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 Ms paralleled by approx 20 pF. LEVEL range is at least +3.5 V to -3.5 V in EXT, at least +3.5 V to -3.5 V in EXT \div 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	MIN SIGNAL REQUIRED	
	FREQUENCY RANGE	INT	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 M Ω inputs. Max input voltage 250 V (DC + peak AC) for 1 M Ω input; approx 1 watt average for 50 Ω input. Input R and C is approx 1 M Ω paralleled by approx 20 pF. LEVEL range is at least +3.5 V to -3.5 V.

Order 7B92 TIME BASE\$1400

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Curve Tracer 7CT1N

- TESTS SEMICONDUCTOR DEVICES TO 0.5 W
- 10 nA/DIV TO 20 mA/DIV VERTICAL DEFLECTION FACTORS
- 0.5 V/DIV TO 20 V/DIV HORIZONTAL DEFLECTION FACTORS
 - LIGHTED KNOB SKIRTS
 FOR SCALE FACTOR READOUT
 - EASY TO OPERATE



The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems. Characteristic curves of small-signal semiconductor devices to power levels up to 0.5 watt can be displayed. The 7CT1N operates in either vertical compartment. Horizontal deflection is achieved through a front panel source which drives the external input of either a vertical or horizontal plug-in unit installed in the mainframe's horizontal compartment.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are $1\,\mu\text{A/step}$ to $1\,\text{mA/step}$ for current and $1\,\text{mV/step}$ to $1\,\text{V/step}$ for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.

A front panel button switches the base/gate step generator output from current steps of the same polarity as the collector/rain sweep for checking transistors, to voltage steps of the opposite polarity of the collector/drain sweep for checking FETS in the depletion region. This button also internally switches the test fixture leads so that one test socket can be used to test both transistors and FETs.

The OFFSET control allows the base/gate step generator output to be offset at least 5 steps in the aiding or opposing direction for conveniently checking the enhancement region of FETs.

A ÷1000 button increases the sensitivity of the vertical display amplifier to 10 nA/div allowing leakage current measurements. When the button is pressed, the collector/drain supply is changed from a sweeping output to a DC output for checking leakage currents without looping aberrations.

CHARACTERISTICS COLLECTOR/DRAIN SUPPLY

	X1		X10	
Horizontal Volts/Div	0.5	2	5	20
Voltage Range	0 - 7.5 V	0 - 30 V	0 - 75 V	0 - 300 V
Maximum Current	240 mA	60 mA	24 mA	6 mA

Maximum Open Circuit Voltage—Within $\pm 20\%$. 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 $1 \mu A/\text{step}$ 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 k Ω \pm 1%.

7000-SERIES OSCILLOSCOPES 7CT1N Curve Tracer



Accuracy—Incremental; within 3% between steps. Absolute; within \pm (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 aid(s) or oppose(s) the step polarity.

Vertical Deflection Factors— 10 nA/div to 20 μ A/div with the \div 1000 control activated. 10 μ A/div to 20 mA/div in the X1 mode.

Vertical Display Accuracy—Within 5% in the X1 mode. Within 5% \pm 0.2 nA per displayed horizontal volt when in the \div 1000 mode.

Horizontal Deflection Factors—Selectable: 0.5 V, 2 V, 5 V, or 20 V.

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

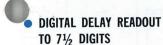
factor and an input R of at least $50\,\mathrm{k}\Omega$ and would be used in the horizontal compartment of the 7000-Series Oscilloscop mainframe.

Included Accessories—Test Fixture (013-0128-00) with two sets of test terminals, one with TO-5 basing and the other with TO-18 basing.

Order 7CT1N CURVE TRACER	\$400
OPTIONAL ACCESSORIES	
Adapters—For transistors with long leads. Order 013-0069-00	\$6.60
For transistors with TO-3 or TO-66 basing. Order 013-0070-01	\$5.50
Diode Test Fixture—Holds axial-lead diodes. Order 013-0072-00	\$6.60
Adapter Box—Allows mounting of additional semiconor sockets. Order 013-0073-00	
Power Transistor Socket—For power transistors with leads. Order 013-0074-00	
Diode Test Adapter—Production test fixture for rapid har Order 013-0079-00	_

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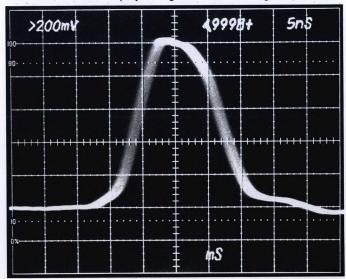
- DELAY BY TIME OR EVENTS
- 100 ns to 1 s DELAY TIME
- 1 ns RESOLUTION
- LESS THAN 2.2 ns JITTER
- 0.5 ppm (±2 ns) ACCURACY
- DELAY INTERVAL CRT DISPLAY



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 outbut after the preselected count has been reached. In both modes, the delay time or the number of events to be counted is selected by a single front panel control.

The 7D11 generates signals which are applied to the vertical channel and Z-axis to aid in obtaining the proper delay. Installed in a vertical compartment, the CRT will display a waveform that lasts for the duration of the delay interval. This waveform can be displayed together with the signal waveform



 $0.2~\mu s$ time marker delayed 4.9998 ms by the 7D11 and displayed at

on which the 7D11 is triggered. From a vertical compartment, the 7D11 can trigger a timebase, such as a 7B70, 7B53A or another 7D11, through the internal mainframe trigger path.

In any horizontal compartment, the 7D11 will generate a blanking pulse for the duration of the delay interval. This provides a display similar to the "A Intensified By B" mode of conventional delayed sweep operation. (See Fig 2.) When used in the A Horizontal compartment, the 7D11 B Sweep delay mode controls will permit the B Sweep to either run or be triggerable after the delay generated by the 7D11. This delay interval is also available at the front panel for such uses as gated interval counter measurements and generating pulses of highly accurate width.

In the Delay By Events operation, an external pulse (Events Start Trigger) may be used to enable counting of the events. In such applications as a line selector on a video monitor, the vertical sync pulse is the Events Start Trigger. Then the 7D11 counts "n" number of horizontal sync pulses (Events) into the field or frame (See Fig 3). In a similar manner, the origin pulse of a disc memory can be used as the Events Start Trigger, and the disc clock pulses become the events that are counted.

For timing measurements requiring a higher degree of accuracy than the 0.5 PPM source available in the 7D11, the Delay By Time clock may be referenced to an external 1-MHz timing standard through the EXT 1-MHz input.

Time delay resolution up to 1 ns can be obtained by using the front panel Fine Delay control.

By setting an internal switch, the indicated delay time is half the actual delay time. In such applications as TDR, radar timing, etc., the CRT READOUT would display the "one-way-trip" time.

The 7D11 Digital Delay Unit is very helpful in making measurements under complex timing conditions such as those encountered in troubleshooting modern digital circuitry.

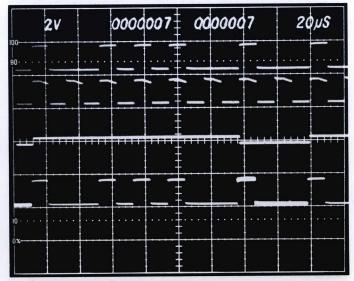


Fig. 2: Events Delay Mode (delay equals seven events). The top trace is a digital wavetrain and the second waveform is its clock. The third waveform represents the delay interval generated by the 7D11 in a vertical compartment; this began on the 1st clock pulse and ended on the 7th. The lower trace shows the display obtained with a 7D11 in a horizontal compartment (deathle averagetics). (double exposure)





Fig. 3: Digital Delay Analog-Delay operation. The 7D11 triggers Time Base A at the beginning of the 374th line (upper trace). The 7th and 8th vertical bars are intensified by Time Base B set by the 7B71 delay time multiplier. The lower trace shows video information on the B delayed sweep.

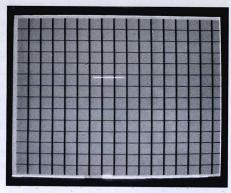


Fig. 4: The cross hatch signal seen on a Video Monitor. The B sweep gate of Fig. 3 applied to the monitor shows the 7th and 8th vertical bars unblanked at the 374th line.

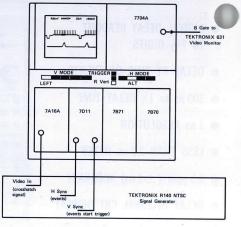


Fig. 5: Equipment set up for figures 3 and 4.

EVENTS DELAY

Events Delay Range—One to 107 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

	EX	TERNAL TRIGGER		
SOURCE	Int, Line, Ext, Ext ÷ 10			
COUPLING	DC, AC, AC	DC, AC, AC LF Rej, AC HF Rej		
MAX INPUT VOLTAGE	150 V DC +	150 V DC + Peak AC		
LEVEL RANGE		±3.5 V in Ext ±35 V in Ext : 10		
INPUT R and C	1 MΩ ±5%, 20 pF ±2 pF			
	COUPLING	FREQUENCY	MIN SIGNAL REQUIRED	
		RANGE	INT	EXT
	AC	30 kHz - 10 MHz 10 MHz - 50 MHz	0.3 div 1.0 div	150 mV 750 mV
SENSITIVITY	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 diy 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	OC Only	
MAX INPUT VOLTAGE	150 V DC + Peak AC	
LEVEL RANGE	±3 V	
INPUT R and C	1 MΩ within 5%, 20 pF ± 2 pF	
SENSITIVITY	40 mV minimum, 30 Hz to 4 MHz; increasing to 100 mV, 4 MHz to 20 MHz; increasing to 250 mV, 20 MHz to 50 MHz.	

TIME DELAY

Digital Delay Range—Normal Mode: 100 ns to 1 s in 100 ns increments. Echo Mode: 200 ns to 2 s in 200 ns increments.

Analog Delay—Continuously variable from 0 to at least 100 ns, accuracy within 2 ns of indicated delay.

Jitter With Internal Clock—2.2 ns or (delay time X 10^{-7}) whichever is greater.

Insertion Delay-Zero within 2 ns.

Recycle Time-Less than 575 ns.

Time Base— 500 MHz oscillator phase locked to internal or external clock.

Internal Clock-5 MHz Crystal oscillator. Accuracy is 0.5 ppm.

External Clock— 1 MHz within 2%, AC coupled, 50 Ω .

OUTPUTS

Delayed Trigger Out—Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω . Risetime into 50 Ω Load: 2 ns or less. Falltime into 50 Ω Load: 5 ns or less. Pulse width: 200 to 250 ns.

Delay Interval Out—Amplitude: 2 V or greater into open circuit, 1 V or greater into 50 Ω . Risetime and Falltime: 5 ns or less. Accuracy: Equal to Delay Interval less 20 to 30 ns.

READOUT

Display— $7\frac{1}{2}$ 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

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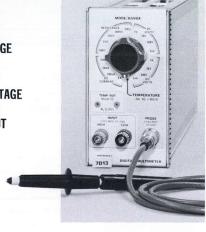
7000-SERIES OSCILLOSCOPES Digital Multimeter 7D13

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 Oscilloscopes 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, temperature may be measured simultaneously with any other function. Most any NPN transistor can be used as a separate sensor to make small space, "free air," measurements.

When the 7D13 is used, the character generator traces out a $3\frac{1}{2}$ -digit display on the face of the CRT, along with a legend for units like $k\Omega$, mA, C (temperature).

DC Voltage Range— 0 to 1000 V in four ranges. 3 1/2-digit presentation of 1.999 V, 19.99 V, 199.9 V, and 1000 V full scale. Accuracy is $\pm 0.1\%$ of reading ± 1 count from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.2\%$ of reading ± 2 counts from 0° C to $+50^{\circ}$ C. Input impedance is 10 megohms on all ranges. Maximum safe input is 1.5 kV Peak between either contact and ground, 1.0 kV Peak between voltage contacts.

DC Current Range— 0 to 2 A in four ranges. 3 1/2-digit presentation of 1.999 mA, 19.99 mA, 199.9 mA and 1999 mA full scale. Accuracy is $\pm 0.5\%$ of reading ± 2 counts from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.7\%$ of reading ± 4 counts from 0°C to $+50^{\circ}$ C. Maximum input is 3A (fuse protected). Input impedance is 0.2 V/full scale current $+0.3~\Omega$.

Resistance Range— 0 to 2 megohms in five ranges. 3 1/2-digit presentation 199.9 Ω , 1999 Ω , 19.99 k Ω , 199.9 k Ω , and 1999 k Ω full scale. Accuracy is $\pm 0.5\%$ of reading ± 1 count from $+15^{\circ}$ C to $+40^{\circ}$ C, $\pm 0.8\%$ of reading ± 2 counts from 0°C to $+50^{\circ}$ C. Input is fuse protected.

Temperature Measurement Range— -55° C to $+150^{\circ}$ C in one range. 3 1/2-digit presentation to $+150^{\circ}$ C. Accuracy ($+15^{\circ}$ C to $+40^{\circ}$ C ambient) is $\pm 1^{\circ}$ C from -55° C to $+125^{\circ}$ C, $\pm 2^{\circ}$ C above $+125^{\circ}$ C. Accuracy (0°C to $+50^{\circ}$ C ambient) is $\pm 2^{\circ}$ C from -55° C to $+125^{\circ}$ C, $\pm 3^{\circ}$ C above $+125^{\circ}$ C.

ettling 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-k Ω 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 $2 k\Omega$.

Included Accessories—P6058 Voltage/Temperature probe package (010-0260-00); pair of test leads (003-0120-00).

Order 7D13 DIGITAL MULTIMETER \$560

7D13 OPTION

Order Option 2 without P6058 Probe Sub \$65

P6058 PROBE

The P6058 Probe is a combination 1X DC voltage and temperature measuring device. The temperature sensing element consists of a transistor installed in the nose tip that plugs into the end of the probe body. For voltage measurements, a twelve inch and a five inch "common" (low) strap is provided, and is attached by threading into a hole in the side of the probe body. There is no external ground on the P6058 body, "ground" or the low potential point of the circuit under test is obtained via the common strap or connector, which is a floating common that has no tie to chassis ground. This lead may be floated at up to 1500 VDC away from chassis ground. The retractable hook-tip must be used on the probe when voltage measurements are made.

Temperature is measured by applying the flat surface of the probe tip to the device to be measured.

DC Voltage Range— 0 to 1000 V. Accuracy is $\pm 0.1\%$ of reading ± 1 count.

Maximum Safe Input— 1500 V peak between either voltage contact and chassis ground. 1000 V peak between voltage contacts.

Temperature Range—See the 7D13 for the accuracy of a P6058/7D13 combination.

Cable—46 inches including probe body. Output connector is four-pin locking type for attaching the P6058 to the 7D13. Supplies power to the probe sensor transistor and signal to the digital multimeter.

Net Weight—Approximately 5 ounces.

P6058 VOLTAGE/TEMPERATURE PROBE, Order 010-0260-00 ... \$65 Includes: P6058 Probe (010-0259-00); probe retractable hook tip (013-0121-00); 5-inch ground lead (screw-in, 175-0848-01); 12-inch ground lead (screw-in, 175-0848-02); two miniature alligator clips (344-0046-00).

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

7000-SERIES OSCILLOSCOPES 7D14 Digital Counter



- FREQUENCY MEASUREMENTS DIRECTLY TO 525 MHz
- TRIGGER INDICATOR DISPLAY
- NO-WARM-UP OSCILLATOR
- 50- Ω and 1-M Ω 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 10⁵:1, and Totalize—0 to 10⁸.

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 $\pm \frac{1}{\text{total count}} \pm \text{time base.}$

Time Base Stability—Within $\pm 0.00005\%$, 0°C to +50°C ambient temperature.

Long Term Drift—1 part or less in 107/month.

Input Characteristics

CHANNEL A			CHANNEL B	INTERNAL TRIGGER SOURCE
	50 Ω	1 ΜΩ		
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*
SENSI- TIVITY	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

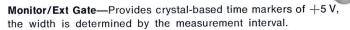
Range—Channel A: 0 to 525 MHz.
Channel B: 10 Hz to 2 MHz.

TOTALIZE

Range— 0 to 108.

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



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

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



- OSCILLOSCOPE CONTROLLED TIME and FREQUENCY MEASUREMENTS
- 10 ns "SINGLE SHOT" TIME INTERVAL MEASUREMENT RESOLUTION
- TIME INTERVAL AVERAGING
- CRT DISPLAY OF COUNTING INTERVAL AND SCHMITT TRIGGER SIGNAL
- 10 PICO SECOND PERIOD AVERAGING RESOLUTION
- SIGNAL CONDITIONING VIA MAINFRAME TRIGGER SOURCE
- FREQUENCY MEASUREMENTS DIRECTLY TO 225 MHz
- ACCURATE "TIME MARK" OUTPUTS



The 7D15 is a Universal Counter/Timer Plug-In unit designed for use in all 7000-Series Oscilloscope mainframes except those without CRT READOUT.

The 7D15 offers all of the measurement capabilities known to the Counter/Timer world such as time interval, period, frequency, frequency ratio, totalize, and manual stop watch.

The performance of the 7D15 is further enhanced by its ability display the count interval or the output of the Channel B chmitt trigger shaper on the CRT. By utilizing the 7000-Series mainframe Vertical Mode switching, these outputs from the 7D15 can be displayed simultaneously with the actual signal being measured. The Pseudo Gate, which is a high rep-rate replica of the actual gate (True Gate), is independent of the Display Time control and therefore a more useful display. Three

displays, the Pseudo Gate, Ch B Schmitt Trigger Output and True Gate are obtainable from a 7D15 front panel switch and are also available at a front panel connector.

Another 7D15 feature useful in complex timing or burst related measurements is its ability to be completely controlled by the oscilloscope's delayed or B Gate. "Arming" inputs are provided for each channel. By using the delayed B Gate to control the start and stop count points, "visually selective" measurements can be made at any desired point on the CRT display. See Fig. 1.

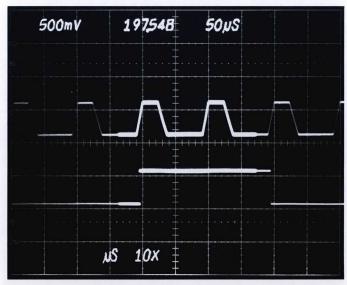
Two identical high speed trigger circuits provide complete signal processing. Identical trigger circuits also allow "single shot" time interval measurements to be made with 10 ns resolution. With repetitive signals, time interval averaging will increase the accuracy of a measurement by a factor of ten or more.

The high resolution capabilities of the 7D15 are made possible by a 10-ns clock, one of five clock positions obtainable from the front panel. A front panel Clock Out connector makes the selected clock signal available at a front panel connector. This provides a "time mark" function that is TTL compatible, which will also drive a 50 Ω load.

The Ext Clock In connector allows an external 1-MHz timing standard to be used for measurements requiring a higher degree of accuracy than that provided by the internal time base.

The 7D15 is compatible in vertical or horizontal compartments of 7000-Series mainframes. It provides a full 8 digit CRT display with leading zero suppression, and positioned decimal. Legend and averaging information appear at the bottom of the CRT display.

The measurement versatility, high degree of accuracy and resolution, that the 7D15 introduces to the 7000-Series Oscilloscopes, will contribute significantly to the higher performance measurement requirements of today's expanding technologies.



1: Oscilloscope controlled digital measurements using the delayed B te as the arming input logic allows user to make precise time measurement from third to fifth pulse on CRT display. Counter Ch A is "armed" with leading edge of B Gate while Ch B is "armed" with falling edge of B Gate. Lower trace is Pseudo Gate of 7D15.

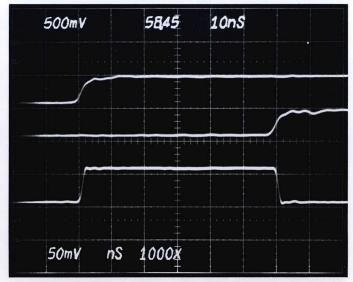


Fig 2: The delay time between the input of a delay line (upper trace) and the output of the delay line (middle trace) is measured digitally. Lower trace is 7D15 Pseudo Gate display.



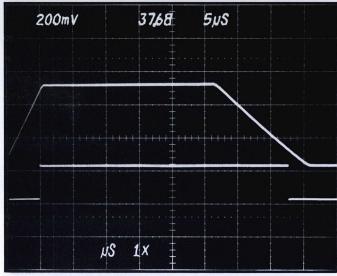


Fig 3: Independent Slope and Level control allows the user to select precise points on the waveform where the counter starts and stops.

MODES OF OPERATION		Separation and the second
	RANGE	DC to 225 MHz
FREQUENCY MODE	ACCURACY	Resolution = 0.1 Hz minimum $\epsilon_{freq(Hz)} = \pm TB \cdot f_{in} \pm \frac{1}{T} \pm 10^{-9} \cdot f_{in}$
alle to Anomon	RANGE	10 ns to 10 ⁵ seconds with averaging times of X1 to X1000 in decade steps.
PERIOD and MULTI-PERIOD	el mente	Resolution: 10 picoseconds
MODE	ACCURACY	$\epsilon_{\text{period(s)}} = \pm \text{ TB} \cdot P_{\text{in}} \pm \frac{10^{-9}}{M} \pm \frac{2E_{\text{npk}}}{\frac{\text{dv}}{\text{dt}} \cdot M} \pm \frac{P_{\text{ck}}}{M}$
	RANGE	6ns to 10^5 seconds with averaging times of X1 to X1000.
TIME INTERVAL		0.1 ns resolution (usable)
TIME INTERVAL (TI) and TI AVERAGE MODE	ACCURACY (NOMINAL)	$\epsilon_{\text{TI(s)}} = \pm \text{ TB} \cdot P_{\text{in}} \pm \frac{P_{\text{ck}}}{\sqrt{M}} \pm 10^{-9} \pm \frac{2E_{\text{npk}}}{\frac{dv}{dt}}$
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 (dec %) is the time base accuracy; $P_{\rm in}$ is the period or time interval of unknown signal; M is the number of averages given; $P_{\rm ck}$ is the measurement clock period; T is the gate time; $f_{\rm in}$ is the frequency of the unknown signal; $E_{\rm npk}$ equals peak noise pulse amplitude as presented to Schmitt trigger circuit; ${\rm d}v/{\rm d}t$ equals signal slope at input to Schmitt trigger (volts/second).

INTERNAL TIME BASE

Crystal Oscillator—Accuracy: Within 0.5 ppm (0°C to +50 ambient.) Long term drift: 1 part or less in 10⁷ per month. Oscillator 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 k Ω , $V_{out} = \pm 0.5 \, V$ into 1 M Ω .

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-P. Trigger Source: 0.5 divisions of vertical deflection.

Input R and C— 1 M Ω 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: $10~\text{k}\Omega$ and 20~pF. Sensitivity Arm "A": Logical "1" $\geq +0.5~\text{V}$, Logical "0" $\leq +0.2~\text{V}$. Sensitivity Arm "B": Logical "1" $\leq +0.2~\text{V}$, Logical "0" $\geq +0.5~\text{V}$.

External Clock In-20 Hz to 5 MHz.

Reset Front Panel—Reset initiates the instrument, all counters are affected, including averaging circuits.

Includes Accessories—Two Cables RF 42" (012-0403-00), (Sealectro to BNC connector).

Order 7D15 UNIVERSAL COUNTER/TIMER \$1475

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



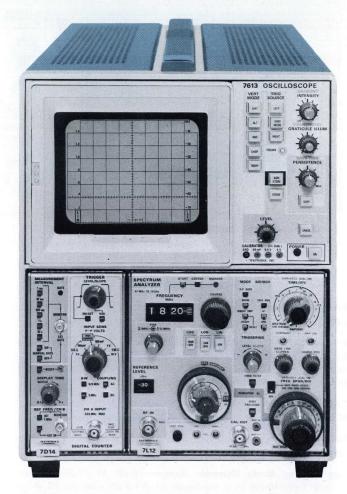


- 0 Hz to 1800 MHz IN ONE DISPLAY
- FULLY CALIBRATED DISPLAYS
- 300 Hz to 3 MHz RESOLUTION
- 4:1 RESOLUTION BANDWIDTH SHAPE FACTOR
- 70 db Dynamic Range
- INTERMODULATION DISTORTION 70 db below full screen
- SPURIOUS FREE OPERATION
- AUTOMATIC PHASE LOCK
- —115 dBm SENSITIVITY

The 7L12 is a swept front-end spectrum analyzer plug-in for all 7000-Series Oscilloscopes. These run from the rackmounts that are only 5¼ inches high, to 500 MHz real-time bandwidth units. The multiple plug-in concept of the 7000 Series allows simultaneous time and frequency domain displays. 7000-Series mainframes with CRT READOUT will display Reference Level, dB/div, Frequency Span, Resolution and Time/div on screen. All display parameters are calibrated and quantitative information is displayed on both front panel and CRT READOUT. CRT READOUT of display parameters is a unique 7L12 feature.

Excellent resolution shape factor (4 to 1) enables the 7L12 user to measure low-amplitude signals close to full screen signals. The wide, 3 MHz resolution position of the 7L12 enhances narrow pulse spectrum analysis and demodulated waveform measurements.

Much effort has gone into human engineering factors designed make the 7L12 easier to use and to reduce the chance of human error. A case in point is the three frequency indication modes from which the operator can choose. In the maximum



The 7L12 is shown inserted in a 7613, a mainframe featuring variable persistence. Variable persistence provides selection of just the right viewing time for Spectrum Analyzer displays. Also shown is 7D14 Digital Counter for precise frequency measurements, ratio determination and totalizing.

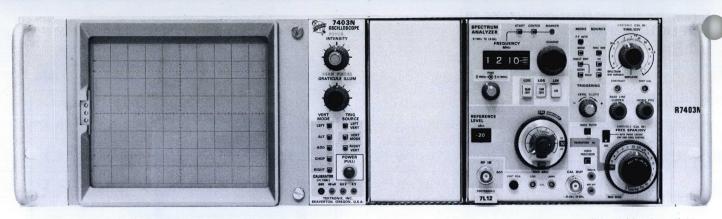
span mode, the frequency dial indication corresponds to the CRT position of a negative-going marker while the analyzer displays the maximum frequency span of 1800 MHz. When the frequency span is reduced, the operator has a choice of two frequency indicating modes, START or CENTER. The former, particularly useful for harmonic and distortion analysis, sweeps with the indicated frequency corresponding to the extreme left hand edge of the display. In the center mode, which is primarily of interest for symmetrical modulation spectra, the center of the display corresponds to the frequency indicated.

Another human engineering innovation is the RF input and reference level self-computing differential mechanism. This mechanism provides direct readout of the full-screen reference level, RF attenuation, and maximum input power for linear operation. Values are presented in dBm on the front panel. The 7000-Series Oscilloscope mainframes with CRT READOUT will also display the full screen reference level value in dBm on the CRT. Further operational ease is provided by color-keyed sections on the front panel.

More →

7L12 0-to-1800 MHz Spectrum Analyzer





51/4-inch rackmount R7403N with 7L12 installed. One of many Spectrum Analyzer configurations possible with the 7L12 and 7000-Series mainframes.

CHARACTERISTICS

Frequency Operating Range—100 kHz to 1.8 GHz continuously variable; accuracy \pm (10 MHz + 1% of dial indication).

Frequency Span—Calibrated 500 Hz/div to 100 MHz/div within 5% in 1-2-5 sequence. 0 Hz (analyzer, not swept) and maximum span (1.8 GHz) modes are also selectable. Span is continuously variable between steps.

Calibrator— 50 MHz $\pm 0.01\%$ —30 dBm ± 0.3 dB. Harmonics of 50 MHz are generated for frequency span calibration.

Reference Level—Selectable -100 dBm to +30 dBm in 10 dBm steps. Continuously variable between steps.

Log Display Mode Dynamic Range—70 dB at 10 dB/div, accuracy 1 dB/10 dB to a maximum of ± 1.5 dB over 70 dB range and 14 dB at 2 dB/div, accuracy 0.4 dB/2 dB for a maximum of 1.0 dB over the 14 dB range.

RF Attenuation—0 dB to 60 dB in 10 dB steps \pm (0.2 dB or 1% of dB reading, whichever is greater).

Resolution Bandwidth (6 dB down)— 300 Hz to 3 MHz in decade steps ±20%; shape factor—4:1, 60 dB to 6 dB.

Video Filter Bandwidth—Automatically selected by the resolution control.

CW Sensitivity— -115 dBm at 300 Hz Resolution; -108 dBm at 3 kHz Resolution; -100 dBm at 30 kHz Resolution; -90 dBm at 300 kHz Resolution; -80 dBm at 3 MHz Resolution.

Internal Spurious Responses—Less than $-100 \ \mathrm{dBm}$, referred to first mixer.

Intermodulation Distortion—Third order: 70 dB down from two —30 dBm signals. Second order: 70 dB down from two —40 dBm signals (within any frequency span).

Incidental FM—Phase locked mode: 200 Hz (P-P) maximum; not phase locked: 20 kHz (P-P) maximum.

Display Flatness— \pm 1.5 dB over any selected span with respect to level at 50 MHz.

Maximum Safe Input Power—RF Attenuation 0 dB: +13 dBm. (-30 dBm linear operating limit) RF Attenuation 60 dB: +30 dBm (Power rating of attenuator).

Sweep Rate—1 μ s/div to 10 ms/div in 1-2-5 sequence continuously variable between steps. Variable control has 100:1 range in 10 ms/div position to decrease sweep rate to approximately 1 s/div.

Triggering Modes-Normal, Peak-to-Peak Auto, Single Sweep.

Triggering Sources—Vertical amplifier channels line frequency and free run.

DIMENSIONS	In	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.0	12.7	NET	10	4.5
WIDTH	5.5	14.0	DOMESTIC SHIPPING	13	5.9
LENGTH	14.5	36.9	EXPORT-PACKED	18	8.2

Note about phosphors and graticules—7000-Series mainframes, except storage versions, are normally shipped with P31 phosphor. Slow swept displays sometimes are more easily viewed with P7 phosphor (an option with most mainframes). Check mainframe specification before ordering. External spectrum analyzer graticules for 7000-Series mainframes come with the 7L12 (see included accessories). See mainframe specification for availability of CRT option with internal Spectrum Analyzer graticules.

Included Accessories—6-ft BNC cable (012-0113-00); adapter BNC male to N female (103-0058-00); special spectrum analyzer graticules (implosion shields 337-1439-01 for 7403N or R7403N, 337-1159-02 for other 7000 Series); Amber light filter (378-0684-01.

Order 7L12 SPECTRUM ANALYZER		4850
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Optional Accessories

mum potential is 50 V DC.	naxi-	
Order 015-0221-00\$3	35.00	
75 Ω to 50 Ω minimum loss attenuator with DC block. Order 011-0112-00	25.00	
50 Ω to 75 Ω minimum loss attenuator, DC coupled. Order 011-0057-00\$1	13.25	
75 0 to 50 0 attenuator with direct 11.25 dB insertion loss	nor-	



INTRODUCTION

These pages represent an overview of TEK-TRONIX Sampling. Detailed instrument descriptions follow on succeeding pages.

Sampling is a process in which voltage samples are acquired from recurring waveforms and displayed on CRT or other display device. The sampling technique is also used in many automated test systems where the sampled data is "digitized" for direct alphanumeric readout or processing by computer. (Described on other pages in this catalog.)

7000-Series Sampling

Every 7000-Series mainframe can become a sampling oscilloscope with 7-Series sampling and time base plug-ins. The applications are as varied as the combination possibilities of mainframes, plug-in units and plug-in heads. The 7000 Series offers the widest choice of sampling possibilities.

Plug-ins

7511	 Sampler
7512	 Sampler/TDR
7T11	 Sampler Time Base
7M11	 Dual Delay Line

Sampling Heads

S-1	350 ps	50 Ω
S-2	75 ps	50 Ω
S-3A		Probe
S-4	30 ps	50 Ω
S-5		1 M Ω
S-6	30 ps	50 Ω

Pulse Generator Heads

S-5	0						F	ul	sei
S-5	2				٠		F	ul	sei
S-5	4						F	ul	ser

Trigger Recognizer Heads

S	-51				٠	18 GHz	Countdown
S	-53					General	Purpose

560-Series Sampling

Several sampling systems are available for use in 560-Series mainframes.

Plug-ins	Plug-in Heads						
3\$2	S-1 S-4						
372	S-2 S-5						
357/377	5-3 5-6						

Time Domain Reflectometry

Time Domain Reflectometry or TDR is closely associated with sampling oscilloscopes because the risetimes achieved with sampling allow best resolution, location and measurement of impedance differences. Time Do-main Reflectometry is possible with any sampling system or fast conventional oscil-loscope, but is easiest and most precise in systems designed for TDR. Tektronix. Inc. offers three sampling systems designed specifically for TDR.

In the 7000 Series-The 7S12 with plug-in

In the 560 Series-The 3S7 and 3T7.

For use in CATV, TV and similar applications—the 1501, with or without oscilloscope.

FOR VERSATILITY: PLUG-IN HEADS IN PLUG-IN UNITS

The user of the 7S11 and 7S12 has six plugin sampling heads available to him. He can choose 50-ohm terminated or 50-ohm loopthrough inputs, high impedance inputs, active or passive probe inputs. Bandwidths range from DC to 14 GHz, depending on the head selected. The user can even operate the heads at a convenient point away from the scope by the use of extension cables.



Time Bases and Other Considerations

The 7T11 Time Base is designed to be used with one or two 7S11 Sampling Units. The 7S12 includes a built-in time base that can also be used with a 7S11, eliminating the need for a time-base plug-in unit. For example, a 7S11 and a 7S12, with plug-in heads, will operate as a dual-trace sampling system with the time base of the 7S12 providing a common time-based sweep. If a delay line is required, the 7M11 delay line plug-in unit can be used in a vacant compartment or outside the mainframe. The 7M11 is a passive unit requiring no power.

7511 7T11 7512 350 ps 50 Ω **75 ps 50** Ω 350 ps Probe S-3A S-4 30 ps 50 Ω S-5 1000 ps 1 MΩ 30 ps 50 Ω Courses for the last to the la 0

7S12—This unit features the flexibility of two plug-in heads for time domain reflectometry or general-purpose sampling. For TDR a sampling head, usually the S-6 feedthrough head, is used in one compartment. A pulse generator head is used in the other compartment as a pulse source. When the 7S12 is to be used as a general-purpose sampler, a trigger recognizer head is substituted for the pulse generator head.

S-50 Pulser 18 GHz S-51 Countdown S-52 Pulser S-53 General Purpose

Pulser

S-54



- 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 $\pm 1\,\mathrm{V}$ 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 k Ω within 1%.

Delay Range—At least 10 ns (helps compare two signals in a dual-trace application.

Memory Slash - 0.1 div or less at 20 Hz.

Vertical Signal Out-200 mV per displayed div within 3%.

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

Weights		
Net weight	2 lb	0.9 kg
Domestic shipping weight	\approx 5 lb	≈2.3 kg
Export-packed weight	≈10 lb	\approx 4.5 kg

Order 7S11 SAMPLING UNIT without sampling head \$575

7S12 TDR and General-Purpose Sampler



- 45-ps TDR or 30-ps GENERAL PURPOSE SAMPLER
- 6 PLUG-IN SAMPLING HEADS AVAILABLE
- 3 PLUG-IN PULSE SOURCES AVAILABLE
- 1 TRIGGER RECOGNIZER HEAD AVAILABLE
- 1 TRIGGER COUNTDOWN HEAD AVAILABLE

The 7S12 is a combined vertical-horizontal, double-width plug-in unit, designed to operate in all 7000-Series mainframes. It permits high-resolution TDR or general-purpose sampling measurements. As a TDR, using the S-6 Sampling Head and S-Pulse Generator Head, the 7S12 has a system risetime of 45 permits from short-circuit termination) and distance range to 32



ft in any cable. Its vertical scale is calibrated in reflection efficient (ρ) from $2 m \rho / \text{div}$ to $500 m \rho / \text{div}$ and in voltage from 2 m V / div to 500 m V / 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.

CHARACTERISTICS SYSTEM PERFORMANCE WITH S-6 AND S-52

System Risetime— 35 ps or less for the incident step. 45 ps or less for the displayed reflection from a short-circuited, 1 ns test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distance to at least 49 ft (airline). Time range is at least .2 μ s, round trip. Both ranges are limited by the duration of the pulse from the S-52.

Pulse Amplitude—At least +200 mV into 50Ω .

put Characteristics—Nominal, $50-\Omega$, feed-through signal channel (termination supplied). SMA (3-mm) connectors.

Jitter-Less than 10 ps (without signal averaging).

Aberrations— +7%, -7% total of 10% P-P within 1.8 ns of step with reference point at 1.8 ns from step; +2%, -2% total of 4% P-P after first 2.5 ns with reference point at 300 ns from step.

TDR SYSTEM PERFORMANCE WITH S-5 AND S-54

System Risetime— 1.5 ns or less, for the displayed reflection from a short-circuited test line.

Time and Distance Ranges—Direct-reading tape dial gives calibrated, one-way distances to 4900 ft (airline, 3240 ft solid polyethelene). Time range is 20 μ s, round trip.

Pulse Amplitude—At least +400 mV into 50 Ω .

Input Characteristics—Nominal, $50-\Omega$ 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 m_{ρ} (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 k Ω .

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 $10 \mu s$, $1 \mu s$, $0.1 \mu s$ (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 μ s/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	\approx 5 lb	2.1 kg
Domestic shipping weight	\approx 8 lb	\approx 3.6 kg
Export-packed weight	\approx 13 lb	\approx 5.9 kg

INCLUDED ACCESSORIES

750 ps rigid "U" delay line (015-1017-01); short-circuit termination (015-1021-00); TDR Measurement Concepts Book (062-1244-00); TDR slide rule (003-0700-00).

Order	7\$12	TDR	SAM	PLING	UNIT	(tape	dial	in	feet)		
withou	ıt sam	pling	head	ds						 	\$1200
Order	Option	1 3 1	ГАРЕ	DIAL	CHAN	GE (m	eters) .		 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	\$1.95
Red, 18 inch, Order 012-0180-00	\$1.95
Black, 8 inch, Order 012-0181-00	\$1.95
Black, 18 inch, Order 012-0182-00	\$1.95
Tape Dial-calibrated in feet, Order 331-0273-00	\$8
Tape Dial—calibrated in meters. Order 331-0276-00	\$8



- 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 \simeq 10 Hz (sequential mode) to above 12.4 GHz. The following describes the modes of operation.

RANDOM SAMPLING—In this mode the triggering event may be displayed without the need of a pretrigger or signal delay line. The sampling process is controlled automatically by circuits which allow samples to be taken before, during and after the signal event of interest. The horizontal coordinate of each sample is then determined by a measurement of the time between the instant of sampling and the occurrence of a trigger. The random-sampling mode is most useful for displaying repetitive signals above 1 kHz.

SEQUENTIAL SAMPLING—When the signal repetition rate is between 10 Hz and 1 kHz, the most useful display is obtained in the sequential-sampling mode. In this mode, the sampling process is initiated by the trigger signal. As a result, either a pretrigger or signal delay line (such as the 7M11) is required to display the triggering event. For measurements which do not require display of the trigger-event (i.e., sinewaves) a pretrigger is not necessary and the decision to use random or sequential mode is based on repetition rate.

REAL-TIME SAMPLING—To provide a wide measurement range, the 7T11 automatically crosses from equivalent-time to real-time sampling for the three longest Time Position Ranges (50 ms, 5 ms, 0.5 ms). In this mode, sampling occurs at a free-running (50 kHz) rate with the horizontal coordinate determined in a manner similar to that described above for Random Sampling. Lead-time is fixed at about 3 μ s 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 above 12.4 GHz. The EXT mode has $50~\Omega,~1~M\Omega,~$ and HF SYN positions, each with its special application advantage. The $50~\Omega$ 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 M Ω input inserts a X1 FET amplifier in the $50~\Omega$ 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 VARI-ABLE 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 M\Omega 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 M Ω 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 M Ω . Max input voltage is 2 V P-P.

Int Trigger Source (Sinewave Triggering)*—Frequency range is 5 kHz to 500 MHz in X1 TRIG AMP; 5 kHz to 50 MHz in X10 TRIG AMP. Sensitivity range is 50 mV to 1 V P-P (referred to the vertical input) in X1 TRIG AMP; 5 mV to 1 V P-P (referred to the vertical input) in the X10 TRIG AMP.

 ${}^\star NOTE$: Trigger circuits will operate to DC with pulse triggering, except for HF Sync.

Random Mode Trigger Rate-100 Hz minimum.

Display Jitter—Measured under optimum trigger conditions TIME/DIV switch cw.

TIME POS RNG	SEQUENTIAL MODE	RANDOM MODE
50 μs to 500 ns	0.4 div at 10 ps/div	1 div at 10 ps/div
50 ns	10 ps	30 ps

Pulse Out—Positive pulse amplitude at least 400 mV (into 50 Ω) with 2.5-ns risetime or less.

Trigger Kickout— 2 mV or less into 50 Ω (except HF SYNC).





SAMPLING and TDR Sampling Sweep Unit 7T11

Pisplay Scan Rate—Continuously selectable from at least 40 eeps/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 k Ω within 10%. Max input voltage is 100 V (DC + Peak AC).

Sweep Out— 1 V/div within 2%, source R is 10 k Ω within 1%.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C.

Weights

Net weight	2.8 lb	1.3 kg
Domestic shipping weight	\approx 6 lb	\approx 2.7 kg
Export-packed weight	≈11 lb	\approx 5.0 kg

INCLUDED ACCESSORIES

42-inch BNC 50 Ω cable (012-0057-01); 10X, 50 Ω attenuator (011-0059-01); SMA (3 mm) male to BNC adapter (015-1018-00); SMA (3 mm) male to GR874* adapter (015-1007-00).

Order 7T11 SAMPLING SWEEP UNIT \$1625

Dual Delay Line 7M11

• 75 ns TIME DELAY

SELECTABLE TRIGGER OUT

• 175 ps RISETIME



The 7M11 is a passive dual DELAY LINE unit for use with the 7000-Series sampling system. In low-repetition rate applications, requiring the sequential mode of operation, the 7M11 provides the trigger source and signal delay necessary to view the triggering event.

Vertical delay for two 7S11 vertical sampling units is available with the dual 50- Ω , 75-ns delay lines. The closely matched (30 ps) lines have GR874* INPUT-OUTPUT connectors, 175-ps risetime, and 2X signal attenuation. Trigger selection is from either input, 5X attenuated, with a risetime of 600 ps or less.

CHARACTERISTICS DELAY LINE

Time Delay- 75 ns within 1 ns.

Delay Difference- 30 ps or less between channels.

Risetime— 175 ps or less.

Attenuation— 2X within 2% into 50 Ω .

Input Impedance— 50 Ω within 2%.

Maximum Input Voltage— ± 5 V (DC + Peak AC).

TRIGGER OUTPUT

Risetime-600 ps or less.

Attenuation— 5X within 10% into 50 Ω (referred to INPUT).

Output Impedance— 50Ω within 10%.

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

Weights

Net weight	5.8 lb	2.6 kg
Domestic shipping weight	≈9 lb	\approx 4.1 kg
Export-packed weight	\approx 14 lb	\approx 6.3 kg

INCLUDED ACCESSORIES

10-inch BNC cable (012-0208-00); two 2 ns GR cables (017-0505-00).

uraer	AMIT DEF	AT LINE	LINI			 	 \$325
7M11	CARRYING	CASE.	Order -	437-0106	6-00		\$30

Delay Line 11



be TEKTRONIX 113 Delay Cable has a delay of 60 ns and characteristic impedance of $50\,\Omega$. In general it is used in those sampling applications where the vertical amplifier does not contain internal delay lines and the triggering of the sweep is external and signal delay is required.

Characteristic Impedance— $50 \Omega \pm 1 \Omega$.

High Quality Cable—Approx 1.5-dB loss per 100 feet at 1000 MHz. 0 to 50% risetime approx 0.1 ns.

Dimensions and Weights

O.J. 7M11 DELAY LINE UNIT

Height	22% in	57.1 cm
Width	85/8 in	21.9 cm
Depth	21% in	55.5 cm
Net weight	44¾ lb	20.3 kg
Domestic shipping weight	≈60 lb	\approx 27.3 kg
Export-packed weight	≈75 lb	\approx 34.1 kg

Order 113 DELAY CABLE \$350

*Registered Trademark General Radio Company
U.S. Sales Prices FOB Beaverton, Oregon
Please refer to General Information page

A20F





- DC-TO-1 GHz BANDWIDTH
- CLEAN TRANSIENT RESPONSE

The S-1 Sampling Head is a low-noise, 350-ps risetime unit with a 50- Ω input impedance. It is designed for use with the 3S2, 3S5 and 3S6 Dual-Trace Sampling Units, 7S11 Sampling Unit, and 7S12 TDR Unit. The S-1 can be plugged in or attached by a cable for remote use. A trigger pickoff within the S-1 provides a trigger signal output from the plug-in unit.

RISETIME

350 ps or less.

BANDWIDTH

Equivalent to DC to 1 GHz at 3-dB down.

TRANSIENT RESPONSE

Aberrations as observed with the 284 Pulse Generator are +0.5%, -3% or less, total of 3.5% or less P-P, first 5 ns following the step transition; +0.5%, -5% or less, total of 1% or less P-P after 5 ns.

DISPLAYED NOISE

2 mV or less, unsmoothed; 1 mV, smoothed.

SIGNAL RANGE

Variable DC offset allows signals between +1~V and -1~V limits to be displayed at 2~mV/div. Signals between +2~V and -2~V limits may be displayed at 200~mV/div. For best dot response with random-sampling sweep unit, signal amplitude should be less than 500~mV P-P.

INPUT CHARACTERISTICS

Nominally 50 $\Omega.$ Safe overload is $\pm 5\,\text{V}.$ GR874* input connectors.

WEIGHTS

VLIGITIS		
Net weight	≈1 lb	0.2 kg
Domestic shipping weight	≈2 lb	\approx 0.9 kg

INCLUDED ACCESSORIES

5-ns, 50- Ω RG58 A/U cable (017-0512-00); 10X, 50- Ω GR attenuator (017-0078-00).

Order S-1 SAMPLING HEAD \$375



- DC-TO-4.6 GHz BANDWIDTH
- DISPLAYED NOISE LESS THAN 6 mV (unsmoothed)

The S-2 Sampling Head is a 75-ps risetime unit with a $50-\Omega$ 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 at +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 $2 \, \text{mV/div}$. Signals between $+2 \, V$ and $-2 \, V$ limits may be displayed at $200 \, \text{mV/div}$. For best dot response with random-sampling sweep unit, signal amplitude should be less than $200 \, \text{mV}$ P-P.

INPUT CHARACTERISTICS

Nominally 50 Ω . Safe overload is ± 5 V. GR874 input connectors.

WEIGHTS

Net weight	\approx 1 lb	0.2 kg
Domestic shipping weight	pprox2 lb	≈0.9 kg

INCLUDED ACCESSORIES

5-ns, 50- Ω RG213/U cable (017-0502-00); 10X, 50- Ω , GR attenuator (017-0078-00).

Order S-2 SAMPLING HEAD \$430

OPTIONAL ACCESSORIES

P6040/CT-1	Current Probe, order 015-0041-00 \$5	50
CT-3 Signal I	Pickoff, order 017-0061-00\$3	38
	assive Probe, order 010-6056-03\$4	
P6057 100X F	Passive Probe, order 010-6057-03\$4	45
1000/ 100// 1	433176 11000, 51461 515 6667 66 111111111 4	

Coupling Capacitor, GR874-K*, order 017-0028-00	\$17
Power Divider GR874-TPD*, order 017-0082-00	
VP-1 Voltage Pickoff "T", order 017-0073-01	
GR to BNC Adapter, order 017-0063-00 \$	7.50

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- 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-k Ω , 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.

RANSIENT RESPONSE (Probe Only)

Aberrations in the first 2 ns following a step are +8%, -2% or less, total of 10% or less P-P, +1%, -1% or less, total of 2% or less P-P after 2 ns, with 284 pulse displayed.

DISPLAYED NOISE (Probe Only)

3 mV or less referred to probe tip (includes 90% of dots).

SIGNAL RANGE

Variable DC offset allows signals between +1 V and -1 V, X1 range; or +2 V and -2 V, X2 range to be displayed at 2 mV/div. The signal range may be increased X10 or X100 with the use of the probe attenuators.

WEIGHTS

Net weight	3 lb	1.4 kg
Domestic shipping weight	\approx 5 lb	\approx 2.3 kg
Export-packed weight	≈10 lb	≈4.5 kg

INCLUDED ACCESSORIES

10X attenuator head (010-0364-00); 100X attenuator head 010-0365-00); coupling capacitor (011-0098-00); probe tip (206-0114-00); tip-ground adapter (013-0085-00); two test-point jacks (131-0258-00); $51/_2$ -inch ground lead (175-1017-00); $121/_2$ -inch ground lead (175-1018-00); 3-inch cable assembly (175-0249-00); three ground clips (344-0046-00); end cap (200-0834-00); two end caps (200-0835-00); probe holder (352-0090-00); retractable hook tip (013-0097-00); 50- Ω voltage pickoff (017-0077-01); carrying case (016-0121-00).

Order S-3A SAMPLING HEAD \$580



- 25-ps SAMPLING HEAD
- DC-to-14 GHz BANDWIDTH
- DISPLAYED NOISE LESS THAN 5 mV (unsmoothed)

The S-4 Sampling Head is a 25-ps risetime unit with a $50-\Omega$ 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

 $5\,\text{mV}$ or less, unsmoothed; $2.5\,\text{mV}$, 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 $\Omega.$ Safe overload $\pm 5\,\text{V}.$ SMA (3-mm) input connector.

WEIGHTS

Net weight	≈1 lb	\approx 0.2 kg
Domestic shipping weight	≈2 lb	\approx 0.9 kg

INCLUDED ACCESSORIES

2-ns cable with SMA connectors (015-1005-00); 10X 50- Ω SMA attenuator (015-1003-00); GR874* to SMA male adapter (015-1007-00); SMA male-to-male adapter (015-1011-00); $^5/_{16}$ -inch wrench (003-0247-00).

Order S-4 SAMPLING HEAD \$875

^{*}Registered Trademark General Radio Company





- 1-M Ω , 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-M Ω , 15-pF input impedance. When used with the included P6010 passive probe the input impedance increases to 10 M Ω , 10 pF while maintaining the 1-ns risetime at the probe tip. A switch on the sampling head selects either AC or DC coupling of the input.

The S-5 Sampling Head is designed for use with the 7S11, 7S12, 3S2, 3S5, 3S6 and 286 and can be plugged in or attached by an optional Sampling-Head extender for remote use.

CHARACTERISTICS

RISETIME

S-5 only, 1 ns or less; with 3.5 foot P6010, 1 ns or less.

BANDWIDTH

Equivalent to DC-to-350 MHz at 3-dB down at input connector or probe tip.

TRANSIENT RESPONSE

S-5 only (driven with a $50-\Omega$ source terminated in $50~\Omega$): aberrations +2.5%, -5% or less, total of 7.5% or less P-P within 17 ns after step +1%, -1% or less, total of 2% or less P-P thereafter.

S-5/P6010 (3.5-foot probe properly compensated): aberrations +5%, -5% or less, total of 10% or less P-P within 25 ns after step; +1%, -1% or less, total of 2% or less P-P thereafter.

DISPLAYED NOISE

S-5 only, 500 μV or less (includes 90% of dots). S-5/P6010, 5 mV or less (includes 90% of dots).

SIGNAL RANGE

S-5 only: DC coupled—1 V P-P from +1 V to -1 V. AC coupled 1 V P-P.

S-5/P6010: DC coupled (DC + peak AC)—10 V P-P; AC coupled, DC voltage—100 V.

INPUT CHARACTERISTICS

S-5 only is 1 M Ω within 1% paralleled by 15 pF within 1 pF. S-5/P6010 is 10 M Ω paralleled by approx 10 pF.

ATTENUATION ACCURACY

Probe attenuation is 10X within 3%.

WEIGHT

Net weight \approx 9 oz \approx 0.2 kg
Domestic shipping weight \approx 3 lb \approx 1.4 kg

INCLUDED ACCESSORIES

P6010 probe package (010-0188-00), 50-Ω termination (011-0049-01).

Order S-5 SAMPLING HEAD \$375

OPTIONAL ACCESSORIES

P6010 passive 10X probe package, order 010-0188-00	\$41.00
Probe tip-to-BNC adapter, order 013-0084-01	\$5.30
Probe tip-to-GR adapter, order 017-0076-00	\$8.30
Probe tip-to-GR terminated adapter, order 017-0088-00.	





- 30-ps RISETIME
- DISPLAYED NOISE LESS THAN 5 mV (UNSMOOTHED)
- LOOP-THROUGH INPUT

The S-6 Sampling Head is a $50-\Omega$ feed-through unit for high-speed applications in the 7S11, 3S2, 3S5, 3S6 or 286, and TDR applications in the 7S12 Time Domain Reflectometer.

30 ps or less. 35 ps or less as observed with S-52 Pulse Generator.

ANDWIDTH

Equivalent to DC to 11.5 GHz at 3-dB down.

TRANSIENT RESPONSE

Pulse aberrations following the step are: +7%, -7% total of 10% P-P within 1.8 ns of step with reference point at 1.8 ns from step; +2%, -2% total of 4% P-P after first 2.5 ns with reference point at 300 ns from step.

DISPLAYED NOISE

5 mV or less, measured tangentially.

SIGNAL RANGE

+1 V to -1 V (DC plus peak AC). 1 V P-P. DC offset allows any portion of input signal to be displayed.

INPUT CHARACTERISTICS

Nominally $50-\Omega$, loop-through system, unterminated. SMA (3-mm) connectors. Maximum safe overload is $\pm 5 \, \text{V}$.

WEIGHTS

Net weight \approx 1 lb 0.2 kg Domestic shipping weight \approx 2 lb \approx 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).

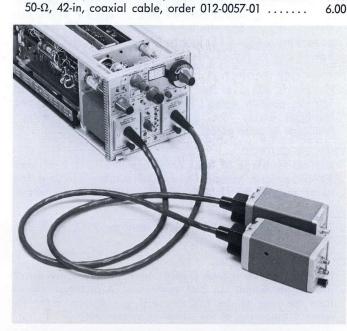
Order S-6 SAMPLING HEAD \$875

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OPTIONAL ACCESSORIES FOR SAMPLING HEADS

With SMA (3-mm) Connectors

Will SMA (5-IIIII) Connectors	
2X $50-\Omega$ attenuator, order $015-1001-00$ $5X 50-\Omega$ attenuator, order $015-1002-00$ $10X 50-\Omega$ attenuator, order $015-1003-00$ $50-\Omega$ termination, order $015-1004-00$ $2-ns 50-\Omega$ signal cable, order $015-1005-00$ $5-ns 50-\Omega$ signal cable, order $015-1006-00$ Male-to-GR874 adapter, order $015-1007-00$ Female-to-GR874 adapter, order $015-1008-00$ Male-to-N female adapter, order $015-1009-00$ Male-to-T-mm adapter, order $015-1010-00$ Male-to-male adapter, order $015-1011-00$ Female-to-female adapter, order $015-1011-00$ Coupling capacitor, order $015-1013-00$ $050-\Omega$ power divider T, order $015-1014-00$ $050-\Omega$ semi-rigid cable, order $015-1015-00$ SMA T adapter, order $015-1016-00$ SMA male-to-BNC female adapter, order $015-1018-00$	\$66.00 100.00 72.00 40.00 40.00 20.00 20.00 40.00 105.00 9.00 7.00 75.00 94.00 24.00 18.00 4.50
1-ns 50- Ω cable, order 015-1019-00	22.00
SMA male short-circuit termination, order 015-1020-00 SMA female short-circuit termination,	6.60
order 015-1021-00	6.60
SMA male $50-\Omega$ termination, order 015-1022-00	27.50
With BNC Connectors	
50- Ω feedthrough (5 watt), order 011-0099-00 50- Ω 2X attenuator, order 011-0069-01 50- Ω 2.5X attenuator, order 011-0076-01 50- Ω 5X attenuator, order 011-0060-01	\$10.00 18.50 16.50 16.50 16.50
50-Ω 10X attenuator, order 011-0059-01	16.50



50- Ω , 18-in, coaxial cable, order 012-0076-00

3-ft 5	Sampling-Head	extender,	order	012-0124-00	 \$64
6-ft S	Sampling-Head	extender,	order	012-0125-00	 \$66

U.S. Sales Prices FOB Beaverton, Oregon Please refer to General Information page 6.00





- 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.

CHARACTERISTICS

PULSE OUTPUT

Risetime is 25 ps or less. Amplitude into $50\,\Omega$ is at least $400\,\text{mV}$, positive going. Pulse duration is $100\,\text{ns}$, 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 $400\,\text{ps}$, -5%, +5% with a total of 8% or less P-P from $400\,\text{ps}$ to $5\,\text{ns}$; -4%, +1% with a total of 5% or less P-P after $5\,\text{ns}$.

PRETRIGGER OUTPUT

Risetime is 400 ps or less. Amplitude into $50\,\Omega$ 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 $50\,\Omega$ 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.

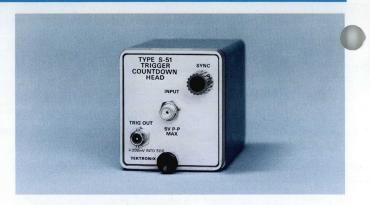
WEIGHTS

Net weight $\approx 1 \text{ lb}$ 0.3 kg Domestic shipping weight $\approx 3 \text{ lb}$ $\approx 1.4 \text{ kg}$

INCLUDED ACCESSORIES

500 ps 50 Ω semi-rigid coax (015-1015-00).

Order S-50 PULSE GENERATOR HEAD \$525



- 18 GHz COUNTDOWN
- 10 ps or less TRIGGER JITTER

The S-51 Trigger Countdown Head is a free-running tunnel-diode oscillator designed to provide stable sampling displays of signals up to 18 GHz. The S-51 may be used with the 3S2, 3S5, 3S6, 7S11 Sampling Units and 7S12 TDR Unit or it may be operated separately with the 285 Power Supply or 286. The S-51 has a front-panel sync control that synchronizes the oscillator frequency to a subharmonic of the input signal. The output from the S-51 is available at a front-panel trigger output connector and through a rear-panel connector for internal triggering. The output signal is a direct countdown of the input and permits triggering by a standard sampling time-base unit.

CHARACTERISTICS

INPUT SIGNAL

Frequency range is 1 GHz to 18 GHz. Stable synchronization on signals at least 100 mV P-P, as measured separately into 50 Ω ; 5 V, P-P maximum.

INPUT CHARACTERISTICS

 $50-\Omega$ SMA (3-mm) connector. Open termination paralleled by 1 pF.

TRIGGER OUTPUT

Front panel trigger output is at least 200 mV into 50Ω , Type BSM connector. Internal trigger output is at least 100 mV into 50Ω , internally connected to sampling unit. Jitter is 10 ps or less, with signals from 5 GHz to 18 GHz; 15 ps or less with signals from 1 GHz to 5 GHz. Kickout at signal input connector is 400 mV or less, kickout occurs between successive samples.

POWER REQUIREMENTS

The necessary power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285 or 286.

WEIGHT

Net weight ≈1 lb 0.2 kg
Domestic shipping weight ≈2 lb ≈0.9 kg

Order S-51 TRIGGER COUNTDOWN HEAD \$500





- 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 $50\,\Omega$ is at least 200 mV, positive-going. Pulse duration 350 ns, pulse period 8.3 μ s within 0.8 μ s. 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 $50\,\Omega$ is at least 1 V, positive-going. Pretrigger pulse duration is 4 ns. Pretrigger occurs 85 ns (within 5 ns) before the pulse output. Pretrigger to pulse output jitter is 10 ps or less. Pretrigger output is also available at rear connector for internal triggering of the sampling sweep unit.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

OUTPUT CONNECTORS

Pulse output uses a SMA (3-mm) connector. Pretrigger output uses a BSM connector.

WEIGHTS

Net weight ≈ 1 lb 0.3 kg Domestic shipping weight ≈ 2 lb ≈ 0.9 kg

INCLUDED ACCESSORIES

500-ps, 50-Ω semi-rigid coax (015-1023-00).

Order S-52 PULSE GENERATOR HEAD \$550



- DC-to-1 GHz OPERATION
- 10-mV SENSITIVITY

The S-53 Trigger Recognizer Head is intended for use with the 7S12 to permit operation as a general-purpose sampling system. The S-53 supplies triggering for the 7S12 or for other applications. The S-53 can also be powered from the 7S11, 3S2, 3S5, 3S6, 285, or 286.

INPUT CHARACTERISTICS

Frequency range is DC to 1 GHz. Sensitivity range is 10 mV to 2 V P-P into 50 Ω . Kickout at input, ± 5 mV or less.

OUTPUT CHARACTERISTICS

Risetime is 1 ns or less. Amplitude is at least 1.5 V positive-going into $50\,\Omega$. Pulse duration is 3 ns within 2 ns at the 50% amplitude level. Trigger-to-signal delay is $15\,\text{ns}$ or less; jitter is $15\,\text{ps}$ 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	\approx 1 lb	0.3 kg
Domestic shipping weight	\approx 2 lb	\approx 0.9 kg

INCLUDED ACCESSORIES

42-inch, 50- Ω cable (012-0057-01); 10X, 50- Ω attenuator (011-0059-01).

Order S-53 TRIGGER RECOGNIZER HEAD \$425

285 Power Supply for S-50 Series Heads





- 1-ns RISETIME
- LOW ABBERATIONS
- 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 $50-\Omega$ 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 $+400\,\mathrm{mV}$ or greater. Pulse duration is 25 $\mu\mathrm{s}$ within 2 $\mu\mathrm{s}$. 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 μ s or greater. Pretrigger to pulse output jitter is 100 ps or less at 120 ns lead time to 1 ns or less at 1 μ s lead time.

POWER REQUIREMENTS

Power is provided from the 7S11, 7S12, 3S2, 3S5, 3S6, 285, or 286.

OUTPUT CONNECTORS

Pulse output uses a BNC connector. Pretrigger output uses a BSM connector.

WEIGHTS

Net weight ≈1 lb 0.3 kg

Domestic shipping weight 2 lb 0.9 kg

INCLUDED ACCESSORIES

BNC T connector (103-0030-00); 8-inch, $50-\Omega$ cable (012-0123-00).

Order S-54 PULSE GENERATOR HEAD \$325



ACCEPTS ONE S-50 SERIES HEAD

TRIGGER OUTPUT JACK

The 285 Power Supply provides the regulated power supplies necessary to power one S-50 Series Head. It also has a front panel trigger output jack which delivers the trigger pulse from the plug-in Head to the front panel of the 285. It makes the S-50, S-52 or S-54 a complete pulse generator package.

CHARACTERISTICS

POWER REQUIREMENTS

90 V to 136 V or 180 V to 272 V, 50 Hz to 400 Hz, 8.5 watts at 115 V and 60 Hz. Slide switch on rear panel selects high or low voltage operation.

TRIGGER OUTPUT

BSM Connector provides internal trigger output of S-50 Series Heads to the front panel.

DIMENSIONS AND WEIGHTS

Height	3.1 in	5.1 cm
Width	5 in	12.7 cm
Depth	8 in	20.3 cm
Net weight	2 lb	0.9 kg
Domestic shipping weight	\approx 4 lb	\approx 2.8 kg

INCLUDED ACCESSORIES

18-inch trigger output cable (012-0127-00).

Order 285 POWER SUPPLY, without Heads \$225



2 mV/DIV to 200 mV/DIV CALIBRATED DEFLECTION FACTORS

- PLUG-IN SAMPLING HEADS
- VARIABLE INTER-CHANNEL DELAY

The Type 3S2 Dual-Trace Sampling Unit is designed for use in the Type 561B, 564B or 568 Oscilloscope. The unit can be used with sampling sweep units, including the Type 3T2, 3T77A and 3T5 Sampling Sweeps. The unit can be used with sampling sweep units, or with real time, real time from 5 s/div to 0.1 ms/div and sampling from 1 ms/div to 20 ps/div. In the Type 568 Oscilloscope, information can be presented in digital as well as analog form.

The Type 3S2 accepts two Sampling Heads that can be inserted directly or located remotely with an optional extender. Sampling Heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front panel control allows adjustment of the interchannel time relationship to compensate for signal cables or other external delays.

Five display modes provide for a variety of single-trace, dual-trace or X-Y displays. The 3S2 can also be operated with only one head, for applications not presently requiring dual-trace displays.



SAMPLING HEADS

May be plugged into the Type 3S2 or located remotely on the optional 3-ft or 6-ft Sampling-Head extenders.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874*	2 mV/div	\leq 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	$1 M\Omega$, $15 pF BNC$	2 mV/div	≤500 <i>μ</i> V
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

DEFLECTION FACTOR

2 mV/div to 200 mV/div in 7 calibrated steps, 1-2-5 sequence. Each step accurate within 3%. Variable between steps, extending to approximately 0.8 mV/cm, uncalibrated.

DC OFFSET RANGE

+1~V to -1~V. Allows signals between +1~V and -1~V limits to be displayed at 2~mV/div. Signals between +2~V and -2~V limits can be displayed at 200~mV/div. Monitor jacks provide 10~V actual DC offset (+10~V to -10~V) within 2~V through 10~V.

TRIGGERING

Trigger pickoff within most Sampling Heads permits triggering on either input signal. $50-\Omega$ Trigger Out connector at the front panel delivers pulse signals with approximately 1X gain for AC signals up to 500 mV peak-to-peak and 2-ns risetime to the $50-\Omega$ External Trigger Input of the sweep unit.



B-DELAY RANGE

Channel B display can be continuously positioned in time from +5 ns to -5 ns with respect to Channel A. Accommodates 3-foot difference in signal or Sampling-Head cables.

DISPLAY MODES

A only, B only, Dual Trace, Algebraic Addition of A and B signals, and X-Y display of A-vertically and B-horizontally, (for observation of hysteresis loops, phase shift, and similar displays). Independent controls for each channel permit positioning and inverting displays as desired.

VERTICAL OUTPUT

200 mV for each division of displayed signal through 10 k Ω .

WEIGHTS

LICITIO		
Net weight	10 lb	4.5 kg
Domestic shipping weight	\approx 17 lb	≈7.7 kg
Export-packed weight	\approx 27 lb	\approx 12.2 kg

INCLUDED ACCESSORIES

10-inch RG58 trigger cable with BNC/BSM connectors (012-0128-00); 18-inch RG58 trigger cable with BNC/BSM connectors (012-0127-00).

Order 3S2 DUAL-TRACE SAMPLING UNIT, without sampling heads\$700

OPTIONAL ACCESSORIES

3-ft	Sampling-Head	extender,	order	012-0124-00	 \$64
6-ft	Sampling-Head	extender,	order	012-0125-00	 \$66

^{*}Registered Trademark General Radio Company



- RANDOM OR SEQUENTIAL SAMPLING
- 20 ps/DIV to 100 μs/DIV CALIBRATED TIME BASE
- NO PRETRIGGER REQUIRED

The 3T2 Random Sampling Sweep Unit provides a unique, state-of-the-art advancement in measurement capabilities. This unit may be used in a 561B, 564B or 568 Oscilloscope, in conjunction with a Vertical Dual-Trace Sampling Unit.

Random sampling permits observation of the leading edge (or other portions) of signals even when used with vertical units that have no delay lines and without a pretrigger. Random sampling is especially useful with sampling units such as the 3S2 with S-1, S-2, S-3A, S-4, S-5 or S-6 Sampling Heads.

A front-panel switch (START POINT) selects either conventional, sequentially-stepped sampling or random sampling modes of operation.

SWEEP TIME/DIV

100 µs/div to 200 ps/div, 1-2-5 sequence extending to 20 ps/div with X10 DISPLAY MAGNIFIER. Accurate within 3% from 100 µs/div to 2 ns/div, within 5% from 1 ns/div to 200 ps/div. TIME/DIV is a resultant of the combined settings of TIME POSITION RANGE, TIME MAGNIFIER, and DISPLAY MAG. The sweep rate is displayed (digitally) in the TIME/DIV "window" for all combinations of these controls.

DISPLAY MAG

X10 expansion of time scale while maintaining a constant number of dots per division. Display magnifier accurate within 2%, in addition to specified sweep time/div accuracy.

TIME POSITION RANGE

100 ns, 1 μ s, 10 μ s, 100 μ s, and 1 ms. TIME POSITION and FINE variable controls position start of the display through an interval equal to TIME POSITION RANGE setting.

SAMPLES/DIV

Continuously variable adjustment of samples displayed per horizontal division from approx 5 samples/div to an immeasurable number of samples/div. Allows optimum adjustment of display rate and dot density.

DISPLAY MODES

Normal (repetitive), Single Sweep, Manual, or Ext. Horiz. For external input, deflection factor is adjustable from 1.5 V/div to 15 V/div. Front-panel START button for single-sweep operation.

PULSE OUTPUT

At least 100 mV into 50 Ω , negative going. Coincides with trigger recognition.

TRIGGERING

SOURCES (AC-coupled): Internal—if Sampling Unit contains a trigger pickoff. External, both 1-M Ω (for hi-Z probes) and 50- Ω terminated inputs.

JITTER: Depends on signal shape, repetition rate and amplitude; Less than or equal to 20 ps under optimum conditions.

	R REPETITION RATE DRE TRIGGER'' MODE
RANGE SWITCH	REPETITION RATE
1 ms and 100 μ s	10 Hz
10 μs	100 Hz
1 μs	1 kHz
100 ns	10 kHz



HORIZONTAL OUTPUT

1 V for each division of displayed signal through 10 k Ω .

PULSE TRIGGERING					
SOURCE	REPETITION RATE	AMPLITUDE*			
EXTERNAL	10 Hz to 100 MHz	10 mV to 250 mV			
1-MΩ/UHF Sync input	600 MHz to 3 GHz	(100 V max DC)			
EXTERNAL	10 Hz to 600 MHz	5 mV to 125 mV			
50- $Ω$ input		(5 V max DC)			

*Either polarity. Minimum rise rate is $150 \text{ mV}/\mu\text{s}$.

SINEWAVE TRIGGERING					
SOURCE FREQUENCY AMPLITU					
EXTERNAL 1-MΩ/UHF Sync input	10 kHz to 100 MHz 500 MHz to 3 GHz (+ polarity)	10 mV to 500 mV peak-to-peak			
gote many see alox annuality of the	100 kHz to 100 MHz 500 MHz to 3 GHz (— polarity)	ros e gala docu			
EXTERNAL 50-Ω input	100 kHz to 500 MHz	10 mV to 250 mV peak-to-peak			

WEIGHTS

Net weight	8 lb	3.6 kg
Domestic shipping weight	≈15 lb	≈6.8 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED ACCESSORIES

10X 50-Ω attenuator, BNC (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00)

Order 3T2 RANDOM SAMPLING SWEEP UNIT \$800







- 140-ps TDR SYSTEM RISETIME
- RHO AND VOLTAGE CALIBRATION
- TIME POSITION LOCATE BUTTON
- DIRECT-READING TO 4920 FT

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

The 3S7 TDR Sampler is a single channel, loop-through unit calibrated in V/div or ρ /div (rho/div). The 3T7 TDR Sweep Unit has concentric TIME/DIV and TIME-DISTANCE range controls, with time or distance measurements made from a direct-reading tape scale.

A LOCATE push button provides a quick way to determine which portion of the time position range is being displayed. When the button is pressed, the entire range is displayed with a brightened portion indicating which portion was displayed.

The tunnel diode pulse output has an amplitude of about $125\,\text{mV}$ into $50\,\Omega$. An automatic bias circuit stabilizes the TD under all conditions of external loading and temperature.

Because of their simplified and specialized design, the 3S7 3T7 is not compatible with other plug-in units, nor are they uitable for use as a general-purpose sampling system.

3S7 PERFORMANCE

SYSTEM RISETIME

140 ps or less, for the displayed reflection from a shorted 20-cm air line.

VERTICAL SCALE

Calibrated in ρ (rho) and volts: 0.005 ρ /div to 0.5 ρ /div or 5 mV/div to 500 mV/div in 7 calibrated steps (1-2-5 sequence), accurate within 3%. Continuous uncalibrated variation between steps.

INPUT CHARACTERISTICS

Nominal 50- Ω feed-through signal channel (termination supplied). GR874* connectors.

DC OFFSET RANGE

+1 V to -1 V. Allows open-circuit reflection to be displayed at full sensitivity.

VERTICAL OUTPUT

 $0.2\,\mathrm{V}$ for each division of displayed signal through $10\,\mathrm{k}\Omega$.

3T7 PERFORMANCE

TIME/DISTANCE

The direct-reading TIME-DISTANCE tape dial has three scales. TIME reads 0 to .1 μ s, 1 μ s or 10 μ s; AIR dielectric reads 0 to 49 ft, 492 ft or 4920 ft; POLY dielectric reads 0 to 32 ft, 324 ft or 3240 ft.

Round-trip time readings are accurate within 1% of indication. Optional tape dial is calibrated in metric units.

^{*}Registered Trademark General Radio Company





EQUIVALENT TIME/DIV

100 ps to 1 μs in thirteen calibrated steps, 1-2-5 sequence. Accuracy is within 3%, after arrival of incident edge of pulse.

JITTER

20 ps or less with TIME-DISTANCE MULTIPLIER at X0.1. 0.2 ns or less with TIME-DISTANCE MULTIPLIER at X1. 2 ns or less with TIME-DISTANCE MULTIPLIER at X10.

DIELECTRIC

Calibrated for air (492 ft/ μ s or 150 m/ μ s) and poly (324 ft/ μ s or 98.8 m/ μ s). PRESET position can be front-panel adjusted from 324 ft/ μ s to 492 ft/ μ s or greater.

DISPLAY MODES

Repetitive or single sweep, manual or external scan.

HORIZONTAL OUTPUT

1 V for each division of displayed signal through 10 k Ω .

PULSE SOURCE

Amplitude is 250 mV into 50 Ω , reverse terminated.

W	ΕI	G	H.	Т	3	S7

Net weight	\approx 3 lb	\approx 1 kg
Domestic shipping weight	\approx 5 lb	\approx 2 kg
Export-packed weight	≈9 lb	\approx 4 kg

Order 3S7 TDR SAMPLER \$575

INCLUDED ACCESSORIES

10-inch GR cable (017-0513-00); 20-inch GR cable (017-0515-00); 20-cm Air Line (017-084-00); 50- Ω termination (017-081-00); short circuit termination (017-087-00); TDR Measurement Concepts Book (062-1244-00) TDR Slide Rule (003-0700-00).

WEIGHT 3T7

Order 3T7 TDR SWEEP, tape of	lial in feet	\$620
Export-packed weight	≈9 lb	≈4 kg
Domestic shipping weight	\approx 5 lb	pprox2 kg
Net weight	\approx 4 lb	$\approx 2 \text{ kg}$

Order 3T7 TDR SWEEP Option 1, tape dial in meters \$620 OPTIONAL ACCESSORIES

Tape	dial	in	meters,	Order	331-0276-0	00	 	 	\$8
Tape	dial	in f	feet, Or	der 331	1-0273-00		 	 	\$8





- 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 the presence of noise signals or power voltage on the line. est 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 ohmsselectable with an internal switch. The input circuits are automatically protected from voltage on the line up to ± 100 volts for frequencies up to 440 Hz. Voltages over 5 volts automatically AC couple the input, blocking DC and low frequency voltages, and causing a front panel light to indicate the presence of voltage on the line.

The 1501 is designed to be a complete measurement package when the Chart Recorder (016-0506-00) is plugged in. A strip chart 4 CM wide by 32.5 CM long can be made in about 20 seconds for about 10 cents per chart. For convenience in previewing each chart or as a substitute for graphic records a separate oscilloscope may be easily connected to the Vertical and Horizontal outputs of the 1501. The 323 or 324 SONY/ TEKTRONIX Oscilloscopes are recommended for a size and style match with the 1501. The TEKTRONIX 211 Oscilloscope is also recommended. Most any oscilloscope with DC coupled vertical and horizontal amplifiers having a vertical sensitivity of 0.2 volts per division and a horizontal sensitivity of 0.5 volts per division is suitable.

The recorded portion of each chart has ten major horizontal divisions spaced 2.5 CM apart (about 1 inch) and eight major vertical divisions spaced 0.5 CM apart. The long (25 CM) horizontal scale provides distance resolution down to an inch or vo for the 500 foot range at 2 feet per division. A direct reading, en turn, start point delay dial provides the means for precise distance measurements using an oscilloscope display. Each chart is 7.5 centimeters longer than the recorded portion to provide space for handwritten data.

The chart recorder when installed in the 1501 can be driven by the 1401A or 1401A-1 Spectrum Analyzer, works especially well when coupled with a 323. The 1401A has a $50-\Omega$ 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— \pm 100 volts (DC + peak AC) for AC frequencies to 440 Hz.

Horizontal Scale Factors-2, 5, 20, 50, 200, 500 feet per division. Accuracy within 3%.

Start Point (Delay) Ranges-500 feet and 5000 feet, continuously variable. Direct distance readout on dial. Accuracy within 2% of dial setting.

Distance Ranges-0-520 feet at 2 feet/div

0-550 feet at 5 feet/div

0-5200 feet at 20 feet/div

0-5500 feet at 50 feet/div

0-7000 feet at 200 feet/div

0-10,000 feet at 500 feet/div

Metric Calibration (Option 2)-The metric 1501 Options 2 and 3 have scale factors of 0.5, 2, 5, 20, 50 and 200 meters with delay ranges of 100 and 1000 meters. This allows measurements to be made out to 3000 meters.



Cable Dielectric—Three choices. Either solid polyethylene, foam polyethylene with propagation velocity of 0.81, or one other, adjustable to your choice.

Sweep Rate—Changes from about 40 per second (flicker free) to 4 per second when noise filter mode is selected. Approximately 20 seconds when a chart recording is made. Front panel push button starts the recording. Paper automatically stops when record is complete.

Sweep Output—0 to +5 volt ramp within 2%.

Vertical Output—0.2 V per chart division. Range limited to +2 V to -2 V.

External Pen Drive Input-0.2 V per chart division, 1.6 V P-P.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: -15° C to $+55^{\circ}$ C; Nonoperating: -55° to $+75^{\circ}$ C (without batteries), -40° C to $+60^{\circ}$ C (with batteries); Charging: 0° C to $+40^{\circ}$ 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 $\frac{1}{2}$ sine, 11 ms duration. Two guillotine-type shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity—Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

POWER SOURCES

External DC Source—Operates from an external DC source of 6 V to 16 V, requires 5 W.

External AC Source—Operates from an external AC source of 90 to 136 V, or 180 to 272 V; 48 to 440 Hz, 15 W maximum at 115 VAC.

Battery Operation—Removable power pack contains a battery of 6 size C NiCd cells providing at least 8 hours of operation with 30 recordings at 20° to 25°C. Power packs may be removed and plugged into AC to recharge the cells or may be left in the 1501 for recharge. The cells completely recharge in 16 hours. The 1501 may be operated from AC while the cells recharge or turned off except for recharge.

DIMENSIONS AND WEIGHTS

	15	01
	in	cm
Height	31/2	8.9
Width w/handle	81/2	21.6
Depth w/panel cover	105/8	27.0
Depth w/handle	13	33.0
STATES TO CONTRACT TO THE STATE OF THE STATES	lb	kg
Weight w/Recorder and Accessories	≈8	≈3.6
Net weight w/o Recorder and Accessories	≈6.5	≈3
Domestic shipping weight w/Recorder	≈13	≈5.9
Export-packed weight w/Recorder	≈21	≈9.5

TIME DOMAIN REFLECTOMETER MODULE

1501 Included Accessories—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 concept book (062-1244-00); TDR slide rule (003-0700-00).

Order 1501 (with recorder)	\$1900
Order 1501 Option 1 (without recorder)	\$1425
Order 1501 Option 2 (Metric version)	\$1900
Order 1501 Option 3 (Metric version without recorder)	\$1425

OPTIONAL ACCESSORIES

OPTIONAL ACCESSORIES
Chart Recorder, Order 016-0506-00 \$475
323 Oscilloscope with P7 Phosphor—The 323 with high persistance P7 phosphor is highly recommended. Order 323 MOD 08 (with P7 phosphor)
1501 Convenience Accessory Group —Panel cover (200-0812-00); neck strap (346-0051-00); accessory pouch (016-0113-03); protective cover (016-0112-00); Order 020-0053-00
Protective Cover—Waterproof blue vinyl, Order 016-0112-00 \$10
Handle Conversion Kit (for two instruments)—For combining an existing 323 or 324 Oscilloscope with 1501 TDR. Order 040-0563-00\$30
Handle Conversion Kit (for three instruments)—For combining the 1501 with a 323 or 324/1401A or 1401A-1. Order 040-0596-00
Chart Paper—One roll, Order 006-1658-00 \$6.85
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
Battery Set—Set of 6 NiCd cells, Order 146-0012-01 \$23

*Registered Trademark General Radio Company

"F" female to GR 874*, Order 017-0089-00

Adapters

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

"F" male to BNC female, Order 103-0158-00 \$6.25

"F" female to BNC male, Order 013-0126-00 \$6.25



S-52

S-53

	Plug-in oscilloscope Plug-in oscilloscope with storage					
3	Diug in accillagance with storage					
	riug-iii oscilloscope with storage					
21N 93 Plug-in oscilloscope with storage and auto-erase						
565 95 Dual-beam oscilloscope with built-in time bases						
POWER SUPPLY						
	5					

				PLUG-IN	N UNITS								
PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWIDTH (—3 dB)	T _R	PLUG-IN UNIT	PAGE	MINIMUM DEFLECTION FACTOR	BANDWID		T _R			
		SINGLE TRACE					SPECIAL PURP	OSE					
3A75	106	50 mV/div	DC to 4 MHz	90 ns	3A8	400	00 1// !!	DO 1 05		400			
		MULTIPLE TRACE			Operational 3A10 Trans-	102	20 mV/div	DC to 3.5	MHZ	100 r			
3A3 Dual-Trace	98	100 μV/div	DC to 500 kHz	0.7 μs	ducer	107	10 μV/div	DC to 1 M	Hz	350 n			
3A6 Dual-Trace	99	10 mV/div	DC to 10 MHz	35 ns	2B67 Mod 730A								
3A72 Dual-Trace	101	10 mV/div	DC to 650 kHz	0.54 μs	3A74 Mod 730A	112	Engine An	alyzer Plug-ins					
3A74 Four-Trace	106	20 mV/div	DC to 2 MHz	0.18 μs									
	5.00	DIFFERENTIAL		1	Clay be a manual over		TIME-BASE UN	ITS					
2A63	97	1 mV/div	DC to 300 kHz	1.2 μs		FASTEST							
3A3	98	100 μV/div	DC to 500 kHz	0.7 μs	PLUG-IN UNIT	PAGE	PAGE	PAGE	TIME-BASE RATE	MAGNIFIER	FFΔ	FEATURES	
3A7 Comparator	100	1 mV/div	DC to 10 MHz	35 ns									
3A9	104	10 μV/div	DC to 1 MHz	350 ns	2B67	109	1 μs/div	X5		le swe			
	SP	ECTRUM ANALYZ		000 110	3B3	110	0.5 μs/div	X5	swee	b delay ep; le swee			
3L5	172	10 μV/dlv	10 Hz to 1 MHz		3B4	111	0.2 μs/div	X1 to X50	sing	le swee			
3S2 Dual Trace 3S5 Programmable	85 246	2 mV/div 2 mV/div	Used with S-Serie		PLING 3T2	86	0.2 ns/div	X10	rand samp				
		SAMPLING HEADS			3T5 247 0.1 ns/div ca		aalib	dialta					
S-1	78	50 Ω	DC to 1 GHz	350 ps	Programmable	247	0.1 ns/div	Del Cald	calib digit				
S-2	78	50 Ω	DC to 4.5 GHz	75 ps			TDR SYSTEM	n v					
S-3A	79	100 kΩ	DC to 1 GHz	350 ps	3S7	87	5 mV/div	140-ps risetime	9				
6-4	79	50 Ω	DC to 14 GHz	25 ps	3T7	87	100 ps/div	4920 ft direct-		1			
S-5	80	1 ΜΩ	DC to 350 MHz	1 ns			1-21-3-3						
3-6	81	50 Ω	DC to 11.5 GHz	30 ps									
S-50	82	25-ps Pulse G	enerator Head	CHAILTIM									
S-51	82	1-to-18 GHz T	rigger Countdown H	lead									
	_												

The 560 Series offers 22 different plug-in units providing complete versatility in measurement applications. Mainframes include a dual-beam oscilloscope with two independent vertical and horizontal deflection systems (565), a bistable storage oscilloscope with auto-erase (564B MOD 121N) and without auto-erase (564B), and a conventional oscilloscope (561B). The dual plugin unit feature of the 564B and 561B allows conventional displays or X-Y displays with either single-trace, dual-trace, or four-trace units. Sampling displays, as well as spectrum analysis and raster generation are also available.

25-ps Pulse Generator Head

1-ns Pulse Generator Head

DC-to-1 GHz Trigger Recognizer Head

83

83

84

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

The 568 is described in the Automated Test Systems Section, but can be used with any of the 560-Series plug-ins when digital readout is not required. The 3S6 and 3T6 Programmable Plug-Ins are described in the Systems Section.

560-SERIES OSCILLOSCOPES

10-MHz Oscilloscope 561B

- ILLUMINATED PARALLAX-FREE GRATICULE
- X-Y DISPLAYS
- SOLID-STATE MAINFRAME

The TEKTRONIX Type 561B and Type R561B Oscilloscope have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. They accept all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3S6 and Type 3T6 Plug-Ins. See plug-in chart on reference page 91.

TEKTRONIX CRT

Flat-faced rectangular 5-inch tube with 3.5-kV monoaccelerator and beam deflection unblanking. The edge lighted graticule is marked in 8 vertical and 10 horizontal cm divisions. The centerlines are marked every 2 mm. Illumination is controlled by a front-panel knob. A P31 phosphor is normally supplied; P2, P7 or P11 are optional without extra charge.

Z-AXIS INPUT

A BNC connector at the rear of the instrument permits external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals. Voltage-4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 M Ω or greater; 40 V DC into 1 M Ω or greater; 2 mV, 20 mV or 200 mV ground-to-peak squarewave into 50.0 Ω . Current—Current loop of 10 mA DC or 10 mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within 11/2 % from +20°C to +30°C; within 2% from 0°C to +50°C.

Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μ s or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μ s or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS

Operating temperature 0°C to 50°C, operating altitude to 15,000 feet.

POWER REQUIREMENTS

Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 561B will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 178 watts at 115 VAC. 60 Hz. The Type R561B will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 186 watts at 115 VAC, 60 Hz.

	56	1B	R561B			
DIMENSIONS	in	cm	in	cm		
Height	143/4	37.5	7	17.8		
Width	93/4	24.8	19	48.3		
Depth	211/2	54.7	201/2	52.1		
WEIGHTS	lb	kg	lb	kg		
Net	32	14.6	31 1/4	14.2		
Domestic shipping	≈41	≈18.6	≈56	≈25.4		
Export-packed	≈53	≈24	≈76	≈34.4		



INCLUDED ACCESSORIES FOR TYPE 561B BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

Order TYPE 561B OSCILLOSCOPE,

without plug-in units



INCLUDED ACCESSORIES FOR TYPE R561B Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

Order TYPE R561B OSCILLOSCOPE,

Type R561B MOD 171A mounts to a standard 19-inch rack on slide-out tracks. It can be pulled out, tilted and locked in any one of 7 positions for convenient servicing. The instrument has the same standard accessories as the Type R561B, but also includes slideout assembly (351-0050-00).

Order TYPE R561B MOD 171A OSCILLOSCOPE, without plug-in units \$795

OPTIONAL ACCESSORIES

CAMERAS

The C-12 and C-27 Cameras are recommended for the 561B and R561B, see camera section of catalog for more details. Other accessories are available, see catalog accessory pages.

564B MOD 121N





- DC-to-10 MHz BANDWIDTH
- BISTABLE SPLIT-SCREEN STORAGE AND CONVENTIONAL DISPLAYS
- UP TO 500 cm/ms WRITING SPEED
- X-Y DISPLAYS

The TEKTRONIX Type 564B and Type R564B Oscilloscopes have a complete selection of plug-ins that permit changing measurement capabilities to meet changing measurement needs. They accept all 2-Series and 3-Series Amplifier and Time-Base Units except Type 3T6 and Type 3S6 Plug-Ins. See plug-in chart on reference page 91.

TEKTRONIX STORAGE CRTS

The CRT is a TEKTRONIX bistable storage tube with beamdeflection blanking and an accelerating voltage of 3.5 kV. It has an 8 x 10-cm storage target divided into two 4 x 10-cm areas, individually controllable for storage and erasure.

There are two storage tubes available for use in the Type 564B Oscilloscopes. Both tubes exhibit characteristics of a conventional CRT when used in the non-stored mode. The standard tube, the T5641-200, has the brighter stored display. The other tube, the T5641-201, has the faster writing speed.

By selecting the proper tube, you can obtain optimum oscilloscope performance for your particular application. Such seleclion is important because each tube has a different writing speed and brightness for stored-mode operation. The brightness of a stored display for an individual tube is one value regardless of the intensity of the beam that generated it.

With the split-screen storage feature, either half of the 8 x 10-cm display can be independently controlled, thus allowing stored or conventional displays on either the upper or lower half. The contrast ratio and brightness of the stored displays are constant and independent of viewing time, writing and sweep rates, or signal repetition rates.

WRITING SPEED

Initially, at least 25 cm/ms for the standard CRT T5641-200: at least 100 cm/ms for the MOD 08 CRT T5641-201.

VIEWING TIME

Displays can be stored and viewed up to 1 hour.

ERASURE TIME

Approx 0.25 second.

STORED WRITING-SPEED ENHANCEMENT

This feature controls the single-sweep storage capabilities of the storage CRT. Through adjustment of the front-panel Level control, single-trace spot velocities up to 250 cm/ms using the standard CRT; up to 500 cm/ms using the fast CRT (MOD 08) can be stored with minimal loss of resolution and contrast in the center 7 x 9 cm.

SINGLE-SHOT SIGNALS

At slow or medium speeds, single-shot signals are easily stored for extended viewing time (within writing-speed capabilities of CRT selected).

NTEGRATE MODE

Increases the effective writing speed for repetitive fast signals with repetition rates that are too low for effective storage, but which may be too fast for satisfactory single-shot storage with enhancement.



REMOTE CONTROL OPERATION

A rear-panel connector permits erasing of upper and/or lower half of split screen from a remote location and permits remote operation of the Save Mode.

Erasure can be initiated in either of two ways:

- 1. Pulse initiated—Requires a negative pulse of 5 V to 100 V. Rate of change at least $0.1 \text{ V}/\mu\text{s}$.
- 2. Impedance change initiated—Requires a change from at least $1 \text{ M}\Omega$ to $50 \text{ k}\Omega$ or less in $10 \mu\text{s}$ or less.

AUTO ERASE (MOD 121N only)

In the Auto Erase Mode there is a continuous sequence of storing, viewing time and erasure of either upper screen, lower screen or entire screen. A rear-panel switch provides two modes of operation, either Signal Triggered Sweep or Erase Triggered Sweep.

In the Signal Triggered Sweep Mode, the input Signal initiates a sweep and the viewing time begins as the sweep ends. At the end of the variable viewing time, the selected portion of the screen is automatically erased and the cathode-ray tube is unblanked after the next sweep retrace. This cycle will automatically repeat itself as long as an input signal triggers the sweep.

The Erase Triggered Sweep Mode is primarily useful with sweep rates of 0.1 s/div and slower. In this mode of operation, the CRT is not blanked during the variable viewing time. The sweep unit can be triggered either by the input signal or by the erase pulse output located on the rear of the oscilloscope.

VARIABLE VIEWING TIME. (MOD 121N only)

1 s to at least 12 s. SAVE position disables automatic erasure.

EXTERNAL GRATICULE

The graticule is edge lighted and is marked in 8 vertical and 10 horizontal cm divisions. The centerline is marked every 2 mm. Illumination is controlled by a front-panel knob.

560-SERIES OSCILLOSCOPES

564B MOD 121N Auto-Erase Storage Oscilloscope



Z-AXIS INPUT

Accessible through a BNC connector at the rear of the instrument permitting external modulation of the CRT cathode. Z-axis input is AC coupled to the CRT cathode and requires 10 V P-P for beam modulation at normal intensity.

AMPLITUDE CALIBRATOR

Front-panel selection of calibration signals.

Voltage—4 mV, 40 mV, 400 mV, 4 V and 40 V ground-to-peak squarewave into 1 M Ω or greater; 40 V DC into 1 M Ω or greater; 2-mV 20-mV or 200-mV ground-to-peak squarewave into 50.0 Ω .

Current—Current loop of 10 mA DC or 10-mA ground-to-peak squarewave.

Voltage and current amplitude accuracy is within $1\frac{1}{2}$ % from $+20^{\circ}$ C to $+30^{\circ}$ C; within 2% from 0° C to $+50^{\circ}$ C. Squarewave frequency is 1 kHz, within 1%. Risetime and falltime is 1 μ s or less with load capacitance of 100 pF or less except in the 40-V position where t_r and t_f is 2.5 μ s or less with load capacitance of 100 pF or less.

ENVIRONMENTAL CHARACTERISTICS

Operating temperature 0°C to 50°C, operating altitude to 15,0000 feet.

POWER REQUIREMENTS

Quick-change, line voltage selection permits operation from any of the following voltages: 90 to 110 V, 104 to 126 V, 112 to 136 V, 180 to 220 V, 208 to 252 V, 224 to 272 V. The Type 564B MOD 121N will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of 196 watts at 115 VAC, 60 Hz. The Type R564B MOD 121N will operate over a line frequency from 48 Hz to 66 Hz, with a power consumption of 204 watts at 115 VAC, 60 Hz.

DIMENSIONS	56	4B	R564B		
	in	cm	in	cm	
Height	143/4	37.5	7	17.9	
Width	93/4	24.9	19	48.4	
Depth	211/2	54.7	201/2	52.2	
WEIGHTS	lb	kg	lb	kg	
Net	36	16.3	37	16.7	
Domestic shipping	≈45	≈20.4	≈58	≈ 26.3	
Export-packed	≈55	≈ 25	≈80	≈ 36.3	

INCLUDED ACCESSORIES FOR TYPE 564B MOD 121N BNC-post jack (012-0092-00); $50-\Omega$ BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00).

Order TYPE 564B MOD 121N OSCILLOSCOPE,

TYPE 564B

The auto erase and variable viewing time features of the Type 564B MOD 121N are deleted in the Type 564B and Type R564B. A cost savings is thus realized. All other storage characteristics, electrical characteristics and mechanical characteristics remain the same.

INCLUDED ACCESSORIES FOR TYPE 564B

BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

Order TYPE 564B OSCILLOSCOPE,

TYPE R564B

The Type R564B is a rackmount version of the 564B that is also available with or without auto-erase (MOD 121N).



INCLUDED ACCESSORIES FOR TYPE R564B MOD 121N Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); $50-\Omega$ BNC cable (012-0057-01); adapter, BNC to dual banana connector (103-0090-00).

Order TYPE R564B MOD 121N OSCILLOSCOPE,

INCLUDED ACCESSORIES FOR TYPE R564B

Mounting hardware (016-0131-00); BNC-post jack (012-0092-00); 18-inch patch cord (012-0087-00).

Order TYPE R564B OSCILLOSCOPE,

OPTIONAL MODIFICATIONS

FAST CR

Type 564B, 564B MOD 121N or rackmounts with CRT for fastest stored writing speed. Order MOD 08, no extra charge.

SLIDE-OUT TRACKS

OPTIONAL ACCESSORIES

SLIDE-OUT ASSEMBLY

Converts standard Type R564B or R561B for easy withdrawal and tilt of instrument. Order 351-0050-00 \$50

CRADLE ASSEMBLY

Provides rear slide support when R564B or R561B with slide-out tracks is mounted in a backless rack. Order 040-0344-00 \$10

REMOTE-ERASE CONNECTOR

Mates with 9-pin connector on the rear panel of Type 564B or R564B. Supplied without cable. Order 134-0049-00 \$6

CAMERAS

The C-12 and C-27 Cameras are recommended for the 564B and R564B, see camera section of catalog for more details. Other accessories are available, see catalog accessory pages.



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TWO VERTICAL AND HORIZONTAL SYSTEMS

- 8 x 10-cm DISPLAY PER BEAM
- CALIBRATED DELAYED SWEEP

A Type 565, or rackmount counterpart Type RM565, is essentially two single-beam oscilloscopes sharing a common cathode-ray tube and power supply. Each beam has separate vertical and horizontal deflection systems, focus, and intensity controls.

VERTICAL DEFLECTION

2 identical systems

The vertical amplifiers can be any of 2-Series or 3-Series Plug-In Units, except Spectrum Analyzer and Sampling Units. See plug-in chart on reference page 91.

HORIZONTAL DEFLECTION

2 identical systems

The horizontal amplifiers are built-in and can be driven by either of two sweep systems, simultaneously or independently, or from their external inputs. Front-panel controls permit using "A" sweep as a delaying sweep and "B" as the delayed sweep. In this mode of operation the upper beam is intensified for the duration of the "B" sweep. "B" sweep may also be used for single-sweep operation.

TIME BASE A AND B

 $1~\mu s/div$ to 5~s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable and to approx 12~s/div. A warning light indicates when the variable control is in the uncalibrated position. Either time base can be operated independently, or Time Base B can be delayed by Time Base A. In delayed-sweep operation, Time Base A display is intensified for the duration of the "B" sweep.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 0.1 μ s/div. Magnified time base accurate within 5%.

OPERATING MODES

Time Base A—Normal Sweep.

Time Base B-Normal, B delayed by A, and Single Sweep.

DELAY MODES

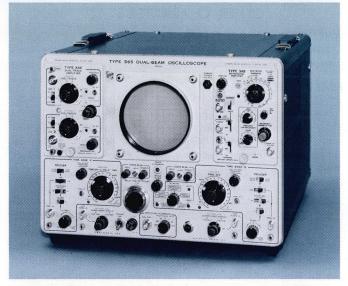
Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

DELAYED SWEEP MODE

Delayed sweep starts after time interval determined by DELAY TIME and DELAY-TIME MULTIPLIER. DELAY TIME control selects 10 μ s to 5 s delay time in a 1-2-5 sequence, accurate to within 3% (5, 2, and 1 μ s delay time, accuracies not specified). DELAY-TIME MULTIPLIER accurate within 0.5% of full scale. Provides continuously calibrated time intervals from 0.50 to 10.00 times the DELAY TIME. Dial is divided into 1000 parts.

DIFFERENTIAL TIME-MEASUREMENT ACCURACY

Within 3% and 10 minor divisions. Jitter \leq 1 part in 20,000 of 10 times DELAY TIME.



DELAY RANGE

 $5~\mu s$ to 50 s after start of delaying sweep. Inherent delay to start of delayed sweep is $1.5~\mu s$ or less.

EXTERNAL INPUT

Upper and Lower Horizontal Display Switches select Time Base A, Time Base B, or Ext. In the External position, the gain is continuously variable from approx 100 mV/div to 30 V/div, DC to 350 kHz. Maximum input voltage is 300-V RMS. Input RC is approx 100 kilohms paralleled by 30-55 pF depending on gain setting.

TRIGGER

2 identical systems

MODES

Manual, Automatic, Free-run. In Automatic mode, sweep free-runs at approx 50 Hz in the absence of a triggering signal.

COUPLING

AC, AC Fast, DC.

SOURCES

Internal from Upper Beam or Lower Beam, External, or Line.

REQUIREMENTS

0.2 divisions of deflection internal or 0.5 V external up to 50 kHz, increasing to 1 div or 1 V at 2 MHz.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 10 x 10-cm display area; 8 x 10 cm per beam with 6-cm overlap. Tube is aluminized with illuminated, internal, no-parallax graticule. Accelerating potential is 4 kV. P2 phosphor is normally supplied, P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, intensity contrast between A sweep and non-intensified B-zone of A sweep (internal screwdriver adjustment), trace rotation.

Z-AXIS MODULATION

AC-coupled to both CRT grids via rear panel input connectors. Time constant is 3.5 ms nominally, CRT modulation requires approx 10 V at normal intensity.

560-SERIES OSCILLOSCOPES

10-MHz Dual-Beam Oscilloscope



OTHER CHARACTERISTICS

AMPLITUDE CALIBRATOR

1-kHz squarewave output, calibrated in 6 steps from 1 mV to 100 V. Accurate within 3%.

REAR-PANEL OUTPUTS

VERTICAL SIGNAL OUT (both upper and lower)—Signal amplitude, DC level, and transient response depend on the vertical plug-in unit used. Typical signal amplitude: $2\,\mathrm{V/div}$ to $4\,\mathrm{V/div}$ of display; DC level $\pm 20\,\mathrm{V}$. Output impedance: approx 500 ohms; maximum load current 2 mA.

HORIZONTAL OUTPUTS (both upper and lower)—Signal amplitude, at least 50 mV/div of display in External position and 0.5 V/div of display in Sweep position. DC level 0 to +5 volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

A AND B +GATES—Pulse height 20 V minimum; DC level zero volts. Output impedance: approx 500 ohms; maximum load current 2 mA.

DELAYED TRIGGER—Fast-rise pulse amplitude +8 V minimum; DC level zero volts. Output impedance: approx 50 ohms; maximum load current 2 mA.

POWER REQUIREMENTS

600 watts maximum, 50 to 60 Hz. Instrument factory wired for 105-V to 125-V (117 V nominal) operation, or 210 V to 250 V (234 V nominal) upon request. Transformer taps permit operation at nominal voltages ranging from 99 V to 132 V or 198 V to 265 V.

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	13 ³ / ₄ in	34.9 cm
Width	167/ ₈ in	42.8 cm
Depth	23% ₁₆ in	59.8 cm
Net weight	67 lb	30.5 kg
Domestic shipping weight	≈95 lb	\approx 43.2 kg
Export-packed weight	≈117 lb	pprox53.2 kg

RACK MODEL DIMENSIONS	AND WEIGHTS	
Height	121/4 in	31.1 cm
Width	19 in	48.3 cm
Rack depth	$22^{3}/_{16}$ in	56.4 cm
Net weight	80 lb	36.3 kg
Domestic shipping weight	≈104 lb	\approx 47.3 kg
Export-packed weight	≈124 lb	\approx 56.4 kg

INCLUDED ACCESSORIES

3-conductor power cable (161-0010-03); smoke-gray light filter (installed) (378-0567-00); clear CRT protection plate (387-0918-00); two patch cords, BNC-to-BNC 18-inch (012-0087-00); post jack, BNC (012-0092-00); Type RM565 also includes slide-out assembly (351-0086-00); power cable (161-0024-03).

Order TYPE 565 OSCILLOSCOPE

without plug-in	units	\$2100

Order TYPE RM565 OSCILLOSCOPE

and the second second second	•••	****
without blug-in un	its	\$2200



RACKMOUNTING

Type RM565 mounts on tilting slide-out tracks to standard 19-inch rack. Additional mounting information on catalog instrument dimension page.

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The probes recommended for use with these instruments are covered on the 2- and 3-Series Plug-In Unit pages. Additional probes are available that may be better suited for a particular application, including current and high-voltage measurements. See the catalog accessory pages for information on these and other items.

CAMERAS

	C-27-547: f/1.9—1:0.7 lens, Polaroid Land ¹ Pack-Film back provides 10 x 10-cm coverage on 31/4 x 41/2 film.
	Order C-27-547-P\$610
	C-27N: $f/1.9$ —1:0.85 lens, no back, provides 10 x 10-cm coverage on 4×5 film with optional Graflok ² back and Polaroid Land film holder. Order C-27-N \$505
	Graflok back for 4 x 5 film holder (not included). Order 122-0604-00
	Type 565, RM565 to C-27-547 or C-27-N Camera adapter. Order 016-0225-02
•	CODE MODILER CART

SCOPE-MOBILE® CART

Model 205-3: holds 4 plug-in units, has 9-position tilt-lock oscilloscope tray. Order 205-3 \$210

CRADLE ASSEMBLY

Provides rear slide support when RM565 is mounted in backless rack. Order 040-0346-00 \$10

¹Registered Trademark Polaroid Corporation.

²Registered Trademark Graflex Inc.



- DC-to-300 kHz BANDWIDTH
- 1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- 250:1 CMRR

The Type 2A63 is a differential amplifier plug-in unit. It can be used to make voltage measurements between two aboveground points while at the same time cancelling in-phase signals such as hum pickup in the connecting leads.

The Type 2A63 may be used in the Type 561B, 564B or 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. Used with the Type 129 Power Supply, the Type 2A63 can drive recorders, X-Y plotters, oscilloscopes, and other indicators.



DC to 300 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

 $1.2 \,\mu s$ or less.

DEFLECTION FACTOR

1 mV/div to 20 V/div in 14 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

DIFFERENTIAL INPUT

DEFLECTION FACTOR	CMRR*	
excess in all the	1 kHz	50 kHz
1 mV/cm to 50 mV/cm	250:1	150:1
0.1 V/cm to 20 V/cm	25:1	25:1

^{*}With a maximum sinewave amplitude of 5 V P-P.

PHASE SHIFT

Phase shift between two Type 2A63 Units used for X-Y displays is nominally less than 1° at $50 \, \text{kHz}$.



INTER-STAGE AC COUPLING

AC STABILIZED switch reduces drift at high gain.

WEIGHTS

33/4 lb	1.7 kg
\approx 7 lb	\approx 3.2 kg
≈11 lb	\approx 5.0 kg
	\approx 7 lb

Order TYPE 2A63 DIFFERENTIAL AMPLIFIER \$275

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package. Order 010-0074-00 \$20
P6055 10X Probe Package, adjustable attenuation helps main-
tain common-mode rejection. Order 010-6055-01 \$75
P6007 100X Probe Package. Order 010-0150-00 \$35



- DC-to-500 kHz BANDWIDTH CONSTANT AT ALL DEFLECTION FACTORS
- 100 μV/DIV to 10 V/DIV
 CALIBRATED DEFLECTION FACTOR
- 50,000:1 CMRR
- FET INPUTS

The Type 3A3 Dual-Trace Differential Amplifier is designed for use in the Type 561B, 564B, 565, or in the 568/230 Oscilloscope, but without digital presentation of the measurement. Used in the Type 129 Power Supply, the unit can be used to drive X-Y plotters, oscilloscopes, and other indicators.

BANDWIDTH

DC-to-500 kHz or 5 kHz (switch selectable). Selected bandwidth is constant at all volts/div settings. Low frequency—3 dB point when AC coupled is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

 $100~\mu V/div$ to 10~V/div in 16 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

MAXIMUM INPUT VOLTAGE

350 V (DC + peak AC, DC to 1 kHz) 0.1 mV/div to 10 mV/div; 350 V (DC + peak AC, DC to 500 kHz) 20 mV/div to 10 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF. Input R can be disconnected by removing internal wire link.

PHASE SHIFT (0.1 mV to 10 mV)

Less than 2° from DC to 100 kHz between two Type 3A3 Amplifiers used in X-Y operation. Phase shift can be adjusted to 0° at any particular deflection factor setting.

NOISE

Displayed noise, tangentially measured, is less than 15 $\mu \rm V$ in the 500 kHz bandwidth position.

DC STABILITY

Drift with ambient temperature (constant line voltage) less than 50 μ V/°C.

INTERCHANNEL ISOLATION

Electrostatic Isolation is 10⁶:1 or better referred to input signal levels. Dual-Trace Isolation in alternate or chopped operation is 100:1 or better referred to divisions of display. Example: 5 divisions displayed on Channel 1 will cause no more than 0.05 divisions of deflection on Channel 2.

TRIGGER PICKOFF

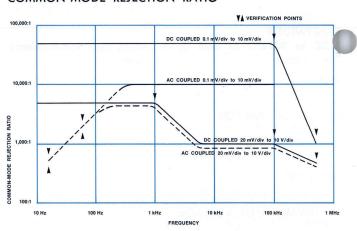
Internally coupled. Can be selected from Channel 1, Channel 2 or the composite signal after switching.

DIFFERENTIAL CF OUTPUTS

Output is available from two of the connector pins at the rear of the plug-in for use in driving recorders or other equipment. Output amplitude is a ground-reference, differential, \approx 5-volt signal for each division of displayed signal. Front-panel TRIGGER SWITCH allows signal out selection of CH 1, CH 2 or composite. Bandwidth is DC to \approx 400 kHz with a non-capacitive load. Jacks can be easily installed at the rear of the oscilloscope to provide access to the CF outputs.



COMMON-MODE REJECTION RATIO



WEIGHTS

Net weight	51/4 lb	2.4 kg
Domestic shipping weight	≈10 lb	\approx 4.5 kg
Export-packed weight	≈14 lb	\approx 6.4 kg

INCLUDED ACCESSORIES

Four BNC-to-binding post adapters (103-0033-00); two BNC-to-BNC 18-inch patch cords (012-0087-00).

Order TYPE 3A3 DUAL-TRACE DIFFERENTIAL AMPLIFIER\$950

P6028 1X Probe Package. Order 010-0074-00 \$20
P6055 10X Probe Package, adjustable attenuation helps main-
tain common-mode rejection. Order 010-6055-01 \$75
P6007 100X Probe Package. Order 010-0150-00 \$3
P6006 10X Probe Package. Order 010-0127-00 \$31



10 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS

35-ns RISETIME

The Type 3A6 Amplifier is a general-purpose, dual-trace plug-in unit designed for use in the Types 561B, 564B and 565 Oscilloscopes. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The Type 3A6 features two separate channels with identical characteristics. It can be operated in any one of five modes for a variety of single and dual-trace displays. Two Type 3A6's can be used for X-Y curve tracing, but without synchronized switching or channel pairing.



BANDWIDTH

DC to 10 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

Approximately 35 ns.

DEFLECTION FACTOR

10 mV/div to 10 V/div in 10 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Includes Channel 1 only (polarity of Channel 1 can be changed to provide 180° inversion); Channel 2 only; alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 4 μ s (approx) segments of each channel are displayed at an approx 125-kHz rate per channel (chopped transient blanking is provided); Added—outputs of Channel 1 and 2 added algebraically.

INTERNAL TRIGGER SIGNAL

Selectable from the output of Channel 1 only or from the combined output of the unit. Triggering from Channel 1 only permits viewing the true relationship between two signals when operating the unit in either alternate or chopped mode.

SIGNAL DELAY

Permits viewing of leading edge of fast-rise waveforms.*

WEIGHTS

, 2101110		
Net weight	7 lb	3.2 kg
Domestic shipping weight	\approx 9 lb	\approx 4.1 kg
Export-packed weight	\approx 13 lb	\approx 5.9 kg

Order TYPE 3A6 DUAL-TRACE AMPLIFIER \$600

OPTIONAL ACCESSORIES

The probes recommended for use with these instruments satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028	1X Probe Package. Order 010-0074-00	\$20
P6006	10X Probe Package. Order 010-0127-00	\$31
P6007	100X Probe Package. Order 010-0150-00	\$35

*The Type 3A6 can be used with a Type 2B67 or Type 3B2 Time-Base Unit, but it will not usually be possible to view the entire leading edge of the triggering waveform. Same applies when the unit is used with Types 565 and RM565 Oscilloscopes.



- DC-to-10 MHz BANDWIDTH
- 1 mV/DIV to 50 V/DIV CALIBRATED DEFLECTION FACTORS
- 20,000:1 CMRR
- ±11,000-cm EFFECTIVE SCREEN HEIGHT

The Type 3A7 High-Gain Differential Comparator adds to the measurement capabilities of Type 561B, 564B, and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. Used with Type 129 Power Supply, the Type 3A7 can drive recording equipment, X-Y plotters, oscilloscopes, or other indicators.

As a differential input amplifier, the dynamic range of the 3A7 Unit permits common-mode signals up to ± 15 volts in amplitude to be applied to the amplifier without attenuation. With a rejection ratio of about 20,000 to 1 for DC or low-frequency signals, differential signals of 1 mV or less on large common-mode signals can be measured. A front-panel attenuator permits the acceptance of common-mode voltages up to 500 V.

As a differential comparator, voltage measurements using the slide-back technique can be made with this unit. The high accuracy and stability of the DC comparison voltage, added differentially to the input signal, makes precise voltage measurements possible. Using this mode of operation, the 3A7 Unit has an effective screen height of $\pm 11,000\,\mathrm{cm}$. This is equivalent to a $\pm 11\text{-volt}$ dynamic signal range at a deflection factor of 1 mV/cm. Within this range, calibrated $\pm \mathrm{DC}$ comparison voltages can be added differentially to the input signal to permit a maximum of about 0.001% or 100 $\mu\mathrm{V}$ per mm to be resolved.

CALIBRATED DEFLECTION FACTOR

1 mV/div to 50 V/div, depending on millivolts/div and attenuator settings. Accuracy of millivolts/div positions is within 3%. Uncalibrated, continuous variation between steps and to approx 125 V/div.

BANDWIDTH (-3 dB)†		
mV/DIV	FREQUENCY	RISETIME
50 mV to 10 mV/div	DC to ≥10 MHz	≤35 ns
5 mV/div	DC to ≥ 8 MHz	≤44 ns
2 mV/div	DC to ≥ 6 MHz	≤58 ns
1 mV/div	DC to ≥ 4 MHz	≤88 ns

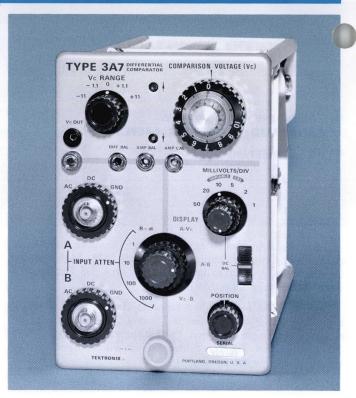
†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

	INPUT CHARACTERISTICS	
INPUT ATTEN	MAX PEAK INPUT VOLTS Common or Differential Mode	MAX INPUT ATTEN ERROR
$R \approx \infty$	±15 V	*
1X	±15 V	**
10X	±150 V	±0.05%
100X	±500 V	±0.15%
1000X	±500 V	±3%

^{*}Input R \approx 10,000 to 50,000 M Ω .

INPUT RC

1 megohm paralleled by approx 20 pF.



COMMON-MODE REJECTION RATIO AT 1 mV/div				
DC COUPLED	\geq 20,000:1 with \pm 11 VDC or 30 V P to P AC, DC to 20 kHz			
AC COUPLED	\geq 1000:1 with 30 V P to P at 60 Hz, to \geq 20,000:1 at 20 kHz			
HF (AC OR DC COUPLED)	\geq 500:1 with 30 V P to P at 500 kHz, to \geq 20,000:1 at 20 kHz			

COMPARISON VOLTAGE

0 to ± 1.1 V, or 0 to ± 11 V. Accuracy: \pm (0.15% of indicated value plus 0.05% of Vc Range). Vc OUT jack on front panel.

OVERDRIVE RECOVERY

Recovers to within $10\,\text{mV}$ of reference signal within $300\,\text{ns}$ after the signal returns to the screen. Certain overdrive signals can cause an additional slow (thermal) shift of up to $5\,\text{mV}$ in the reference level.

WEIG	HTS
Nlot	

Net weight	7 lb	3.2 kg
Domestic shipping weight	\approx 9 lb	\approx 4.1 kg
Export-packed weight	≈14 lb	\approx 6.3 kg

Order TYPE 3A7 DIFFERENTIAL COMPARATOR ... \$750

OPTIONAL ACCESSORIES

P6028 1X Probe Package. Order 010-0074-00 \$20
P6055 10X Probe Package, adjustable attenuation ratio helps
maintain common-mode rejection. Order 010-6055-01 \$75
P6006 10X Probe Package. Order 010-0127-00 \$3
P6007 100X Probe Package. Order 010-0150-00\$35

^{**1}X input R within $\pm 0.1\%$ of 10X input R.



- 10 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- FIVE OPERATING MODES

The Type 3A72 Amplifier is a general-purpose dual-trace plug-in unit that has two separate channels, each with identical characteristics. The unit can operate in any of five operating modes for a variety of single and dual-trace displays. This unit can be used in the Type 561B, 564B, or 565 Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

BANDWIDTH

DC to 650 kHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Includes Channel 1 only (normal or inverted); Channel 2 only; Alternate—Channel 1 and 2 switched electronically on alternate sweeps; Chopped—successive 16-µs segments of each channel are displayed at an approx 30-kHz rate per channel. Chopped transient blanking is provided; Added—outputs of Channel 1 and 2 algebraically added.

MULTIPLE X-Y DISPLAYS

Obtained with two Type 3A72 Plug-In Units; both synchronization and automatic pairing are provided. With two Type 3A72's operated in the dual-trace mode, Channel 1 of the left-hand unit is always plotted against Channel 1 of the right-hand unit.



WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	pprox 9 lb	\approx 4.1 kg
Export-packed weight	\approx 14 lb	\approx 6.3 kg

Order TYPE 3A72 DUAL TRACE AMPLIFIER \$450

OPTIONAL ACCESSORIES

The probes recommended for use with this instrument satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028	1X Probe Package. Order 010-0074-00	\$20
P6006	10X Probe Package. Order 010-0127-00	\$31
P6007	100X Probe Package, Order 010-0150-00	\$35

560-SERIES OSCILLOSCOPES

3A8 Operational Amplifier



- TWO INDEPENDENT OPERATIONAL AMPLIFIERS
- 10 MHz OR GREATER GAIN-BANDWIDTH PRODUCT
- 15,000 OR GREATER OPEN-LOOP GAIN

The Type 3A8 Operational Amplifier performs precise integration, differentiation, function generation, linear and nonlinear amplification. It contains a display amplifier and two operational amplifiers; each operational amplifier has identical features, including front-panel selection of internal Z_i and Z_f components. External components can be used independently or in combination with the internal resistor-capacitor combinations. The output of either operational amplifier can be applied to the other operational amplifier; either output can be applied to the display amplifier and/or fed to other devices. The unit can be used in the Type 561B, 564B, or Type 565. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The Type 3A8 can drive recorders, X-Y plotters, oscilloscopes and other indicators when used in the Type 129 Power Supply.

DISPLAY AMPLIFIER

BANDWIDTH

DC to at least 3.5 MHz at 3-db down.

RISETIME

100 ns or less.

DEFLECTION FACTOR

20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by 47 pF.

OPERATING MODES

Signal source selection from either operational amplifier or an external signal. AC or DC coupling. The display can be inverted to provide the desired deflection polarity.

OPERATIONAL AMPLIFIERS

OPEN-LOOP GAIN

At least 15,000 at DC.

OPEN-LOOP GAIN-BANDWIDTH PRODUCT

At least 10 MHz.

OUTPUT RANGE

 $\pm 25 \text{ V}$, $\pm 7.5 \text{ mA}$. Protected against shorts to ground.

OUTPUT IMPEDANCE

 $30\,\Omega$ or less at 1 MHz for compensated unity-gain amplifier.

INPUT OFFSET

Voltage: adjustable to zero $\pm 500 \,\mu\text{V}$ (front-panel control). Current: adjustable to zero $\pm 50 \,\text{pA}$ (calibration control).

DRIFT

After 30 minute warmup, typically less than 0.5 mV/hour referred to input (averaged over 10 hours).



Provisions for negative and/or positive feedback. Negative feedback utilizes internal and/or external impedances; positive feedback utilizes external impedances only.

SELECTABLE INPUT AND FEEDBACK COMPONENTS

TYPE 3A8 OPERATIONAL AMPLIFIER

Front-panel switches allow independent selection of the following resistors and capacitors in any combination as Z_i and Z_f : 0.01, 0.1, 0.2, 0.5 and 1 megohm; 10 pF, 100 pF, 0.001, 0.01, 0.1 and 1 μ F. All values are $\pm 1\%$ except 10 pF and 100 pF which are adjustable.

INTEGRATION LOW-FREQUENCY REJECT

An RC network which prevents integration below approx 2 Hz (voltage or current offset drift) can be switched in or out as needed. Other networks can be connected externally.

TERMINAL ADAPTERS

Two shielded terminal adapters are included for construction of external circuitry for custom applications. Over one hundred suggested circuits for special applications are shown in the instruction manual.

WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	≈15 lb	≈6.8 kg

INCLUDED ACCESSORIES

Two terminal adapters (013-0048-01); two terminal shields (013-0049-01); two BNC to binding post adapters (103-003, 00).

Order TYPE 3A8 OPERATIONAL AMPLIFIER \$875



OPTIONAL ACCESSORIES



LOG ADAPTER

The Log Adapter allows the display and measurement of highamplitude signals mixed with low-amplitude signals. Pulses and transient waveforms differing in amplitude by up to 1000 to 1 can be displayed and measured on the same trace. The Log Adapter is a logarithmic feedback network that converts the two operation amplifiers from linear amplifiers to essenally logarithmic amplifiers.

Order 013-0067-00 \$83

COMPENSATING ADAPTER

The Compensating Adapter extends the high-frequency performance of either operational amplifier when the internal $Z_{\rm i}$ and $Z_{\rm f}$ resistors are used in any combination for either gain or attenuation.

The adapter compensates for stray capacitance associated with the internal resistors, providing for an adjustment for optimum HF response.

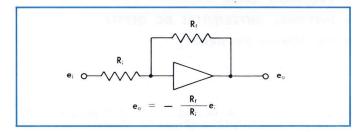
Order 013-0081-00\$40

GATING ADAPTER

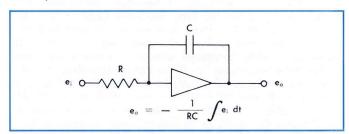
LEAKAGE CURRENT ADAPTER

Used with the 3A8 Plug-In Unit, the Leakage Current Adapter provides the facility for measuring leakage current of semi-inductor diodes and small signal transistors.

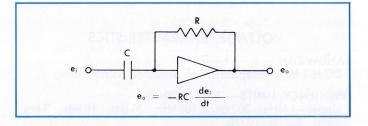
BASIC OPERATING MODES



AMPLIFICATION is determined by the ratio of input to feedback resistors. This provides convenient signal step-up or step-down, with low output impedances, to over 750 kHz. Use of external compensation extends the closed-loop gain-bandwidth product to 10 MHz or more.



INTEGRATION is obtained by placing a capacitor in the feedback loop. Unlike the RC integrator, this circuitry permits loading of the output, and integration without loss of signal level. Integration at repetition rates of approximately 5 MHz is possible. Low-frequency rejection allows drift-free repetitive-waveform integration.



DIFFERENTIATION is accomplished by placing a capacitor in the input circuit. The unique characteristic of differentiation is its ability to extract higher frequency waveform components. It can advantageously detect minute information such as transients and slope changes. Differentiation of waveforms with significant components as high as 1.5 MHz is possible.



- VOLTAGE MEASUREMENTS
 10 μV/div to 10 V/div
 DC-to-1 MHz BANDWIDTH
- CURRENT MEASUREMENTS (with optional current probe)

1 mA/div to 1 A/div 10 Hz-to-1 MHz BANDWIDTH

- SELECTABLE UPPER AND LOWER 3-dB POINTS
- 100,000:1 CMRR
- INTERNAL DIFFERENTIAL DC OFFSET
- 10 μV/hour DC DRIFT

The Type 3A9 is a DC-coupled differential amplifier designed for use in Tektronix 561B, 564B and 565 Oscilloscopes. It can also be used in the 568 Oscilloscope when digital readout is not required. The Type 3A9 can drive recorders, X-Y plotters, oscilloscopes and other indicators when used with the Type 129 Power Supply.

The Type 3A9 represents a significant improvement from previous performance standards in high-gain, differential, DC-coupled amplifiers for the Type 560-Series Oscilloscopes. DC drift is held to $10~\mu\text{V/h}$, long term without chopper stabilization; displayed noise (tangentially measured) is $12~\mu\text{V}$ at $10~\mu\text{V/div}$ and 1-MHz bandwidth with a 25- Ω source resistance. Bandwidth is maintained at DC-to-1 MHz throughout the deflection factor range of $10~\mu\text{V/div}$ to 10~V/div. CMRR is at least 100,000:1 from DC-to-100 kHz from $10~\mu\text{V/div}$ to 10~mV/div. DC differential offset provides an internal voltage to cancel signal DC levels or to inspect signal components over a full differential dynamic range. Bandwidth is selectable at both upper and lower 3-dB points for noise attenuation and AC coupling at very low frequencies (0.1 Hz).

In addition, the Tektronix P6021 (125-turn) AC current probe provides the convenience of current readings from 1 mA/div to 1 A/div with the AC current probe input. The bandwidth when using the optional current probe is from 10 Hz to 1 MHz.

VOLTAGE CHARACTERISTICS

BANDWIDTH

DC-to-1 MHz independent of deflection factor setting.

FREQUENCY LIMITS— 3-dB POINTS

Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz.

Lower—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz. A DC offset position provides DC low frequency response and turns on the DC offset control.

INPUT RC

1 megohm, paralleled by 47 pF.



DEFLECTION FACTOR

10 μ V/div to 10 V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuously variable between steps and to approximately 25 V/div.

INPUT COUPLING

May be switched to AC, GND or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position. Lower—3-dB point is approximately 1.6 Hz when AC coupled at input.

INPUT GATE CURRENT

From 10 μ V/div to 10 mV/div, maximum input gate current is \pm 20 pA at $+25^{\circ}$ C and \pm 100 pA at $+50^{\circ}$ C; 20 mV/div to 10 V/div, maximum input gate current is \pm 10 pA at $+25^{\circ}$ C and \pm 10 pA at $+50^{\circ}$ C. Display shift at 10 μ V/div ($+25^{\circ}$ C, AC coupled) is \pm 2 div.

DISPLAYED NOISE

 \leq 12 μ V or 0.1 div, whichever is greater, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less.

DC STABILITY

Drift with time (constant ambient temperature and line voltage; DC to 100 Hz bandwidth).

Short term: \leq 5 μ V/min (P-P) or 0.1 div (whichever is greater) after 1-hour warm up.

Long term: $\leq 10 \,\mu\text{V/h}$ (P-P) or 0.1 div (whichever is greate after 1-hour warm up.





DIFFERENTIAL DYNAMIC RANGE

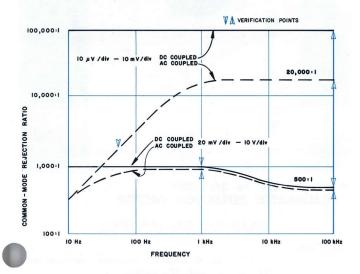
10 μ V/div to 10 mV/div— \pm 1 V. 20 mV/div to 0.1 V/div— \pm 10 V. 0.2 V/div to 1 V/div— \pm 100 V.

2 V/div to 10 V/div—±1000 V (500 V max each input).

DC OFFSET

 $10 \,\mu\text{V/div}$ to $10 \,\text{mV/div}$ — $+1 \,\text{V}$ to $-1 \,\text{V}$. $20 \,\text{mV/div}$ to $0.1 \,\text{V/div}$ — $+10 \,\text{V}$ to $-10 \,\text{V}$. $0.2 \,\text{V/div}$ to $1 \,\text{V/div}$ — $+100 \,\text{V}$ to $-100 \,\text{V}$. $2 \,\text{V/div}$ to $10 \,\text{V/div}$ — $+1000 \,\text{V}$ to $-1000 \,\text{V}$.

COMMON-MODE REJECTION RATIO



COMMON-MODE DYNAMIC RANGE

10 μ V/div to 10 mV/div— \pm 10 V. 20 mV/div to 0.1 V/div— \pm 100 V. 0.2 V/div to 10 V/div— \pm 500 V.

MAXIMUM INPUT VOLTAGE

DC Coupled: $10 \,\mu\text{V/div}$ to $10 \,\text{mV/div}$ — $\pm 15 \,\text{V}$ (DC + peak AC); $20 \,\text{mV/div}$ to $10 \,\text{V/div}$ — $\pm 500 \,\text{V}$ (DC + peak AC).

AC-Coupled Input DC Voltage: ±500 V, each input.

OVERDRIVE RECOVERY

 \leq 10 μs to recover to within 0.5% of zero level after removal of a + or — voltage applied for 1 s. Voltage not to exceed differential dynamic range.

INPUT OVERDRIVE LIGHT

Indicates differential overload is being approached.

AC CURRENT CHARACTERISTICS WITH OPTIONAL CURRENT PROBE

BANDWIDTH

10 Hz to 1 MHz with optional AC current probe.

FREQUENCY LIMITS-3-dB POINTS

Upper—1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 1 kHz, 300 Hz, 100 Hz.

Lower—10 kHz, 1 kHz, 100 Hz. Not calibrated from 10 Hz to DC.

INPUT

Accepts Tektronix P6021 (125-turn) AC current probe.

DEFLECTION FACTOR

1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence accurate within 3%. Uncalibrated continuously variable between steps and to approximately 2.5 A/div.

MAXIMUM INPUT CURRENT 10 A P-P.

FRONT-PANEL SIGNAL OUTPUT

1 V ($\pm 20\%$) per displayed division. DC coupled, internally adjustable to ground reference. Dynamic range is at least +5 V to -5 V. Bandwidth is DC to at least 500 kHz. Output resistance is $100~\Omega$ or less. Minimum load resistance, $10~k\Omega$.

WEIGHTS

Net weight	$4^{3}/_{4}$ lb	2.2 kg
Domestic shipping weight	\approx 8 lb	\approx 3.6 kg
Export-packed weight	≈12 lb	\approx 5.4 kg

Order TYPE 3A9 PLUG-IN UNIT \$600

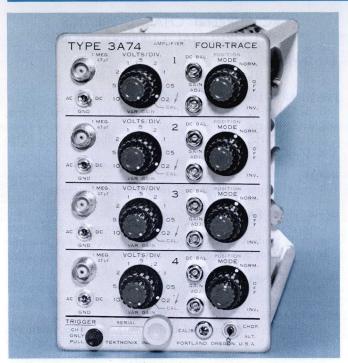
OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available. See the Tektronix Catalog accessory pages for additional information on these and other items.

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection. Order 010-6055-01 . \$75
P6028 1X Probe Package. Order 010-0074-00 \$20
P6007 100X Probe Package. Order 010-0150-00 \$35
P6021 Current Probe. Order 010-0237-02 \$98

3A74 2-MHz Four-Trace Amplifier 3A75 4-MHz Single-Trace Amplifier





20 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS

The Type 3A74 and Type 3A75 are general purpose plug-in units for use in the Type 561B, 564B or 565 Oscilloscope. They can also be used in the Type 568 Oscilloscope when digital readout is not required. Used in the Type 129 Power Supply, they can drive recorders, X-Y plotters, oscilloscopes, and other indicators.

3A74 CHARACTERISTICS

BANDWIDTH

DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

Approximately $0.17 \mu s$.

DEFLECTION FACTOR

20 mV/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

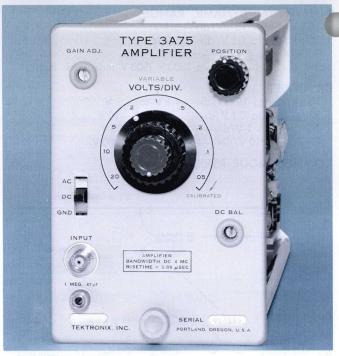
WEIGHTS

Net weight	7 lb	3.2 kg
Domestic shipping weight	≈11 lb	\approx 5.0 kg
Export-packed weight	≈15 lb	\approx 6.8 kg

INCLUDED ACCESSORIES

Four BNC to binding-post adapters (103-0033-00).

Order	TYPE	3A74	AMPLIFIER	 \$900



50 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTOR

3A75 CHARACTERISTICS

BANDWIDTH

DC to 4 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz, 0.2 Hz with 10X probe.

RISETIME

Approximately 90 ns.

DEFLECTION FACTOR

50 mV/div to 20 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

INPUT RC

1 megohm paralleled by approx 47 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

WEIGHTS

Net weight	4 lb	1.8 kg
Domestic shipping weight	\approx 7 lb	≈3.2 kg
Export-packed weight	≈12 lb	≈5.4 kg

Order TYPE 3A75 AMPLIFIER \$285

OPTIONAL ACCESSORIES

The probes recommended for use with these instruments satisfy most measurement requirements. Additional probes are available that may be better suited for a particular application, including high-voltage and current measurements. See catalog accessory pages for information on these and other items.

P6028 1X Probe Package. Order 010-0074-00	\$20
P6006 10X Probe Package. Order 010-0127-00	\$3
P6007 100X Probe Package. Order 010-0150-00	\$35



DC to 1 MHz BANDWIDTH 10 μV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS

- 100,000:1 CMRR
- DC VOLTAGE SUPPLY FOR TRANSDUCERS
- SELECTABLE UPPER AND LOWER —3 dB POINTS

The Type 3A10 is well suited for low-amplitude, low-frequency measurements and can be used with standard voltage probes. As a transducer amplifier, its inputs are designed to allow use of piezoelectric and other self-generating transducers, or strain gage and other voltage-excited transducers, using the built-in variable DC voltage supply.

A wide range of physical quantities, such as pressure, force, acceleration, vibration, displacement, strain, and temperature can be measured with optional transducer accessories. Accessory transducer packages include a snap-in, scale-factor plate to permit direct reading of units being measured without computation.

CHARACTERISTICS

BANDWIDTH

DC Coupled: DC to 1 MHz -0, +30% independent of deflection factor setting.

AC Coupled: lower limit is 1.6 Hz, $\pm 5\%$ in 1 M Ω input mode; 0.16 Hz, $\pm 5\%$ in 10 M Ω input mode.

REQUENCY LIMITS —3 dB POINTS

UPPER— 1 MHz, 300 kHz, 100 kHz, 30 kHz, 10 kHz, 3 kHz, 1 kHz, 300 Hz, 100 Hz, \pm 12%.

LOWER—DC, 0.1 Hz, 1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, \pm 12%. A DC offset position provides DC low frequency response and turns on the DC offset control.

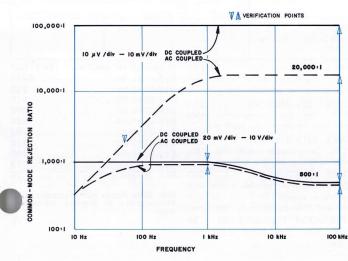
INPUT R and C

1 megohm or 10 megohm paralleled by 47 pF.

DEFLECTION FACTOR

 $10~\mu\text{V/div}$ to 10~V/div in 19 calibrated steps, 1-2-5 sequence, accurate within 2% (3%, 20~mV/div to 10~V/div). Uncalibrated continuously variable between steps and to approximately 25~V/div.

COMMON-MODE REJECTION RATIO





DISPLAYED NOISE

Less than 12 $\mu\rm V$, measured tangentially at full bandwidth (1 MHz), source resistance 25 Ω or less. No more than 1.25 $\mu\rm V$ RMS with UPPER -3 dB FREQUENCY Switch in 100 Hz position.

SIGNAL OUT

1 V per displayed division, $\pm 20\%$. Dynamic range is at least +5 V to -5 V. Maximum current is 15 mA. Bandwidth is DC to at least 500 kHz. Output resistance is 50 Ω or less.

STRAIN GAGE/TRANSDUCER POWER SUPPLY

Voltage range is -1 V to -11 V, $\pm 1\%$. Current range is 0 to at least 60 mA. Maximum (short circuit) current is 90 mA.

For complete specification on DC Drift, Differential Dynamic Range, DC Offset/Transducer Balance, Common-Mode Dynamic Range, Maximum Input Voltage and Overdrive Recovery, please see Type 3A9 description.

WEIGHTS

, 2.00		
Net weight	$4^{3}/_{4}$ lb	2.2 kg
Domestic shipping weight	≈8 lb	\approx 3.6 kg
Export-packed weight	≈12 lb	\approx 5.4 kg

INCLUDED ACCESSORIES

Transducer Measurement Concepts book (062-1246-00).

3A10 TRANSDUCER AMPLIFIER \$800

3A10 Transducer Amplifier



TRANSDUCER PACKAGE		CONTENTS	DESCRIPTION	RECOMMENDED ACCESSORIES	
-98 B	PRESSURE 015-0161-00	TRDCR: 3000 psig 119-0246-00. Scale: 1 to 1000 psi/DIV; 0.1 to 100 (kgf/cm²)/DIV 331-0269-01.	Trdcr element: Bonded STRG 350 Ω_i f _n \approx 65 kHz. Accuracy 2%.	20 ft cable 012-0209-00	
[] [] []	PRESSURE 015-0162-00	TRDCR: 300 psig 119-0245-00. Scale: 0.1 to 100 psi/DIV; 0.01 to 10 (kgf/cm²)/DIV 331-0269-02.	Trdcr element: Bonded STRG 350 Ω ; $f_n \approx 24 \text{kHz}$. Accuracy 2% .	20 ft cable 012-0209-00	
	FORCE 015-0163-00	TRDCR: 3000 lbs f 119-0243-00. Load button: 214-1400-00. Eye bolt (2): 214-1399-00. Scale: 1 to 1000 lbs f/DIV; 0.5 to 500 kgf/DIV 331-0269-03.	Trdcr element: Bonded STRG 350 Ω. Accuracy 1%.	20 ft cable 012-0209-00	
	FORCE 015-0164-00	TRDCR: 50 gram f; 50 lb f 119-0250-00. Adapter: 119-0251-00. Scales: 0.01 to 20 lbs f/DIV; 5 (10 ⁻³) to 10 kgf/DIV 331-0269-04. 0.01 to 20 gram f/DIV; 0.02 (10 ⁻³) to 40 (10 ⁻³) mm/DIV 331-0269-09.	Trdcr element: Unbonded STRG 350 Ω. Accuracy 2%.	to oppg mode to	
	ACCELERATION 015-0165-00	TRDCR: 10,000 g 119-0244-00. Scale: 0.001 to 1000 g/DIV 331-0269-05.	Trdcr 1.5 Hz to 15 kHz; $f_n \approx$ 30 kHz. Element: Piezoelectric. Accuracy 5%.	20 ft cable 012-0211-00	
	VERTICAL VIBRATION 015-0166-00	TRDCR: ± 0.025 inch. Displacement Scale: 1 (10^{-6}) to 10 (10^{-3}) inch /DIV; 0.02 (10^{-3}) to 0.2 mm/DIV	Trdcrs: Inductive self gen 10 Hz to 1 kHz; Damped f _n ≈ 8 Hz.	20 ft cable 012-0136-00	
	HORIZONTAL VIBRATION 015-0167-00	331-0269-06. Velocity Scale: 20 (10 ⁻⁶) to 20 (inch/sec)/ DIV; 0.5 (10 ⁻⁶) to 0.5 (10 ⁻³) (m/s)/DIV 331-0269-07.	Outputs ≈600 mV/inch/s and ≈10 mV/0.001 inch. Accuracy 5%.	10 mm	
	DISPLACEMENT 015-0168-00	TRDCR: \pm 0.2 inch. Feeler gage 0.040-inch 003-0663-00. Scale: 10 (10^{-6}) to 0.1 inch/DIV; 0.2 (10^{-3}) to 2 mm/DIV 331-0269-08.	Element: DC to DC LVDT DC to $>$ 120 Hz. Accuracy 2% within \pm 0.1 inch.	20 ft cable 012-0209-00	
THIN	STRAIN 015-0171-00	Strain Gages: 30,000 μ strain. Package of five.	Elements: Foil STRG 120 Ω . Accuracy 1%. 0.125-inch long attached leads.	Strain gage Adapter 015-0169-00 Cement kit 015-0172-00	
TEMPERATURE	015-0173-00	Thermocouple:	ę		
		+105°C Max 119-0253-00.	PVC Ripcord Insulation; #30 Iron Constantan.		
	+1000°F	+480°С Мах 119-0252-00.	Fiberglass Insulation; #30 Iron Constantan.		
00.0		+480°C Max with Magnet Mounting 119-0236-00.	Fiberglass Insulation; #24 Iron Constantan.	OCMA TO A TO	
	Intersy enlagn	Adapter (2) 103-0033-00. Scale: 0.5 to 500°F/DIV; 0.2 to 200°C/DIV 331-0269-11.	Accuracy 5% from +10°C to max °C.	Ge 69	



STRAIN GAGE ADAPTER (015-0169-00)\$75 Provides means for connecting 1, 2, or 4 arms of a Wheatstone Bridge to the Type 3A10. Has variable shunt resistor for gage factor calibration. The adapter has four binding post terminals and a six-foot cable with 6-pin connector. Scale included is 5 to 50,000 μ strain/DIV, 331-0269-10.



CEMENT KIT (015-0172-00) .. \$20 Provides means for mounting and connecting foil strain gages. Includes Room Temperature Curing Epoxy cement, RTV Clear Silicon Rubber coating, Neoprene pads and metal plates, cementable Wiring terminals, and clear Mylar film.

CABLE (012-0136-00) \$14
20 ft. low-noise coaxial cable with
BNC connectors on both ends.

CABLE (012-0209-00) \$25 20 ft. low-noise six-conductor cable with 6-pin connector on each end.

CABLE (012-0210-00) \$20 20 ft. six-conductor cable with 6-pin male connector on one end.

CABLE (012-0211-00) \$20 20 ft. low-noise coaxial cable with miniature coaxial connector on one end and BNC connector on the other.

CONNECTOR (131-0618-00) . \$6 Mates Type 3A10 INPUT 6-pin consector.

TRANSDUCER	P	A	C	K	A	(31	E	P	श	CE	LIST
015-0161-00				٠								\$225
015-0162-00												225
015-0163-00												450
015-0164-00												390
015-0165-00												225
015-0166-00												95
015-0167-00												110
015-0168-00												200
015-0171-00												15
015-0173-00												30





- 1 μs/DIV to 5 s/DIV CALIBRATED TIME BASE
- 5X MAGNIFIER
- SINGLE SWEEP OPERATION
- LOW COST

The Type 2B67 Time-Base Unit is designed to generate a sweep in the Type 561B and Type 564B. It can also be used in the Type 568 Oscilloscope when digital readout is not required.

The unit is recommended for use with 2- and 3-series vertical plug-in units with bandwidths up to 2 MHz.



ME BASE

 $1 \mu s/div$ to 5 s/div in 21 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12 s/div.

5X MAGNIFIER

Operates over full time base, increases the fastest rate to 0.2 μ s/div. Magnified display accurate within 5%.

SINGLE SWEEP

For one-shot waveform photography and storage applica-

EXTERNAL HORIZONTAL INPUT

Approx 1 V/div, DC to 750 kHz at -3 dB.

TRIGGER

MODES

Manual, automatic, or free-run.

COUPLING

AC slow, AC fast, or DC.

SOURCES

Internal, external, or line.

REQUIREMENTS

Internal Triggering—0.4 divisions of display, DC to 2 MHz. External Triggering—0.5 V at DC increasing to 2 V at 2 MHz.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	\approx 8 lb	\approx 3.6 kg
Export-packed weight	pprox12 lb	\approx 5.4 kg
Order TYPE 2B67 TIME BASE		\$300



- 500 ns/DIV TO 1 s/DIV CALIBRATED TIME BASE
- CALIBRATED DELAYED SWEEP
- TRIGGERING TO 10 MHz
- SINGLE SWEEP OPERATION

The Type 3B3 Time-Base Unit is used to generate normal and delayed sweeps. Flexible triggering facilities are similar for both the normal sweep and delayed sweep. Calibrated sweep delay enables accurate delay intervals to be set and measured. The unit can be used with the Type 561B or Type 564B Oscilloscopes. It can also be used with the Type 568 Oscilloscope when digital readout is not required.

DISPLAY MODES

NORMAL SWEEP

The normal sweep generator operates as the display time base in (1) the NORMAL position, (2) the INTENSIFIED position—where the delayed-sweep generator intensifies a portion of the normal sweep trace, indicating the time during which the delayed sweep operates—and (3) the TRIGGERED, INTENSIFIED position—where the delayed sweep is armed at the end of the delay time and starts by the delayed sweep trigger . . . intensifying a segment of the normal sweep trace as above.

DELAYED SWEEP

The delayed-sweep generator operates as the display time base in (1) the DELAYED SWEEP position—displaying the portion of the trace which was intensified in the INTENSIFIED position . . . with time-jitter less than 1 part in 20,000 of the maximum available delay interval—and (2) the jitter-free TRIGGERED, DELAYED SWEEP position—displaying the portion of the trace which was intensified in the TRIGGERED, INTENSIFIED position.

Delayed sweep starts after time interval determined by DE-LAY TIME and DELAY TIME MULTIPLIER.

CHARACTERISTICS

TIME BASE

(Both normal and delayed sweeps.) $0.5\,\mu s/div$ to $1\,s/div$ in 20 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx $2.5\,s/div$. The Variable control operates with the normal sweep in the normal display mode, and with delayed sweep in all other display modes. Coupled time/div controls may be unlocked for independent setting of delayed sweep time.

5X MAGNIFIER

Expands the fastest sweep rate to 0.1 $\mu s/div$. Magnified sweep accurate within 5%.

DELAY TIME (OR TIME/DIV)

0.5 μs to 1s, 20 calibrated steps, 1-2-5 sequence; accurate within 1% of indicated delay from 0.5 μs to 0.2 s.

DELAY TIME MULTIPLIER

Continuously calibrated time interval from 0.50 to 10.00 times the Delay Time (dial divided into 1000 parts); accurate within 0.2% of maximum delay (DELAY TIME X10.00).



DELAY RANGE

2.5 μs to 2 s after delaying sweep start with 1% accuracy; 10 s total. Inherent delay to start of delayed sweep 500 ns or less.

DIFFERENTIAL TIME

Measurement accuracy within 1% and 3 minor divisions.

SINGLE SWEEP .

Facilitates photographic recordings of waveforms.

TRIGGER MODES

Normal-Sweep Trigger—manual or automatic. Delayed-Sweep Trigger—manual only. Coupling—AC or DC.

SOURCES

Internal or External. Line triggering in normal or delaying sweep operation only.

External trigger facility has two ranges: 0.5 to $15\,\mathrm{V}$ and 5 to $150\,\mathrm{V}$, plus or minus polarity.

REQUIREMENTS

Internal Triggering—0.4 major graticule divisions from DC to 5 MHz, increasing to 1 major division at 10 MHz.

External Triggering—0.5 V from DC to 5 MHz, increasing to 1.25 V at 10 MHz. Requirements increase below 6 Hz with AC-coupling.

WEIGHTS

Net weight	6 lb	2.7 kg
Domestic shipping weight	\approx 10 lb	\approx 4.5 kg
Export-packed weight	\approx 14 lb	\approx 6.3 kg

Order TYPE 3B3 TIME-BASE



- 50 ns/DIV to 5 s/DIV CALIBRATED TIME BASE
- X50 DIRECT READING MAGNIFIER
- TRIGGERING TO 20 MHz
- SINGLE SWEEP OPERATION
- CALIBRATED EXTERNAL HORIZONTAL INPUT

The Type 3B4 Plug-In Unit is a wide-range time base with flexible, high-speed triggering facilities, and a wide-range, direct-reading magnifier for use in the Type 561B or Type 564B Oscilloscope. It can also be used in the Type 568 Oscilloscope when digital readout is not required. The Type 3B4 is recommended for operation with Type 3A6 and other wide-band (2 MHz or greater) vertical amplifier plug-in units.

In addition to time base facilities, the 3B4 provides a DC-coupled external input amplifier with calibrated deflection factors from 0.2 to $5\,\text{V/div}$.

TIME BASE

 $0.2~\mu s/div$ to 5~s/div in 23 calibrated steps, 1-2-5 sequence; accuracy within 3% from $0.2~\mu s/div$ to 2~s/div, within 5% at 5~s/div. Uncalibrated, continuously variable between steps and to 12.5~s/div.

DIRECT READING MAGNIFIER

Provides sweep expansion up to X50 and extends the fastest sweep rate to 50 ns/div. The MAGNIFIER control is concentric with the TIME/DIV control, providing a direct indication of both the sweep rate being magnified and the magnified time/div rate. Up to 5 magnification steps are provided, to X40, or X50, depending on the TIME/DIV control setting before magnification. Magnified sweep rates are confined to the time/div steps on the panel, so there are no "forbidden" (uncalibrated) combinations. Magnified sweep accurate within 5%.

The MAGNIFIER control is also used to set the external input deflection factor when the TIME/DIV control is in the "Ext Input" position.

EXTERNAL HORIZONTAL INPUT

0.2 V/div to 5 V/div in 5 calibrated steps (max input ± 20 V); accuracy, when plug-in unit is matched to oscilloscope, is within 3%. The External Input Amplifier is DC-coupled.

SINGLE SWEEP

Facilitates waveform photography and operation in the Type 561B or 564B Oscilloscope.



TRIGGER

MODES

Manual, free-run, automatic (with bright base-line in the absence of a trigger).

COUPLING

AC, AC LF-Reject, DC.

SOURCES

Internal, Line, External, External ÷ 10. A front-panel light indicates when the sweep is receiving a triggering signal—especially convenient when using an external trigger.

REQUIREMENTS

Internal Triggering—1 minor graticule division from DC to 20 MHz, with additional deflection required above 20 MHz. External Triggering—0.5 V to 15 V (EXT) or 5 V to 150 V (EXT \div 10) from DC to 20 MHz, with additional signal required above 20 MHz. Requirements increase below 30 Hz with AC-coupling.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	\approx 8 lb	\approx 3.6 kg
Export-packed weight	≈14 lb	\approx 6.3 kg

Order TYPE 3B4 TIME BASE\$495





- ELIMINATES GUESSWORK
- REDUCES MAINTENANCE COSTS
- DETECTS
 FAULTY IGNITION
 FAULTY VALVES
 BLOWBY
 DAMAGED RINGS
 DAMAGED BEARINGS
 DAMAGED CYLINDER LININGS
- MEASURE AND DISPLAY
 PRESSURE VS VOLUME
 PRESSURE VS CRANK ANGLE
 PRESSURE VS TIME
 ENGINE VIBRATION
 ENGINE IGNITION
- CRANK-ANGLE MARKERS

The Tektronix Engine Analyzer is designed to eliminate guesswork in locating possible failures in gas and diesel engines and compressors. The over-all performance of the engine can be determined by measuring engine parameters such as cylinder combustion pressure, vibration, ignition, timing and indicated horsepower. When used in conjunction with a preventive maintenance program, the Engine Analyzer can substantially reduce maintenance costs and increase engine and compressor life and efficiency.

The Engine Analyzer detects and locates malfunctions such as faulty ignition, timing, faulty valves, blowby, and broken or frozen piston rings. Damaged bearings, low compression pressures and other failures that impair the performance of the engine are also indicated on the oscilloscope. With the use of the Rotational Function Generator and pressure transducer, the engine horsepower can be calculated.

The Tektronix Engine Analyzer consists of a Type 561B Oscilloscope or Type 564B Storage Oscilloscope, a specially designed Type 2B67 Engine Analyzer Time Base with a Rotational Function Generator input, and a Type 3A74 Engine Analyzer Amplifier featuring four channels, with separate inputs for pressure, ignition, vibration, and crank-shaft rotation markers.

The Engine Analyzer Accessories package includes a Rotational Function Generator, pressure transducers, vibration transducers, ignition pickoff, magnetic pickup, cables and an accessory carrying case. Optional accessories include a Poloid* Trace-Recording Camera, Scope-Mobile® Cart and a tripod for easy mounting of the Rotational Function Generator.

^{*}Registered Trademark Polaroid Corporation



VIBRATION MEASUREMENTS

Vibration measurements are useful in detecting leaking valves, destructive detonation, excessive cylinder wear, blowby, worn bearings, broken compression rings, valve flutter and many other signs of wear and malfunction. The vibration pickup is a piezoelectric crystal mounted in a magnetic head that can be placed anywhere on the engine or compressor.

IGNITION MEASUREMENTS

Ignition measurements are used for proper timing of the engine and can detect bad spark plugs, pulse generator problems, point problems, bad condensers and coil condition. Ignition measurements can also be used to calculate RPM. Ignition measurements are made using a 1000:1 capacitive attenuator that clamps on the secondary coil and spark-plug wire.

PRESSURE MEASUREMENTS

Pressure measurements detect peak firing pressures, compression, early and late cylinder firing, and pre-ignition of the engine under test. Three displays of cylinder pressure are easily and quickly obtained: pressure vs crank angle, pressure vs cylinder volume and pressure vs time.

ENGINE ANALYZER AMPLIFIER

The Type 3A74 Engine Analyzer Amplifier is a four-channel plug-in unit featuring simultaneous displays of pressure, crankangle markers, engine vibration, and ignition. Channel 1 is a charge amplifier designed for use with the pressure transducer; Channel 2 provides a crank-angle marker display from the Rotational Function Generator plus the magnetic pickup display of top dead center; Channel 3 and Channel 4 are identical amplifiers used for vibration and ignition displays.

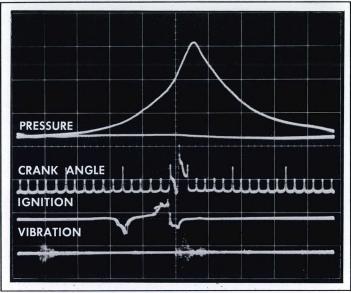
CHARGE AMPLIFIER, CHANNEL 1

1 psi/div to 500 psi/div in 1-2-5 sequence; accurate within 3%. Frequency response: Restore Time — Long is from 0.05 Hz to 10 kHz, Short is from 0.5 Hz to 10 kHz. Maximum charge signal is 0.6 μ C (micro coulomb) at 10 kHz, increasing to 2 μ C at 2.75 kHz. Restore Time is at least 3 s in the Long position, at least 0.3 s in the Short position. Display noise is less than 0.15 pC (pico coulomb) per 1000 pF of source capacitance, with 1 psi/div and gain set to 100 pC/psi.

CHANNELS 2, 3 and 4

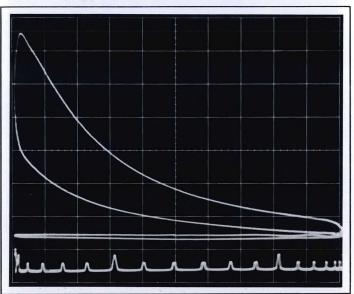
0.02 V/div to 10 V/div in 9 calibrated steps, 1-2-5 sequence; accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div. Bandwidth is DC to 2 MHz at 3-dB down. AC-coupled low-frequency response is 2 Hz. Input characteristics are $1 \text{ M}\Omega$ paralleled by approx 47 pF. Maximum input voltage is 600 V (combined DC plus AC).

FOUR SIMULTANEOUS DISPLAYS



Simultaneous displays of four engine parameters provide the operator with one comprehensive picture of the total engine performance and make identification of malfunctions easy. The top waveform is engine pressure; waveform 2 shows crank-angle markers with the larger marker in the center indicating the top dead center; waveform 3 is engine ignition; waveform 4 is engine vibration showing valves opening and closing and vibration due to combustion.

PRESSURE VS VOLUME



Pressure vs cylinder volume displays are used to determine the indicated engine horsepower and detect over-all problems in engines and compressors. The area within the loop is the mean effective pressure and is used to determine indicated horsepower of the engine.

SPECIAL-PURPOSE PRODUCTS

Engine Analyzer



ENGINE ANALYZER TIME BASE

SWEEP GENERATOR

 $1 \mu s/div$ to 5 s/div and 21 calibrated steps, 1-2-5 sequence; accurate within 3%. 5X magnifier operates over full time base, accurate within 5%.

SINGLE SWEEP

Provides single display for one-shot waveform photography and storage applications. In the Rotational Function Generator mode of operation, single displays of either 360° (2 cycle) or 720° (4 cycle) are possible.

TRIGGER

Automatic, manual, or free-run operation; triggering on + or - slope from an internal, line frequency or external source. In external trigger, a signal from the Rotational Function Generator is available for triggering.

ROTATIONAL FUNCTION AMPLIFIER

Accepts inputs from the Rotational Function Generator providing horizontal displays of piston volume or crank angle. Crank-angle degree markers are internally coupled to Channel 2 of the Type 3A74 Engine Analyzer Amplifier.

ENGINE ANALYZER ACCESSORIES

PRESSURE TRANSDUCER (015-0117-00)



The Pressure Transducer is designed for use at engine speeds up to 6000 RPM, providing thread temperature is limited to 150° C. Engine speed must be derated to 1500 RPM when using the cooling adapter and to 1000 RPM when a 5-inch to 10-inch coupling pipe is used. The piezoelectric Pressure Transducer, when used with the charge amplifier of the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

PRESSURE RANGE is 0 to 3000 psi.

DEFLECTION FACTOR is 1 psi/div to 500 psi/div in 1-2-5 sequence, accurate within 5% throughout calibrated range. Maximum overload pressure is 300%.

BANDWIDTH in the Long Restore Time position is from 0.05 Hz or less to at least 10 kHz; in the Short Restore Time position, from 0.5 Hz or less to at least 10 kHz.

RESTORE TIME in the Long position is at least 3 seconds; in the Short position is at least 0.3 seconds.

NOISE is not discernible with the 50-ft low-noise cable supplied.

TEMPERATURE RANGE is from -40°C to +150°C. A cooling adapter is supplied for environmental conditions above +150°C.

VIBRATION TRANSDUCER (015-0116-00)



The piezoelectric Vibration Transducer has a magnetic mount and is used with Channel 2, 3 or 4 of the Type 3A74 Engine Analyzer Amplifier with the included 50-ft low-noise cable.

TRANSDUCER SENSITIVITY is nominally 6 mV/g (4.5 mV/g with the included cable). Exact value is shown with the calibration chart supplied with the transducer.

MAXIMUM ACCELERATION is 1000 g's.

TEMPERATURE RANGE is from -40°C to +150°C.

IGNITION PICKOFF CABLE ASSEMBLY (012-0139-00)



The Ignition Pickoff, when used with Channel 2, 3 or 4 with the Type 3A74 Engine Analyzer Amplifier and the included 50-ft low-noise cable, has the following characteristics.

ATTENUATION is nominally 1000:1. Exact attenuation is determined by the capacitance between the pickoff and the secondary lead under test. The oscilloscope calibrator and a piece of ignition cable can be used to calibrate the ignition pickoff and the vertical amplifier.

TIME CONSTANT is at least 6.5 ms.

VELOCITY TRANSDUCER (015-0119-00)



The Velocity Transducer, when used with Channel 2 of the Type 3A74 Engine Analyzer Amplifier and the included 20-ft or 50-ft low-noise cable, has the following characteristics.

OUTPUT VOLTAGE is at least 15 V P-P at 1000 inch/s and a clearance gap of 0.005 inch using a 20-pitch, 30-tooth ferrous metal gear.

COIL RESISTANCE is 90 Ω to 110 Ω .

COIL INDUCTANCE is 26 mH to 40 mH.

TEMPERATURE RANGE is from -54°C to +107°C.



ROTATIONAL FUNCTION GENERATOR (015-0108-01)



The Rotational Function Generator is mechanically coupled to the engine under test and generates 10°, 60° and 360° markers. Crank-Angle Markers are displayed on Channel 2 of the Type 3A74 Engine Analyzer. The Rotational Function Generator is mechanically timed to an engine reference point by comparing the display of the top dead center mark of the magnetic pickup from the fly wheel with the 0°/360° pulse generated by the function generator. The Rotational Function Generator also generates a sawtooth ramp for displays related to crank angle, and a waveform that is equivalent to piston volume for P-V curves. The Rotational Function Generator, when used with the Type 2B67 Engine Analyzer Time Base and the included 20-ft cable supplied, has the following characteristics.

MAXIMUM RPM is 20,000 revolutions per minute.

DEGREE MARKER angular accuracy is within 1°.

SHAFT LOAD axial and radial is 10 lb maximum.

CRANK-ANGLE MARKERS are generated every 10°, a pulse of larger amplitude every 60°, and a pulse riding on a pedestal every 360°. The markers are internally coupled to Channel 2 and have an amplitude of at least a division of the display. The magnetic pickup signal can be superimposed on Channel 2 to permit timing of the function generator markers to the engine under test.

CRANK ANGLE displays provide 350° of useable display related directly to crank angle; incremental accuracy is within 3% of full scale display.

PISTON VOLUME displays have an incremental accuracy within 3% of full scale display. The phase shift is 0.5° or less at 20,000 RPM.

TEMPERATURE RANGE -15° C to +75° C.

SYSTEM TEMPERATURE 0°C to +50°C.

ORDERING INFORMATION

TYPE 564B STORAGE OSCILLOSCOPE, without plug-in units	95
OR OR	
TYPE 561B P7 OSCILLOSCOPE, without plug-in units \$6	95
TYPE 2B67 ENGINE ANALYZER TIME BASE, order Type 2B67 MOD 730A \$ 4 Includes: Engine Analyzer instruction manual (070-0890-0	50
TYPE 3A74 ENGINE ANALYZER AMPLIFIER, order Type 3A74 MOD 730A	50

ENGINE ANALYZER ACCESSORY PACKAGE

For price and availability information on specific items included in the Engine Analyzer accessory package, contact your nearby Tektronix Field Office, Representative or Distributor.

RECOMMENDED OPTIONAL ACCESSORIES

*Registered Trademark Polaroid Corporation



FEATURES OF 5103N OSCILLOSCOPE

- LOW COST, MODULAR
- UNEQUALED VERSATILITY USING INTERCHANGEABLE PLUG-INS PLUS INTERCHANGEABLE DISPLAY MODULES PLUS BENCH-TO-RACK CONVERTIBILITY
- LARGE 6½-INCH CRT (8 x 10 DIV)
- CHOICE of STORAGE DISPLAYS
- MAINFRAME ACCEPTS UP to THREE PLUG-INS
- BANDWIDTH to 2 MHz
- 10 μV/DIV HIGH GAIN DIFFERENTIAL

When Tektronix, Inc. introduced the first plug-in oscilloscope, customer acceptance quickly established this concept as one of the outstanding contributions to instrumentation. The ability to interchange display units in an oscilloscope, and the ability to convert between cabinet and rackmount configurations is introduced in the 5100 Series.

This oscilloscope system provides present and future measurement capabilities at a sound price/performance ratio, and the user will realize continuing benefits from this new concept as it is applied to tomorrow's oscilloscopes.

Low frequency oscilloscope users are no longer confronted with choosing a non-plug-in oscilloscope designed to meet specific measurement criteria, or a more costly wide bandwidth plug-in oscilloscope. To date, plug-in oscilloscopes have been designed for mid or high frequency use and as such were often too expensive for lower frequency requirements. Therefore, the low frequency oscilloscope buyer has been unable to purchase an instrument which suited his particular measurement needs at a price/performance ratio comparable to that which exists for users of higher frequency oscilloscopes. To solve this problem, Tektronix, Inc. designed the 5103N Oscilloscope System.

Users of low frequency oscilloscopes now have the versatility of plug-ins, PLUS the new versatility of interchangeable display units, PLUS the versatility of converting to and from cabinet or rackmount—PLUS prices consistent with his measurement needs. These features allow choice of an instrument for immediate individual requirements and unequaled ability to change the configuration when applications change.

The 5103N Oscilloscope System consists of five interchangeable display modules, eleven amplifier plug-ins, three time base plug-ins and a power supply/amplifier module with three plug-in compartments.

The 5103N mainframe module contains the low voltage power supplies, some vertical and horizontal circuitry and the electronic switching and logic circuitry for dual trace or dual beam operation. The display module may be attached in a cabinet model or rackmount configuration.

- ONE to EIGHT TRACE CAPABILITY
- SIMULTANEOUS DISPLAY of TWO INDEPENDENT TIME BASES or DELAYED SWEEP
- LIGHTED KNOB SKIRTS for SCALE FACTOR READOUT
- Y-T or X-Y OPERATION
- SIMPLIFIED CONSTRUCTION, EASY to MAINTAIN, RELIABLE
- COLOR CODED FRONT PANELS for EASY OPERATION
- LIGHT WEIGHT, EASY to CARRY
- SOLID STATE STABILITY

DISPLAY MODULES

All five modules have 3.5-kV accelerating potential and internal graticules. P31 phosphor is standard for the nonstorage units and a phosphor similar to P1 is standard for the storage units. These modules include the power switch, a voltage-current-time calibrator, a beam finder which positions the beam on screen regardless of vertical and horizontal control settings, the controls related to the CRT display, and the Z-axis input. Each is powered from the 5103N mainframe.

The Storage Display Modules have an adjustable control to vary the stored brightness level to retain information up to 10 hours at specified resolution and without damaging the CRT. Even at high output light levels the storage CRT is highly resistant to burns, and requires no more care than a conventional CRT. The stored brightness control used in conjunction with the other storage controls also allows "integration" to increase the effective writing rate.

Dual Beam Display Modules have two writing guns and two pairs of vertical deflection plates. One pair of horizontal deflection plates drive both beams, which cover the full 8 x 10 division screen.

MAINFRAME AND INTERCHANGEABLE DISPLAY UNITS								
PRODUCT	PAGE		FEATURE	S				
5103N MAINFRAME	117	Power Su with each units	Unit compatible hangeable display					
INTERCHANGEABLE DISPLAY UNITS	a =028	BEAMS	BISTABLE STORAGE	DISPLAY SIZE				
D10	118	Single	the few Hol	8 x 10 div (½ in/div)				
D11	118	Single	Yes	8 x 10 div (½ in/div)				
D12	118	Dual	1.0克	8 x 10 div (½ in/div)				
D13	118	Dual	Yes	8 x 10 div (½ in/div)				
D15	118	Single	Yes	8 x 10 div (½ in/div)				



PLUG-INS

cale factor readout is provided by back-lighted skirt knobs which automatically indicate the correct reading when using the X10 magnifier and the recommended 1X and 10X probes. The lights turn off when a plug-in or a channel is switched off.

Scale factor readout prevents many measurement errors and provides an easy, quick means of identifying deflection factors and sweep rates and indicating which channels are in use—even in low ambient room light.

	AMPLIFIER PLUG-INS								
PRODUCT	PAGE	TRACES	MINIMUM DEFLECTION FACTOR	BANDWIDTH —3 dB	CMRR				
5A13N	120	Single	1 mV	2 MHz	10,000:1				
5A14N	121	Four	1 mV	1 MHz					
5A15N	121	Single	1 mV	2 MHz					
5A18N	121	Dual	1 mV	2 MHz					
5A19N	124	Single	1 mV	2 MHz	1,000:1				
5A20N	122	Single	50 μV	1 MHz	100,000:1				
5A21N	122	Single (Voltage and Current)	50 μV 0.5 mA	1 MHz	100,000:1				
5A22N	123	Single	10 μV	1 MHz	100,000:1				
5A23N	124	Single	10 mV/div	1.5 MHz	1000				
5A24N	124	Single	50 mV/div	2 MHz					
5CT1N	127	Semico	nductor Curve	Tracer					

TIME BASE PLUG-INS										
RODUCT	PAGE	DUAL and DELAYED SWEEP	SWEEP RATE	MAG	SINGLE SWEEP	VOLTS/DIV EXT MODE				
5B10N	125		1 μs to 5 s	X10	Yes	50 mV and 500 mV				
5B12N	126	Yes	A 1 μs to 5 s B 2 μs to 0.5 s	X10	Yes —	50 mV and 500 mV				
5B13N	127		1 μs to 100 ms			50 mV				

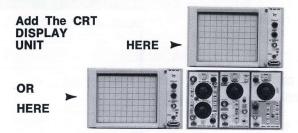
5100 Series Plug-in Dimensions and Weights

Dimensions	in	cm	Weights (Approx)	lb	kg
Height	5.0	12.5	Net	2.8	1.2
Width	2.6	6.7	Domestic Shipping	10.0	4.5
Length	12.0	30.5	Export Packed	15.0	6.9

Oscilloscope Dimensions and Weights

	CABINET		RACKMOUN	TOUNT
Dimensions	in	cm	in	cm
Height	11.5	29.5	5.3	13.5
Width	8.5	21.5	19.0	48.0
Length	20.0	50.9	19.0	48.3
Weights (approx)	lb.	kg	lb	kg
Net	23.0	10.5	23.0	10.5
Domestic Shipping	32.0	14.5	42.0	19.0
Export acked	44.0	20.0	59.0	24.5

SELECT EITHER CONFIGURATION



5103N MAINFRAME CHARACTERISTICS VERTICAL SYSTEM

Channels—Two plug-in compartments (left and center) compatible with all 5100-Series Plug-Ins.

Deflection Factor—Determined by plug-in unit.

Bandwidth-2 MHz maximum.

Chopped Mode—The 5103N will chop between two amplifiers, at an approx 25-kHz to 100-kHz rate, depending on plug-ins used and operating modes. The chop mode is selected from the time base unit.

Alternate Mode—In this mode each amplifier plug-in is swept twice before switching to the next. A single-trace amplifier is swept twice and each channel of a dual-trace amplifier is swept once before the 5103N switches to the second amplifier. When two vertical amplifiers are used with the 5B12N Dual Time Base, the left amplifier can be slaved to the A sweep, and the right amplifier slaved to the B sweep in the dual-sweep mode.

HORIZONTAL SYSTEM

Channel—One right-hand plug-in compartment compatible with all 5100-Series Plug-Ins. Dual sweep is available with the 5B12N Time Base.

Fastest Calibrated Sweep Rate— $0.1~\mu s/div$ (X10 mag) with 5B10N or 5B12N.

X-Y Mode—PHASE SHIFT is within 1° from DC to 100 kHz, checked with two amplifiers of the same type.

OTHER CHARACTERISTICS

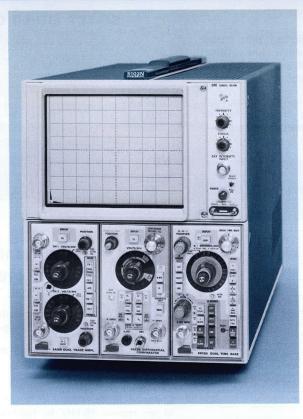
Ambient Temperature—Performance characteristics are valid from 0°C to $+50^{\circ}\text{C}$.

Power Requirements—100, 110, 120, 200, 220, and 240 V (\pm 10% on each range), 50 to 60 Hz and 440 Hz; internally selectable with quick-change jumpers.





- BRIGHT DISPLAYS
- CABINET or 5¼-INCH RACKMOUNT OSCILLOSCOPE
- DC COUPLED Z-AXIS INPUT





5103N/D10

D10

D10 SINGLE BEAM DISPLAY UNIT

The D10 provides a single beam conventional display for the 5103N Mainframe. The electrostatic-deflection cathode-ray tube has an 8 x 10 division (1/2 in/div) display area with internal graticule. A bright display is provided by a 3.5 kV accelerating potential. P31 phosphor is standard; P7 or P11 optional without extra charge.

D11 and D15 SINGLE BEAM STORAGE DISPLAY UNITS

The D11 and D15 provide storage displays for the 5103N Mainframe. Each unit features a single-beam, $6\frac{1}{2}$ -inch 8×10 -div ($\frac{1}{2}$ in/div) CRT with bistable, split-screen storage and an internal graticule. Accelerating potential is 3.5~kV and the phosphor is similar to P1. The D11 has a brighter stored display. The D15 has the higher stored writing speed (center $6\times 8~\text{div}$).

D11 writing speed is at least 20 div/ms (Normal mode only). D15 writing speed is at least 200 div/ms in the normal mode and 800 div/ms (>1000 cm/ms) in the enhanced mode. Storage viewing time is at least one hour at normal intensity. A variable brightness control allows the storage time to be extended to at least 10 hours at reduced intensity, after which time the intensity may be increased to its original level. Variable brightness also permits optimum photographic results, and integration of multiple traces. Erase time is ≈250 ms.

D12 DUAL BEAM DISPLAY UNIT

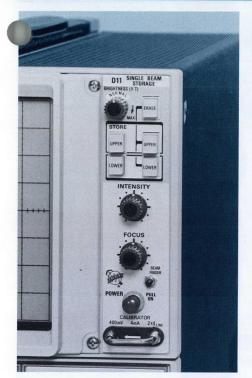
The D12 provides a dual beam display for the 5103N Mainframe. Dual beam oscilloscopes are essential to the many applications where two transient events must be compared simultaneously. Application areas include stimulation and reaction events in areas such as medicine, biology, chemistry, engineering mechanics and many other electronic and scientific measurement areas. Both beams of the D12 are driven by one set of horizontal deflection plates. When using a dual time base plug-in in the dual sweep mode, both beams will be deflected by both sweeps and with two single trace plugins four traces will be displayed. Other characteristics are the same as the D10 Single Beam Display Unit.

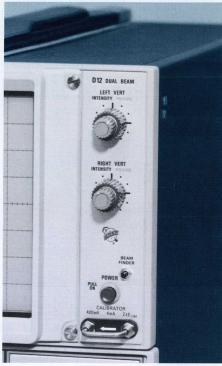
D13 DUAL BEAM STORAGE DISPLAY UNIT

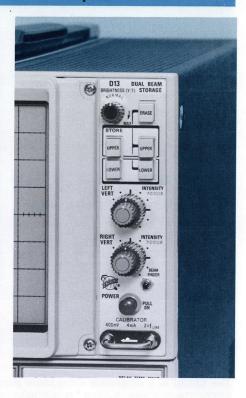
The D13 provides a dual beam, bistable, split-screen storage display for the 5103N Mainframe. The storage display characteristics and operation are the same as the D11 Storage Display Unit. Other characteristics are the same as the D12. New measurement problems are continuously developing which can only be solved with a dual beam storage oscilloscope. Experimenters and researchers in areas such as electronics, mechanics and bio-medicine recognize the expediency and thoroughness of dual beam storage for retaining two related transients.

Writing speed is at least 20 div/ms. (Option 3, 200 div/ms, ceter 6×8 div). Storage time is at least one hour at normintensity increasing to 10 hours at reduced intensity. Erase time is ≈ 250 ms.









D11 and D15

D12

D13

COMMON CHARACTERISTICS

External Intensity Input— $5\,\text{V}$ will turn the beam on to full brightness from an off level. Frequency range is DC to 1 MHz. Input R and C is $\approx \! 10\,\text{k}\Omega$ paralleled by $\approx \! 40\,\text{pF}$. Maximum input is $\pm \, 50\,\text{V}$ (DC + peak AC).

Calibrator—Voltage output is 400 mV within 1%. Current output (loop) is 4 mA within 1%. Frequency is 2X line.

Beam Finder—When pressed, the beam is positioned on screen, regardless of vertical and horizontal position control settings.

Power Requirements—100, 110, 120, 200, 220, and 240 V (\pm 10% on each range), 50 to 60 Hz and 400 Hz. Internally selectable with quick-change jumpers.

ORDER INFORMATION

The 5103N Mainframe Unit and a Display Unit may be ordered as a cabinet model oscilloscope equipped with a tilt bail or it may be ordered as a 51/4-inch rackmount oscilloscope equipped with a slide-out assembly.

(Cabinet (w	rithout plug-ins)—	
	5103N/D10	OSCILLOSCOPE	\$ 540
	5103N/D11	STORAGE OSCILLOSCOPE	\$1020
	5103N/D12	OSCILLOSCOPE	\$ 870
	03N/D13	STORAGE OSCILLOSCOPE	\$1370
	103N/D13	STORAGE OSCILLOSCOPE, Option 3	\$1395
	5103N/D15	STORAGE OSCILLOSCOPE	\$1095

Rackmount (without plug-ins)—	
R5103N/D10 OSCILLOSCOPE	\$ 540
R5103N/D11 STORAGE OSCILLOSCOPE	\$1020
R5103N/D12 OSCILLOSCOPE	\$ 870
R5103N/D13 STORAGE OSCILLOSCOPE	\$1370
R5103N/D13 STORAGE OSCILLOSCOPE, Option 3	\$1395
R5103N/D15 STORAGE OSCILLOSCOPE	\$1095

OPTION 2

Protective Panel Cover

This cover protects the front panel and the plug-in knobs of cabinet models from transportation or storage damage. The Option 2 instruments have modified side panels which accept the panel cover.

PROTECTIVE PANEL COVER, Option 2 Add \$15

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 .. \$30 Rackmount-to-cabinet conversion kit order 040-0584-01 .. \$30

SCOPE-MOBILE® CART AND CAMERA—See optional accessories at the conclusion of this oscilloscope section.



- 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 5103N Oscilloscope System. It incorporates a number of performance features which make it particularly versatile, especially in multi-trace combination with other 5100-Series vertical 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 \pm 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 \pm 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

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 M Ω , 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 $100 \,\mu\text{V}$ or less, depending on external loading) at 25°C .

Overdrive Recovery— 1 μ s 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 k Ω .

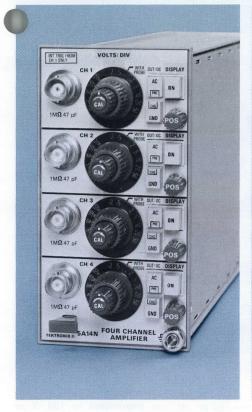
Common-Mode Rejection Ratio—At least 10,000:1, DC to 10 kHz at 1 mV/div to 50 mV/div DC coupled, with up to 20-volt peak-to-peak sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, DC to 10 kHz at 0.1 V/div to 5 V/div DC coupled, with up to 100-volt peak-to-peak sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz AC coupled, CMRR is the same as stated for DC coupled. Below 5 kHz AC coupled, CMRR decreases to 400:1 at 10 Hz. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

Order 5A13N DIFFERENTIAL COMPARATOR AMPLIFIER

Recommended Probes-See page 128.

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









1 mV/DIV to 5 V/DIV

The 5A15N (single channel), 5A18N (two identical channels) and 5A14N (four identical channels) are amplifiers with solid-state circuits. Each features simplified front panel controls and is used in the 5103N Mainframe. These plug-ins may be used in combination for displaying up to eight traces. For instance, two 5A14N amplifiers provide eight traces; one each 5A14N and 5A15N amplifiers provide five traces. Each amplifier may be used in the 5103N horizontal plug-in compartment for X-Y operation.

5A18N operating modes include channel one or two only, channels one and two added, and channel one alternate or chopped with channel two. Internal trigger source is selectable from channel one and channel two.

5A14N operating modes are each channel separately, and alternate or chop between any combination of channels. Internal trigger is available from channel one only.

CHARACTERISTICS

Bandwidth—DC coupled, DC to at least 2 MHz (5A14N, 1 MHz) at all deflection factors. AC coupled, 2 Hz or less to at least 2 MHz (5A14N, 1 MHz) at all deflection factors.

Deflection Factor—1 mV/div to 5 V/div in 12 calibrated steps (1-2-5 sequence). Accuracy is within 2%. Uncalibrated, continuously variable between calibrated steps and to 12.5 V/div.

Input R and C— 1 M Ω within 1%, approx 47 pF.

<code>Maximum Input</code>—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.

ORDER INFORMATION

5A14N	FOUR-TRACE AMPLIFIER	\$575
5A15N	SINGLE-TRACE AMPLIFIER	\$115
5A18N	DUAL-TRACE AMPLIFIER	\$265

Recommended Probes—See page 128.

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







- 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 μ V/div, DC coupled differential amplifiers for the 5103N Oscilloscope System. The units are identical except that the 5A21N has a current probe input. Each plug-in is compatible with each compartment of the 5103N Mainframe. By inserting a vertical plug-in unit into the horizontal compartment, the user assembles an X-Y oscilloscope. Thus, the oscilloscope can be adapted to solve individual application problems.

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— $50~\mu\text{V/div}$ 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 M Ω within 0.15%, approx 47 pF.

Maximum Input Voltage

	DC COUPLED	AC COUPLED
$50~\mu V/div$ to $50~mV/div$	10 V (DC + peak AC)	350 VDC (Coupling cap pre-charged), 10 V peak AC
100 mV/div to 5 V/div	350 V (DC + peak AC)	350 V (DC + peak AC)

Input Gate Current— 100 pA or less (equivalent to $100 \,\mu\text{V}$ or less, depending on external loading) at 25°C .

Displayed Noise— 30 μV or less, tangentially measured.

Common-Mode Rejection Ratio—AC coupled, 50 μ V/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 μ V/div and 100 μ V/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— $300~\mu A$ or less, tangentially measured. Performance characteristics are valid for the 5A20N and 5A21N from 0°C to +50°C.

ORDER INFORMATION

5A20N	DIFFERENTIAL AMPLIFIER	\$165
5A21N	DIFFERENTIAL AMPLIFIER	\$185
P6021	5-FT Current Probe, order 010-0237-02	\$98
P6021	9-FT Current Probe, order 010-0244-02	\$

Voltage Probe-See page 128.

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



- 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 μ V 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 sigpals often ride a small DC component, perhaps a few millivolts, hich would place a DC-coupled display offscreen at 10 μ V/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 μ V/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 M Ω within 0.15%, approx 47 pF.

Drift With Temperature— $100 \,\mu\text{V}/^{\circ}\text{C}$ or less.

Max Input Gate Current-200 pA or less.



Signal and Offset Range

DEFLECTION FACTOR SETTINGS	10 μV to 50 mV/div	0.1 V to 5 V/div
COMMON-MODE SIGNAL RANGE	±10 V	±350 V
MAX DC COUPLED INPUT (DC + PEAK AC AT 1 kHz OR LESS)	±12 V	±350 V
MAX AC COUPLED INPUT (DC VOLTAGE)	±35 DC rejection, a	
DC OFFSET RANGE	+0.5 V to −0.5 V	+50 V to -50 V

Displayed Noise— 20 μ V at maximum bandwidth, source resistance 25 Ω or less, measured tangentially.

Overdrive Recovery— 10 μ s 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 common-mode signal range.

Common-Mode Rejection Ratio—AC coupled, $10 \,\mu\text{V/div}$ 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 $10 \,\mu\text{V/div}$ to $100 \,\mu\text{V/div}$ with up to 20 V P-P sinewave, decreasing by less than 20 dB/decade on sensitivity ranges up to 50 mV/div. From 100 mV/div to 5 V/div, CMRR is at least 400:1 with up to 100 V P-P sinewave. CMRR with two P6060 probes is at least 400:1 at any deflection factor.

Order 5A22N DIFFERENTIAL AMPLIFIER\$425

Recommended Probes-See page 128.

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



NEW 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 5103N 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 M Ω 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)	±35	O V 132-MO 30 W
MAX AC COUPLED INPUT (AC VOLTAGE)	±35	0 V
	+15 V	+350 V
DC OFFSET RANGE	to —15 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.

5A23N AMPLIFIER

 10 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS



The 5A23N is a general-purpose amplifier for the 5103N Oscilloscope System. 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 5103N mainframe 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 M Ω within 1%, approx 47 pF.

Maximum Input—350 volts (DC + peak AC).

Order 5A23N SINGLE-TRACE AMPLIFIER\$65

5A24N AMPLIFIER

- 50 mV/DIV to 1 V/DIV DEFLECTION FACTORS
- EASY TO CUSTOMIZE

The 5A24N is a low-cost utility plug-in providing direct access to either the vertical or horizontal deflection system of the 5103N mainframe. It contains mode switching, CRT beam positioning, trigger pick-



off for basic measurements, and a built-in 3% x 2%-inch soldering pad matrix for use by the customer who wishes to build his own input circuits for special applications. Customerbuilt circuits are powered through the circuit board which provides access to all mainframe power supplies.

Bandwidth—DC coupled, DC to at least 2 MHz at 50 mV/div, decreasing to DC to 200 kHz at mid-attenuator range. AC coupled, 25 Hz to at least 2 MHz at 50 mV/div, decreasing to 25 Hz to 200 kHz at mid-attenuator range. Uncompensated input.

Deflection Factor—50 mV/div, accurate within 3%. Continuously variable, uncalibrated from 50 mV/div to at least 1 V/div.

Input R and C-Approx 100 kΩ, approx 30 pF.

Maximum Input— 50 volts (DC + peak AC).

Order 5A24N SINGLE-TRACE AMPLIFIER

. \$25

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



- 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 5103N Oscilloscope System. An external input allows use of the 5B10N as a voltage amplifier with calibrated deflection factors of 50 mV/div and 500 mV/div.

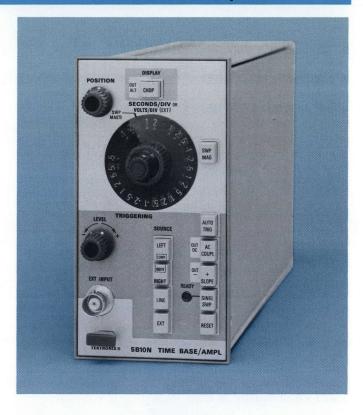
Triggering the 5B10N is straightforward even with the many triggering modes which are push button selected. Source positions include left or right plug-in, composite (from the mainframe vertical amplifier), line and external.

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 μ s/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 μ s/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 inc	rease 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 M Ω within 2% paralleled by \approx 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 $5\,\text{V/div}$.

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 M Ω within 2%, approx 70 pF.

Maximum Input Voltage— 350 V (DC + peak AC).

Order 5B10N TIME BASE/AMPLIFIER\$175

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

5100-SERIES OSCILLOSCOPES 5B12N Dual Time Base



- 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 5103N Oscilloscope System. The 5B12N is normally used in the right hand plug-in compartment but is compatible with the vertical amplifier compartments as well.

The display modes are A sweep, B sweep, A intensified — B delayed and dual sweep. Each mode is selectable by push-button switches. Triggering sources for A and B sweep include left and right plug-in, line and display composite. In the display composite mode the sweep is triggered from the composite signal being displayed. Auto and external trigger and single sweep are provided for the A sweep. The B sweep is triggerable after the delay time. The 5B12N triggers to frequencies well beyond the oscilloscope bandwidth.

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 timeshare 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— $1 \mu s/div$ 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 $1\,\mu s/div$ 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— $0.2 \,\mu\text{s/div}$ to $0.5 \,\text{s/div}$ in 20 calibrated steps.

B Sweep Accuracy—Within 3% from 1 μ s/div to 0.1 s/div. Within 4% at 0.2 μ s/div, 0.5 μ s/div, 0.2 s/div and 0.5 s/div.

TRIGGERING

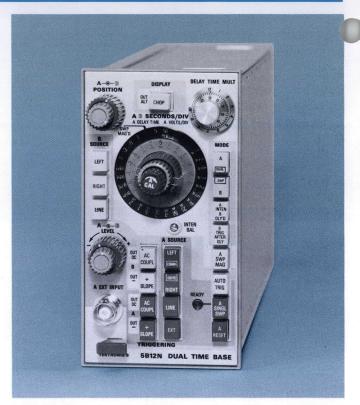
The following applies to the A and B trigger except as noted.

	COUPLING	TO 1 MHz	AT 2 MHz
	Internal	0.4 div	0.6 div
DC	External*	200 mV	200 mV
AC		Requirements inc	rease 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 M Ω within 2% paralleled by \approx 70 pF. Trigger level voltage range is +5 V to -5 V.

DELAYING SWEEP CHARACTERISTICS

Delay Time Accuracy— 1 μ s/div to 0.5 s/div, within 1%. 1 s/div to 5 s/div, within 2%.

Delay Time Multiplier Range—0.2 to 10.2 times the Time/Div setting.

Delay Time Multiplier Incremental Linearity-Within 0.2%.

Differential Time Measurement Accuracy—Within 1% and 2 minor dial divisions for 1 μs to 0.5 s delay times. Within 2% and 2 minor dial divisions for 1 s to 5 s delay times.

Jitter- 1 part or less in 20,000 of 10X the A Time/Div setting.

EXTERNAL HORIZONTAL MODE

Deflection Factor— 50 mV/div and 500 mV/div accurate within 3%. 10X variable extends range to at least 5 V/div.

Bandwidth—DC coupled, DC to at least 1 MHz. AC coupled, 50 Hz or less to at least 1 MHz.

Input R and C— 1 $M\Omega$ within 2%, approx 70 pF.

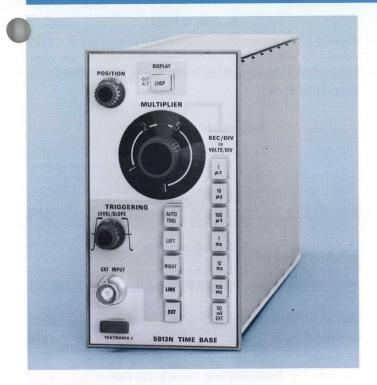
Maximum Input Voltage— 350 V (DC + peak AC).

Order 5B12N DUAL TIME BASE

\$450

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





- 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 5103N Oscilloscope System. 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 μ s/div sweep rates are needed.

CHARACTERISTICS

Sweep Rates— $1 \mu s$ /div to 100 ms/div within 5% in 6 calibrated decade steps. A lighted multiplier control provides continuous uncalibrated variation between steps, and extends the push-button selected rate to at least 1 s/div.

TRIGGERING

COUPLING	SENSITIVITY AND FREQUENCY RANGE
AC	0.4 div from 50 Hz to 100 kHz, increasing to 1 div at 1 MHz
Preselected	200 mV from 50 Hz to 1 MHz

External Trigger Input—Maximum input voltage is 200 V (DC + peak AC). Input R and C is approx 100 k Ω 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- 50 Hz or less to at least 250 kHz.

Input R and C—Approx 50 k Ω , approx 1000 pF.

Maximum Input Voltage—200 V (DC + peak AC).

Order 5B13N TIME BASE\$85

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



- TESTS SEMICONDUCTOR DEVICES to 0.5 W
- 10 nA/DIV to 20 mA/DIV VERTICAL DEFLECTION FACTORS
- 0.5 V/DIV to 20 V/DIV HORIZONTAL DEFLECTION FACTORS

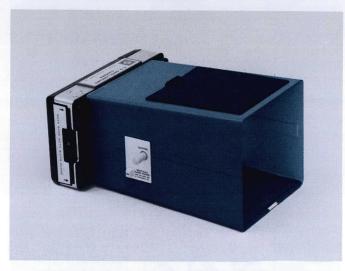
The 5CT1N Curve Tracer is a plug-in unit used in TEKTRONIX 5100-Series Oscilloscope Systems for displaying characteristic curves of semiconductor devices to power levels up to 0.5 watts. The plug-in operates in either vertical compartment of the mainframe. Horizontal deflection is achieved through a front panel source which drives the external input of either a vertical or horizontal plug-in unit installed in the mainframe's horizontal compartment.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are $1\,\mu\text{A/step}$ to $1\,\text{mA/step}$ for current and $1\,\text{mV/step}$ to $1\,\text{V/step}$ for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.

Order 5CT1N CURVE TRACER \$350
See complete description page 182-183.



CAMERA



The low-cost C-5 Camera is designed to complement the 5100-Series Oscilloscopes and the 603 and 604 Display Units. Its light weight, fixed-focus (f/16), fixed aperture design simplifies waveform photography. The C-5 Camera fits directly onto the instrument and needs no additional adapter. The film-back is permanently attached to the camera.

Order	C-5	CAMERA	 \$185

PROBES

The P6060 is a general-purpose probe for the 5100-Series Oscilloscopes. A special BNC connector activates sensing circuitry in the vertical plug-in units to automatically change the scale factor readout on the front panel. This convenience eliminates the need to mentally calculate the true deflection factor when using the probe. Accurate 10X attenuation provides commonmode rejection of 52 dB (400:1) when used with 5A20N and 5A21N Differential Amplifiers. Net weight is 8 oz.

P6060 3.5-FT PROBE, order 010-6060-01	a d (a,m);	\$35
P6060 6-FT PROBE, order 010-6060-03	Porting and the second second	\$35

The P6021 is a 125-turn AC Current Probe which can be used directly with the 5A21N Amplifier without a termination or amplifier. Accurate current measurement can be made to the upper frequency range of the 5A21N with the P6021 by simply opening a spring-loaded slide and placing the current conductor into the probe head slot.

P6021 PROBE 5-FT Cable,	order 010-0237-02	\$98
P6021 PROBE 9-FT Cable,	order 010-0244-02	\$98

BLANK PANEL

Blank Plug-in Panel—When operating the 5100-Series instruments with less than the full complement of plug-ins, the blank plug-in panel can be used to cover unused compartments.

Order	016-0195-00	\$4
Oluci	010 0133 00	 .74

SCOPE-MOBILE® CART

The Model 203-2 Cart supports the 5100-Series Oscilloscopes in any of nine convenient viewing positions. A storage drawer is provided, as well as a carrier for storing up to four 5-Series plug-in units. Bottom tray dimensions are $14\% \times 26\%$ inches.

Order	203-3	 7714
Uluci	702-7	 ככונ

VIEWING HOODS

Improve viewing in high ambient-light conditions, fits all 5100-Series Oscilloscopes, the 603 storage monitor and the 604 monitor.

Order 016-0260-00 (foldi	ng)	\$8.00
Order 016-0154-00		\$9.50

PROTECTIVE PANEL COVER

This cover snaps on to protect the front panel and the plug-in knobs on cabinet models from transportation or storage damage. The kit contains the front panel cover and the modified sidepanels for the 5103N Oscilloscopes. This kit is not required if an option 2 instrument has been ordered.

Order 040-0636-00	620
VIUCI V40-0030-00	(41)

RAIN COVER

This vinyl rain cover slips easily over the top of the instrument and has a slot which allows access to the instrument handle. The cover will accommodate the 5100-Series Oscilloscopes with or without Option 2 attached.

Order	016-0544-00	 \$10



The TEKTRONIX 550-Series offers the user *proven performance* in one of the most respected, flexible, versatile oscilloscope systems presently available.

This series of laboratory plug-in oscilloscopes provides a wide range of measurement capabilities. Dual-beam performance is provided in the 556. With its many operating modes and display features it is one of today's most versatile oscilloscopes.

The plug-ins that are available for this series are briefly described in the plug-in chart below. More details are given on their respective page.

550-SERIES MAINFRAME PERFORMANCE CHART APPLIES TO CABINET AND RACKMOUNT MODELS

MAINFRAME	PAGE	BANDWIDTH
556 Dual Beam/Delayed Sweep	130	DC to 50 MHz

550-SERIES MAINFRAME/PLUG-IN PERFORMANCE CHARTS

Bandwidth is in MHz unless noted otherwise. Risetime is in ns unless noted otherwise.

		MUL	TI-TRACE		
PLUG- IN	PAGE	AGE NUMBER MINIMUM DEFLECTION FACTOR		DC to 50 MHz MAINFRAME 556	
	-	TP WAZ ON	Two lo TV	BW	\mathbf{T}_{R}
1A1	132	TWO	50 mV/cm 5 mV/cm ~500 μV/cm	DC to 50 DC to 28 2 Hz to 15	7 13 24
1A4	133	FOUR	10 mV/cm	DC to 50	7

DIFFERENTIAL AND COMPARATOR						
PLUG- IN	PAGE	MINIMUM DEFLECTION FACTOR	MAXIMUM CMRR	DC to 50 MHz MAINFRAME 556		
	x 1, 5			BW	T_{R}	
1A5	134	5 mV/cm	20,000:1	DC - 50	7	
IAO		2 mV/cm		DC - 45	8	
		1 mV/cm	11111	DC - 40	9	
1A7A	136	10 μV/cm	100,000:1	DC - 1	350	

	SPECTRUM ANALYZERS							
PLUG- IN	PAGE	MAXIMUM SENS	CENTER FREQUENCY RANGE	CAL. DISPERSION PER CM	RESOLUTION			
1L5	172	10 μV/cm	50 Hz-990 kHz	10 Hz - 100 kHz	10 Hz - 500 Hz			
1L20	174	—100 dBm	10 MHz-4.2 GHz	1 kHz - 10 MHz	1 kHz - 100 kHz			

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. The following describes some of the accessories commonly used with these instruments. The accessory section of the catalog contains a complete description of all accessories.

CAMERAS

C-12 has beam-splitting mirror for straight-on viewing and use of optional projected graticule, f/1.9—1:0.85 lens, Polaroid* Land Pack-Film back accepts 3000-speed film. Projected graticule eliminates parallax in oscilloscopes having external graticules.

Order Standard C-12-P \$590

C-27 provides direct viewing and maximum transmission of light to film, f/1.9—1:0.85 lens, Polaroid Land Pack-Film back accepts 3000-speed film.

Order Standard C-27-P \$590

Bezels for adapting Cameras to Oscilloscopes are listed in the Camera accessory section.

PROBES

The standard 10X probes supplied with the instrument satisfy most measurement requirements; however, optional probes (recommended on plug-in unit pages) may be better suited for particular applications.

SCOPE-MOBILE® CART

*Registered Trademark Polaroid Corporation

556 50-MHz Dual-Beam Oscilloscope



- TWO VERTICAL AND HORIZONTAL SYSTEMS
- OVER 50 DISPLAY MODES INCLUDING DUAL-BEAM DISPLAY WITH ONE INPUT
- CALIBRATED DELAYED SWEEP
- EMI SUPPRESSION
- 6 x 10-cm DISPLAY PER BEAM
- ILLUMINATED PARALLAX-FREE GRATICULE
- FULL-BANDWIDTH TRIGGERING
- ACCEPTS MULTI-TRACE, DIFFERENTIAL, SAMPLING, SPECTRUM ANALYZER AND SPECIAL PURPOSE PLUG-IN UNITS

The Type 556 and R556 are dual-beam laboratory instruments for accurate measurement in the DC to 50 MHz range. Features include independent vertical and horizontal deflection systems, trigger selectability for cross triggering, and uniform-focus CRT with 6×10 -cm scan per beam.

Unique display capability allows simultaneous display of one signal at two different sweep times, using only one probe for minimum circuit loading.

VERTICAL DEFLECTION

2 identical systems

BANDWIDTH

DC to \geq 50 MHz at 3-dB down, depending on plug-in unit. RISETIME

≤7 ns, depending on plug-in unit.

DELAY LINE

Permits viewing leading edge of displayed waveform.

HORIZONTAL DEFLECTION

2 identical systems

TIME BASE A AND B

 $0.1~\mu s/cm$ to 5~s/cm in 24 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 12.5~s/cm. Warning light indicates uncalibrated setting.

X10 MAGNIFIER

Operates over full time base, increases fastest rate to 10 ns/cm. Magnified time base accurate within 5%.

DELAYED SWEEP MODE

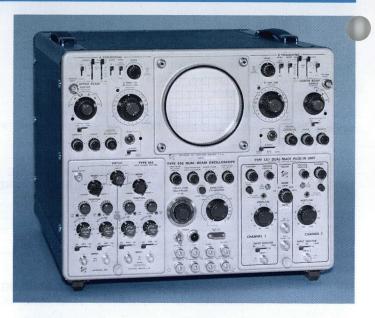
Delayed sweep starts after time interval determined by DELAY TIME and DELAY TIME MULTIPLIER. DELAY TIME CONTROL selects 0.1 μ s to 5 s delay time in a 1, 2, 5 sequence. Accurate within 1%. DELAY TIME MULTIPLIER provides continuously calibrated time intervals from 0.20 to 10.00 times the DELAY TIME. Dial divided into 1,000 parts. Accuracy within 0.2% of full scale from 1 μ s to 5 s and within 0.5% of full scale from 0.1 μ s to 0.5 μ s. Inherent delay to start of delayed sweep 150 ns or less.

DELAY RANGE

0.1 μ s to 50 s after start of delaying sweep.

DIFFERENTIAL TIME MEASUREMENT ACCURACY

Within 1% and ± 2 minor divisions from 1 μs to 5 s and within 1% and ± 5 minor divisions from 0.1 μs to 0.5 μs . Jitter ≤ 1 part in 20,000 of 10 times DELAY TIME.



DELAY MODES

Delayed sweep starts immediately at end of delay time, or is triggerable at end of delay time (for jitter-free displays).

OPERATING MODES

Time Base A-Normal and Single Sweep.

Time Base B-Normal, B delayed by A, and Single Sweep.

EXTERNAL INPUT

 \leq 0.1 V/cm with X10 Display Mag, \leq 1 V/cm with X1 Display Mag, continuously variable from \leq 0.1 V/cm to approx 10 V/cm. DC to \geq 400 kHz at 3-dB down. 50 V maximum (DC + peak AC). Input RC approx 1 megohm paralleled by \approx 65 pF.

SIGNAL OUTPUTS

Gates from both time bases ($\geq +9$ V), sawtooths from both time bases (≥ 9 V/cm), delayed trigger pulse (≥ 7 V).

TRIGGER

(2 identical systems)

MODES

Triggered and Auto Stability. Latter mode free runs sweep in absence of triggering signal, triggers on signals ≥30 Hz. COUPLING

AC, DC, AC LF reject, AC HF reject.

SOURCES

Internal from left or right vertical amplifier, left or right plugin, external, or line. External trigger input RC approx 1 megohm paralleled by approx 35 pF. 50-V maximum external input (DC + peak AC). External trigger signals that have an amplitude greater than 2 V and a rate of rise exceeding 1/3 V/ns may cause erratic triggering. Internal source selectable from the oscilloscope vertical amplifier, or direct from a single channel of Type 1A1, 1A2, and 1A4 Plug-In Units. The latter mode displays the true time relationship between signals when plug-ins are in chopped or alternate operation.

REQUIREMENTS

AC INTERNAL—0.2-cm, 60 Hz to 10 MHz; 1 cm to 50 MHz.

AC EXTERNAL—0.2 V, 60 Hz to 10 MHz; 0.4 V at 50 MHz.

AC LF REJECT—INT or EXT requirement increases below 2.5 kHz.

AC HF REJECT—INT or EXT requirement increases above 60 kHz (≥2-cm deflection or >2 V at 2 MHz).

DC INTERNAL-0.35-cm, DC-to-10 MHz; 2 cm at 50 MHz.

DC EXTERNAL—0.2 V, DC-to-10 MHz; 0.4 V at 50 MHz.



DISPLAY LOGIC

A dual-beam oscilloscope, with two horizontal and vertical deflection systems, presents the ability to select the driving source to the deflection systems . . . thereby greatly increasing the versatility.

The Time Base generators can be switched to either UPPER-BEAM horizontal or LOWER-BEAM horizontal to give independent or identical time-based displays, or simultaneous display of

one time base delayed accurately by the other.

The signal under test has the potential to be channeled from the plug-ins to either vertical amplifier. In the Type 556, the RIGHT plug-in unit output can be directed to either the UPPER-BEAM vertical or the LOWER-BEAM vertical or both. This means, among other things, only one probe need be attached to the signal source to perform delaying sweep operations. This reduces the loading effect on sensitive circuitry. The LEFT plug-in unit can be coupled to the UPPER-BEAM vertical only.

The triggering signal source to each Time Base trigger circuit can be selected from either UPPER-BEAM or LOWER-BEAM vertical (NORM), RIGHT or LEFT plug-in unit (necessary only in

1-series multi-trace plug-ins), or EXTERNAL.

CRT AND DISPLAY FEATURES

TEKTRONIX DUAL-BEAM CRT

5-inch round tube, 8×10 -cm display area; $\geq 6 \times 10$ cm per beam with 4-cm overlap. Spot size, focus uniformity and geometry equivalent to our finest single-beam tubes. Aluminized construction, helical post acceleration. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability. Z-axis input requires 10 V peak to peak for CRT modulation at normal intensity.

INTERNAL GRATICULE

Variable edge lighting. Vertical and horizontal centerlines marked in 2-mm divisions.

DISPLAY CONTROLS

Separate intensity, focus and astigmatism controls for each beam, upper and lower beam intensity contrast controls between A sweep and nonintensified-B-zone of A sweep, trace rotation (screwdriver adjustment), and trace separation. BEAM FINDER button functions in both X-Y systems, indicates direction of off-screen signals.

OTHER CHARACTERISTICS

ELECTROMAGNETIC INTERFERENCE

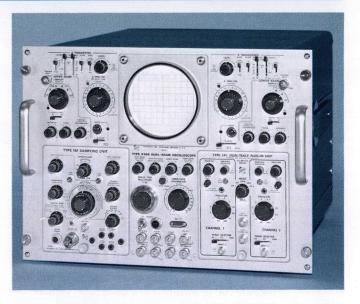
Oscilloscopes meet interference specifications of MIL-I-6181 D over the following frequency ranges: Radiated (with CRT mesh filter and BNC connector covers installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

AMPLITUDE CALIBRATOR

0.2 mV to 100 V in 18 calibrated steps (1-2-5 sequence), accuracy within $\pm 2\%$. 50- Ω source resistance from 0.2 mV to 0.2 V. \leq 1.5- μ s risetime; 1-kHz \pm 25% repetition rate; 45% to 55% duty cycle. 100-V DC reference output also provided. Front-panel current loop for 5-mA \pm 2%, squarewave or DC.

OWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 50 to 60 Hz source with less than 2% harmonic distortion; approx 840 W maximum, approx 1 kVA maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.



RACKMOUNTING

Type R556 mounts on tilting slide-out tracks to standard 19inch rack. Further mounting information on catalog instrument dimension page.

CABINET MODEL DIMENSIONS	S AND WEIGHTS	
Height	$15^{3}/_{16}$ in	38.6 cm
Width	$16^{15}/_{16}$ in	43.0 cm
Depth	24 in	61.0 cm
Net weight	83 lb	37.7 kg
Domestic shipping weight	≈135 lb	\approx 61.5 kg
Export-packed weight	≈148 lb	\approx 67.3 kg

RACK MODEL DIMENSIONS AND WEIGHTS

Height	14 in	35.6 cm
Width	19 in	48.3 cm
Rack depth	$22^{13}/_{16}$ in	57.9 cm
Net weight	873/4 lb	39.9 kg
Domestic shipping weight	≈151 lb	\approx 68.6 kg
Export-packed weight	≈162 lb	\approx 73.6 kg

INCLUDED ACCESSORIES

Four P6008 10X probe package (010-0129-00); eighteen BNC covers, ten installed (016-0088-00); 3-conductor power cable (161-0030-01); smoke-gray light filter (378-0567-00); clear CRT protector plate (387-0918-00); graticule cover (200-0382-00); CRT mesh filter, installed (378-0572-00). Type R556 also includes slideout assembly (351-0086-00) and mounting hardware.

Order TYPE 556 OSCILLOSCOPE, without plug-in units

OPTIONAL ACCESSORIES

Optional accessories expand measurement capabilities and provide added operating convenience. Cameras, Probes, Scope-Mobile® Carts and other major accessories are completely described in the catalog accessory pages. Some of the accessories commonly used with this instrument are described in the Reference Section for this series.

SCOPE-MOBILE® CART

Model 205-2: storage drawer, carrier for 3 plug-in units, 9-postion tilt-lock oscilloscope tray. Order 205-2 \$210

1A1 Dual-Trace Amplifier



- 5 mV/cm to 20 V/cm
 CALIBRATED DEFLECTION FACTORS
- \approx 500- μ V/cm SINGLE CHANNEL
- CHANNEL 1 SIGNAL & TRIGGER OUTPUTS
- 1-MHz CHOPPING RATE
- FET INPUTS

Type 1A1 provides dual-trace displays in Type 530, 540, 550 and 580* Series Oscilloscopes. Maximum bandwidth is achieved in Type 544, 546, 547, 556, and 585A Oscilloscopes. Input channels are identical with separate controls for coupling, attenuating, inverting and positioning the signal.

Used with the Type 547 or RM547 Oscilloscopes, the alternate switching circuit can be slaved to the display switching circuit in the oscilloscope, thus locking Channel 1 to Time Base A and Channel 2 to Time Base B. For many applications this provides the equivalent of a dual-beam oscilloscope without the additional complexity and cost.

Solid state components are used throughout except for the output stage.

TYPE 1A1 UNIT AND OSCILLO- SCOPE	DEFLECTION FACTOR	BANDWIDTH† (—3 dB)	RISE- TIME
535A	50 mV/cm	DC to 15 MHz	24 ns
	5 mV/cm	DC to 14 MHz	25 ns
	≈500 μV/cm	2 Hz to 10 MHz	35 ns
545B	50 mV/cm	DC to 33 MHz	11 ns
	5 mV/cm	DC to 23 MHz	16 ns
	≈500 μV/cm	2 Hz to 14 MHz	25 ns
544, 546, 547, 556, 585A*	50 mV/cm 5 mV/cm ≈500 μV/cm	DC to 50 MHz DC to 28 MHz 2 Hz to 15 MHz	7 ns 13 ns 24 ns
549	50 mV/cm	DC to 30 MHz	12 ns
	5 mV/cm	DC to 23 MHz	16 ns
	≈500 μV/cm	2 Hz to 14 MHz	25 ns
551	50 mV/cm	DC to 27 MHz	13 ns
	5 mV/cm	DC to 21 MHz	17 ns
	≈500 μV/cm	2 Hz to 13 MHz	27 ns

*A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: 2 Hz, 0.2 Hz with 10X probe.

DEFLECTION FACTOR

 $5\,\text{mV/cm}$ to $20\,\text{V/cm}$ in 12 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx $50\,\text{V/cm}$.

INPUT RC

1 megohm paralleled by approx 15 pF.

MAXIMUM INPUT VOLTAGE

600 V combined DC + peak AC.

OPERATING MODES

Either single channel, normal or inverted; algebraic addition; chopped or alternate electronic switching between channels. Alternate: channels switched at the end of each sweep. Chopped: successive 500-ns segments of each channel displayed at an approx 1-MHz rate per channel. Chopped transient blanking except in Type 551 and 585A Oscilloscopes.



SIGNAL OUTPUT

Channel 1 Output provides up to X10 gain, can be AC coupled into Channel 2 for approx $500-\mu\text{V/cm}$ deflection factor. Noise or frequency filters can be inserted between channels if desired. Output impedance is approx $50~\Omega$. Maximum bandwidth of output alone is DC to 35~MHz; see chalfor bandwidths at $500~\mu\text{V/cm}$.

TRIGGER OUTPUT

Channel 1 output for external triggering permits viewing true time relationship between signals in alternate or chopped operation. Output also applied internally to Type 544, 546, 547, 549, and 556 Oscilloscopes. Approx 0.5 V for each centimeter of displayed signal at 1 kHz with calibrated deflection factors.

WEIGHTS

Net weight	6 lb	2.6 kg
Domestic shipping weight	≈11 lb	≈5.0 kg
Export-packed weight	\approx 14 lb	\approx 6.4 kg

INCLUDED ACCESSORIES

BNC-to-BNC 50- Ω cable (012-0076-00).

Order TYPF 1A1	PLUG-IN UNIT	 \$725
GIACI III E IAI	I FOO-III OIIII	 4123

OPTIONAL ACCESSORIES

See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package. Order 010-0129-00	\$50
P6009 100X Probe Package. Order 010-0170-00	\$66
P6028 1X Probe Package. Order 010-0074-00	\$20

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 M Ω and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetim is approx 7 ns.



- 10 mV/cm to 20 V/cm CALIBRATED DEFLECTION FACTORS
- FOUR-CHANNEL ADDING $(\pm 1 \pm 2) + (\pm 3 \pm 4)$
- SIGNAL OUTPUT
- FET INPUTS

This plug-in unit for Type 530, 540, 550, and (with adapter) 580*-Series Oscilloscopes through versatile switching logic provides the equivalent of two wide-band, dual-trace units connected to a third wide-band, dual-trace unit. Maximum bandwidth of DC to 50 MHz is achieved with Type 544, 546, 547 and 556 Oscilloscopes. The Type 1A4 provides a new standard of multi-channel versatility in all TEKTRONIX Oscilloscopes that accept Letter-Series or 1-Series Plug-In Units.

CHARACTERISTICS

TYPE 1A4 UNIT AND OSCILLOSCOPE	BANDWIDTH† (—3 dB)	RISETIME
544, 546, 547, 556, 585A	DC to 50 MHz	7 ns
545B	DC to 33 MHz	11 ns
549	DC to 30 MHz	12 ns
551	DC to 27 MHz	13 ns
535A	DC to 15 MHz	24 ns

^{*}A Type 81A Adapter is required.

†Low-frequency 3-dB point, AC coupled: \leq 2 Hz, \leq 0.2 Hz with 10X probe.

DEFLECTION FACTOR

10 mV/cm to 20 V/cm in 11 calibrated steps (1-2-5 sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/cm.

INPUT RC

1 megohm ($\pm 1\%$) paralleled by approx 20 pF.

MAXIMUM INPUT VOLTAGE

600 V DC + peak AC.

COMMON-MODE REJECTION

At least 20:1, DC to 10 MHz common-mode signals up to 10 cm in amplitude.

CHANNEL ISOLATION

At least 50:1 for signals from DC to 20 MHz.

DISPLAY MODES

Any single-channel; any two channels (alternated, chopped, or added); three channels (alternated, chopped, or added in any combination); and four channels (Channels 1 and 2 alternated, chopped, or added with Channels 3 and 4). Four channel addition is useful in single-shot displays of four different signals, as in delay and coincidence studies.

Channels are always displayed in numerical sequence in chopped and alternate modes. One channel will run twice when only three are turned on. In chopped operation, successive 2.5- μ s (approx) segments of each channel are displayed. Chopping rate is approx 400 kHz. Chopped transient blanking with all oscilloscopes except Type 551, and 585A.

SIGNAL OUTPUT AND TRIGGER SOURCE

Signal from any channel can be used to externally trigger the oscilloscope, thus indicating the true time relationship between signals displayed in alternate and chopped mode. Selected output also applied internally to Type 544, 546,



547, 549 and 556 Oscilloscopes. The front-panel output can also be cascaded with another channel, providing additional gain useful in many applications. Signal output amplitude is $>\!0.5\,\text{V/cm}$ of display signal, unterminated at 1 kHz. Bandwidth is $\leq\!20\,\text{Hz}$ to $\geq\!10\,\text{MHz}$ (to approx 500 kHz with any channel operated in chopped mode). Approx 50- Ω output impedance.

WEIGHTS

Net weight	6½ lb	3.1 kg
Domestic shipping weight	≈10 lb	\approx 4.5 kg
Export-packed weight	≈16 lb	\approx 7.3 kg

INCLUDED ACCESSORIES

BNC-to-BNC 18-inch cable (012-0076-00).

Order TYPE 1A4 PLUG-IN UNIT \$1150

OPTIONAL ACCESSORIES

The probes recommended for use with this plug-in unit satisfy most measurement requirements. Other probes are available for current and high-voltage measurements. See catalog accessory pages for additional information on these and other items.

P6008** 10X Probe Package. Order 010-0129-00	\$50
P6009 100X Probe Package. Order 010-0170-00	\$66
P6028 1X Probe Package. Order 010-0074-00	\$20

**P6008 10X Probes included with Type 544, 546, 547 and 556 Oscilloscopes increase input resistance to 10 M Ω and decrease input capacitance to approx 7.5 pF. Bandwidth of probe and oscilloscope is 45 MHz or greater; risetime is approx 7 ns.

1A5 Differential Comparator Amplifier



- 1 mV/cm to 20 V/cm
 CALIBRATED DEFLECTION FACTOR
- 20,000:1 CMRR
- ±5-V COMPARISON VOLTAGE
- FET INPUTS

This wide-band differential unit for Type 530, 540, 550, and 580*-Series Oscilloscopes achieves a new high in common-mode rejection. The 132 Power Supply is available to operate the Type 1A5 outside an oscilloscope. See the description of this instrument for details.

Solid state design, with FET inputs, provides low drift and eliminates microphonics.

CHARACTERISTICS

TYPE 1A5 UNIT AND OSCILLO- SCOPE	DEFLECTION FACTOR	BANDWIDTH†	RISE- TIME
544, 546,	5 mV/cm to 20 V/cm	DC to 50 MHz	7 ns
547, 556,	2 mV/cm	DC to 45 MHz	8 ns
585A*	1 mV/cm	DC to 40 MHz	9 ns
545B	5 mV/cm to 20 V/cm	DC to 33 MHz	11 ns
	2 mV/cm	DC to 31 MHz	12 ns
	1 mV/cm	DC to 30 MHz	12 ns
549	5 mV/cm to 20 V/cm	DC to 30 MHz	12 ns
	2 mV/cm	DC to 29 MHz	13 ns
	1 mV/cm	DC to 28 MHz	13 ns
551	5 mV/cm to 20 V/cm	DC to 27 MHz	13 ns
	2 mV/cm	DC to 26 MHz	14 ns
	1 mV/cm	DC to 25 MHz	14 ns
535A	5 mV/cm to 20 V/cm	DC to 15 MHz	24 ns
	2 and 1 mV/cm	DC to 14 MHz	25 ns

†Low-frequency 3-dB point, AC coupled: \leq 10 Hz.

DEFLECTION FACTOR

1 mV/cm to 20 V/cm in 14 calibrated steps (1-2-5 sequence), accurate within 2.5% (within 2% from 1 mV/cm to 20 mV/cm). Uncalibrated, continuously variable between steps and to \geq 50 V/cm.

INPUT RC

1 megohm paralleled by approx 20 pF.

INPUT COUPLING

May be switched to AC, GND, or DC. Input coupling capacitor is automatically charged to proper voltage through a 1-megohm resistor when switch is in GND position.



MAXIMUM INPUT VOLTAGE

 $\pm 400\,\mathrm{V}$ (DC + peak AC) from 1 mV/cm to 20 mV/cm, $\pm 500\,\mathrm{V}$ (DC + peak AC) from 10 mV/cm to 20 V/cm.

COMMON-MODE DYNAMIC RANGE

 $\geq \pm 5$ V (DC + peak AC) from 1 mV/cm to 20 mV/cm, $\geq \pm 50$ V from 50 mV/cm to 0.2 V/cm, $\geq \pm 500$ V from 0.5 V/cm to 20 V/cm. The ± 50 V range can be extended from 50 mV/cm to 10 mV/cm, and the ± 500 V range can be extended from 0.5 V/cm to 0.1 V/cm by pulling and turning the VOLTS/CM control.

COMMON-MODE REJECTION RATIOS*

FREQUENCY	REJECTION RATIO	SINEWAVE AMPLITUDE	DEFLECTION FACTOR
DC to 100 kHz	≥20,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
100 kHz to 1 MHz	≥10,000:1	±5 V P to P	1 mV/cm to 20 mV/cm
1 MHz to 10 MHz	≥10,000:1 divided by freq. in MHz	±5 V P to P divided by freq. in MHz	1 mV/cm to 20 mV/cm
DC to 10 kHz	≥2,000:1	±50 V P to P	10 mV/cm to 2 V/cm
DC to 10 kHz	≥100:1	±50 V P to P	5 V/cm to 20 V/cm
60 Hz (AC coupled)	≥1,000:1	±5 V P to P	1 mV/cm to 20 mV/cm

*At 0°C to 50°C

^{*}A Type 81A Adapter is required.



Differential Comparator Amplifier 1A5

DC STABILITY

Drift with time: \leq 200 μ V/h at 25°C. With temperature: \leq 200 μ V/°C. With line voltage change: \leq 300 μ V from 105 to 125 VAC.

NOISE

 \leq 50 μ V RMS.

DC SHIFT DUE TO OVERDRIVE

Within 1% of \pm overdrive signal, but not exceeding 10 mV in the 5 V input signal range, 0.1 V in the 50 V input signal range, or 1.0 V in the 500 V input signal range.

OVERDRIVE RECOVERY

Recovers to within 10 mV of DC-shifted level after 0.15 μ s in the 5 V input signal range.

COMPARISON VOLTAGE

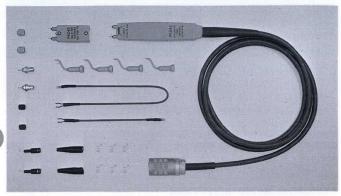
0 to $\pm 5\,\text{V}$, internally applied to + input or - input, monitorable at front panel. Accuracy within 7 mV or 0.5% of comparison voltage, whichever is greater.

WEIGHTS

Net weight	5 lb	2.3 kg
Domestic shipping weight	\approx 7 lb	≈3.2 kg
Export-packed weight	≈13 lb	\approx 5.9 kg

Order TYPE 1A5 PLUG-IN UNIT \$750

Differential Probe P6046



The P6046 expands the differential measurement capabilities of the Type 1A5 Plug-In Unit. With this probe, the differential-signal-adding takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. This differential probe-tip performance minimizes the measurement errors caused by differences in probes, cable lengths, and input attenuators. In addition, the wide-band capability of the P6046 assures DC-to-45 MHz performance at the probe tip where the measurements are made.

CHARACTERISTICS

Probe with Type 1A5 Plug-In Unit

ATTENUATION is 1X.

INPUT RESISTANCE is 1 megohm, $\pm 1\%$.

INPUT CAPACITANCE is approx 10 pF.

COMMON-MODE LINEAR DYNAMIC RANGE is ± 5 V (DC + peak AC), ± 50 V with 10X attenuator.

COMMON-MODE REJECTION RATIOS with deflection factors of 1 mV/cm to 20 mV/cm are 10,000:1 at DC, 1,000:1 at 45 MHz. Min AC-coupled CMRR from 1 mV/cm to 20 mV/cm is 1000:1 at 20 MHz decreasing to 500:1 from 40 MHz to 45 MHz.

BANDWIDTH/RISETIME

TYPE 1A5 DEFLECTION FACTOR	BANDWIDTH*	RISETIME*	
200 mV/cm to 5 mV/cm	DC to 45 MHz	7.8 ns	
2 mV/cm	DC to 43 MHz	8.1 ns	
1 mV/cm	DC to 38 MHz	9.2 ns	

*With Oscilloscope Types 544, 546, 547, 556, or 585A with Type 81A Adapter.

MAXIMUM INPUT VOLTAGE is $\pm 25\,\mathrm{V}$ (DC + peak AC), $\pm 250\,\mathrm{V}$ with 10X attenuator.

NOISE (periodic and random deviation) is 200 μV or less.

THERMAL DRIFT at the probe head is 250 μ V/°C or less.

PROBE CABLE is 6 feet long, terminated with a special ninepin connector.

P6046 PROBE PACKAGE. Order 010-0213-00 \$470

1A7A Differential Amplifier



- DC-to-1 MHz BANDWIDTH
- 10 μV/cm to 10 V/cm
 CALIBRATED DEFLECTION FACTORS
- SELECTABLE UPPER AND LOWER ─3-dB POINTS
- 100,000:1 CMRR
- DC OFFSET
- FET INPUTS
- 10-μV/HOUR DC DRIFT*

Designed for use with any TEKTRONIX 530, 540, 550, or (with Type 81A Adapter) 580-Series Oscilloscopes. Used with Type 132 Power Supply, the Type 1A7A can drive recording equipment, X-Y plotters, oscilloscopes or other indicators.

DEFLECTION FACTOR

 $10~\mu V/cm$ to 10~V/cm in 19 calibrated steps, 1-2-5 sequence, accurate within 2%. Uncalibrated continuous variation between steps and to approx 25~V/cm.

INPUT RC

1 megohm, paralleled by 47 pF.

MAXIMUM INPUT CURRENT

DEFLECTION FACTOR	INPUT	at 25°C	at 50°C	
$10~\mu\text{V/cm}$ to $10~\text{mV/cm}$	each input	±20 pA	±100 pA	
10 μ γ / cm 10 10 m γ / cm	both inputs	±40 pA	±200 pA	
20 mV/cm to 10 V/cm	each input	±10 pA	$\pm 10\mathrm{pA}$	
Display shift at 10 μ V/cm (AC coupled)	each input	± 2 cm	±10 cm	

MAXIMUM INPUT VOLTAGE

DC Coupled: $10 \,\mu\text{V/cm}$ to $10 \,\text{mV/cm}$ — $\pm 20 \,\text{V}$ (DC + peak AC) $20 \,\text{mV/cm}$ to $10 \,\text{V/cm}$ — $\pm 500 \,\text{V}$ (DC + peak AC)

AC Coupled Input DC Voltage: $10~\mu\text{V/cm}$ to 10~V/cm $-\pm500~\text{V}$

OVERDRIVE RECOVERY

 \leq 10 μs to recover within 0.5% of zero level after removal of a + or - voltage applied for 1 s, applied voltage within the differential dynamic range.

DISPLAYED NOISE

 \leq 16 μ V or 0.1 cm, whichever is greater, measured tangentially at full bandwidth (DC to 1 MHz), source resistance 25 Ω or less. See catalog glossary for definition of "tangential noise measurement".

DC STABILITY

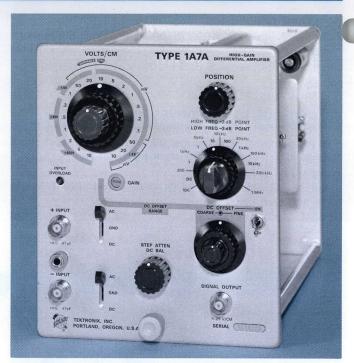
Drift with time (ambient temperature and line voltage constant).

Short term: $5\,\mu\text{V/minute}$ (P-P) after 1 hour warm up. Long term: $10\,\mu\text{V/hour}$ (P-P) after 1 hour warm up. Drift with ambient temperature (line voltage constant): $50\,\mu\text{V/°C}$.

FRONT-PANEL SIGNAL OUTPUT

0.25 V per displayed cm, $\pm 10\%$. Output is DC coupled, output impedance $\leq 750\,\Omega$. Minimum load resistance, $10\,\mathrm{k}\Omega$.

*With constant temperature. See DC STABILITY specifications.



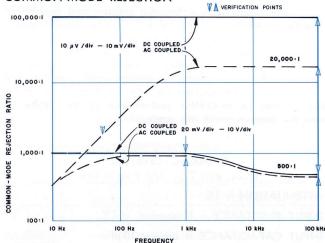
COMMON-MODE DYNAMIC RANGE

 $10~\mu\text{V/cm}$ to 10~mV/cm — $\pm10~\text{V}$ (DC + peak AC). 20~mV/cm to 0.1~V/cm — $\pm100~\text{V}$ (DC + peak AC). 0.2~V/cm to 10~V/cm — $\pm500~\text{V}$ (DC + peak AC).

DC OFFSET (within ±10%)

 \pm 400 mV from 10 μ V/cm to 10 mV/cm; \pm 4 V from 20 mV/cm to 0.1 V/cm; \pm 40 V from 0.2 V/cm to 1 V/cm; \pm 400 V from 2 V/cm to 10 V/cm.

COMMON-MODE REJECTION

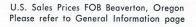


WEIGHTS Net weight Domestic shipping weight Export-packed weight $4^{3}/_{4}$ lb ≈ 9 lb ≈ 4.1 kg ≈ 13 lb ≈ 5.9 kg

Order TYPE 1A7A PLUG-IN UNIT \$575

OPTIONAL ACCESSORIES

P6055 10X Probe Package, adjustable attenuation ratio helps maintain common-mode rejection. Order 010-6055-01 \$75.00





PORTABLE OSCILLOSCOPE REFERENCE

PRODUCT	PAGE	STORAGE	BW	DEFLECTION FACTOR	DUAL TRACE	DELAYED SWEEP	SWEEP RATE (WITH MAG)	MAG	BATTERY POWER	DISPLAY SIZE
211	160	BATRÍS (500 kHz	10 mV/div @ BW 1 mV/div Min			1 μs/div	X5	Yes	6 x 10 div 0.2 in/div
323	158		4 MHz	10 mV/div @ BW 1 mV/div Min			0.5 μs/div	X10	Yes	6 x 10 div 1/4 in/div
324	156		10 MHz	10 mV/div @ BW 2 mV/div Min	. 4.=		0.2 μs/div	X5	Yes	6 x 10 div 1/4 in/div
326	154	7 1 7 7	10 MHz	10 mV/div @ BW 1 mV/div Min	Yes	Ha Thurse	0.1 μs/div	X10	Yes	8 x 10 div 1/4 in/div
422/ R422	152		15 MHz	10 mV/div @ BW 1 mV/div Min	Yes		50 ns/div	X10	Yes	8 x 10 div 0.8 cm/div
432/ R432	149		25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50		8 x 10 cm
434/ R434	149	Yes	25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50	MATERI	8 x 10 div 0.98 cm/div
453A/ R453A	148		60 MHz	20 mV/div @ BW 5 mV/div Min	Yes	Yes	10 ns/div	X10	THE IS	8 x 10 div 0.8 cm/div
454A R454A	147		150 MHz	10 mV/div @ BW 2 mV/div Min	Yes	Yes	2 ns/div	X10	II, et a sed	8 x 10 div 0.8 cm/div
465	143		100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes	8 x 10 div 1 cm/div
475	143	15.1	200 MHz	2 mV/div @ BW 2 mV/div Min	Yes	Yes	1 ns/div	X10	Yes	8 x 10 div 1 cm/div
485	139		350 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	1 ns/div	X10	Yes	8 x 10 div 0.8 cm/div

The TEKTRONIX family of portable oscilloscopes is designed to solve measurement problems with laboratory precision—in the field or in the lab. These instruments are designed to be carried comfortably in a position which places the front panel in a vertical plane, rather than the horizontal format which is usually used for non-portable oscilloscopes. These ruggedized oscilloscopes will withstand severe environments wherever you go without the additional costs usually associated with militarized instruments.

Beginning with the first TEKTRONIX portable oscilloscope, measurements compromised by adverse field conditions have been significantly reduced. Today, with the availability of these new and improved portables, compromised field measurements are even less likely to occur.

485 The 485 is a 350 MHz, 1 ns/div, 20.5 lb portable dual-trace oscilloscope. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, trigger holdoff, external trigger display, alternate delayed sweep with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control.

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 M Ω), the 485 offers more gain bandwidth than any other oscilloscope available today. Selectable input impedance provides the capability to measure high and low impedance points in the same application with the same scope and without special purpose probes.

Sweep rates to 1 ns/div without magnifier complement the high bandwidth. An alternate sweep mode expands the delayed sweep concept in portables. This feature allows the delayed sweep to appear alternately with the intensified main sweep.

465/475 Customer preference made TEKTRONIX Portables the most widely used service and laboratory oscilloscopes in virtually an unlimited range of applications. The reasons are many, including performance and features such as delayed sweep that's easy to use, simplified full-range triggering and other straightforward functions which make oscilloscope operation easy. The 465 and 475 are the newest addition to this growing series of oscilloscopes. A carefully designed front panel provides space for a bright 8 x 10-cm, high-resolution CRT. Properly spaced, logically arranged controls optimizes operator learning time. Users will switch quickly and precisely among the many operating modes for positive solutions to complex measurement problems.

The majority of laboratory problems are solved by high-performance, dual-trace oscilloscopes. These are the laboratory measurements which the 465 and 475 will also solve. Their price-performance value offers sound solutions to the majority of laboratory measurements.

324/326 The SONY®/TEKTRONIX® 326 (dual channel) and the SONY®/TEKTRONIX® 324 (single channel) are 10 mV/div oscilloscopes with 10-MHz bandwidth which operate from internal rechargeable batteries, AC or external batteries. The 324/326 extends to 10 MHz the capabilities of the widely used 4-MHz 323. Higher performance solves more measure-

PORTABLE OSCILLOSCOPES

Reference



ment problems and with the addition of the 326 these problems are more quickly diagnosed. The small size and power options make the 324/326 ideal for applications where space and power sources are at a premium.

211 The 211 miniscope is optimized for field maintenance and other applications where space and portability are primary considerations. Though small, 3 lb, 3 x 5½ x 9 inches, it's complete. The 211 is the first laboratory-quality miniscope. It offers performance and carrying convenience at a lower price than many other 500-kHz scopes. The integral probe and power line wrap around a recessed area in the case. They are out of the way, and the user knows exactly where they'll be when he reaches the next job.

Industrial applications may necessitate "floating" an oscilloscope. The 211 may be elevated to 700 volts above ground when operated from batteries, and 250 volts RMS above ground from AC.

432/434 OSCILLOSCOPES

The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div and deflection factors to 1 mV/div cover a wide range of laboratory and field applications. Cabinet height is 5¾ inches including the feet (rackmount height is 5½ inches) and weight is 20¾ pounds.

434 STORAGE OSCILLOSCOPE

The 434 Storage Oscilloscope is virtually two instruments in one. It offers all of the advantages of Bistable Split-Screen Storage, plus those of a conventional oscilloscope in a portable instrument.

Storage has long been a desired characteristic in portable oscilloscopes. Uses for storage continue to expand as electronic equipment uses and costs place stronger demands upon quick isolation and solution of problems. Signals which are single event or low repetition rate, aperidoic or random are usually difficult to measure with a nonstorage oscilloscope. The 434 Oscilloscope provides easy solutions to many of these problems.

Now there is a choice of two storage CRTs; one provides a writing speed of 100 div/ms (400 div/ms enhanced) and the other 500 div/ms (5000 div/ms enhanced).

Split-screen storage operates in each of three modes: full-screen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the lower (or upper) area. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

TEKTRONIX storage oscilloscopes free the operator to concentrate on the test point rather than the storage controls. To capture aperiodic events the 434 is operated in a store/ single sweep mode. When an event occurs, it is stored and retained in a view mode without further operator attention for up to four hours. The user is then free to concentrate on the test point and leave the oscilloscope unattended, confident

that when the event occurs it will be displayed in a stored mode for viewing at his convenience. Information may be retained on either half of the CRT when the other half is erased by a push-button control.

RUGGEDIZED PORTABLES

This family of TEKTRONIX oscilloscopes are solid-state instruments that combine small size, light weight and the ability to make precision waveform measurements. As such, these instruments must withstand the shock, vibration, and other extremes of environment associated with portability.

The environmental characteristics of these instruments allow them to operate over a temperature range of $-15^{\circ}\mathrm{C}$ to $+55^{\circ}\mathrm{C}$ and be stored for long periods from $-55^{\circ}\mathrm{C}$ to $+75^{\circ}\mathrm{C}$. For those instruments including batteries, the storage temperatures are $-40^{\circ}\mathrm{C}$ to $+60^{\circ}\mathrm{C}$.

These environmentalized instruments will operate at an altitude of 15,000 feet, but can be carried, non-operating, to altitudes as high as 50,000 feet. The effects of high humidity have been minimized since these instruments meet 5 cycles of a test as defined by MIL-STD-202C method 106B, or MIL-E-16400F. Non-nutrient materials are used where possible.

These instruments will withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles, while operating. They will also withstand shock of 30 g's, half sine, 11-ms duration, two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Electromagnetic interference (EMI) should be considered in both laboratory and field applications. 400-Series portables have been subjected to tests as specified in MIL-I-6181D where EMI radiated from the instrument is held within the given limits from 150 kHz to 1 GHz. EMI conducted out of the instrument through the power cord is held within the given limits from 150 kHz to 25 MHz. Instruments meeting EMI requirements can be ordered as an option.

BATTERY OPERATION

Eight portables (211, 323, 324, 326, 422, 465, 475 and 485) can be battery operated. With battery operation, the user moves from one remote location to another without concern for power connections. Battery powered instruments are especially suited for maintenance at sites such as remote microwave installations, mobile communications equipment, aircraft and marine instrumentation and production control equipment.

The nickel cadmium battery cells used in TEKTRONIX instruments have been selected after extensive evaluation. Each battery cell in the battery pack receives an ampere-hour test, has met or exceeds the ampere-hour storage requirement and has been rigidly inspected. The battery cells used in the battery pack should provide a useful operating life extending over several hundred charge-discharge cycles with routine care.

Each TEKTRONIX portable oscilloscope is a complete measuring system. Standard accessory items such as probes, adapters, cords, filters and a manual are included at no extra cost. Additional value is provided by a complete line of optional items: a new spectrum analyzer module compatible with these oscilloscopes, voltage probes, current probes, special adapters, cameras, protective covers and SCOPE-MOBILE® Carts.



- 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-M Ω and 50- Ω INPUT IMPEDANCES
- 50-Ω INTERNAL INPUT PROTECTION
- AUTOMATIC DEFLECTION FACTOR READOUT
- AUTO FOCUS
- ADJUSTABLE TRIGGER HOLDOFF
- PUSH BUTTON EXT TRIGGER DISPLAY





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. A human engineered front panel reduces measurement time. Single function push buttons and automatic vertical scale-factor indication increases 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 M Ω), the 485 offers more gain bandwidth than any other oscilloscope available today. Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes. Internal detection circuitry protects the 50- Ω input by automatically disconnecting when the signal exceeds 5 V RMS .

utomatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen volts/div even when the recommended 10X or 100X probes are used. The operator no longer

has to remember to divide attenuation factors into dial settings each time he makes a measurement.

To complement the higher bandwidth, the 485 has a 1 ns/div sweep. A new alternate sweep mode expands the delayed sweep concept in portables. This feature allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, the operator sees the intensified zone and delayed display at the same time. He always knows exactly where in a pulse train he is making a delayed sweep measurement.

The external trigger signal may be easily viewed on the 485 without disconnecting leads and resetting controls. A front panel push button automatically routes the external signal used to trigger Time Base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

Full bandwidth triggering (without HF sync) and "Adjustable 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.

PORTABLE OSCILLOSCOPES

NEW 485 350-MHz Dual-Trace Oscilloscope



VERTICAL DEFLECTION (2 Identical Channels)

Selectable Input Impedance— $50-\Omega$ and $1-M\Omega$ impedance are available at a single BNC connector by push button selection.

 $50~\Omega$ 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 at 350 MHz.

1 M Ω within 1% paralleled by approx 20 pF.

Bandwidth* and Risetime at all deflection factors from 50- Ω terminated source, $+15^{\circ}\mathrm{C}$ to $+35^{\circ}\mathrm{C}$

50 Ω	DC to 350 MHz, 1 ns
1 ΜΩ	DC to 250 MHz, 1.4 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 M Ω . 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.
	DC Coupled— 250 V (DC $+$ peak AC), 500 V P-P to 1 kHz
1 ΜΩ	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 $50-\Omega$ load in $50-\Omega$ 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 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 Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	\pm (1% of reading $+$ 0.2% of full scale)
50 ns/div to 1 ms/div	\pm (0.5% of reading $+$ 0.1% of full scale)
2 ms/div to 0.5 s/div	\pm (1% of reading $+$ 0.1% of full scale)

Full scale is 10 times the Delay/Div setting.

Jitter-1 part or less in 20,000 of 10X the Time/Div setting.

TRIGGERING A and B

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

Trig	ger Mode	To 50 MHz	To 350 MHz	
DC	Internal	0.3 div deflection	1.5 div deflection	
ЪС	External	20 mV	100 mV	
AC	C Signals below 16 Hz are attenuat		Iz are attenuated	
AC	LF Reject	Signals below 16 kHz are attenuated		
AC	HF Reject	Signals below 16 Hz are attenuated	and above 50 kHz	

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).

evel 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 $\pm 0.5 \text{ V}$ for either polarity; $\pm 5 \text{ V}$ for EXT \div 10.

A Sources—Internal, line, external, external ÷ 10.

B Sources—B Runs After Delay Time, internal, external, external \div 10.

External Inputs— 1 M Ω 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)— $5\,\text{mV/div}$ to $5\,\text{V/div}$ 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 ($-3\,\text{dB}$). Phase difference between amplifiers is 3° or less to 4 MHz.

CRT

TEKTRONIX CRT— 4-inch rectangular tube; 8 x 10-div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P11 optional without extra charge; 21-kV accelerating potential.

Photographic Writing Speed—At least 3 div/ns with standard P31 phosphor and at least 6.0 div/ns with optional P11 phosphor using the TEKTRONIX C-31-R Camera and Polaroid* 10,000 ASA film.

Auto Focus—Automatically maintains beam focus for all intensity settings.

Graticule—Internal, no parallax; variable edge lighting; markings for measurement of risetime. Graticule is dark with illumination off.

Beam Finder-Limits display within graticule area.

External Z-Axis—Risetime \approx 15 ns. Input R \approx 500 Ω . +0.2 V (DC to 20 MHz) blanks trace of average intensity. +2 V (DC to 2 MHz) blanks maximum intensity trace.

Beam Current Limit—Automatically limits the average beam current to protect the CRT phosphor.

*Registered Trademark Polaroid Corporation

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: -15°C to +55°C. Filtered forced air ventilation is provided. Storage: -35°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axis, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, 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 M Ω 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.

PORTABLE OSCILLOSCOPES

NEW 485 350-MHz Dual-Trace Oscilloscope



485 Dimensions and Weights		
Height	6.6 in	16.8 cm
Width	12.0 in	30.5 cm
Depth		
handle extended	20.6 in	52.3 cm
handle not extended	18.5 in	47.0 cm
Net Weight		
with accessories	24 lb	10.9 kg
without accessories	21 lb	9.5 kg
Domestic Shipping Weight	≈31 lb	≈14 kg
Export Packed Weight	≈42 lb	≈19 kg

Included Accessories— $50-\Omega$ 18-inch BNC cable (012-0076-00); two BNC jack posts (012-0092-00); $50-\Omega$ 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 Add \$40
485-1 OSCILLOSCOPE, without A EXT TRIG Display \$4100
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485-2 OSCILLOSCOPE, without A EXT TRIG Display and with $50-\Omega$ input only instead of selectable input impedance

Battery and external DC power capability to power this and other instruments is available in a stand-alone package.

OPTION 4

Electromagnetic Interference (EMI) Modification

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).

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability a provide added convenience.

Folding Viewing Hoods—Improves viewing in high ambient light conditions.

Folds to 9/16 x 6-3/4 x 13-3/4 inches.

Order 016-0082-00\$9

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

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
S G and was	P6056	10X	500 Ω 1 pF	200 Hz	350 MHz	010-6056-03 — 6 ft 010-6056-05 — 9 ft	\$45
50-Ω Input	P6057	100X	5000 Ω 1 pF	20 Hz	350 MHz	010-6057-03 — 6 ft 010-6057-05 — 9 ft	\$45
1-MΩ Input	P6201 (FET Probe)	1X 10X Plug-on	100 k Ω 3 pF 1 M Ω <1.5 pF 1 M Ω <1.5 pF	10 Hz 1 Hz 10 Hz	330 MHz	010-6201-01 — 6 ft	\$375
	P6053A	10X	10 MΩ 9.5 pF 12 pF 13.5 pF	1 Hz	250 MHz 250 MHz 215 MHz	010-6053-01 — 3.5 ft 010-6053-03 — 6 ft 010-6053-05 — 9 ft	\$55

Refer to probe section of catalog for more detailed specifications.

^{*}Registered Trademark Polaroid Corporation

NEW





475 pictured above is identical in appearance to the 465 (not shown) except the 465 deletes the 0.01 and 0.02 μs TIME/DIV and 2 mV VOLTS/DIV switch positions.

- 200 MHz at 2 mV/DIV (475)
- 1 nsec/DIV SWEEP RATE (475)
- 100 MHz at 5 mV/DIV (465)
- 5 nsec/DIV SWEEP RATE (465)
- 8 x 10-cm DISPLAY
- EASY-TO-OPERATE
- TRIGGER VIEW
- AUTOMATIC VOLTS/DIV READOUT
- LESS THAN 23 lb
- VERSATILE TRIGGER SELECTION
- BATTERY OPERATION
- DELAYED SWEEP

The need to view and accurately measure complex nanosecond signals on customer locations or in a "field" environment is commonplace and expected. The new 465 and 475 have been specifically designed to be easy to use and meet the high performance and portable demands of these applications.

The exceptionally low-cost of the 465 with 100 MHz at $5\,\text{mV/cm}$ and the 475 with 200 MHz at $2\,\text{mV/cm}$ represents a price/performance breakthrough for portables and insures top value for the future.

At less than 23 lb the new 465 and 475 portables are light, short and easy to carry (25.3 lb with panel cover and accessories). They use less travel space and are approx 20% lighter than the TEKTRONIX 453A and 454A, the world's most widely used portables.

Although light weight, small and rugged, the 465 and 475 contain a big, bright, high-resolution CRT. Even in adverse ambient light conditions low rep-rate pulses are easily viewed. With 8 cm vertically and 10 cm horizontally the CRT display covers ½ of the entire front panel. Though the front panel is all 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.

PORTABLE OSCILLOSCOPES

NEW 475 200-MHz Dual-Trace Oscilloscope NEW 465 100-MHz Dual-Trace Oscilloscope



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, 0°C to $+40\,^{\circ}\mathrm{C}$

465—DC to at least 100 MHz, 3.5 ns or less. 50 MHz cascaded at approx 1 mV/div.

475—DC to at least 200 MHz, 1.75 ns or less. 50 MHz cascaded at approx 400 μ V/div.

 $^\star \text{Measured}$ at $-3 \, \text{dB}$ down. Bandwidth may be limited to approximately 20 MHz by bandwidth limit switch.

Lower -3 dB point, AC coupling from $50-\Omega$ source

	X1 Probe	10 Hz or less
465/475	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 MHz or less
AC Coupled	500 V (DC + Peak AC)
	500 V P-P AC at 1 kHz or less

Signal Output—CH 1 vertical signal is DC to at least 50 MHz -3 dB and approx 25 mV/div when terminated in 50 Ω , and approx 50 mV/div terminated into 1 megohm.

Delay Line—Permits viewing leading edge of displayed waveform.

Probe Power (for 475 only)—Connectors provide correct voltages for two optional P6021 FET Probes.

HORIZONTAL DEFLECTION

465

Time Base A— $0.05\,\mu s/div$ 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— $0.05 \,\mu\text{s}/\text{div}$ 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— $0.01 \,\mu\text{s}/\text{div}$ to $0.5 \,\text{s}/\text{div}$ 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 (465/475)

	+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 Trig gerable 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 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.

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.



465 NEW





TRIGGERING A and B

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

		4	65	4	75
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
ьс	External	50 mV	150 mV	50 mV	250 mV
	External ÷ 10	500 mV	1.5 V	500 mV	2.5 V
AC		Requiremen	ts increase b	elow 60 Hz	
AC	LF Reject	Requirements increase below 50 kHz			
AC	HF Reject	Requiremen 50 kHz	ts increase b	elow 60 Hz a	nd above

465 Jitter-0.5 ns or less at 100 MHz and 5 ns/div. (X10 Mag on)

475 Jitter-0.2 ns or less at 200 MHz and 1 ns/div. (X10 Mag

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 external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is approx 50 mV/div (0.5 V/div with Ext \div 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 \div 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

External Inputs—R and C approx $1 M\Omega$ 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 at least 1 MHz. Phase difference between amplifiers is 1° or ess from DC to 1 MHz.

CRT

TEKTRONIX CRT-5 inch rectangular tube; 8 x 10 cm display area. Horizontal and vertical centerlines further marked in 0.2cm 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 usable frequency range.

Graticule-Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder-Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: -15°C to +55°C. Storage: -55° C to $+75^{\circ}$ 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 axis, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock-Operating and nonoperating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12

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

Frequency	Approx 1 kHz	
Output Current	30 mA	2% +20° to +30°C
Output Voltage	0.3 Volts	0°C to +40°C

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 $\pm 10\%$. 48 to 440 Hz, 75 watts (465) or 100 watts (475) maximum at 115 V and 60 Hz. Battery and external DC power capability to power the 465 and 475 is available. Contact your TEKTRONIX Field Engineer or Representative for further information.

PORTABLE OSCILLOSCOPES

NEW 475 200-MHz Dual-Trace Oscilloscope NEW 465 100-MHz Dual-Trace Oscilloscope



6.2	in	15.7 cm
12.9	in	32.8 cm
18.1	in	46.0 cm
20.3	in	51.6 cm
22.8	lb	10.3 kg
25.3	lb	11.5 kg
≈32.7	lb	≈14.8 kg
≈48.0	lb	\approx 21.8 kg
	12.9 18.1 20.3 22.8 25.3 ≈32.7	6.2 in 12.9 in 18.1 in 20.3 in 22.8 lb 25.3 lb ≈32.7 lb ≈48.0 lb

465

Included Accessories—Two 6 ft. P6065 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).

475

Included Accessories—Two 6 ft. P6075 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).

ORDERING INFORMATION

465 OSCILLOSCOPE	tinev ala coprot batellist. Dravis al co	\$1725
475 OSCILLOSCOPE		\$2500

EMI ENVIRONMENTALIZED, OPTION 4

Includes the features of the standard 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.

Order 465	OPTION 4	OSCILLOSCOPE		\$1800
Order 475	OPTION 4	OSCILLOSCOPE	********	\$2575

TV SYNC SEPARATOR, OPTION 5 (465 ONLY)

Option 5 adds a TV sync separator, providing stable sweep trigering 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 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 4 instruction book insert.

Order 465 OPTION 5 OSCILLOSCOPE\$1825

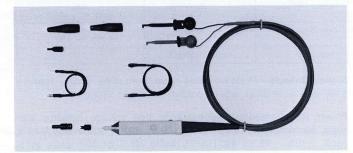
OPTIONAL ACCESSORIES

	OPTIONAL ACCESSORIES	
Probes	O.S. Weighout A.	
P6201	1X FET Probe Package (for 475 only),	
order	010-6201-01	\$375
P6048	10X Probe Package, order 010-0215-00	\$65
C-30A	Compact Camera—f/1.9 lens, magnification variable	from
1:0.8,	Polaroid Land* Pack-Film back for 3000-speed	film,
order (C-30A-P	\$525
Camer	a Adaptor-Adapts C-30A to 465 or 475,	
order	016-0301-00	\$3
Folding	g Polarized Viewing Hood—order 016-0180-00	\$ 9
Mesh	Filter—Improves contrast and EMI filtering,	
order	378-0726-01	\$15
	E-MOBILE® Cart—Occupies less than 18 inches has storage area in base, order 200-1B	

*Registered Trademark Polaroid Corporation

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

NEW P6401 Logic Probe



The TEKTRONIX P6401 Logic Probe is a device to extend and improve your capability to analyze and trouble shoot TTL and DTL circuitry. The P6401 Probe detects and positively identifies logic states or conditions at the point checked. Just touch and see, no control usage is involved. 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 TEKTRONIX probe accessories that extend the usefulness of TEKTRONIX scopes. See Accessory Section for more information.



The 454A offers convenient measurement of fast-rise pulses and high-frequency signals to at least 150 MHz. Risetime is 2.4 ns with or without probe.

Two vertical channels provide sensitivities to 2 mV/div, cascaded single-trace displays at $\approx\!400\,\mu\text{V/div}$ and wide bandwidth X-Y displays to 2 mV/div. The dual-trace vertical system displays either channel separately, adds channels algebraically, alternates between channels, or chops between channels at a 1-MHz rate.

The 454A is mechanically designed to withstand environmental extremes and rough handling in transit. Plug-in transistors provide ease of maintenance.

The R454A (the rackmount model) is electrically identical to the 454A, but is mechanically designed to mount on tilting slide-out tracks in a standard 19-inch rack.

CHARACTERISTIC SUMMARY

VERTICAL (2 Identical Channels)

Bandwidth and Risetime—DC to 150 MHz (2.4 ns) from 10 mV/div to 5 V/div, DC to 100 MHz (3.5 ns) at 5 mV/div, DC to 50 MHz (7.0 ns) at 2 mV/div.

Calibrated Deflection Factor— 10 mV/div to 5 V/div at full bandwidth, 2 mV/div and 5 mV/div at reduced bandwidth.

Input R and C-1 megohm paralleled by approx 15 pF.

HORIZONTAL

Calibrated Time Base 20 ns/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 2 ns/div.

Delay Range-10 ns to 50 s.

Calibrated X-Y Operation— 2 mV/div to 5 V/div in 11 steps, DC to 2 MHz.

CRT

Display Area—8 x 10 division (0.8 cm/div).

Accelerating Voltage- 14 kV.

Phosphor-P31.

OTHER

Amplitude and Time Calibrator— 1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 116 W at 115 VAC.



453A and 454A Dimensions and	Weights	
Height	7.1 in	18.1 cm
Width (with handle)	12.5 in	31.8 cm
Depth (incl. panel cover)	20.5 in	52.1 cm
Depth (handle extended)	22.4 in	56.8 cm
Net weight (w/o panel cover)	29.3 in	13.3 cm
Net weight (with panel cover and accessories)	31.3 in	14.2 cm
Domestic shipping weight	≈43 lb	\approx 19.5 kg
Export-packed weight	≈57 lb	\approx 25.9 kg
R453A and R454A Dimensions a	nd Weights	
Height	7.0 in	17.8 cm
Width	19.0 in	48.3 cm
Depth (behind front panel)	18.0 in	45.7 cm
Net weight	33.5 in	15.2 cm
Domestic shipping weight	≈65 lb	\approx 29.5 kg
Export-packed weight	≈86 lb	pprox39.0 kg

Included Accessories—Two P6054 Probes with accessories (010-6054-01); $50-\Omega$ 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

Order 454A OSCILLOSCOPE	\$3200
Order R454A OSCILLOSCOPE (Rackmount model)	\$3285
Order 454A 431Y (for 400 Hz operation)	\$3300

EMI ENVIRONMENTALIZED OSCILLOSCOPE

Includes the features of the standard 454A and R454A and in addition meets electromagnetic 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.

Orde	454A I	MOD 1	63D O	SCILLOSCOPE			\$3300
Orde	R454A	MOD	163D	OSCILLOSCOPE	(Rackmount	model)	\$3385

PORTABLE OSCILLOSCOPES

453A-Series 60-MHz Dual-Trace Oscilloscopes



Most laboratory measurements are solved by high gain dual trace oscilloscopes. The 453A Series meets or exceeds the requirements of the vast majority of laboratory measurements. Many field problems involve measuring low-frequency signals in high ambient light. The increased light output of the 453A Series makes it particularly suited for these applications.

The 453A Series of oscilloscopes provides the user with performance at a cost compatible with his measurement needs. In addition to the standard 453A, they offer an unusually wide choice of performance in high-frequency oscilloscopes. Each oscilloscope has a different horizontal system allowing the user to select the system which represents the best value.

453A CHARACTERISTIC SUMMARY

VERTICAL (2 Identical Channels)

Bandwidth and Risetime—DC to 60 MHz (5.8 ns) from 20 mV/div to 10 V/div, DC to 50 MHz (7 ns) at 10 mV/div, DC to 40 MHz (8.75 ns) at 5 mV/div.

Calibrated Deflection Factor— 20 mV/div to 10 V/div at full bandwidth, 5 mV/div and 10 mV/div at reduced bandwidth.

Input R and C-1 megohm paralleled by approx 20 pF.

HORIZONTAL

Calibrated Time Base— $0.1 \,\mu\text{s/div}$ to $5 \,\text{s/div}$.

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div.

Calibrated X-Y Operation - 5 mV/div to 10 V/div in 11 steps.

Delay Range— $0.2 \mu s$ to 50 s.

External Input— 270 mV/div or 2.7 V/div dual trace, 5 mV/div to 10 V/div single trace.

CRT

Display Area—8 x 10 divisions (0.8 cm/div)

Accelerating Voltage— 14 kV.

Phosphor-P31

OTHER

Amplitude and Time Calibrator— 1 V or 0.1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 92 W at 115 VAC.

Dimensions and Weights—Same as 454A.

Included Accessories—Two P6061 Probes with accessories (010-6061-01); $50-\Omega$ 18-inch BNC cable (012-0076-00; BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

Included Accessories with 453A-1, 2, 3, or 4—Includes two P6061 Probes with accessories (010-6061-01).



HORIZONTAL DISPLAY MODES	453A	453A-1	453A-2	453A-3	453A-4
NORMAL SWEEP	•	•	•	•	•
UNCAL DLY'D SWP	(alenn	Inci Inci	right S)		
CAL DLY'D SWP	•		•	•	
MIXED SWEEP	•	aHILL COT	י. פל ומ	•	wits Lidm.
5 mV X-Y	•	,yilb'ila		a O.C. ph	

453A-3 HORIZONTAL DEFLECTION

The 453A-3 horizontal deflection system includes all of the characteristics of the 453A horizontal system except X-Y operation, reduced sweep rates for Time Base A and B (to 0.5 s/div and 50 ms/div respectively), and calibrated delay range (to 5 s).

453A-2 HORIZONTAL DEFLECTION

The 453A-2 horizontal deflection system includes all the characteristics of the 453A-3 horizontal system except mixed mode.

453A-1 HORIZONTAL DEFLECTION

The 453A-1 horizontal deflection system includes all the characteristics of the 453A-2 except delay is uncalibrated.

453A-4 HORIZONTAL DEFLECTION

The 453A-4 horizontal deflection system has no delayed sweep. 453A-4 sweep and trigger characteristics are identical to the Time Base A characteristics of the 453A-1, 453A-2 and 453A-3.

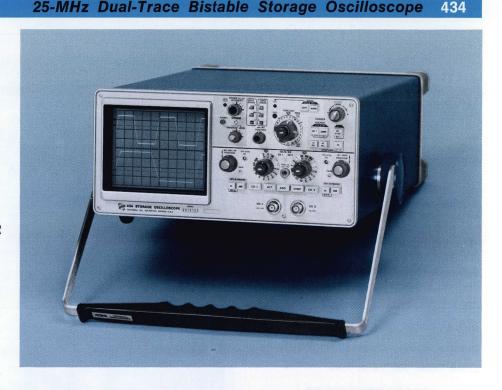
ORD	ERII	NG	INF	ORM	ATION
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453A OSCILLOSCOPE* R453A OSCILLOSCOPE* (Rack Model)	\$2135
453A-1 OSCILLOSCOPE 453A-2 OSCILLOSCOPE	
453A-3 OSCILLOSCOPE	\$1900
453A-4 OSCILLOSCOPE *with normal, calibrated delayed sweep, calibrated sweep and 5 mV X-Y.	

25-MHz Dual-Trace Bistable Storage Oscilloscope



- DEFLECTION FACTORS to 1 mV/DIV
- LIGHTED KNOB SKIRTS for VOLTS/DIV READOUT, AUTOMATICALLY CORRECTS for 10X PROBES
- DIRECT-READING WIDE-RANGE MAGNIFIER
- 203/4 LB
- 5½-INCH RACKMOUNT



The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div and deflection factors to 1 mV/div cover a wide range of laboratory and field applications. Both instruments are small and light. Cabinet height is 53/4 inches including the feet, (rackmount height is 51/4 inches) and weight is 203/4 pounds. Applications include field maintenance areas where conventional AND storage capability are needed. Laboratory and engineering applications areas include electrical, mechanical and civil engineering, medicine, education, acoustics, biology, chemistry, forestry, oceanography and many others. Small size makes it easy to take these instruments to the field as well as carry them from one laboratory to another.

The retention feature of the 434 storage CRT is useful for displaying many kinds of signals, especially single and low repetition rate events. Signals with repetition rates low enough to cause flicker are usually very distracting. Storage displays these signals at a constant light level. With storage, the operator can obtain displays of aperiodic or random events quickly and easily. Once the signal of interest is located and stored, the display can be photographed for high quality, permanent records.

The 434 displays stored events in a view mode for as long as four hours at constant intensity and resolution. This permits the operator to view the event as it's displayed, and study it as long as necessary at his convenience. When interruptions occur he's free to leave the stored display for extended periods without being concerned that the trace might degrade or lose resolution.

Split-screen storage operates in each of three modes: fullscreen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the other half of the CRT.

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

Comparison of changing phenomena is easily made using the TEKTRONIX unique split-screen storage CRT. In measurement of pulse response as a function of temperature, for example, a reference display can be stored on the upper screen area. then compared with subsequent displays stored on the lower screen area. The effect of the temperature change is easily seen. After studying the pulse changes, the user can erase either half of the screen and store a third display under still different conditions. This procedure can be repeated as often as needed. The operator presses one button to erase the upper half of the CRT and a second button to erase the lower half. Pressing both buttons simultaneously erases the full screen.

The writing speed of the bistable storage CRT is variable from 100 div/ms to 400 div/ms on the 434. Option 1 increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation. This allows the user to choose the writing rate best suited for his requirements.

The design of the TEKTRONIX storage CRT makes it highly resistant to burns. It requires only the same operating care as a conventional CRT.

Vertical scale-factor readout is provided by lighted knob skirts which automatically indicate the correct reading, even when using the recommended 10X probes. This feature saves time and reduces errors by freeing the user from having to calculate the scale factor each time a measurement is made with the 10X probes.



434 STORAGE

TEKTRONIX Storage CRT— 5-inch rectangular tube, 8×10 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.

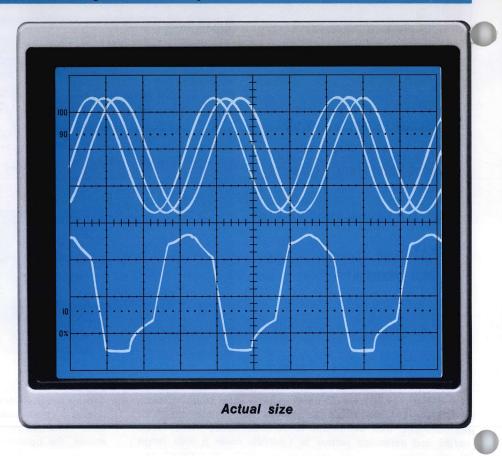
Writing Speed (Center 8 div)—Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 1, 500 div/ms, normal; to 5000 div/ms, enhanced).

Storage Viewing Time-Up to four hours.

Erase Time-300 ms or less.

CHARACTERISTICS

The following characteristics apply to both the 432 Oscilloscope and 434 Storage Oscilloscope, except where noted:



VERTICAL DEFLECTION(2 Identical Channels)

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 3%. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Bandwidth and Risetime—(from $50-\Omega$ terminated source, with or without 10X probe) DC to at least 25 MHz at 3-dB down*, 10 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 $\pm 2\%$ 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— $0.2\,\mu s$ /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 $+20\,^{\circ}\mathrm{C}$ to $+30\,^{\circ}\mathrm{C}$, within 4% unmagnified and 5% magnified from $-15\,^{\circ}\mathrm{C}$ to $+55\,^{\circ}\mathrm{C}$.

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 k Ω .

TRIGGER

COUPLING		TO 5 MHz	AT 25 MHz		
DC INTERNAL EXTERNAL		0.3 div deflection	1 div deflection		
		50 mV	175 mV		
AC		Same as DC at 20 H increase below 20 Hz	z and above, requirements		
AC LF REJECT		Same as AC at 50 kH increase below 50 kHz	lz and above, requirements		
AC HF REJECT		Same as AC at 50 kH increase above 50 kHz	z and below, requirements		

Sources—Channel 1 only, composite, line, external and external \div 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.

432 CRT

TEKTRONIX CRT -- 5-inch rectangular tube, 8 x 10 cm display area. P31 phosphor normally supplied. P7 is optional without extra charge. 4-kV accelerating potential.

Graticule-Internal, parallax-free, nonilluminated.



ENVIRONMENTAL CAPABILITIES

(Oscilloscope and Probe)

Ambient Temperature—Operating, -15°C to +55°C. Storage, -55° C to $+75^{\circ}$ 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 sweeps.

Shock-Operating and non-operating. 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference-With the optional mesh filter (378-0682-00) installed the 432 and 434 meet interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity-Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, 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.

Beam Finder-Compresses display to within graticule area independent of position controls or input signal amplitude, for ease in determining the location of an off-screen signal.

Z Axis-Input DC coupled to CRT, noticeable modulation at normal intensity with 5 volts or more P-P, DC to at least 20 MHz.

Amplitude and Time Calibrator-0.6 V adjustable within 1.0%. Repetition rate is adjustable to 1 kHz within 1.0% (+20°C to +30°C). Output resistance is 575 ohms.

Power Requirements-Operates without range switching on all voltages from 100 V to 240 V, 50 to 400 Hz, 90 VA (55 w) max (432), 120 VA (75 w) max (434). Also operates from 105 VDC to 250 VDC.



	Cabinet		Rackmount	
Dimensions Height Width with handle Depth	in	cm	in	cm
	5.6	14.2	5.3	13.3
	13.0	33.0	19.0	48.3
	18.7	47.5	18.0	45.7
Weight (approx)	Ib	kg	lb	kg
Net weight	20.8	9.4	23.1	10.5
Domestic shipping	30.0	13.6	42.6	19.4
Export-packed	35.0	15.9	62.6	28.4

Included Accessories-Two P6061 3.5-ft probes with accessories (010-6061-01); accessory pouch (016-0165-00).

ORDER INFORMATION

432 OSCILLOSCOPE	\$1585
434 STORAGE OSCILLOSCOPE	\$2150
434 STORAGE OSCILLOSCOPE (Option 1)	\$2175
R432 OSCILLOSCOPE (Rackmount model)	\$1625
R434 STORAGE OSCILLOSCOPE (Rackmount model)	\$2190
R434 STORAGE OSCILLOSCOPE (Rackmount model, Option 1) .	\$2215

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probes supplied with these oscilloscopes satisfy most measurement requirements; optional probes, including high voltage and current probes, may be better suited for particular applications. See the accessory pages of the TEKTRONIX catalog.

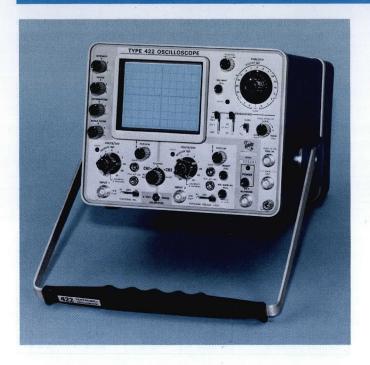
Mesh Filter—Improves contrast and EMI filtering.
Order 378-0682-00
Portable to Rackmount Assembly—Includes hardware for converting standard 432 and 434 to 19-inch rack installation. Order 016-0272-00
Folding Polarized Viewing Hood—Order 016-0180-00 \$9
Clear Plastic CRT Filter—Order 378-0677-00 \$.90
Camera Adapter—Mounts C-30A Series Camera to the 432 & 434 Oscilloscope. Order 016-0301-00

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

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle

space, has storage area in base. Order 200-1B \$120





- 1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC and AC/DC VERSIONS
- DUAL TRACE, FET INPUTS
- DESIGNED for SEVERE ENVIRONMENTS
- UP to 5 HOURS OPERATION from INTERNAL BATTERY PACK (AC/DC VERSION)
- ILLUMINATED PARALLAX-FREE GRATICULE

The 422 is a portable dual-trace oscilloscope that combines small size and light weight with the ability to make precise waveform measurements. It weighs under 22 pounds and is ruggedly constructed to withstand shock, vibration, and other extremes of environment. Solid-state design, using FET input circuitry, provides minimum drift and fast stabilization time. No longer need measurements be compromised due to adverse field conditions; the 422 brings the precision of the laboratory to the field.

Two models are available. One operates on AC; the other on AC or DC, with an optional battery pack providing up to 5 hours operating time for completely portable operation. The AC model is also available as R422, arranged in a rackmount panel assembly with a hinged-door compartment for storing accessories. The hinged door can be removed to allow the installation of a second 422 for applications that require two instruments. The entire assembly is mounted to the rack with slide-out tracks.

VERTICAL DEFLECTION (2 Identical Channels)

Bandwidth—DC to 15 MHz at 3-dB down (each channel); 5 Hz to 5 MHz at 3-dB down, on X10 gain (channel 2). Low-frequency 3-dB-down point is 2 Hz or less with AC coupling (each channel), 0.2 Hz or less with included 10X probe.

Risetime 24 ns each channel; 70 ns at X10 gain (channel 2)

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps, 1-2-5 sequence (each channel). Deflection factor extended to 1 mV/div in X10 position (channel 2). All steps accurate within 3%; 7.5% on X10 GAIN (channel 2). Uncalibrated, continuously variable between steps and to approx 50 V/div. Warning light indicates uncalibrated setting.

Display Modes—Channel 1 only; Channel 2 only; Channels 1 and 2 added algebraically; dual-trace chopped; dual-trace alternate. In chopped mode, successive segments of each channel are displayed at an approx 150-kHz rate. Channel 2 has polarity inversion.

Input R and C—1 megohm $\pm 2\%$ paralleled by approx 33 pF.

Maximum Input Voltage— 300 V (DC plus peak AC), AC not to exceed 300 V P-P at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

HORIZONTAL DEFLECTION

Time Base— $0.5\,\mu s$ /div to $0.5\,s$ /div in 19 calibrated steps (1-2-5 sequence), accurate within 3% over center 8 div. Uncalibrated, continuously variable between steps and to approx $1.25\,s$ /div. Warning light indicates uncalibrated vernier settings.

X10 Magnifier—Operates over full time base, increases fastest rate to 50 ns/div. Accuracy of magnified time base is within 5% over center 8 div.

External Input—Variable between approx 1 V/div to 100 V/div. DC to at least 500 kHz at 3-dB down. Input R 300 k Ω \pm 10% paralleled by approx 35 pF.

Other—Gate output (on front panel) is a negative-going rectangular pulse with same duration as time base; approx 0.5-V; approx 620-ohm output resistance.

TRIGGER

Modes—Automatic or Normal. Automatic operation useful between 20 Hz and 15 MHz, minimizes trigger adjustments for signals of different amplitudes, shapes and repetition rates. With no input (or input less than 20 Hz), the automatic triggering free runs the sweep and provides a bright reference trace at all sweep rates.

Coupling-DC; AC; AC LOW FREQ REJECT.

Sources—Internal: Channels 1 and 2, Channel 1 only. External: Input RC is $100 \text{ k}\Omega \pm 3\%$ paralleled by approx 33 pF. Positive or Negative slope. Trigger level range at least +10 V to -10 V. Maximum input voltage 250 V (DC plus peak AC).

Requirements—DC: 0.2-div deflection or 125 mV ext up to 5 MHz, increasing to 1 div or 0.6 V at 15 MHz. AC: Same as DC above 50 Hz. AC LOW FREQ REJECT: Same as DC above 50 kHz.



ENVIRONMENTAL CAPABILITIES

Ambient Temperature

	AC Model	AC/DC Model	
Operating	—15°C to +55°C	0°C to +40°C*	
Storage	-55°C to +75°C	-40°C to +60°C	

*charging

Vibration—Operating and nonoperating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating. 30 g's, $\frac{1}{2}$ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—With the optional mesh filter installed, the 422 meets interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator— 1-kHz squarewave, negative-going. Provides 0.2 V, internally, $\pm 1.5\%$ ($\pm 20^{\circ}$ C to $\pm 30^{\circ}$ C), and 2 V, $\pm 0.5\%$ ($\pm 20^{\circ}$ C to $\pm 30^{\circ}$ C), at Probe Cal jack on front panel.

Power Options—AC Model: 90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz, 34 watts at 115 VAC.

AC/DC Model: AC mode: 92 to 137 VAC or 184 to 274 VAC, 48 to 440 Hz, 25 W maximum. DC mode: 11.5 to 33 VDC, 23 W maximum. 24-V battery pack (part number 016-0066-02) provides up to 5 hours continuous operation.

TEKTRONIX CRT—Rectangular, 4-inch, with 0.8-cm divisions; 8 x 10-div display area. Illuminated internal graticule. 6-kV accelerating potential. External blanking, DC-coupled +2 V and greater will completely blank trace. P31 phosphor normally supplied; P2, P7, or P11 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

Dimensions and Weights (R422)		
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Depth behind front panel	12.5 in	31.8 cm
Net weight	23.3 lb	10.6 kg
Domestic shipping weight	≈50 lb	\approx 22.7 kg
Export-packed weight	≈73 lb	\approx 33.2 kg
Dimensions and Weights (422)		
Height	6.9 in	17.7 cm
Width with handle	9.4 in	23.8 cm
Depth, handle not extended	15.8 in	40.0 cm
Depth, handle extended	17.8 in	45.3 cm
Weight with accessories	21.3 lb	9.7 kg
Domestic shipping weight	≈30.0 lb	\approx 13.6 kg
Export-packed weight	≈44 lb	≈20.0 kg

ORDER INFORMATION 422 AC POWERED PORTABLE

Included Accessories—Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00); both installed; clear, CRT protector plate (386-0118-00); AC power supply (016-0072-00); power cord, 117 V, 3-conductor right-angle, female with straight male plug (161-0024-03).

422 OSCILLOSCOPE \$1600

422 AC/DC POWERED PORTABLE

Included Accessories—Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00), both installed; clear, CRT protector plate (386-0118-00); AC/DC power supply (016-0073-00); 3-wire AC with female connector and male plug power cord (161-0015-01); 3-wire DC with female connector power cord (161-0016-01).

 422 MOD 125B OSCILLOSCOPE, without Battery Pack
 \$1770

 Battery Pack for 422 MOD 125B

 Order 016-0066-02
 \$100

AC/DC POWER SUPPLY WITHOUT BATTERY PACK Converts the 422 Portable Oscilloscope for DC or (with battery pack) battery operation. Domestic shipping weight is 101/4 lb.

Includes: power cord, 3-wire AC w/female connector and male plug (161-0015-01); power cord, 3-wire DC w/female connector (161-0016-01).

Order 016-0073-00 \$660

R422 AC POWERED RACKMOUNTS

The R422 Oscilloscope (mounted on left side) includes accessories listed for 422 above plus slide-out assembly (351-0100-00); and mounting hardware.

R422 OSCILLOSCOPE \$1675

Oscilloscopes Side By Side, Mod 150B—Two 422's mounted in a rackmount panel include two sets of accessories listed for the 422 above plus slide-out assembly (351-0100-00); and mounting hardware.

R422 MOD 150B OSCILLOSCOPE\$3250

Oscilloscope Without Cabinet, Mod 146B—422 Oscilloscope without cabinet for rackmount conversion includes accessories listed for the 422.

422 MOD 146B OSCILLOSCOPE\$1575

CONVERSION KITS

Rackmount to Portable Conversion Kit—This kit includes the cabinet and necessary hardware to convert existing R422 Oscilloscopes for portable operation. Order 040-0421-00 \$66

- 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 probe.

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.

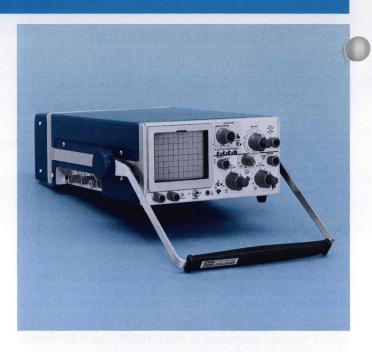
Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 110-kHz rate); Added.

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 μ s/div to 1 s/div in 19 calibrated steps (1-2-5 sequence); accurate within 3% over the center 8 divisions from 1 μ s/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 $0.1 \,\mu\text{s}/\text{div}$. Accuracy of magnified display is within 4% over the center 8 divisions from $0.5 \,\mu\text{s}/\text{div}$ to 20 ms/div, within 5% at $0.1 \,\mu\text{s}/\text{div}$, $0.2 \,\mu\text{s}/\text{div}$, 50 ms/div and $0.1 \,\text{s}/\text{div}$.

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 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your field engineer, representative or distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 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 $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C (without batteries). -40° C to $+60^{\circ}$ C (with batteries). Charging: 0° C to $+40^{\circ}$ 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, $\frac{1}{2}$ 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 $+25^{\circ}$ C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from $+20^{\circ}$ C to $+30^{\circ}$ C, within 2% throughout the operating temperature range. Output resistance approx 10 k Ω . 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 M Ω 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 7.2 V to 32 V, requires up to 12 W.

External AC source: Operates from an external AC source of 90 V to 136 V or 180 V to 272 V. 48 to 440 Hz, 35 W maximum at 115 VAC.

4.0 in	10.2 cm
8.7 in	22.2 cm
15.0 in	38.1 cm
12.2 in	31.0 cm
18.2 in	46.2 cm
15.8 in	40.1 cm
≈13 lb	≈5.9 kg
≈10 lb	\approx 4.5 kg
≈21 lb	≈9.5 kg
≈29 lb	≈13.1 kg
	8.7 in 15.0 in 12.2 in 18.2 in 15.8 in ≈13 lb ≈10 lb ≈21 lb

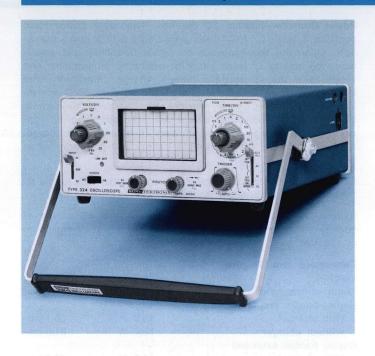
Included Accessories—Two P6049A 10X probes (010-6049-01); carrying case (016-0532-00); strap asembly (346-0098-00); viewing hood (016-0297-00); blue light filter (426-0871-00); external DC cable assembly (012-0406-00).

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 N	iCd cells, order	146-0018-00	\$40
Battery Pack—Includes	146-0018-00 in	battery hous	sing, order
016-0296-00			\$50

324 10-MHz Oscilloscope



- 2 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC, DC or BATTERY POWERED
- COMPACT SIZE—WEIGHT ≈8 lb
- 8-MHz BANDWIDTH at 2 mV/DIV
- DESIGNED for SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE

The 324 is an all solid-state, single-channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 324 features small size and light weight, together with low power consumption. Depth is 10.6 inches, width—8.5 inches, height—4.3 inches, weight—≈8 pounds. Power consumption is only 8.5 watts from an external DC source and 20 watts when powered from the AC line. Internal rechargeable batteries will provide up to 3 hours continuous operation. The portability/performance provided by the 324 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 8 MHz at 3-dB down using X5 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime - 36 ns or less; 45 ns or less using X5 gain.

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 2 mV/div to 4 V/div using X5 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage— 500 V (DC + peak AC).

HORIZONTAL DEFLECTION

Time Base—1 μ s/div to 0.2 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μ s/div to 0.1 s/div; accurate within 4% at 1 μ s/div, 2 μ s/div and 0.2 s/div. Uncalibrated, continuously variable between steps and to approx 0.5 s/div.

X5 Magnifier—Operates over full time base, increases fastest sweep rate to $0.2 \,\mu\text{s}/\text{div}$. Accuracy of magnified display is within 4%, over the center 8 divisions, from 1 $\mu\text{s}/\text{div}$ to 20 ms/div, within 5% at $0.2 \,\mu\text{s}/\text{div}$, $0.4 \,\mu\text{s}/\text{div}$, and 40 ms/div.

External Input—Continuously variable from approx 25 mV/div to approx 2.5 V/div, AC or DC coupled. DC to at least 200 kHz at 3-dB down.



Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements— 0.3-div deflection or 100 mV external to 1.5 MHz, increasing to 1-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 15 kHz with AC LF REJ coupling.

CRT

CRT— 6 x 10-div display area; each div is 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires $+5\,\mathrm{V}$ to $+20\,\mathrm{V}$ (DC coupled), is usable from DC to at least 100 kHz. $150\,\mathrm{V}$ maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4 inch division.



ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: -15°C to +55°C. Non-operating: -55°C to +75°C (without batteries). -40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at $+25^{\circ}$ C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— $0.5\,\text{V}$ at external jack, accurate within 1% from $+20\,^{\circ}\text{C}$ to $+30\,^{\circ}\text{C}$, within 2% throughout the operating temperature range. Output resistance approx 10 k Ω . 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 $10~M\Omega$ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 6 size "C" NiCd cells providing 1 to 3 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of $6.5\ V$ to $16\ V$, requires up to $8.5\ W$.

External AC source: Operates from an external AC source of 115 V $\pm 10\%,$ or 230 V $\pm 10\%.$ 48 to 440 Hz, 20 W maximum at 126 VAC.

Dimensions and Weights—

4.3 in	10.8 cm
8.5 in	21.6 cm
9.3 in	23.5 cm
10.6 in	27.0 cm
	8.5 in 9.3 in

Depth, handle extended	12.8 in	32.4 cm
Net weight without accessories	8 lb	3.6 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈22 lb	\approx 10.0 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00).

The SONY®/TEKTRONIX® 324 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 324 is available from Tektronix,Inc., its marketing subsidiaries and distributors.

PORTABLE TIME DOMAIN REFLECTOMETER

The 324, when packaged with a 1501 Time Domain Reflectometer (TDR), becomes a portable unit used to detect and locate faults and to measure impedance variations in transmission cables out to 10,000 feet through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever transmission or power cable systems are used, whether it be in-plant, or in the field, above or below ground.

The 1501 is especially designed for use with a 324 battery-powered oscilloscope, but other oscilloscopes can be used. The 1501 can be used without an oscilloscope if a strip chart recorder is plugged into a center compartment in the 1501. Each strip chart is four centimeters wide by 32.5 centimeters long to allow permanent, inexpensive, high-resolution TDR plots of entire cables, or any particular portion of a cable. Notes may be handwritten on each chart.

The chart recorder in the 1501 can also be driven by the 1401A or 1401A-1 Spectrum Analyzer. Refer to the Spectrum Analyzer section of this catalog for complete specifications and ordering information for the 1501, 1401A, and 1401A-1.

OPTIONAL ACCESSORIES

Power Pack—Extra power pack, in addition to the one supplied with the 324 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0160-02 \$98

Battery Set-Set of 6 NiCd cells, order 146-0012-01 \$23



- 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— $5 \mu s/div$ to 1 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from $5 \mu s/div$ 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 $0.5\,\mu\text{s}/\text{div}$. Accuracy of magnified display is within 4%, over the center 8 divisions, from $2\,\mu\text{s}/\text{div}$ to $20\,\text{ms}/\text{div}$, within 5% at $0.5\,\mu\text{s}/\text{div}$, $1\,\mu\text{s}/\text{div}$, $50\,\text{ms}/\text{div}$, and $0.1\,\text{s}/\text{div}$.

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 $+55^{\circ}$ C. Nonoperating: -55° C to $+75^{\circ}$ C (without batteries). -40° C to $+60^{\circ}$ C (with batteries). Charging: 0° C to $+40^{\circ}$ 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, $\frac{1}{2}$ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of Mil-Std-202C. Method 106B (omit freezing and vibration, and allow a postest drying period at $+25^{\circ}$ C $\pm 5^{\circ}$ C at 20% to 80% relative humidity.

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V at external jack, accurate within 1% from $+20^{\circ}$ C to $+30^{\circ}$ C, within 2% throughout the operating temperature range. Output resistance approx 10 k Ω . 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 $M\Omega$ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: removable power pack contains 6 size "C" NiCd cells providing 3- to 7-hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Front-panel light indicates when internal batteries are low, or when external DC source is low. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: operates from an external DC source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.

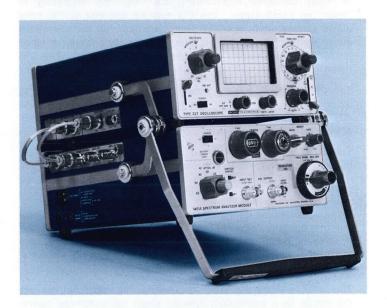
External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 VAC.

Dimensions	and	Weights-	
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Height with accessory pounch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with AC power cord	9.3 in	23.5 cm
Depth with handle not extended	10.6 in	27.0 cm
Depth with handle extended	13.0 in	33.0 cm
Net weight without accessories	7 lb	3.2 kg
Domestic shipping weight	pprox13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00).

Order 323 OSCILLOSCOPE (includes power pack) \$950



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.

OPTIONAL ACCESSORIES

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\$98

Battery Set-Set of 6 NiCd cells, order 146-0012-01 \$23

PORTABLE OSCILLOSCOPES

NEW 211 500-kHz Oscilloscope



- 3 LB, 3 x 51/4 x 9 INCHES
- UP to 5 HOURS OPERATION from INTERNAL BATTERY PACK
- 1 mV/DIV to 50 V/DIV, INTEGRAL 1 MΩ PROBE
- DOUBLE INSULATED
- DESIGNED for SEVERE ENVIRONMENTS

The 211 is optimized for field maintenance and other applications where space and portability are primary considerations. Though small, it's complete. The 211 is the first laboratory-quality miniscope. It offers performance plus unmatched portability and carrying convenience at a lower price than many other 500-kHz scopes.

In many industrial applications, it's frequently necessary to "float" an oscilloscope. The 211 may be elevated to 700 volts above ground when operated from batteries, and 250 volts RMS above ground from AC. Caution should be observed when connecting the oscilloscope probe to the test point. The 211 meets or exceeds IEC standards for class II instruments.

The 211 is easy to use. Deflection factors from 1 millivolt to 50 volts/division, and sweep rates from 5 microseconds to 200 milliseconds/div are read out directly from the front panel, where they are related easily to the CRT display.

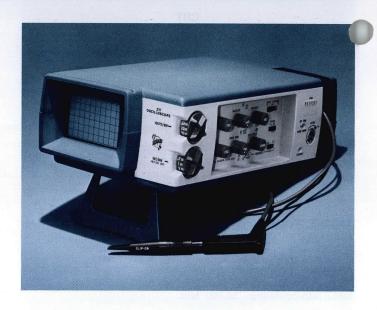
Trigger controls are simplified to one rotary control. A bright baseline is provided at all sweep rates, even with no signal in. When a signal is received, the oscilloscope triggers on the signal.

Some applications do require an adjustable trigger level. Turning the control clockwise causes the scope to trigger on the positive slope of the triggering waveform. Rotating the control further clockwise causes the scope to trigger on the negative slope of the triggering waveform.

The 211 is equipped with an integral flip stand which tilts the scope to a convenient viewing angle for bench-top operation. The integral probe and power cord wrap around a recessed area in the case. They are out of the way, and the user knows exactly where they'll be when he reaches the next job.

An oscilloscope used in maintenance applications should be ready to travel when needed. This means that it has to be easy to service, to eliminate the purchase of back-up scopes. The 211 disassembles quickly and easily into its modular components for access to internal components.

The 211 covers an extremely wide range of applications including industrial controls, mobile electronic facilities, audio communications, telephone and military applications, office equipment, logic probing, numerical control equipment, electronic scales, motor controls, interoffice and interplant communications, avionics, marine electronics, frequency translator maintenance and others.



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 and to at least 150 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 1.6 Hz.

Input R and C—Approx 1 M Ω paralleled by approx 130 pF via permanently 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 AC, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 x line + (DC + peak AC) not to exceed 350 V.

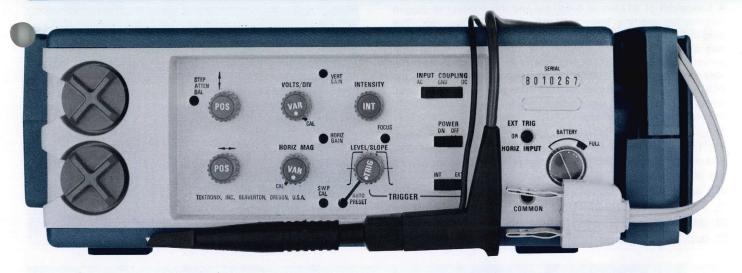
Maximum Input Voltage (probe tip to common)— 600 V (DC + peak AC), 600 V peak-to-peak AC, (5 MHz or less) from 50 V/div to 0.1 V/div; 600 V (DC + peak AC), AC not over 2 kHz from 50 mV/div to 1 mV/div.

HORIZONTAL DEFLECTION

Time Base— $5 \mu s/div$ to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate within 5% over center 8 divisions.

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable magnification extends the maximum sweep rate to at least 1 μ s/div.

External Horizontal Input— 1 and 10 V/div within 10%; DC to 75 kHz. Approx 0.5 M Ω paralleled by approx 30 pF. Maximum input voltage, 200 V (DC + peak AC), 200 V P-P AC, referenced to probe common.



TRIGGER

Modes-Internal, triggers on signals of at least 0.2 division from two hertz to 500 kilohertz. External, triggers on signals of 1 volt to 20 volts from DC to 500 kilohertz. Sweep free-runs in absence of trigger signal or for trigger-repetition rates below seven hertz in the auto preset mode. Normal mode of triggering is obtained when level slope knob is rotated out of the auto preset position. Maximum usable external input voltage, 20 volts (DC + peak AC), 20 V P-P AC, referenced to probe common.

CRT

CRT-6 x 10-div display area; each div is approx 0.2 inch. CRT uses low-power cathode, providing a useful display approx one second after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. 1-kV accelerating potential.

Graticule-Internal, black, nonilluminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating, -15°C to +55°C. Charging, 0°C to +40°C. Storage, -40°C to +60°C.

Altitude-Operating: 25,000 feet; maximum ambient temperature rating is 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 1-minute cycles.

Shock-Operating and nonoperating: 150 g's, ½ sine, 2-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.

OTHER CHARACTERISTICS

Power Sources-Internal DC source contains 10 size "AA" NiCd cells provide up to 5 hours operation. Operating time depends on trace intensity, operating temperature and temperature during previous battery charge. Maximum operating time is achieved at $+20^{\circ}$ C to $+30^{\circ}$ C charge and operating temperature. Internal charger provides for charging the batteries when connected to the AC line with the instrument turned off. A battery meter indicates full charge at 15 volts and discharged at 10 volts. DC operation is automatically interrupted when battery charge drops to 10 volts to protect batteries against deep discharge. Full recharge requires approximately 16 hours. Extended time charges won't damage the batteries.

External AC source, 110 to 126 V, 58 to 62 Hz, 2 W maximum at 126 VAC. Can be operated between 104 and 110 volts with resulting slow discharge of internal batteries. Power options are shown below.

Dimensions and Weights

Height	3.0	in	7.6 cm
Width	5.3	in	13.3 cm
Depth	8.9	in	22.6 cm
Net weight without accessories	3.0	lb	1.4 kg
Domestic shipping weight	≈7.5	lb	\approx 3.4 kg
Export-packed weight	≈12.0	lb	\approx 5.4 kg

Included Accessories-Viewing hood (016-0199-00); carrying case (016-0512-00).

Order 211 OSCILLOSCOPE, includes batteries

POWER OPTIONS

Option	1	for	220	to	250 V,	50 Hz,	includes	batteries	 \$545
Option	2	for	90	to	110 V,	50 Hz	includes	batteries	 \$545
Option	3	for	110	to	126 V,	400 Hz,	includes	batteries	 \$545

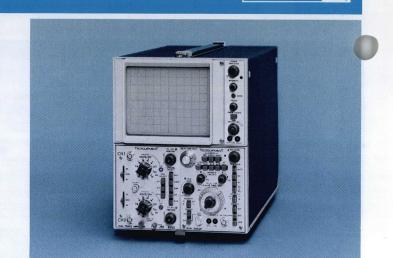
TELEQUIPMENT OSCILLOSCOPES

NEW D83 50-MHz Dual-Trace Oscilloscope

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, order TLD83 Oscilloscope	\$800
V2, Dual-Trace Amplifier, order TLV2	\$295
V3, Differential Amplifier, order TLV3	\$295
그걸 때문 내가 그리에 가르겠다.	\$400



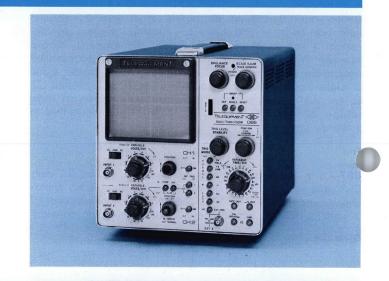
TELEQUIPMENT <

NEW D66 25-MHz Dual-Trace Oscilloscope

The D66 provides 25 MHz bandwidth at 10 mV/cm. X10 gain expands the sensitivity to $1 \, \text{mV/cm}$ at $15 \, \text{MHz}$ bandwidth. Sweep rates extend from 2 sec/cm to $100 \, \text{ns/cm}$ (to $20 \, \text{ns/cm}$ 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, order TLD66 Oscilloscope\$795



NEW DM64 Dual-Trace Bistable Storage Oscilloscope

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.

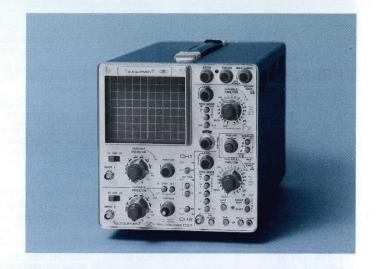
The bandwidth of the DM64 is 10 MHz with a deflection factor of 10 mV/cm, using the X10 gain will extend the sensitivity to 1 mV/cm. Sweep rates extend from 100 ns/div to 2 sec/div. A full complement of vertical display modes is included: channel 1, channel 2 (normal and inverted), chopped (approx 150 kHz rate), alternate and added.

DM64, order TLDM64 Oscilloscope\$1095



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. And there are many more advantages to this truly remarkable oscilloscope.

D67, order TLD67 Oscilloscope \$975

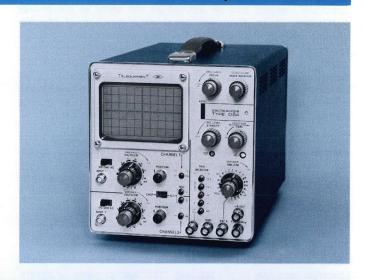


10-MHz Oscilloscopes 54 Series

Represents a new standard of performance for low-priced oscilloscopes. Features include: • 10-MHz bandwidth • 10-mV sensitivity • sweep rates from 200 ns/cm to 2 s/cm • FET inputs • bright trace • all solid-state design. Other features such as variable controls, probe calibration outputs, illuminated graticule and television field or line triggering make the instrument easy to use and versatile.

The 54 Series is available in three different configurations. The D54 is a dual-trace version and the S54A is the single-race configuration. AC, DC or battery power is available in the single-trace S54U; batteries are included. The D54 and S54A may be ordered also in a rackmount configuration.

D54, order TLD54 Oscilloscope	 	 	 	 	\$595
D54R, order TLD54R Oscilloscope	 	 	 	 	\$640
S54A, order TLS54A Oscilloscope	 	 	 	 	\$450
S54AR, order TLS54AR Oscilloscope	 	 	 	 	\$495
S54II order TLS54II Oscilloscope					\$715



6-MHz Dual-Beam Oscilloscope D51 3-MHz Oscilloscope S51B

This low-cost product line includes a dual-beam and a single-beam oscilloscope. The D51 has a 6-MHz bandwidth on Ch 1 and 3-MHz on Ch 2. The S51B is a 3-MHz bandwidth oscilloscope. Sweep rates extend from 1 $\mu s/\text{div}$ to 100 ms/div and each has a X2 magnifier. An $8\times10\,\text{cm}$ (S51) or a $6\times10\,\text{cm}$ (D51) viewing area allows for quick measurement evaluation. Other TELEQUIPMENT features are part of this low-priced oscilloscope line.

D51, order TLD51 Oscilloscope	\$375
S51B, order TLS51B Oscilloscope	\$245

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

The products on these two pages are manufactured and marketed in the United Kingdom by Telequipment, London, England. Outside the United Kingdom they are available from Tektronix, nc., its marketing subsidiaries and distributors. Warranty, sales and service are the same as for other TEKTRONIX products.

For complete information on these and other TELEQUIP-MENT products just check and return the reply card at the back of this catalog.



SPECTRUM ANALYZER

Reference



INSTRUMENT	CHARACTERISTICS									
	CENTER FREQUENCY	FREQUENCY SPAN (DISPERSION)	RESOLUTION BW	INCIDENTAL FM						
7L12	100 kHz to 1.8 GHz	500 Hz to 100 MHz/div and 180 MHz/div (1.8 GHz full screen)	300 Hz to 3 MHz	200 Hz phase locked						
1L5 3L5	50 Hz to 1 MHz	10 Hz to 100 kHz/div (100 Hz to 1 MHz full scale).	≤10 Hz to ≥500 Hz	\leq 3 Hz from 50 to 9900 Hz \leq 10 kHz from 9.9 to 990 kHz						
1L20	10 MHz to 4.2 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale— CF ≥275 MHz).	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock						
491	10 MHz to 40 GHz			57, arder 74.06% Osciffoscope						
491 MOD 139L	10 MHz to 2.0 GHz	1 kHz/div to 10 MHz/div (10 kHz to 100 MHz full scale—	1 kHz to 100 kHz	<300 Hz at fundamental, with phase lock						
491 MOD 139M	1.5 GHz to 40 GHz	CF ≥275 MHz).								
1401A (50 Ω) 1401A-1 (75 Ω)	1 MHz to 500 MHz	100 kHz/div to 50 MHz/div (0 Hz to 500 MHz full span).	3 kHz, 100 kHz, 1 MHz	\leq 20 kHz at 1 MHz, \leq 10 kHz at 500 MHz center frequency						

Spectrum analysis can be defined as the study of the energy distribution of an electrical signal as a function of the frequencies within that signal. The information gained through spectrum analysis is frequently unobtainable by any other means. As a result, Spectrum Analyzers have developed into measurement tools which accurately provide information in an increasingly wide range of applications. Today, engineers and technicians are putting the spectrum analyzer into use in production, maintenance, in the laboratory, and in the field.

TEKTRONIX analyzers are nonreal time instruments using swept intermediate frequency or swept front end techniques. A swept front end spectrum analyzer is a heterodyning device in which the first local oscillator is swept. A swept intermediate frequency spectrum analyzer is a heterodyning device in which a local oscillator other than the first is swept.

PLUG-IN SPECTRUM ANALYZERS

Users of TEKTRONIX oscilloscopes can achieve high-quality spectrum analysis at a cost less than that of other analyzers. In addition to cost, convenience is another significant advantage which oscilloscopes with plug-in analyzers offer over ordinary spectrum analyzers. The oscilloscope or spectrum analyzer calibrated time base and versatile triggering allow direct measurement of pulse repetition rate and provide stable displays even in the presence of interference. The oscilloscope powers the analyzer and displays the spectrum on its CRT.

PORTABLE SPECTRUM ANALYZERS

There are two portable spectrum analyzers available:

The 1401A which combines with the 323 Portable Oscilloscope to make up a 15-lb, battery-operated system and the 491, a 38-lb, wide-range system.

The 491 is a compact, lightweight, self-contained, wideband spectrum analyzer designed for rugged environmental conditions and easy mobility. The display and analyzer circuitry is conveniently packaged in an easy-to-carry (38 lb) configuration. For very broadband analysis (up to 40 GHz), constant usage, rackmounting (7-inch height), or portable applications, the 491 is an ideal instrument.

Two modified 491 analyzers are available for applications which do not require the full 10 MHz-to-40 GHz center frequency range. The 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz and the 491 MOD 139M has a center frequency range of 1.5 GHz to 12.4 GHz (to 40 GHz with optional accessories).

The 1401A Spectrum Analyzer Module can be used with any oscilloscope that has X-axis inputs to make measurements in the range of 1 MHz to 500 MHz. Since it is AC, DC, or battery powered and small . . . it mates very well with the 323 battery operated oscilloscope to make a complete voltage-versus-tim oscilloscope as well as a spectrum analysis system, unexcelled in portability.



The 7L12 Spectrum Analyzer Plug-in, being examined here by TEKTRONIX design engineers, provides excellent performance and value.



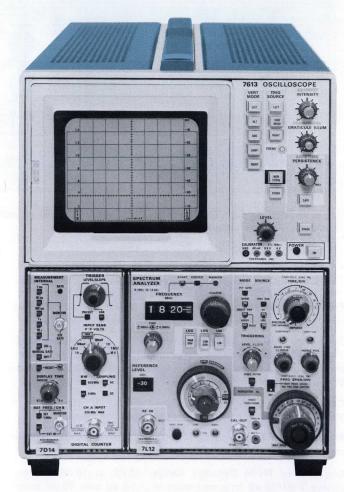
CONVERTS ANY 7000-SERIES OSCILLOSCOPE TO AN EXCELLENT SPECTRUM ANALYZER

- 0 Hz to 1800 MHz IN ONE DISPLAY
- FULLY CALIBRATED DISPLAYS
- 300 Hz to 3 MHz RESOLUTION
- 4:1 RESOLUTION BANDWIDTH SHAPE FACTOR
- 70 db dynamic range
- INTERMODULATION DISTORTION 70 db below full screen
- SPURIOUS FREE OPERATION
- AUTOMATIC PHASE LOCK
- —115 dBm SENSITIVITY

The 7L12 is a swept front-end spectrum analyzer plug-in for all 7000-Series Oscilloscopes. These run from the rackmounts that are only 5¼ inches high, to 500 MHz real-time bandwidth units. The multiple plug-in concept of the 7000 Series allows simultaneous time and frequency domain displays. 7000-Series mainframes with CRT READOUT will display Reference Level, dB/div, Frequency Span, Resolution and Time/div on screen. All display parameters are calibrated and quantitative information is displayed on both front panel and CRT READOUT. CRT READOUT of display parameters is a unique 7L12 feature.

Excellent resolution shape factor (4 to 1) enables the 7L12 user to measure low-amplitude signals close to full screen signals. The wide, 3 MHz resolution position of the 7L12 enhances narrow pulse spectrum analysis and demodulated waveform measurements.

Much effort has gone into human engineering factors designed make the 7L12 easier to use and to reduce the chance of man error. A case in point is the three frequency indication modes from which the operator can choose. In the maximum

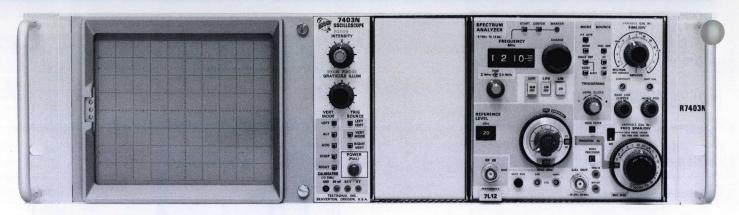


The 7L12 is shown inserted in a 7613, a mainframe featuring variable persistence. Variable persistence provides selection of just the right viewing time for Spectrum Analyzer displays. Also shown is 7D14 Digital Counter for precise frequency measurements, ratio determination and totalizing.

span mode, the frequency dial indication corresponds to the CRT position of a negative-going marker while the analyzer displays the maximum frequency span of 1800 MHz. When the frequency span is reduced, the operator has a choice of two frequency indicating modes, START or CENTER. The former, particularly useful for harmonic and distortion analysis, sweeps with the indicated frequency corresponding to the extreme left hand edge of the display. In the center mode, which is primarily of interest for symmetrical modulation spectra, the center of the display corresponds to the frequency indicated.

Another human engineering innovation is the RF input and reference level self-computing differential mechanism. This mechanism provides direct readout of the full-screen reference level, RF attenuation, and maximum input power for linear operation. Values are presented in dBm on the front panel. The 7000-Series Oscilloscope mainframes with CRT READOUT will also display the full screen reference level value in dBm on the CRT. Further operational ease is provided by color-keyed sections on the front panel.





51/4-inch rackmount R7403N with 7L12 installed. One of many Spectrum Analyzer configurations possible with the 7L12 and 7000-Series mainframes.

CHARACTERISTICS

Frequency Operating Range—100 kHz to 1.8 GHz continuously variable; accuracy \pm (10 MHz + 1% of dial indication).

Frequency Span—Calibrated 500 Hz/div to 100 MHz/div within 5% in 1-2-5 sequence. 0 Hz (analyzer, not swept) and maximum span (1.8 GHz) modes are also selectable. Span is continuously variable between steps.

Calibrator— 50 MHz $\pm 0.01\%$ —30 dBm ± 0.3 dB. Harmonics of 50 MHz are generated for frequency span calibration.

Reference Level—Selectable $-100~\mathrm{dBm}$ to $+30~\mathrm{dBm}$ in 10 dBm steps. Continuously variable between steps.

Log Display Mode Dynamic Range—70 dB at 10 dB/div, accuracy 1 dB/10 dB to a maximum of ± 1.5 dB over 70 dB range and 14 dB at 2 dB/div, accuracy 0.4 dB/2 dB for a maximum of 1.0 dB over the 14 dB range.

RF Attenuation—0 dB to 60 dB in 10 dB steps \pm (0.2 dB or 1% of dB reading, whichever is greater).

Resolution Bandwidth (6 dB down)— 300 Hz to 3 MHz in decade steps $\pm 20\%$; shape factor—4:1, 60 dB to 6 dB.

Video Filter Bandwidth—Automatically selected by the resolution control.

CW Sensitivity— -115 dBm at 300 Hz Resolution; -108 dBm at 3 kHz Resolution; -100 dBm at 30 kHz Resolution; -90 dBm at 300 kHz Resolution; -80 dBm at 3 MHz Resolution.

Internal Spurious Responses—Less than -100 dBm, referred to first mixer.

Incidental FM—Phase locked mode: 200 Hz (P-P) maximum; not phase locked: 20 kHz (P-P) maximum.

Display Flatness— \pm 1.5 dB over any selected span with respect to level at 50 MHz.

Maximum Safe Input Power—RF Attenuation 0 dB: +13 dBm. (—30 dBm linear operating limit) RF Attenuation 60 dB: +30 dBm (Power rating of attenuator).

Sweep Rate—1 μ s/div to 10 ms/div in 1-2-5 sequence continuously variable between steps. Variable control has 100:1 range in 10 ms/div position to decrease sweep rate to approximately 1 s/div.

Triggering Modes-Normal, Peak-to-Peak Auto, Single Sweep.

Triggering Sources—Vertical amplifier channels line frequency and free run.

DIMENSIONS	in	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.0	12.7	NET	10	4.5
WIDTH	5.5	14.0	DOMESTIC SHIPPING	13	5.9
LENGTH	14.5	36.9	EXPORT-PACKED	18	8.2

Note about phosphors and graticules—7000-Series mainframes, except storage versions, are normally shipped with P31 phosphor. Slow swept displays sometimes are more easily viewed with P7 phosphor (an option with most mainframes). Check mainframe specification before ordering. External spectrum analyzer graticules for 7000-Series mainframes come with the 7L12 (see included accessories). See mainframe specification for availability of CRT option with internal Spectrum Analyzer graticules.

Included Accessories—6-ft BNC cable (012-0113-00); adapter BNC male to N female (103-0058-00); special spectrum analyzer graticules (implosion shields 337-1439-01 for 7403N or R7403N, 337-1159-02 for other 7000 Series); Amber light filter (378-0684-01.

Order 7L12 SPECTRUM ANALYZER \$4850

Optional Accessories

DC Block for applying signals riding on a DC potential mum potential is 50 V DC. Order 015-0221-00	
75 Ω to 50 Ω minimum loss attenuator with DC block. Order 011-0112-00	\$25.00
50 Ω to 75 Ω minimum loss attenuator, DC coupled. Order 011-0057-00	\$13.25
$75~\Omega$ to $50~\Omega$ attenuator with direct 11.25 dB insertion lomits display to be conveniently converted to dBmV. Order 011-0118-00	platas



- GATED MODE for PULSED R.F. and TELEVISION 75-OHM INPUT (1401A-1)
- 50-OHM INPUT (1401A)
- AC, DC or BATTERY POWERED
- UP to 500 MHz in ONE DISPLAY
- FREQUENCY and AMPLITUDE CALIBRATOR
- 60-dB LOG DYNAMIC RANGE
- INTERMODULATION DISTORTION MORE THAN 60-db DOWN
- FLAT WITHIN 1.5 dB OVER 200 MHz



1401A Spectrum Analyzer Module

The 1401A and 1401A-1 Spectrum Analyzer Modules are an expansion of the plug-in concept of using an oscilloscope for spectrum analysis. These modules, used with the SONY/TEKTRONIX 323, 324, or other oscilloscopes, provide measurement facilities in the 1 MHz to 500 MHz frequency range. The 1401A is designed for 50 Ω systems, the 1401A-1 is for e with 75- Ω systems. Statements about the 1401A apply also the 1401A-1 unless indicated.

The 1401A and 1401A-1 are compatible with any oscilloscope having 0.5 V/div horizontal deflection factor (adjustable \pm 10%) and 1.2 V full-screen vertical deflection.

One of the unique features of the 1401A is automatic center frequency positioning in the search mode. At 50 MHz/div frequency span (dispersion), the center frequency automatically becomes 250 MHz, preventing a possible erroneous display. In the search mode, the center frequency control positions a negative marker to indicate that part of the spectrum which will appear at center screen when the frequency span is reduced to less than 50 MHz/div.

Design of the 1401A/323 provides for easy carrying and convenient viewing and access. Power may be obtained from the normal AC line, 6 to 16 VDC, or internal rechargeable batteries.

ANALYZER CHARACTERISTICS

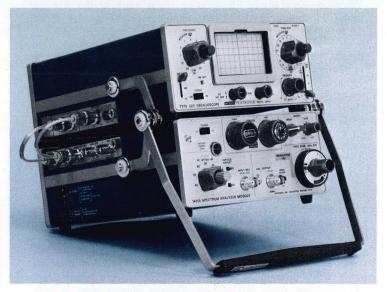
Center Frequency—Continuously selectable with 10-turn digital frequency readout control over the range of 1 to 500 MHz. Absolute accuracy within \pm (5 MHz +5% of dial reading). Fine control provides a calibrated variation of up to plus or minus 1 MHz, within 10%.

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 splay, plus 0 Hz span. Frequency span can be continuously aried (uncalibrated) from any calibrated value toward zero.

Resolution Bandwidth-3, 100, and 1000 kHz.

Display Flatness-Amplitude variations are within 1.5 dB to



1401A/323 Spectrum Analyzer System

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 $+20^{\circ}$ C to $+30^{\circ}$ C ambient. Temperature coefficient = 0.5 MHz/°C or less.

RF Attenuator—0 to 60 dB in 10 dB steps (accurate within \pm 0.2 dB \pm 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 $+5\,\mathrm{V}$. 0 V corresponds to approximately 0 frequency and $+5\,\mathrm{V}$ corresponds to approximately 500 MHz in Search Mode. 10 V maximum input.

CALIBRATOR

Frequency- 50 MHz within 0.01%.

Amplitude of the Fundamental—1401A, $-30 \, \mathrm{dBm}$; 1401A-1, $+25 \, \mathrm{dBmV}$. Accuracy, within 0.3 dB at 25°C and within 0.5 dB from $-15^{\circ}\mathrm{C}$ to $+55^{\circ}\mathrm{C}$.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: -15° C to $+55^{\circ}$ C; Nonoperating: -55° C to $+75^{\circ}$ C (without batteries), -40° C to $+60^{\circ}$ C (with batteries); Charging: 0° C to $+40^{\circ}$ C.

Altitude—Operating: 30,000 feet; maximum ambient temperature rating must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet; Nonoperating: 50,000 feet.



Vibration-Operating: 15 minutes along each of the 3 major axes, 0.025-inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Electromagnetic Interference-Meets radiated interference requirements of MIL-1-6181D and MIL-1-16910C over the range 150 kHz to 1 GHz. Instrument must be battery operated.

Humidity-Operating and Storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

OTHER CHARACTERISTICS

Power Sources-Battery operation: removable power pack contains 6 size "C" NiCd cells providing at least 3-1/2 hours 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 at 115 VAC.

推发 		1401A 1401A-1		3 4	1401A/323 1401A/324		
	in	cm	in	cm	in	cm	
Height	3-1/2	8.9	3-1/2	8.9	7	17.8	
Width w/handle	8-1/2	21.6	8-1/2	21.6	9-3/8	23.8	
Depth w/panel cover	10-5/8	27.0	10-5/8	27.0	10-5/8	27.0	
Depth w/handle	13	33.0	13	33.0	14-4/8	37.2	
	lb	kg	lb	kg	lb	kg	
Net weight w/o accessories	7-1/2	3.4	≈ 8	≈ 3.6	≈15	≈ 6.8	
Domestic shipping weight	13	5.9	≈14	≈ 6	≈23	≈10.4	
Export-packed weight	21	9.5	≈22	≈10	≈31	≈14.0	

SPECTRUM ANALYZER MODULE

1401A Included Accessories -- 8-ft power cable assembly (161-0043-02); panel cover (200-0812-00); blue filter (378-0670-01); amber filter (378-0670-02); three $5\frac{1}{2}$ -inch, $50-\Omega$ BNC to BNC cable assemblies (012-0214-00); 6-ft 50- Ω BNC to BNC cable assembly (012-0113-00); screwdriver (003-0672-00); strap assembly (346-0051-00); operator's handbook (1401A); instruction manual (1401A).

Order 1401A \$2400

SPECTRUM ANALYZER MODULE

1401A-1 Included Accessories—Same as for 1401A except: Insert for instruction manual; two BNC to F adapters (013-0126-00); change 6-ft, 50-- Ω BNC to BNC cable assembly to 6-ft 75- Ω BNC to BNC cable assembly (012-0113-01).

Order 1401A-1 \$2450

SPECTRUM ANALYZER SYSTEM

1401A/323 (P7 Phosphor) Included Accessories—Includes a cessories for both the 1401A, 323 and a two-instrument handle conversion kit (040-0563-00).

Order	1401A/323P7	\$3350

SPECTRUM ANALYZER SYSTEM

1401A/324 (P7 Phosphor) Included Accessories-Includes accessories for both the 1401A, 324 and a two-instrument handle conversion kit (040-0563-00).

Order	1401A/324P7	\$3625
	1401A-1/324P7	

CHARACTERISTIC	323	324	
Bandwidth	DC to 4 MHz	DC to 10 MHz	
Risetime	90 ns	36 ns	
Deflection Factor	10 mV/div to 20 V/div 1 mV/div at 2.75 MHz	at full bandwidth 2 mV/div at 8 MHz	
Input R and C	1 megohm paralleled	by approx 47 pF	
Time Base	5 μs/div to 1 s/div	1 μs/div to 0.2 s/div	
Magnifier	X10	X5	
CRT Display Area	6 x 10 divisions (1/4-inch divisions)		
Phosphor	P7 supplied when ord	ered with 1401A or 1401A-	
Amplitude Calibrator	Internal, 0.5 V at exte	rnal jack	
Power Sources	Internal batteries	Internal batteries	
	External 6 to 16 VDC	External 6.5 to 16 VDC	
	90 to 136 VAC	115 VAC ±10%	
	180 to 272 VAC	230 VAC ±10%	
	48 to 440 Hz	48 to 440 Hz	
A RELIGIOUS DIRECTOR	14 W at 115 VAC	20 W at 126 VAC	
Price with batteries	\$950	\$1225	

The SONY/TEKTRONIX 323 and 324 are manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan, they are available from Tektronix, Inc., its marketing subsidiaries and distributors. tributors

OPTIONAL ACCESSORIES

Protective Cover-Waterproof blue vinyl, Order 016-0112-00 \$10

Handle Conversion Kit (for two instruments)-For combining an existing 323 or 324 Oscilloscope with 1401A or 1401A-1, for

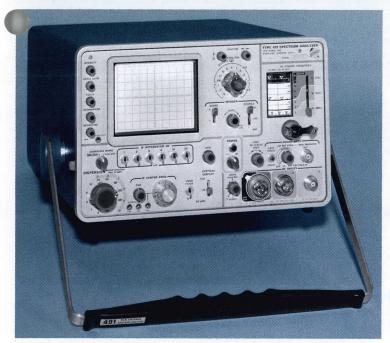
Handle Conversion Kit (for three instruments)-For combining an existing 323 or 324/1401A or 1401A-1 and 1501 TDR. Order 040-0596-00 \$50

Power Pack-Extra power pack, in addition to the one supplied with the 1401A or 1401A-1, allows one power pack to charge while the other is powering the analyzer. An identical power

pack is used in the 323.	
Order 016-0119-02 \$	98
Adapter—BNC 75 Ω to 50 Ω minimum loss attenuator.	

Order 011-0112-00\$25 Battery Set-Set of 6 NiCd cells, Order 146-0012-01 \$23





The Type 491 is a precision, wide-band spectrum analyzer designed for rugged environmental conditions and easy mobility. It is an easy-to-carry package weighing less than 40 unds complete with accessories. The Type R491 is electrical-identical, requires only 7 inches of rack height.

Operation is simple. Resolution and calibrated dispersion controls are coupled, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Since dispersion is calibrated, frequency differences can be read directly from the CRT. Internal phase lock provides stable displays even at 1 kHz/div dispersion.

Two modified instruments are available for applications which do not require the full center frequency range (10 MHz to 40 GHz) of the Type 491. These are the 491 MOD 139L (10 MHz to 2000 MHz) and the 491 MOD 139M (1.5 GHz to 40 GHz). Specifications for the MOD 139L and MOD 139M are the same as for the 491 except where noted.

Each instrument is completely self-contained, has oscilloscopetype 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.

CHARACTERISTICS

DIAL ACCURACY

 \pm (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION

1 kHz/div to 10 MHz/div in 1-2-5 sequence, 2 ranges (kHz/div —MHz/div). Accuracy throughout full range of RF-center

- COMPACT, LIGHT WEIGHT
- INTERNAL PHASE LOCK
- CALIBRATED DISPERSION TO 100 MHz
- COUPLED RESOLUTION
- WIDE-RANGE TIME BASE
- LOW POWER CONSUMPTION
- ENVIRONMENTALIZED

BAND	FREQUENCY RANGE	MINIMUM CW 1-kHz	100-kHz
		RESOLUTION	RESOLUTION
1	10 MHz to 275 MHz	\geq $-100~\mathrm{dBm}$	≥ —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	≥ —60 dBm
197	40 GHZ	≥ —70 dBm to 40 GHz	\geq $-50~\mathrm{dBm}$

*Signal + noise = 2 X noise

Bands 1-8 are covered in the Type 491.

Bands 1-3 only are available in 491 MOD 139L.

Bands 4-8 only are available in 491 MOD 139M, bands 4-6 directly, bands 7-8 using optional accessories.

frequency control, within $\pm 3\%$ except at $2\,\text{MHz/div}$ ($\pm 5\%$) and $1\,\text{MHz/div}$ ($\pm 7\%$). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within $\pm 3\%$. Zero dispersion useful for PRF measurements.

COUPLED RESOLUTION

1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

SPECTRUM ANALYZER

491 10 MHz-to-40 GHz Portable



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 50Ω 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)

 $Log - \ge 40$ -dB dynamic range.

Linear

Square Law $- \ge 13$ -dB dynamic range.

HORIZONTAL DEFLECTION

INTERNAL SAWTOOTH GENERATOR

 $10~\mu s/div$ to 0.5 s/div in 15 calibrated steps (1-2-5 sequence). Uncalibrated continuously variable between steps and to approx 1.25 s/div.

TRIGGER SOURCE

Internal, external, or line. 100-V maximum external input (DC + peak AC).

TRIGGER REQUIREMENTS

0.2-div deflection or 0.2-V external from 20 Hz to 100 kHz.

CRT AND DISPLAY FEATURES

TEKTRONIX CRT

 8×10 -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

0

ELECTROMAGNETIC INTERFERENCE

Meets specifications of MIL-I-6181D over the following frequency ranges: Radiated (with included CRT mesh filter installed) —150 kHz to 1 GHz; conducted (power line) —150 kHz to 25 MHz.

TEMPERATURE

Operating: -15° C to $+55^{\circ}$ C. Non-operating: -55° C to $+75^{\circ}$ C.

ALTITUDE

Operating: 15,000 feet. Non-operating: 50,000 feet.

HUMIDITY

Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (Paragraph 4.5.9 through 4.5.9.5.1, Class 4).

VIBRATION

Operating: 15 minutes along each of the three axes, 0.025 inch peak to peak displacement (4 g's at 55 c/s) 10 to 55 to 10 c/s in 1-minute cycles.

SHOCK

Operating and non-operating: 30 g's, $\frac{1}{2}$ sine, 11-ms duration, 1 shock per axis.

OTHER CHARACTERISTICS

POWER REQUIREMENTS

90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz; 55 watts maximum. Rear panel selector provides rapid accommodation for six line-voltage ranges.

REAR PANEL CONNECTORS

BNC connectors for external trigger input, sawtooth output (70 to 90 mV P to P) and recorder output (\geq 4 mV/div of displayed signal in LIN mode, DC-coupled, approx 600- Ω source resistance).

CABINET MODEL DIMENSIONS AND WEIGHTS

Height	$7^{3}/_{16}$ in	18.2 cm
Width	$12\frac{7}{16}$ in	31.6 cm
Depth (incl. panel cover)	$19^{11}/_{16}$ in	50.0 cm
Depth (with handle extended)	$21\frac{9}{16}$ in	54.7 cm
Net weight (w/o panel cover)	30 lb	13.6 kg
Weight (with panel cover and accessories)	38 lb	17.3 kg
Domestic shipping weight	≈50 lb	\approx 22.7 kg
Export-packed weight	≈62 lb	\approx 28.2 kg

RACK MODEL DIMENSIONS AND WEIGHTS

THE MICEL BIME TOTAL	1101110	
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	$17\frac{1}{2}$ in	44.4 cm
Net weight	41 lb	18.6 k
Domestic shipping weight	≈72 lb	≈32.7 kg



CLUDED STANDARD ACCESSORIES

ft BNC cable, 50Ω miniature coax (012-0113-00); 6 ft N cable, RG 223/U coax (012-0114-00); 2 ft TNC cable, RG 223/U coax (012-0115-00); wave guide mixer, 12.4 to 18 GHz (119-0097-00); wave guide mixer, 18 to 26.5 GHz (119-0098-00); wave guide mixer, 26.5 to 40 GHz (119-0099-00); 10-dB attenuator, Type N fittings (011-0085-00); 20-dB attenuator, Type N fittings (011-0086-00); 40-dB attenuator, Type N fittings (011-0087-00); two BNC male to N female adapters (103-0058-00); two BNC female to N male adapters (103-0045-00); wave guide mixer adapter (119-0104-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); clear CRT protector plate (386-0118-00); ornamental ring (354-0248-00); two one-ampere fuses (159-0022-00); $\frac{1}{2}$ -ampere fuse (159-0025-00); front cover (200-0633-03); instruction manual (070-0598-01). Type R491 includes all above accessories except the front cover and protective cover, also includes slide-out assembly and hardware.

TYPE 491 SPECTRUM ANALYZER	\$4895
TYPE R491 SPECTRUM ANALYZER	\$4995

TYPE 491 MOD 139L

The Type 491 MOD 139L has a center frequency range of 10 MHz to 2000 MHz. The chart on the first page defines the Frequency Range and Minimum CW Sensitivity (S + N = 2N) the MOD 139L. The appearance is the same as that of the Type 491 with the following exceptions: the C-band input is removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139L ONLY)

6-ft BNC cable, $50-\Omega$ miniature coax (012-0113-00); 6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); 1/2-ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00).

The R491 MOD 139L also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

TYPE 491 MOD 139L	\$3500
TYPE R491 MOD 139L	\$3600

TYPE 491 MOD 139M

The Type 491 MOD 139M has a center frequency range of $1.5\,\mathrm{GHz}$ to 40 GHz with optional accessories. The chart on the first page defines the Frequency Range and Minimum CW Senivity (S + N = 2N). The appearance is the same as that of Type 491 with the following exceptions: the A and B band inputs are removed and the center frequency range dial is changed to reflect the reduction in the number of frequency bands.

INCLUDED STANDARD ACCESSORIES (491 MOD 139M ONLY)

6-ft N cable, RG 223/U coax (012-0114-00); power cord (161-0024-03); protective cover (016-0074-01); blue light filter (378-0558-00); amber light filter (378-0559-00); two 1-ampere fuses (159-0022-00); $\frac{1}{2}$ -ampere fuse (159-0025-00); front cover (200-0633-03); ornamental ring (354-0248-00); clear CRT protector plate (386-0118-00).

The R491 MOD 139M also includes slide-out assembly (351-0101-00) and hardware (016-0096-00). The front cover and protective cover are deleted.

TYPE 491 MOD 139M	 \$3700
TYPE R491 MOD 139M	\$3800

OPTIONAL ACCESSORIES FOR THE 491 MOD 139M

NOTE: These accessories are required to extend the frequency range of the MOD 139M from 12.4 GHz to 40 GHz.

Cable, TNC, coaxial, 2 feet (012-0115-00)	\$ 10.00
Waveguide mixer adapter (119-0104-00)	
Waveguide mixer 12.4-18.0 GHz (119-0097-00)	\$ 77.00
Waveguide mixer 18.0-26.5 GHz (119-0098-00)	\$ 88.00
Waveguide mixer 26.5-40.0 GHz (119-0099-00)	\$138.00

OPTIONAL ACCESSORIES FOR THE 491 MOD 139L AND 491 MOD 139M

BNC male to N female adapter (103-0058-00)	\$ 275
BNC female to N male adapter (103-0045-00)	
10-dB attenuator, Type N fittings (011-0085-00)	
20-dB attenuator, Type N fittings (011-0086-00)	\$45.00
40-dB attenuator, Type N fittings (011-0087-00)	\$55.00

CONVERSION KITS

PORTABLE TO RACK-MODEL

RACK MODEL TO PORTABLE

Kit includes cabinet, panel cover, oscilloscope cover, and instructions to convert Type R491 Analyzers for portable operation.

Order 040-0445-00\$85





ACCESSORY STORAGE

Included panel cover for Type 491 and drawer for Type R491 hold all standard accessories except manual and protective cover.





- CALIBRATED VERTICAL DEFLECTION
- CALIBRATED DISPERSION
- 10 Hz to 1 MHz IN ONE DISPLAY
- TIME-BASED OR FREQUENCY-BASED DISPLAYS
- RECORDER OUTPUT

The Type 1L5 and 3L5 operate over a center-frequency range of 50 Hz to 1 MHz, and provide accurate spectral and time-based displays from 10 Hz to 1 MHz. Calibrated volts/cm and Hz/cm controls make the Type 1L5 and 3L5 as easy to use as the oscilloscope in which each is operated. The 1L5 operates in the Type 530, 540, 550, or (with adapter) 580-Series Oscilloscopes. The Type 3L5 operates in the Type 561B or 564B (and the earlier 561A and 564) Oscilloscopes in combination with a Type 2B67, 3B3, 3B4, or 3B5 Time-Base Unit.*

Resolution bandwidth extends from 10 Hz to 500 Hz. Highresolution spectral displays can be viewed in their entirety (even at the very slow sweep rates required for maximum resolution) with the Type 549 or 564B Storage Oscilloscope. Stored displays can also be compared with subsequent displays, and can be easily photographed for permanent record.

Applications include vibration studies, waveform analysis, and noise measurements. Others are listed in the reference section.

SPECTRAL DISPLAYS

CENTER FREQUENCY RANGE

50-Hz to 990-kHz, calibrated in 10-Hz, 100-Hz, 1-kHz and 10-kHz steps. Continuously variable to at least 1 MHz.

*IMPORTANT: Time Base Units with serial numbers under those listed require a simple modification to provide a sweep signal to the Analyzer. Type 2B67: 15180, Type 3B3: 4270, Type 3B4: 740. Modification Kit part number 040-0413-00.



CENTER FREQUENCY	ACCURACY
50 Hz to 990 Hz	±(5% + 50 Hz + 50 Hz/°C chang
1000 Hz to 9900 Hz	\pm (5% + 100 Hz + 100 Hz/°C change)
10 kHz to 99 kHz	\pm (5% + 3 kHz + 200 Hz/°C change)
100 kHz to 990 kHz	±(5% + 10 kHz + 200 Hz/°C change)

STABILITY

50 Hz to 9900 Hz - 100 Hz/hour or less with stable ambient temperature ($\pm 1\,^{\circ}$ C).

DEFLECTION FACTOR

10 μ V/cm to 2 V/cm, calibrated in RMS volt/cm (1-2-5 sequence). Accurate within 3% from 1 mV/cm to 2 V/cm, within 6% from 10 μ V/cm to 500 μ V/cm (\div 100 pulled), for linear displays at maximum resolution. The uncalibrated variable control is continuous between steps (\approx 3:1).

CALIBRATED DISPERSION

10 Hz/cm to 100 kHz/cm in 9 steps. Accuracy at center frequencies of:

a) 50 Hz to 9900 Hz $-\le\pm10\%$ (20°C to 30°C) $-\le\pm20\%$ (0°C to 50°C)

b) 10 kHz to 990 kHz — \leq 15% (0°C to 50°C) Linearity is within 3%.

COUPLED RESOLUTION

 \leq 10 Hz to \geq 500 Hz (20°C to 30°C), coupled with the dispersion control but separately switchable.

DISPLAY FLATNESS

Amplitude variations are within 0.5 dB from 10 Hz to 1 MHz at most deflection factors; except within +0.5 dB, -3 dB at 1 mV/cm and 2 mV/cm (or 10 μ V/cm and 20 μ V/cm with \div 100 pulled).

NOISE

 \leq 5 μ V RMS.

DYNAMIC RANGE

≥60 dB in LOG (uncalibrated) mode.



SPECTRUM ANALYZER 50 Hz-to-1 MHz Plug-ins 1L5 and 3L5

NTERMODULATION DISTORTION AND SPURIOUS GNALS

(1L5) \geq 50 dB below the 6-cm signal level. (3L5) \geq 50 dB below the 8-cm signal level.

RECORDER OUTPUT

5 to 15 mV for 6-cm linear display, into $600-\Omega$.

LOCAL OSCILLATOR OUTPUT

Must sweep ≥ 1 MHz from ≈ 3 MHz to ≈ 2 MHz; > 1 V P-P. 1L5 SWEEP MODES

Manual, internal and external. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 549 Storage Oscilloscope and Type 556 Dual-Beam Oscilloscope provides an internally-coupled sweep to the Analyzer: external input is used with other oscilloscopes.

3L5 SWEEP MODES

Manual and internal. Accuracy of frequency measurements can be increased using manual scan and monitoring the local oscillator output with a frequency counter. Type 561B and 564B Oscilloscopes with time base unit provide an internallycoupled sweep to the Analyzer.

TIME-BASED DISPLAYS

BANDWIDTH

10 Hz to 1 MHz at most deflection factors; 10 Hz to 700 kHz at 0.1 V/cm and 0.2 V/cm (or 1 mV/cm and 2 mV/cm with ÷100 switch pulled).

DEFLECTION FACTOR

1 mV/cm to 100 V/cm in calibrated P-to-P steps (1-2-5 sequence), accurate within 3% (within 6% from 2 V/cm to 100 V/cm). Uncalibrated control provides continuous variation between steps, reduces gain by a factor of approx 3.

1 megohm paralleled by approx 30 pF. 300 V DC + peak AC maximum input voltage.

OTHER CHARACTERISTICS

1L5 WEIGHTS		
Net weight	8 lb	3.6 kg
Domestic shipping weight	≈13 lb	≈9.0 kg
Export-packed weight	\approx 21 lb	\approx 5.8 kg
3L5 WEIGHTS		
Net weight	6 lb	2.7 kg
Domestic shipping weight	\approx 13 lb	\approx 5.8 kg
Export-packed weight	≈17 lb	\approx 7.7 kg

INCLUDED STANDARD ACCESSORIES

1X probe (010-0193-00), banana-to-banana cable (012-0031-00), BNC-to-banana cable (012-0091-00), plug (134-0052-00), plug protector (134-0076-00).

TYPE	1L5	SPECTRUM	ANALYZER	UNIT	 \$1300
TYPE	3L5	SPECTRUM	ANALYZER	UNIT	 \$1400

OPTIONAL ACCESSORIES

P6007	100X	Probe	Package,	order	010-0150-00	 \$35
P6012	10X	Probe	Package,	order	010-0203-00	 \$40
$600-\Omega$	Term	nination	(BNC), o	rder 0	11-0092-00	 \$18

50 Hz-to-1 MHz Swept Frequency Source



SLAVED SPECTRUM ANALYZER-SWEPT FREQUENCY DISPLAYS

- 50-Hz to 1-MHz CENTER FREQUENCY
- 1-MHz DISPERSION CAPABILITY

The Swept Frequency Converter is an accessory unit to the Type 1L5 or Type 3L5 Spectrum Analyzer Plug-In Units. It accepts the local oscillator output from the analyzer and converts it to a signal source slaved to the center frequency and dispersion setting of the analyzer.

The result is a signal source with center frequency range of Hz to 1 MHz, single frequency (analyzer in MANUAL SWEEP node) or swept frequency with dispersion capability of 1 MHz max to 100 Hz min. It provides for variable amplitude control and regulation for constant output within 0.5 dB. Sweep rate is controlled by the horizontal time base.

CHARACTERISTICS

OUTPUT FREQUENCY-50 Hz to 1 MHz, selectable within the center frequency range of the Spectrum Analyzer.

OUTPUT VOLTAGE—4 V P-P to 8 V P-P max behind 600 Ω .

OUTPUT FREQUENCY FLATNESS—within 0.5 dB into 600 Ω .

OSCILLATOR INPUT VOLTAGE (from Spectrum Analyzer) 0.8 V P-P to 2 V P-P.

OUTPUT REGULATION

FAST—effective in preserving amplitude flatness when lowest frequency component is not less than 10 kHz and sweep rate is 10 ms/div or faster.

SLOW—used when frequency is less than 10 kHz and for sweep rates slower than 10 ms/div.

OUTPUT AMPLITUDE RECOVERY (output regulator FAST to SLOW)—10 s or less to recover to same amplitude as FAST.

OUTPUT RESISTANCE—600 Ω within 15%.

POWER REQUIREMENTS-90 VAC to 272 VAC, 50 to 400 Hz. INCLUDED STANDARD ACCESSORIES

600-Ω termination (011-0092-00); two BNC cables (012-0075-00); BNC-to-dual banana adapter (103-0090-00).

SWEPT FREQUENCY CONVERTER, order 015-0107-00 . . \$330 $600-\Omega$ STEP ATTENUATOR

A 0 to 51 dB switch attenuator for use with the Type 1L5 or 3L5. The input resistance is 600Ω (within 2%). The attenuation error is within 0.05 dB/dB. Power rating is 1/8 W max. Bandwidth is DC to 1 MHz, order 011-0093-00 \$83



- INTERNAL PHASE LOCK
- CALIBRATED DISPERSION TO 100 MHz
- COUPLED RESOLUTION
- AMPLITUDE VARIATIONS WITHIN 3 dB OR LESS
- RECORDER OUTPUT

		MINI CW SEN	
BAND	FREQUENCY RANGE	1-kHz RESOLUTION	100-kHz RESOLUTION
1	10 MHz to 275 MHz	\geq $-100\mathrm{dBm}$	\geq $-80~\mathrm{dBm}$
2	275 MHz to 900 MHz	\geq $-110\mathrm{dBm}$	≥ —90 dBm
3	850 MHz to 2 GHz	\geq $-100\mathrm{dBm}$	\geq $-80~\mathrm{dBm}$
4	1.95 GHz to 3.1 GHz	≥ —95 dBm	≥ —75 dBm
5	3 GHz to 4.2 GHz	≥ —90 dBm	≥ —70 dBm

*Signal + noise = 2X noise

Operating convenience and performance is offered in multi-band plug-in units for all TEKTRONIX 530, 540, 550 or (with adapter) 580-Series Oscilloscopes.



BUILT-IN PHASE LOCK circuit synchronizes the analyzer local oscillator with a stable reference frequency (internal 1 MHz or external 1 to 5 MHz). When the local oscillatis locked in phase to the reference frequency, the local oscillator stability approaches that of the reference frequency. This allows very narrow dispersion at high frequencies where the analyzer would normally be limited by oscillator drift, microphonics, and other perturbations. Phase lock can be used to view any signal within the tuning range of the analyzer.

CALIBRATED DISPERSION from 1 kHz/cm to 10 MHz/cm makes frequency measurement as easy and accurate as time measurement. Frequency differences can be read directly from the CRT.

COUPLED RESOLUTION from 1 kHz to 100 kHz greatly simplifies operation, providing narrow resolution bandwidth at narrow dispersion and wide resolution bandwidth at wide dispersion. Dispersion and resolution controls can be uncoupled and operated separately if desired, for optimized viewing of a particular signal.



DIAL ACCURACY

 \pm (2 MHz + 1% of dial reading).

CALIBRATED DISPERSION

1 kHz/cm to 10 MHz/cm in 1-2-5 sequence, 2 ranges (kHz/cm—MHz/cm). Accuracy of 10-cm display, throughout full range of IF center frequency control, within $\pm 3\%$ except at 2 MHz/cm ($\pm 5\%$) and 1 MHz/cm ($\pm 7\%$). Accuracy can be increased using internal 1-MHz crystal markers for calibration. Dispersion linearity within $\pm 3\%$. Zero dispersion useful for PRF measurements.

BANDWIDTH RESOLUTION

1 kHz to 100 kHz, coupled with calibrated dispersion positions but separately switchable.

DISPLAY FLATNESS

Amplitude variations are within 3 dB over the full 100-MHz dispersion range (or less) except: over 50 MHz in Band 1.

INCIDENTAL FM (LO + IF)

300 Hz or less at LO fundamental when phase locked.

PHASE LOCK

Internal 1-MHz reference. External input accepts 1-MHz to 5-MHz signals from 1 V to 5 V peak to peak.

NPUT IMPEDANCE

Approx 50Ω .

MAXIMUM INPUT POWER

 $-30 \, \mathrm{dBm}$ for linear operation, $+15 \, \mathrm{dBm}$ (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

 $\pm 25\text{-MHz}$ range from 5 MHz/cm to 0.2 MHz/cm, $\pm 10\,\text{MHz}$ at 10 MHz/cm. $\pm 2.5\text{-MHz}$ range in all kHz/cm positions. FINE control has $\pm 1\text{-MHz}$ and $\pm 50\text{-kHz}$ range in MHz/cm and kHz/cm modes respectively.

VERTICAL DISPLAY (6 cm)

Log—≥40-dB dynamic range.

Linear

Square Law—>13-dB total dynamic range.

Video— \leq 16 Hz to \geq 10 MHz, approx 50- Ω input resistance.

RECORDER OUTPUT

12 mV to 20 mV with 6-cm linear display.

EIGHTS

LICITIS		
Net weight	71/2 lb	3.4 kg
Domestic shipping weight	≈14 lb	\approx 6.4 kg
Export-packed weight	≈20 lb	≈9.1 kg

INCLUDED STANDARD ACCESSORIES

Patch cord, BNC to banana (012-0091-00); plug protector (134-0076-00); tini-plug (134-0052-00).

1L20 SPECTRUM ANALYZER UNIT \$2550

OPTIONAL ACCESSORIES

50-Ω ATTENUATORS



Attenuators are all supplied with Type N fittings. See accessory section for adapters for other series. Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300-W peak. Impedance is 50 Ω .

10-dB	attenuator,	order	011-0085-00		\$45	
20-dB	attenuator,	order	011-0086-00	ar Hillan	\$45	
40-dB	attenuator.	order	011-0087-00	E	\$55	



DESCRIPTION	PART NUMBER	PRICE
$50-\Omega$ feedthrough termination	011-0049-01	\$10.00
50-Ω 10X attenuator	011-0059-01	16.50
50-Ω 5X attenuator	011-0060-01	16.50
50-Ω 2X attenuator	011-0069-01	16.50
50-Ω 2.5X attenuator	011-0076-01	16.50
50- Ω feedthrough termination		
(5 watt)*	011-0099-00	18.50

CHARACTERISTICS (for $50-\Omega$ termination and attenuators above).

Accuracy of Indicated Attenuation Ratio is $\pm 2\%$ at DC; $\pm 3\%$ at 500 MHz. Power Rating is 2 watts.

Voltage Standing Wave Ratio (VSWR) is less than 1.1 up to 250 MHz. *VSWR less than 1.1 up to 100 MHz.

SEMICONDUCTOR CURVE TRACERS

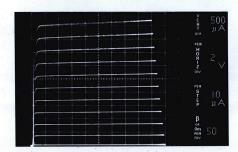
Reference



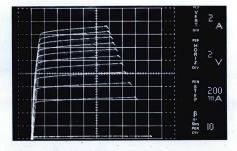
Curve tracers are capable of displaying one or more characteristic curves of two- and three-terminal devices and ICs. Each curve is developed by driving one terminal with a constant voltage or current and then sweeping the other with a half sinewave of voltage. If more than one curve is to be drawn, the driving source is stepped through several values and the sweep repeated, once for each step. The horizontal deflection is then a plot of either the driving voltage or the sweep voltage across the device under test, while the vertical deflection is a plot of the current drawn from the sweep source.

The reasons for measuring the characteristics of semiconductor devices are varied. Typical measurements are for tl purpose of producing better components, sorting components, predicting performance in a circuit, or simply checking to see if the device meets specs. The characteristics of semiconductor devices that are of practical importance to their use in an electrical circuit can usually be measured with a curve tracer. Many of these measurements also provide analytical information for improving component design or maintaining production quality and specifications.

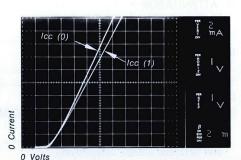
PRODUCT	PAGE	MEASUREMENT CAPABILITIES	PRICE
576	177	Displays characteristics of diodes, FETs, SCRs, power transistors, transistors, tunnel diodes, zeners and integrated circuits (with an IC adapter). Optional CRT readout of scale factors, β /div, g_m /div.	\$2300 2800
172	179	A programmable test fixture for the 576. Programs up to eleven measurements for faster measurements with few errors in applications such as device manufacturing, incoming inspection and device evaluation.	1400
176	181	A pulsed high-current fixture for the 576 which extends collector current range to 200 amps peak and base current range to 20 amps peak.	1600
5CT1N	182	A plug-in curve tracer for the TEKTRONIX 5100-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	350
7CT1N	182	A plug-in curve tracer for the TEKTRONIX 7000-Series Oscilloscopes for displaying characteristics of transistors, FETs and diodes.	400
СТ71		A low-cost semiconductor tester which displays characteristic curves of transistors, FETS and diodes manufactured by TELEQUIPMENT, a Tektronix, Inc. subsidiary.	795



This is an NPN transistor family of curves as displayed on a 576. When the positive collector supply polarity was selected, the step generator polarity automatically became positive and the trace start was positioned to the proper point. The display shows a full 10-step family but the number of steps could have been digitally selected between 1 and 10. The parameter readout effectively labels the waveform, giving vertical collector current/div, horizontal collector volts/div, current amplitude per step, and computes Beta/div.



This waveform is a power transistor displayed on the 576. The test is a pulsed high current beta test. The collector voltage is manually swept to obtain entire family of curves. The standard 576 can be used to measure Beta up to 20 A collector current. The 176 extends this range up to 200 A.



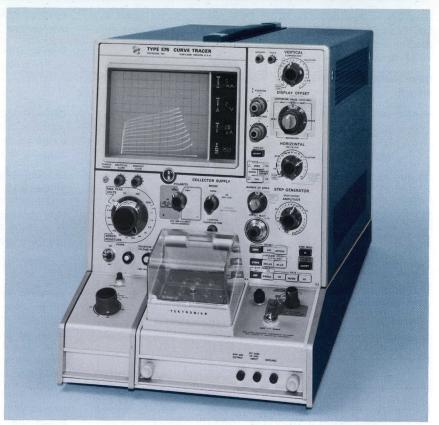
This waveform displays the current as a function of supply voltage of a TTL gate. The two different curves show the current for the logical 1 and logical 0 states of the inputs. Many integrated circuit measurements can be performed by using the Integrated Circuits Adapter and an external power supply.





BIG 6 1/2-INCH CRT

- AUTO SCALE-FACTOR READOUT INCLUDING β/div or g_m/div
- THREE COLLECTOR SUPPLY MODES
- AUTO POSITIONING and POLARITY TRACKING
- PULSED BASE OPERATION
- CALIBRATED DISPLAY OFFSET with MAGNIFIER
- KELVIN SENSING ADAPTERS for HIGH CURRENT TESTS
- PROTECTIVE FEATURES for OPERATOR and DEVICE
- OPTIONAL ACCESSORIES
 PROGRAMMABLE TEST FIXTURE
 HIGH-CURRENT FIXTURE
 INTEGRATED CIRCUITS ADAPTER



The 576 brings meaningful performance to semiconductor esting and establishes a new standard in human engineering features. The measurement requirements for diodes, transistors, and FETs (in all their different forms) established the functions of the 576; innovative circuits and component engineering make those measurements easy, accurate, safe and more understandable.

The most noticeable new feature is AUTO SCALE-FACTOR READOUT. Placed adjacent to the CRT (where you normally focus your attention) are digital indicators of vertical and horizontal deflection factors, step amplitude, and Beta/div or $g_{\rm m}/$ div. Readout offers convenience for test setup and labeled waveform photography. It also offers freedom from the simple but bothersome arithmetic required to compute Beta/div or $g_{\rm m}/{\rm div}$ or to correct for magnifiers or multipliers. The other features, such as multifunction switching, calibrated display offset, and many more, are equally important to semiconductor testing applications.

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 M Ω 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 \pm 100%, \pm 0%; 2 A \pm 50%, \pm 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.

SEMICONDUCTOR CURVE TRACERS 576



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 IN-VERT push button.

Step Family—REPETITIVE or SINGLE FAMILY (manually actuated).

Number of Steps-Digitally selectable between 1 and 10.

VERTICAL and HORIZONTAL AMPLIFIERS

Display Accuracies—As percentage of highest on-screen value.

		OFFSET and MAGNIFIED with CENTERLINE VALUE from			
NORM and DC MODES	NORMAL	100-40 div	35-15 div	10-0 div	
Vert Collector Current	3%	2%	3%	4%	
Horiz Collector Volts	3%	2%	3%	4%	
Horiz Base Volts	3%	2%	3%	4%	
LEAKAGE MODE Vert Emitter Current/div:					
10 nA-2 mA/div	3% ± 1 nA				
1 nA-200 μA/div (magnified)		2% ± 1 nA	3% ± 1 nA	4% ± 1 nA	
5, 2, 1 nA/div	5% ± 1 nA				
Horiz Collector or Base Volts with Emitter Current/div of:					
≥1 <i>μ</i> A	3%	2%	3%	4%	
100, 10, or 1 nA	3% plus 25 mV/vert div	NOT	APPLICA	BLE	
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 $1\,\mu\text{A/div}$ to $2\,\text{A/div}$, 20 steps in 1-2-5 sequence (0.1 $\mu\text{A/div}$ with X10 magnification). Emitter current is $1\,\text{nA/div}$ to $2\,\text{mA/div}$, 20 steps in 1-2-5 sequence. Step generator is $1\,\text{step/div}$.

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:

RANGÉ	15 V	75 V	350 V	1500 V
VERTICAL—COLLECTOR	1 μΑ	1 μΑ	2 μΑ	5 μΑ
VERTICAL—EMITTER	1 nA	1 nA	2 nA	5 nA
HORIZONTAL—BASE	5 mV	5 mV	5 mV	5 mV
HORIZONTAL—COLLECTOR	5 mV	5 mV	20 mV	200 mV

Calibrator (CAL)—DC voltage (accurate within 1.5%) provided to check and adjust vertical and horizontal gain.

Position Controls—Fixed 5-div increments within 0.1 div. Continuous fine control over 5 div or less.

Display Offset— 21 calibrated positioning increments, vertically or horizontally, of 0.5 div or 5 div with X10 MAGNIFIER.

CRT and READOUT

CRT— 6 1/2-inch rectangular with parallax-free, illuminated graticule in centimeters. The calibrated area is 10 cm vertical by 10 cm horizontal (12 cm usable horizontal). P31 phosphor normally supplied; P2 and P7 are optional without extra charge.

Readout—The readouts, adjacent to CRT, are digital indicators of the following parameters: PER VERT DIV from 1 nA/div to 2 A/div; PER HORIZ DIV from 5 mV/div to 200 V/div; PER STEP from 5 nA/step to 2 A/step, 5 mV/step to 2 V/step; β (BETA) or g_m PER DIV from 1 μ to 500 k calculated from CURRENT/DIV, X10 MAG, STEP AMPLITUDE, and 0.1X MULT.

OTHER CHARACTERISTICS

Standard Test Fixture—A plug-in fixture with two sets of 5-pin test terminals, the EMITTER GROUNDED or BASE GROUNDED switch, LEFT-OFF-RIGHT switch, STEP GEN OUTPUT EXT BASE or EMITTER input, and the OPERATOR PROTECTION BOX. The test terminals accept either the 6-pin universal adapters, 3-pin adapters, or the high-power transistor adapters with KELVIN contacts.

Power Requirements—Power Source; operates only with an unbalanced-to-ground power source. For safe operation, the power line neutral (white or "identified" conductor) must be connected to the instrument neutral (unfused), and the power plug safety ground (green conductor) must return to ground through a different path than the power line neutral. Voltage Ranges; the quick-change line-voltage range selector accommodates 90 VAC to 136 VAC or 180 VAC to 272 VAC (six positions), at 48 Hz to 66 Hz line frequency. Max power consumption is 305 W, standby power is approx 60 W.

Ambient Temperature—Performance characteristics are valid over an ambient temperature range of $+10^{\circ}\text{C}$ to $+40^{\circ}\text{C}$.

Dimensions and Weights		
Height	15.0 in	38.1 cm
Width	11.5 in	29.2 cm
Depth	23.0 in	58.2 cm
Net Weight	70.5 lb	32.0 kg
Domestic shipping weight	≈107 lb	≈48.5 kg
Export-packed weight	≈127 lb	≈57.6 kg

INCLUDED ACCESSORIES

TEST ADAPTERS: Shown in accessories section.

Not shown: measurement concepts booklet "Semiconductor Device Measurements" (062-1009-00).

Order 576 CURVE TRACER	\$2800
UIUCI J/U CUNVE INACEN	 92000

INSTRUMENT OPTION

The 576 MOD 301W deletes the parameter readout module, but maintains provision for insertion of the module (020-0031-00) at any time.

Order 576 MOD 301W CURVE TRACER	 \$2300
Order Auto Scale-Factor Readout Module (020-0031-00)	\$525



- PROGRAMS TESTS on FETs, TRANSISTOR and DIODES
- UP to 11 PROGRAM TESTS





The 172 Programmable Test Fixture, when used with the TEKTRONIX 576 Curve Tracer, permits the operator to program up to eleven sequential tests on J FETs, transistors and diodes. This fixture saves measurement time in applications where a series of tests are to be made on a number of devices. To make the same tests without this fixture requires setting the 576 controls for a particular test and inserting the devices one at a time. After the first test is completed, the 576 controls are set for the next test and the devices are inserted, again one at a time. This process is repeated for each test. The programmable fixture performs as many as eleven different tests on each device while the device remains in the test socket.

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 makes tests quickly and accurately since the automatic programming removes human errors.

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 operator comparison of test results and limits. A more experienced operator may determine if the device performs to test limits directly from the CRT.

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.

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.

When testing several different devices, program and limit cards may be made up in advance. Then the operator simply exchanges cards each time a different device is tested.

SEMICONDUCTOR CURVE TRACERS

172 Programmable Test Fixture



CHARACTERISTICS VERTICAL AND HORIZONTAL AMPLIFIERS

Display Accuracies—As a percentage of the highest on-screen value.

		OFFSET and MAGNIFIED with CENTERLINE VALUE from		
NORM DISPLAY MODES	NORMAL (UNMAGNIFIED)	100 - 40 div	35 - 15 div	10 - 0 d iv
Vert Current	3%	2%	3%	4%
Horiz Base Volts	3%	2%	3%	4%
Horiz Volts	3%	2%	3%	4%
LEAKAGE DISPLAY MODE Vert Current				1.
10 nA - 0.5 A/div	3% ±1 nA			
1 nA - 50 mA/div (magnified)		2% ±1 nA	3% ±1 nA	4% ±1 nA
5, 2, & 1 nA/div	5% ±1 nA		CHILD THE STATE	
Horiz Volts (Vert current of 1 μA/div or more)	3%	2%	3%	4%
Horiz Volts with Vert Current of:				
100, 10 or 1 nA/div	3% + 0.025 V/vert div	10407		
200, 20 or 2 nA/div	3% + 0.050 V/vert div	NOT	APPLICA	ABLE
500, 50, 5 nA/div	3% + 0.125 V/vert div			

		THAT C		PROGRAMMABLE
TEST	XSTR	J FETs	DIODES	CAPABILITIES
1*	Н _{сс} ,	V _p †	V _F †	PEAK VOLTS up to 350 V
2	V _{CE} (sat)†			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 Collector Sweep: 2 V to 20 V peak Vert range is 1 μ A/div to 0.5 A/div Horiz range is 0.1 V/div to 2 V/div
4		Same	as #3	2 100 100 100
5	I _{CEO} or external		with resistor	Voltage Supply: 1 V to 500 VDC Vert range is 1 nA/div to 0.5 A/div Horiz range is 0.1 V/div to 50 V/div
6	I _{CBO}	I _{GSS}	no like	Same as #5
7	I _{EBO}	Tamos I	I _R	Same as #5
8	V _{(BR)CEO} V _{(BR)CER} external	or with resistor	eroju s	Current Supply: 100 nA to 110 mA DC Vert range is 1 μA/div to 0.5 A/div Horizontal range is 0.1 V/div to 50 V/div
9	V _{(BR)CES}		33	Same as #8
10	V _{(BR)CBO}	BV _{GSS}		Same as #8
11	V _{(BR)EBO}		V _R	Same as #8

Vertical Deflection Factor—Test 1 and 2 (Collector or Emitter Current): I_c , 1 μ A to 2 A/div in 20 steps. Test 3, 4, and 8, 10, 11 (Collector or Breakdown Current): 1 μ A 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 M Ω at 100 mV/div and 200 mV/div. 1 M Ω (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— $0.1~\mu A$ to 11 mA, accurate within 2% \pm 30 nA with up to 500 V compliance. 10 mA to 110 mA, accurate within 2% \pm 30 nA with up to 50 V compliance. Increments of current are: $0.1~\mu A$ (from $0.1~\mu A$ to $11~\mu A$), $1~\mu A$ (from $10~\mu A$ to $110~\mu A$), $10~\mu A$ (from $100~\mu A$ to 1.1~m A) $100~\mu A$ (from 1~m A) and 1~m A (from 10~m A) to 110~m A).

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 $+10^{\circ}$ C to $+40^{\circ}$ C.

Dimensions and Weights

Height w/cover	6.5 in	16.5 cm
Width	7.8 in	19.7 cm
Depth	12.4 in	31.4 cm
Net weight	11.5 lb	5.2 kg
Shipping weight	≈16 lb	\approx 7.3 kg
Export weight	≈23 lb	\approx 10.4 kg

Included Accessories—One protective cover, five programming cards, 250 programming card pins, five CRT overlay limit cards.

Order 172 PROGRAMMABLE TEST FIXTURE \$1400

Optional Accessories Package—Includes 50 programming card pins, one programming card and one limit card.

Order 016-0518-00\$5

†These are the *usual* tests performed because of the higher current capability and pulse mode operation. However, other tests could be performed as well.

*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.





200 AMP PEAK COLLECTOR DISPLAYS

20 AMP PEAK BASE SUPPLY





The 176 Pulsed High-Current Fixture extends the capabilities of the 576 Curve Tracer by providing pulsed collector operation to 200 amps peak and pulsed base steps to 20 amps peak. The step offset, when selected, is also pulsed. The pulsed operating mode allows many tests previously impossible. For example, small signal transistors can be tested under pulsed collector breakdown conditions without over dissipation. The 176 "front porch" configuration fits in place of the 576 Standard Test Fixture, and is programmed from the 576 mainframe except for controls not provided on the mainframe. The collector pulse is slaved to the 576 in regard to width and repetition rate. The pulse width is selected by depressing the 300 μs or 80 μs push button on the 576 mainframe (usually, 300 μ s 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 AMPLI-TUDE 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 fiberoptic 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 μ s or 80 μ s determined by 576.

Repetition Rate-Power-line frequency.

Polarity— + or - determined by 576 polarity control.

Amplitude—Ranges are 15, 75, 350 volts nominal, controlled y 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— $300 \mu s$ or $80 \mu s$ 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 \pm 1% of one step or within 3% of one step, whichever is greater.

VERTICAL AMPLIFIER

Deflection Factor (X10 VERT selected)— 1 A/div to 20 A/div, 5 steps in a 1-2-5 sequence.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid over a temperature range of 0°C to +40°C.

Dimensions and Weights

Height	4.6 in	11.8 cm
Width	7.9 in	20.0 cm
Depth	11.4 in	28.9 cm
Net weight	12.8 lb	5.8 kg

INCLUDED ACCESSORIES

Adapter TO-36 (013-0112-00); adapter stud diode (013-0110-00); protective cover (337-1194-00).

Order 176 PULSED HIGH-CURRENT FIXTURE \$1600







- 10 na/DIV TO 20 ma/DIV VERTICAL DEFLECTION FACTORS
- 0.5 V/DIV TO 20 V/DIV HORIZONTAL DEFLECTION FACTORS
- LIGHTED KNOB SKIRTS FOR SCALE FACTOR READOUT
- EASY TO OPERATE

The 7CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 7000-Series Oscilloscope Systems and the 5CT1N Curve Tracer is a plug-in unit for use in TEKTRONIX 5100-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 either vertical compartment of the respective mainframes. Horizontal deflection is achieved through a front panel source which drives the external input of either a vertical or horizontal plug-in unit installed in the mainframe's horizontal compartment. The 7CT1N also operates in the horizontal compartments of the 7000-Series Oscilloscope Systems.

The following discussion and characteristics apply to both units.

A variable collector/drain sweep produces a maximum peak voltage of at least 250 volts; a base/gate step generator produces up to 10 calibrated current or voltage steps. Ranges of step amplitudes are 1 μ A/step to 1 mA/step for current and 1 mV/step to 1 V/step for voltage. Maximum power output is 0.5 watts. In addition, the unit has a vertical display amplifier with deflection factors ranging from 10 nA/div to 20 mA/div and a horizontal display amplifier with deflection factors ranging from 0.5 V/div to 20 V/div.



A front panel button switches the base/gate step generated output from current steps of the same polarity as the collector/drain sweep for checking transistors, to voltage steps of the opposite polarity of the collector/drain sweep for checking FETS in the depletion region. This button also internally switches the test fixture leads so that one test socket can be used to test both transistors and FETs.

The OFFSET control allows the base/gate step generator output to be offset at least 5 steps in the aiding or opposing direction for conveniently checking the enhancement region of FETs.

A \div 1000 button increases the sensitivity of the vertical display amplifier to 10 nA/div allowing leakage current measurements. When the button is pressed, the collector/drain supply is changed from a sweeping output to a DC output for checking leakage currents without looping aberrations.

CHARACTERISTICS COLLECTOR/DRAIN SUPPLY

	X	rı	x	10
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 $\pm 20\%$. Maximum short circuit current, within 30%.



SEMICONDUCTOR CURVE TRACERS Plug-In Curve Tracers 5CT1N and 7CT1N

Series Resistance—Automatically selected with horizontal lts/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 $1\,\mu\text{A/step}$ to $1\,\text{mA/step}$, 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 k Ω \pm 1%.

Accuracy—Incremental; within 3% between steps. Absolute; within \pm (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 and 10.

Offset—Selectable from 0 to 5 steps. Polarity aid(s) or oppose(s) the step polarity.

Vertical Deflection Factors— 10 nA/div to 20 μ A/div with the \div 1000 control activated. 10 μ A/div to 20 mA/div in the χ X1 mode.

Vertical Display Accuracy—Within 5% in the X1 mode. Within 5% \pm 0.2 nA per displayed horizontal volt when in the \div 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 5100-Series plug-ins) with a 50 mV/div deflection factor and would be used in the horizontal compartment of the 5100-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 would be used in the horizontal or vertical compartment of the 7000-Series Oscilloscope mainframe.

OTHER CHARACTERISTICS

Ambient Temperature—Performance characteristics are valid from 0°C to $+50^{\circ}\text{C}$.

	5C	T1N	7C	T1N
Dimensions	<u>in</u>	cm	in	cm
Length	12.0	30.5	14.5	36.8
Width	2.6	6.6	2.8	7.1
Height	5.0	12.7	5.0	12.7
Weight	lb	kg	lb	kg
Net	1.8	0.8	2.5	1.1
Domestic Shipping	≈4	≈2	≈6	≈3
Export Packed	≈9	≈4	≈11	≈5

Included Accessories—Test Fixture (013-0128-00) with two sets of test terminals, one with TO-5 basing and the other with TO-18 basing.

Order	5CT1N	CURVE	TRACER	 \$350
Order	7CT1N	CURVE	TRACER	\$400

OPTIONAL ACCESSORIES

Adapters—For transistors with long leads. Order 013-0069-00\$6.60
For transistors with TO-3 or TO-66 basing. Order 013-0070-01
Diode Test Fixture—Holds axial-lead diodes. Order 013-0072-00 \$6.60
Adapter Box—Allows mounting of additional semiconductor sockets. Order 013-0073-00
Power Transistor Socket—For power transistors with hookleads. Order 013-0074-00
Diode Test Adapter—Production test fixture for rapid handling. Order 013-0079-00 \$29.00

SEMICONDUCTOR CURVE TRACERS

Curve Tracer Accessories

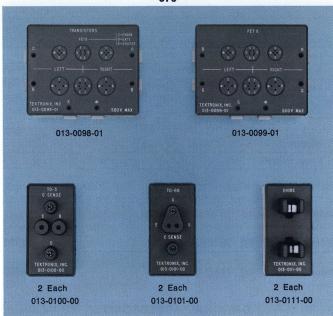


CURVE TRACER ACCESSORIES

The following accessories are most suitable for use with the 576 test fixtures. Some of them are also useful with the 5CT1N or 7CT1N. The 576 has terminals for Kelvin sensing, and adapters having Kelvin sensing contacts should be used when making high current measurements. The 5CT1N, and 7CT1N do not have Kelvin sensing but the adapters may be used. The double width adapters are not compatible with the 176, 5CT1N or 7CT1N.

Included Accessories

576



013-0098-01 Transistor Adapter. Useful for most bipolar transistors and some MOS FETs.

013-0099-01 FET Adapter. Useful for most FETs.

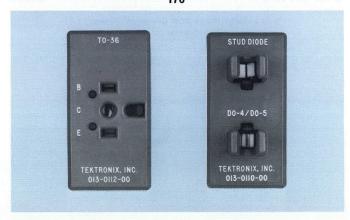
013-0100-00 TO3 Adapter with Kelvin sensing terminals.

013-0101-00 TO66 Adapter with Kelvin sensing terminals.

013-0111-00 Axial Lead Diode Adapter with Kelvin sensing terminals.

Included Accessories

176



TO36 Adapter—Has Kelvin sensing terminals. Optional for the 576 or 172. Order 013-0112-00
Stud Diode Adapter—Has Kelvin sensing terminals. Optional
for the 576 or 172. Order 013-0110-00

Included Accessory 5CT1N or 7CT1N



TO5 or TO18 Transistor Adapter.	
Order 013-0128-00	\$10

OPTIONAL ACCESSORIES

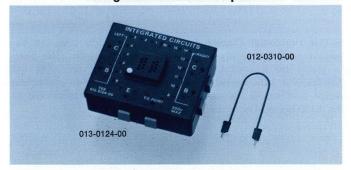
576/172



Designed to accept untrimmed bipolar or single FET's or transistors.

Long-lead	transistor	adapter,	order	013-0102-00	 \$28
Long-lead	FET adap	ter, orde	r 013-0	103-00	 \$28

Integrated Circuits Adapter



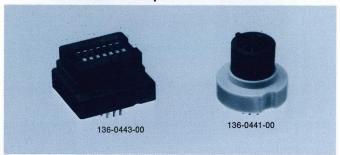
The integrated circuits adapter allows many integrated circuit measurements to be made using 576 Curve Tracer. The appropriate Barnes Corporation socket is plugged into the integrated circuits adapter. The pins are then connected to the collector, base, or emitter terminals by means of the patocords. A tie point is also provided so that an external power supply or signal source may conveniently be patched to the IC pins. The pin numbers on the adapter correspond to the IC pin numbers with any of the four Barnes Corporation sockets



SEMICONDUCTOR CURVE TRACERS Curve Tracer Accessories

available from Tektronix, Inc. Barnes Corporation, Landsdowne, a. has several other sockets available which may be purchased directly from them. All of the ones with yellow bases (and some that are not yellow) are compatible with the adapter pin numbering system.

Barnes Corporation Sockets



Socket for 8-lead TO package (not shown),	
order 136-0444-00	\$9
Socket for 10-lead TO package, order 136-0441-00	
Socket for 14-lead dual-in-line package,	
order 136-0443-00	\$7
Socket for 16-lead dual-in-line package (not shown),	
order 136-0442-00	\$7

Large In-Line Adapter—Accepts large transistors with in-line leads. Has Kelvin sensing terminals. It is wired for a B-C-E rminal configuration but may be easily rewired for the C-B-E erminal configuration.

order 013-0138-00 \$25

Optional Accessories

576/172/176





Transistor Adapter—Has Kelvin sensing terminals and accepts long or short lead transistors. It can be rewired to accommodate nonstandard lead configurations.

Order 013-0127-00 \$26.50

Camera

Adapter-frame/corrector lens, part no. 016-0264-01, permits use of the C-12 or C-27 Cameras with the 576. Refer to the camera section of this catalog for full information.

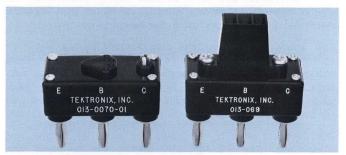
Adapter frame/corrector lens, part no. 016-0271-00, permits use of the C-50 Camera with the 576. Refer to the camera section of this catalog for full information.

SCOPE-MOBILE® Cart

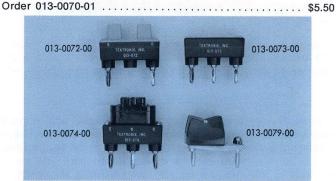
Model 202-1 with storage drawer \$165

Optional Accessories 576/172/176/5CT1N/7CT1N

The following accessories may be used with any of the TEK-TRONIX Curve Tracer Products. They do not have Kelvin sensing contacts.



Long Lead Transistor Adapter Order 013-0069-00	\$6.60
TO3 or TO66 Transistor Adapter	



Diode Test Fixture—Holds axial-lead diodes, order 013-0072-00	\$6.60
Adapter Box—Allows mounting of additional sockets, order 013-0073-00	
Power Transistor Socket—For power transistors leads, order 013-0074-00	
Diode Test Fixture—Holds axial-lead diodes, order 013-0072-00	\$6.60
¹ Registered Trademark Polaroid Corporation ² Registered Trademark Graflex, Inc.	

J16 Digital Photometer/Radiometer



- DIGITAL LED READOUT
- LOW COST
- 31/4-LB. SINGLE, COMPACT UNIT
- INTERNAL RECHARGEABLE BATTERIES
- ENVIRONMENTALIZED
- FIVE SILICON SENSOR PROBES QUICKLY INTERCHANGED WITHOUT RECALIBRATION

The TEKTRONIX J16 is a portable digital photometer/radiometer capable of making a wide variety of light measurements—in the laboratory or in the field.

Five quickly interchangeable precalibrated probes are available for measuring illuminance, irradiance, luminance, lightemitting diode output, and relative intensity. The probes automatically select the correct front panel, light-emitting diode (LED), units indicator (footcandles, footlamberts, μ watts/sq cm). All probes use silicon sensors (1 cm²) for maximum stability.

The excellent stability eliminates the need for routine zero adjustments. The 2½-digit LED display can be easily read under low ambient light conditions. Integrated circuits are used extensively 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 with each J16.

A shoulder strap is provided for carrying ease. The cabinet and probes have a standard threaded socket ($\frac{1}{4}$ inch x 20) and can be conveniently mounted on a tripod or optical bench.

J6501 Illuminance Probe

The J6501 measures illuminance in footcandles and is used where light incident upon a surface must be measured. Measurements are made with the J6501 pointed at the light source. Street lighting, television scene illumination and light levels on working surfaces are typical applications of the J6501.

A silicon photodiode and a computer-designed multilayer glass filter are used to very closely match the CIE photopic curve (spectral response of the average human eye). This assures accurate measurements even when measuring spectrally differing light sources. These include incandescent, fluorescent, mercury vapor and sodium lamps.

A probe HOLD switch is provided to allow the reading to be stored at any time. The footcandle indicator automatically lights when the J6501 is connected.

J6502 Irradiance Probe

The J6502 measures irradiance in microwatts/cm² within the spectral range of 450 to 1000 nanometers. Irradiance measurements are made in many technical applications where the radiant energy incident upon a surface needs to be determined. Typical applications include laser research experiments and measurements of radiant efficiencies.



A silicon photodiode and a computer-designed glass filter are used to provide flat spectral response from 450 to 1000 nanometers within $\pm 5\%$. The response is typically down to 50% at 400 and 1060 nanometers.

The acceptance angle approximates a cosine distribution curve. A probe HOLD switch is provided to allow the reading to be stored at any time. The microwatts/cm² indicator automatically lights when the J6502 is connected.

An optional filter holder is available to mount standard one-inch diameter customer-supplied filters of up to %-inch thickness. These include interference, neutral density and glass color filters.

J6503 Luminance Probe

The J6503 measures luminance in footlamberts where light scattered or emitted by a surface must be measured. Measurements are made with the J6503 pointed at the surface. Television screens, light reflected from work surfaces and electroluminescent devices are typical measurement applications of the J6503.

A silicon photodiode and a computer-designed multilayer glass filter are used to very closely match the CIE photopic curve (spectral response of the average human eye). This assures accurate measurements even when measuring spectrally differing light sources. Those include incandescent lamps, fluorescent lamps, phosphors, etc.

The acceptance angle is approximately 8° , which is determined by internal field stop apertures. A probe HOLD switch is provided to allow the reading to be stored at any time. The footlambert indicator automatically lights when the J6503 is connected.

J6504 Uncorrected Probe

The J6504 is for applications where only relative measurements need to be made. A silicon sensor is used with no correction filter so that the spectral response characteristic of the silicon detector may be utilized directly. The J6504 is usef for checking light sources used in photoresist and photoprocessing applications.

NEW

The acceptance angle approximates a cosine distribution curve. A HOLD switch is provided to allow the reading to be stored at any time. No units are indicated on the J16 front panel when using the J6504 since it provides relative readings only.

An optional filter holder is available to mount standard oneinch diameter customer-supplied filters of up to %-inch thickness. These include interference, neutral density and color filters.

J6505 LED Test Probe

The principal application of the J6505 is measurement of lightemitting diode (LED) output. The J6505 measures illuminance in footcandles of light sources having spectral outputs in the red region. Luminous intensity in candelas or millicandelas can be easily determined by using a controlled spacing between the J6505 and the LED.

A silicon photodiode and a computer-designed multilayer glass filter are used to provide a very close spectral match to the red end of the CIE photopic curve. Standard photopic filters cannot provide a close enough match in the red region to allow accurate LED measurements.

J16 CHARACTERISTICS

Display - 21/2 - digit LED readout and three LED's automatically indicating correct units for probe in use.

Stability-Within 2% per year.

Linearity-Within 2% over the entire range, enabling single point calibration.

Integration Time—Approximately 100 milliseconds.

Calibration-Electrical calibration of the J16 is performed by use of a calibrated voltage source or DVM traceable to NBS. Calibrated probes can be used with any J16 without additional calibration.

Power Requirements-Internal rechargeable NiCd batteries only need recharging weekly in normal usage. Two hours of continuous operation is provided. (A battery charger is supplied.)

PROBE CHARACTERISTICS

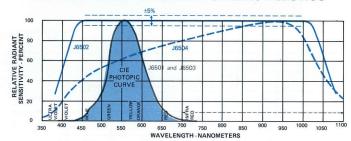
	J6501	J6502	J6503	J6504	J6505	
Range 0.199 to 1990 0.199 to 1990 microwatts/cm².		19.9 to 199,000 footlamberts.	Relative re- sponse only.	0.199 to 1990 footcandles.		
Maximum Resolution	0.001 foot- candles*.	1 nanowatt/ cm².	0.1 foot- lamberts.	Relative re- sponse only.	0.001 foot- candles**.	
Accuracy (including J16)	last place. Pr	NBS standards a obes individually source traceable	calibrated to	Probe-to-probe accuracy with- in ±5% with tungsten light source.	Same as J6501	
Spectral Response Within 2% (integrated) CIE photopicurve.		Flat within ±5% from 450 to 1000 nanometers.	Within 2% (integrated) of CIE photopic curve.	Silicon spec- tral curve.	Within 2% (integrated) of CIE photopic curve from 600 to 710 nanome- ters.	
Acceptance Angle	† + + + + + + + + + + + + + + + + + + +		8 degrees.	Approximately cosine.	†	
Sensor	Silicon— 1 cm ² .	Silicon— 1 cm ² .	Silicon— 1 cm ² .	Silicon— 1 cm ²	Silicon— 1 cm ² .	

*Can be used for green and yellow LED measurements in millicandelas by positioning the sensor a predetermined distance from the LED. Maximum resolution at 1.2 inches is 0.01 millicandela and 0.1 millicandela at 3.8 inches.

**Can be used for red LED measurements in millicandelas by positioning the sensor a pre-determined distance from the LED. Maximum resolution at 1.2 inches is 0.01 millicandela and 0.1 millicandela at 3.8 inches.

+50% sensitivity at 48° off-axis.

TYPICAL PROBE SPECTRAL CHARACTERISTICS



(All curve heights adjusted to 100% for clarity)

Environmental Capabilities

Ambient Temperature—Nonoperating, -50°C to +75°C; operating, -15° C to $+40^{\circ}$ C.

Altitude—Nonoperating, to 50,000 feet; operating, to 15,000 feet.

Humidity-Operating and storage, 5 cycles (120 hours) to 95% relative humidity at 40°C. Referenced to MIL-E-16400F.

Vibration-Operating, 15 minutes along each of the 3 major axes at a total displacement of 0.025 inches P-P (4 g's) from 10 to 55 to 10 Hz in 1-minute cycles. Hold for 3 minutes at 55 Hz. All major resonances must be above 55 Hz.

Dimensions & Weights-With probe and battery pack installed.

Dimensions	in	cm	Weights (approx)	lb	kg
Height	2.4	6.0	Net	3.3	1.5
Width	4.6	12.3	Domestic Shipping	5.0	2.3
Length	8.0	20.3	Export-packed	10.0	4.5

Included Accessories-Battery pack; battery charger; shoulder strap.

ORDERING INFORMATION

J16, without probe

J16 option 1 for 230 V, 50 Hz operation	\$605
J16 option 2 for metric readout	\$600
Probes	
J6501 for Illuminance Probe	\$200
J6502 for Irradiance Probe	\$250
J6503 for Luminance Probe	\$250
J6504 for Uncorrected Probe	\$150
J6505 for LED Probe	\$250
Specify probe with option 2 for metric readout.	

Optional Accessories	
42-Inch Probe Extender Cable —Connects between the J16 probe.	and
Order 012-0414-00	\$15
Filter Holder—Mounts one-inch diameter filters, of up to inch thickness, to probes.	
Order 016-0527-00	\$10
Spare Battery Pack—	
Order 016-0539-00	\$60
AC Power Supply-Allows J16 to be used without batte	eries.

Order 119-0404-00 \$75 U.S. Sales Prices FOB Beaverton, Oregon Please refer to General Information page



TEKTRONIX CAMERAS

		PERFORMANCE	LENS							ITTER	FILM BACK	PRICE
CAMERA	PAGE	FEATURE	FOCAL LENGTH (mm)	MAGNI- FICATION	F/STOP	RELATIVE SPEED*	MAXIMUM COVERAGE (cm)	INTER- CHANGEABLE	MECHAN- ICAL	ELEC- TRONIC	INTER- CHANGEABLE	(STANDARD BACK)
C-5	204	Low Cost, Easy To Use	60	0.68	f/16 (fixed)	0.02	10.2 x 12.7	no	yes	no	no	\$185 Fixed (Pack
C-10	204	For Information Display Prod- ucts With 11-Inch Diagonal CRT	64.4	0.5	f/8 to f/22	-	16.2 x 21	no	yes	no	no	\$450 Fixed (Graflok)
C-12	198	Straight-On Binocular Viewing Via Beam-Splitting Mirror, Plus Optional Projected Graticule	75	0.85	f/1.9 to f/16	0.65	8 x 10	yes	yes (standard)	yes (with SPEED- COMPUTER)	yes	\$590 (Pack)
C-27	198	Adjustable Viewing Positions Plus Removable Viewing-Tun- nel For Compact Stacking On Rackmount Oscilloscope	75	0.85	f/1.9 to f/16	1.0	8 x 10	yes	yes (standard)	yes (with SPEED- COMPUTER)	yes	\$590 (Pack)
C-30A	202	General Purpose Variable Magnification	56	1.5 to 0.7	f/1.9 to f/16	1.0	6.4 x 8	no	yes (standard)	yes (with SPEED- COMPUTER)	yes	\$525 (Pack)
C-31	202	Highest Writing Speed Of C-30- Series With 0.5 Magnification	56	0.5	f/1.2 to f/16	3.4	6.4 x 8	no	yes (standard)	yes (with SPEED- COMPUTER)	yes	\$675 (RoII)
C-32	202	High Writing Speed With Full- Size Image	60	1.2 to 0.85	f/1.4 to f/16	1.5	6.4 x 8	no	yes (standard)	yes (with SPEED- COMPUTER)	yes	\$715 (Pack)
C-50	192	General Purpose	57.6	0.7	f/1.9 to f/16	1.2	9 x 11.5	no	no	yes	yes	\$750 (Pack)
C-51	192	Highest Writing Speed Of C-50- Series	57.6	0.5	f/1.2 to f/11	3.6	8 x 10	no	no	yes	yes	\$1085 (Roll)
C-52	192	Full-Size Image	60	1.0	f/1.4 to f/16	1.5	8 x 10	no	no	yes	yes	\$1065 (Graflok)
C-53	192	General Purpose Large Image	57.6	0.85	f/1.9 to f/16	1.0	8 x 10	no	no	yes	yes	\$825 (Pack)
C-58	192	Low Cost Full-Size Image	60	1.0	f/2.8 to f/16	0.4	9.8 x 12	no	yes	no	yes	\$590 (Graflok)
C-59	192	Low Cost General Purpose	55.33	0.67	f/2.8 to f/16	0.65	10.2 x 12.7	no	yes	no	yes	\$450 (Pack)

^{*}Approximate relative light gathering power of TEKTRONIX Cameras

GLOSSARY

beam splitter—A device such as a prism or half-silvered mirror which splits a light beam into 2 or more beams not necessarily equal in intensity.

bezel—The flange or cover used for holding an external graticule or cathode-ray tube cover in front of the cathode-ray tube in an oscilloscope.

cable release—a cable provided for remote actuation of a camera shutter.

camera adapter—a mounting frame used to attach a camera to an oscilloscope.

collimate—To render parallel.

definition—The degree of clarity of reproduction of an object by an optical system.

dichroic—Exhibiting the quality of selective reflection and transmission of light as a function of wavelength.

magnification—The relationship of the size or apparent size of the image to an object when viewed through or imaged by an optical system. Sometimes referred to as object-to-image ratio. For example a 0.85 lens is one whose image will be 0.85 times the object size.

parallax—The apparent displacement of an observed object due to the angle of observation.

postfogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light after the image producing exposure.

prefogging—A technique of increasing the apparent sensitivity of film by a uniformly controlled exposure to light before the image producing exposure.

resolving power—The degree to which a system or a device distinguishes fineness of detail.



TEKTRONIX cameras and accessories are specifically designed o meet a wide range of oscilloscope trace-recording needs. Of the many design considerations made during the development of a TEKTRONIX oscilloscope-camera system, one of the most important considerations is ease of operation. The attention given to this objective is evident from the improvements of the C-50-Series Cameras. The ability of a particular user to photograph a given event is dependent primarily upon the selection of the oscilloscope-camera system and secondarily on his ability to apply appropriate photographic techniques.

The various TEKTRONIX cameras can be classified into four groups: Laboratory-Oscilloscope Cameras, Portable-Oscilloscope Cameras, a Low-Cost Camera and an 11-inch Display-Monitor Camera. From these four groups, virtually any photographic requirement can be met. For a detailed camera/compatibility breakdown see page 205. When a camera is recommended for a particular oscilloscope, it could also be suitable for use with other instruments. The application would be the primary determining factor.

The C-50-Series Cameras are compact, with features not available on other cameras. To add to photographic ease and convenience, these cameras (except C-58) are focused by merging two bars of light which are projected from the camera to the CRT. The exposure photometer (except C-58) projects the virtual image of a spot of light into the plane of the CRT where the spot can be matched to the trace intensity. When the exposure is properly set, a locking mechanism secures the aperture and shutter speed controls so that if one is moved, the other tracks to maintain the correct exposure ratio (except C-59).

Factors to consider in choosing the most appropriate camera include: lens type, CRT phosphor, type and size of print desired, ability to up-grade or add to a present camera, type of viewing, compatibility with different oscilloscopes, and writing speed requirements. These factors are discussed below.

VIEWING

All cameras (except C-5 and C-10) may be easily swung away from the display area for wide-angle viewing. The C-12, C-27, and C-50-Series Cameras also provide a comfortable viewing tunnel, through which the display may be viewed without interference from ambient light. The C-12 features a beam-splitting mirror, which simulates a viewing position directly in front of the CRT, and thus eliminates parallax. A projected graticule is available for use with the C-12 in applications where parallax is to be further reduced, or a special-purpose graticule or mask is needed.

CAMERA FLEXIBILITY AND COMPATIBILITY

TEKTRONIX cameras are designed to offer maximum flexibility and compatibility. These two considerations are so broad the information is presented in a chart on page 205 for ease of understanding. Your Field Engineer will be pleased to assist you in those instances where additional information is required.

¹Registered Trademark Polaroid Corporation. ²Registered Trademark Graflex, Inc.

PICTURE SIZE

With either Polaroid Land¹ or conventional films, the exposable area of the film must be at least as large as the image from the lens. Image size will depend on the magnification (object-to-image ratio) of the camera lens and on the size of the oscilloscope display. For example, the Graflok² Back with 120 or 620 roll film would probably not be used with a 0.85 lens and a 10-cm wide oscilloscope display. This is because the image of the display is 8.5 cm wide and the exposable area (long dimension) of the film is only 7.8 cm maximum (it can be as short as 5.7 cm, depending on film format). The film size should be at least 5 mm larger than the size of the image to allow for normal tolerances in the construction of the Camera Backs and for the position of the film in the back.

ASA RATINGS, FILM AND BACK TYPES

Polaroid Pack Backs, Roll Backs and Graflok Backs may be interchanged on each camera (except C-5 and C-10) within the appropriate series).

Polaroid films can also be used in a Polaroid 4×5 film holder with the 4×5 Graflok Back. This combination, used with Type 57 film (3000 speed), a unity lens, and a C-27, C-52 or C-58 Camera will give full-size records of graticule areas as large as 8×10 cm. A Standard C-27 Camera (0.85 lens) equipped in the same way will make a complete record of a 10×10 -cm graticule.

If you want to obtain a negative from which a number of prints can be made, either Type 55 P/N film (which comes in Polaroid Land 4×5 , only) or conventional film is satisfactory.

Conventional cut film and 120 roll film can be used with either the 4×5 or $21/4\times31/4$ Graflok Back and the proper holder or adapter. A number of film types, manufactured by Eastman Kodak, Agfa, Ansco, and others, are available in both forms, at ASA speeds from 64 to 1250.

A detailed list of film types and characteristics of these and other films not mentioned here can be obtained from the respective manufacturer.

Polaroid Type 47 and Type 107 (roll film and pack film, respectively) each have an ASA equivalent exposure index of 3000. Polaroid Type 410 ASA 10,000 roll film is especially suited for high-speed photography. Each film type has 8 exposures, develops in 15 seconds and has an exposable area of 9.5 cm x 7.3 cm. Continuous-tone slides can be made using Polaroid Type 46 or 46-L; each film type is on an 8-exposure roll and develops in 2 minutes. Roll film develops inside the film back; pack film develops outside.

ASA exposure ratings are measured under a specific set of conditions. Oscilloscope exposures differ from these conditions such that ASA ratings do not accurately apply to oscilloscopes. However, the writing speed of ASA 10,000 is approximately 2 times that of ASA 3000 for oscilloscope photography.

PHOTOGRAPHIC WRITING SPEED

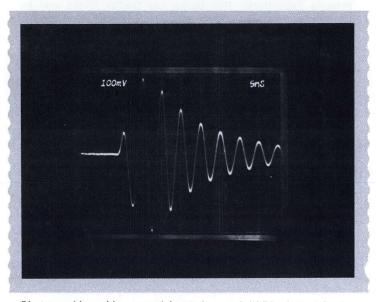
Photographic writing speed describes the ability of a particular camera, film, oscilloscope, and phosphor to record fast moving traces. The writing speed figure expresses the maximum single event spot velocity (usually in centimeters per microsecond) which may be recorded on film.

Reference



The following illustration shows one way in which writing speed can be measured to determine if a particular system has the ability to record an important single-sweep display which will be difficult if not impossible to repeat. There is displayed a single trace of a damped sinewave whose frequency and amplitude is such that the rapidly rising and falling portions of the first cycle or two fail to record. The peak to peak amplitude of the sinewave should be three to four times as great as the horizontal distance occupied by one cycle.

The writing speed capability of the oscilloscope is determined as follows: mask out the sinewave peaks on the photograph leaving the central one-third visible. View the photograph while backlighted. Starting from the left, find the first rapidly rising or falling portion of the damped sinewave which is discernible. Let D represent the vertical distance in centimeters between the peaks which are connected by this portion.



Photographic writing speed in cm/ μ s = 3.14 Df where f is the frequency of the damped sinewave in megahertz. The above photo was taken with a 7904 Oscilloscope with P11 phosphor using a C-51-R Camera, 10,000 ASA film.

Although the writing speed is an important characteristic of the oscilloscope, it does not completely describe the ability of the oscilloscope to present detailed information.

LENSES

The essential differences in the lens system of TEKTRONIX cameras are their ability to photograph extremely dim traces such as those produced in single-sweep applications at the highest sweep rates, and their angular coverage, or ability to photograph large or small displays.

Two factors should be considered in selecting a lens system. They are the f number and the magnification, since writing speed is directly dependent upon both. Writing speed for a given system can always be expected to increase as the f number and magnification decreases. The individual specification pages for each camera provide a complete description of the camera's lens system.

Came	ras and L	enses	Relative Lens Speeds
C-5	f/16	1:0.68	0.02
C-12†	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	0.65 1.0 1.7
C-27	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	1.0 1.5 2.6
C-30A	f/1.9	1:0.7	1.0
C-31	f/1.2	1:0.5	3.4
C-32	f/1.5	1:1	1.5
C-50	f/1.9	1:0.7	1.2
C-51	f/1.2	1:0.5	3.6
C-52	f/1.4	1:1	1.5
C-53	f/1.9	1:0.85	1.0
C-58	f/2.8	1:1	0.4
C-59	f/2.8	1:0.67	0.65

+With light loss through beam-splitting mirror taken into account.

CRT SELECTION

There are a great number of phosphor types presently available to the purchaser of a cathode-ray oscilloscope. Each of these phosphors has certain advantages and disadvantages compared to the others. There is no one phosphor which is best for all applications.

The catalog description of each oscilloscope indicates the phosphor normally supplied. However, phosphors may be ordered which would be more suitable for particular requirements. The phosphor data chart in the General Oscilloscope Reference Section of the general catalog will help in your selection.





C-59 CAMERA

LOW COST, MODERATE PERFORMANCE **GENERAL PURPOSE**

This camera offers optimum price/performance for applications with TEKTRONIX 7000-Series Oscilloscopes, other laboratory oscilloscopes and display units where medium writing speed and performance is required.





NEW C-53-P



NEW C-58-G



NEW C-59-P

C-50, C-51, C-52 and C-53 FEATURES

- ELECTRONIC-CONTROLLED SHUTTER
- PHOTOMETER EXPOSURE AID
- ACCURATE EXPOSURE CONTROL
- AUTOMATIC SINGLE-SWEEP CONTROL

C-58 FEATURES

- LOW COST
- FULL-SIZE IMAGE ON 4 x 5 FILM WITHOUT VIGNETTING

C-59 FEATURES

- LOW COST
- PHOTOMETER EXPOSURE AID
- ACCURATE EXPOSURE CONTROL
- INTERNAL BATTERY POWER

COMMON C-50-SERIES FEATURES

- RANGE-FINDER FOCUSING (except C-58)
- COMPACT, LIGHTWEIGHT

Three different versions comprise the C-50-Series Cameras: The C-50, C-51, C-52, and C-53 all with photometer exposure aid and electronic-controlled shutter; the low-cost C-59 with photometer exposure aid and mechanical shutter; and the C-58 with mechanical shutter and wide-angle 1.0 mag lens.

The six C-50-Series Cameras are designed for use with all TEKTRONIX 7000-Series Oscilloscopes. They can also be

- LIFT-OFF MOUNTING, SWING-AWAY HINGING
- INTERCHANGEABLE FILM BACKS

adapted to most other laboratory-model oscilloscopes and display units. Please refer to the OSCILLOSCOPE/CAMERA ADAPTER guide on page 205.

All the C-50-Series Cameras can be ordered with a Polaroid¹ Pack-Film or Roll-Film Back, a Graflok² 4 x 5 Back, or with no film back. The backs can be removed easily, without fogging the film, and interchanged without need to refocus the camera. See page 197 for Ordering Information.

C-50-SERIES SPECIFICATIONS

CAMERA	C-50	C-51	C-52	C-53	C-58	C-59	
PERFORMANCE FEATURE	General Purpose	Highest- Writing Speed	Full Size Image	**General Purpose Large Image	Low Cost Full Size Image	Low Cost General Purpose	
LENS	57.6 mm	57.6 mm	60.0 mm	57.6 mm	60.0 mm	55.33 mm	
f/STOP	f/1.9 to f/1.2 to f/16		f/1.4 to f/16	f/1.9 to f/16	f/2.8	to f/16	
MAGNIFI- CATION	0.7 0.5		1.0	0.85	1.0	0.67	
*RELATIVE LENS SPEED	1.2 (f/1.9)	3.6 (f/1.2)	1.5 (f/1.4)	1.0 Reference (f/1.9)	0.4 (f/2.8)	0.65 (f/2.8)	
SHUTTER RANGE	Electrically	actuated, 4 to	1/60 s, plus I	Bulb and Time	Mechanically actuated, 1 to 1/100 s C-58, 1 to 1/50 s C-59, plus Bulb and Time		
TIMING ACCURACY	70/	Within 10% (+ Within 20% (-20°C to +30° 0°C to +50°C	°C)	V e.		
PRICE (Standard Back)	\$750 (Pack)	\$1085 (Roll)	\$1065 (Graflok)	\$825 (Pack)	\$590 (Graflok)	\$450 (Pack)	

^{*}This is a comparative figure of the relative speeds (i.e. their light gathering power) of different camera systems. The C-53, f/1.9 lens is the reference.

^{**}The new C-53 lens projects the largest practical image of an 8×10 -cm graticule on Polaroid $3 \% \times 4 \%$ film.

¹Registered Trademark Polaroid Corporation

²Registered Trademark Graflex, Inc.



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. Ease of operation is highlighted by the functional control panel where all the camera controls are grouped for easy access (the C-53 is shown, C-50, C-51 and C-52 have similar controls).



COMMON FEATURES

Modes—A five-position switch turns the camera power on and selects normal, time, bulb or single-sweep operation. A power-on indicator lights when the mode switch is turned from the off position.

Focus—A spring-loaded knob is pushed in to project two vertical bars of light onto the CRT. By turning the focus control the light bars can be merged, indicating that the camera is properly focused. When the focus control is released, the camera is then locked in focus and the lamps are turned off.

Photometer Exposure Aid—The proper combination of shutter speed and f-number is selected to match the ASA film index and trace brightness as measured by the photometer. A thumb-wheel inside the camera housing selects absorption filters for making an approximate visual color match of the photometer spot to the particular color of phosphor in use. Four filters are provided: P1, P2, P11, and P31. The exposure setting is obtained as follows: The ASA index is set, then the f-knob is pushed in and turned to match the spot brightness to trace brightness. When the f-knob is released, it locks into the proper relation with the shutter-speed knob. Thus, if either is changed, the other tracks to maintain the same ratio.

hutter—The shutter is electronically actuated in each operating mode. In the single-sweep mode, the shutter opens when the actuator button is depressed. Simultaneously the camera provides a pulse to reset the oscilloscope single sweep. The shutter remains open in this mode unless the camera is ex-

ternally connected to the oscilloscope plus gate. When connected to the plus gate, the shutter is electronically closed approximately five seconds after the end of the sweep (end of + gate).

Shutter Closure Delay—In bulb mode only, 250 ms or less after release of shutter button. In single-sweep only, 5 seconds (within 20%) after sweep ends with + gate applied.

Camera Power and Sweep Reset—A 3-pin connector on the bezel of the TEKTRONIX 7000-Series Oscilloscopes provides +15 V, a ground connection to the camera and a sweep-reset pulse (in single-sweep function only) back to the oscilloscope. An optional battery pack is available for use with other oscilloscopes.

See Page 197 for Ordering Information.

C-58 CAMERA

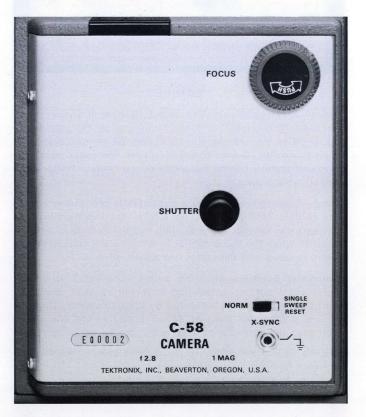
The C-58 Camera features an extra-wide angle f/2.8 lens with unity magnification. This permits a full-size image to be recorded on Polaroid 4×5 film without vignetting. Simplified design and use of a mechanically actuated shutter provide ease of operation and low cost.

FEATURES

Modes—A two-position switch selects normal or single sweep operation. In normal the X-sync contacts in the shutter are connected to the external X-sync connector, while in single sweep, the X-sync contacts connect the sweep reset line to ground, thereby triggering the oscilloscope.

Focus—A spring-loaded knob is pushed and turned to adjust the camera for correct focus. When the focus control is released, the camera is then locked in focus.

See page 197 for Ordering Information.





C-59 CAMERA

The C-59 is a general-purpose low-cost camera which is suitable for most photographic needs. It is designed primarily for use with TEKTRONIX 7000-Series Oscilloscopes with 6½-inch CRTs, but fits all 7000-Series Oscilloscopes (adapter not required), or any oscilloscope* that accommodates a TEKTRONIX C-27 Adapter. Internal batteries supply power to the electronic circuitry in the camera when the camera is not used with 7000-Series Oscilloscopes. The C-59 features an exposure aid that mechanically indicates the proper shutter speed and f-number for a wide range of ASA film ratings and display luminances.



FEATURES

Modes—A two-position switch selects normal or single sweep operation. In normal the X-sync contacts in the shutter are connected to the external X-sync connector on the camera. In single sweep the X-sync contacts connect the sweep reset line to ground thereby arming the single sweep circuitry of the 7000-Series Oscilloscopes.

Focus—A spring-loaded knob is pushed in to project two vertical bars of light onto the CRT. By turning the focus control, the light bars can be merged, indicating that the camera is properly focused. When the focus control is released, the camera is then locked in focus and the lamps are turned off.

Photometer Exposure Aid—The proper combination of shutter speed and f number is selected to match the ASA film index and trace brightness as measured by the photometer. Depressing the photometer push-on switch turns on the photometer light spot. Its intensity is then varied by the secondary knob

*Can only be used with 5100-Series Oscilloscopes when in the store mode.

on top of the ASA setting control. The photometer light spot brightness and trace brightness are matched. The push-switch is then released and the reading indicated under the skirt of the secondary knob is compared with the table on the camera. This indicates the proper shutter speed and f-number combination.

An absorption filter snapped in place inside the camera housing allows an approximate match of the photometer light spot to standard P31 phosphor color. Optional filters may be ordered for P1, P2 and P11 phosphors.

Camera Power And Sweep Reset Connector—A three-pin connector on the bezel of TEKTRONIX 7000-Series Oscilloscopes provides +15 volts, ground and a sweep reset connection. The shutter is manually operated. Whenever the camera is attached to a 7000-Series Oscilloscope the internal batteries in the camera are disconnected.

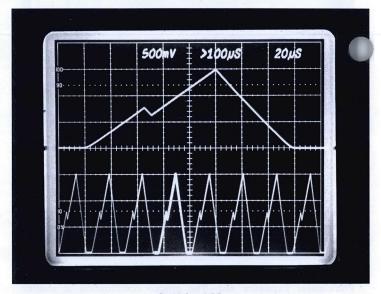
See Page 197 for Ordering Information.

C-50-SERIES LENS SYSTEMS

The following are typical examples (shown actual size) of each camera's recording image.

C-50 CAMERA GENERAL PURPOSE

(f/1.9, 0.7 magnification)



C-50/7704A (8 x 10-cm CRT)

The C-50 can record $6\frac{1}{2}$ -inch CRT displays on Polaroid $3\frac{1}{4}$ x $4\frac{1}{4}$ film but with some vignetting of the graticule corners. The C-50 Camera's f/1.9, 0.7 lens has a light-gathering power 1.2 times that of the C-53 lens (f/1.9, 0.85 mag).

¹Registered Trademark Polaroid Corporation

²Registered Trademark Graflex, Inc.

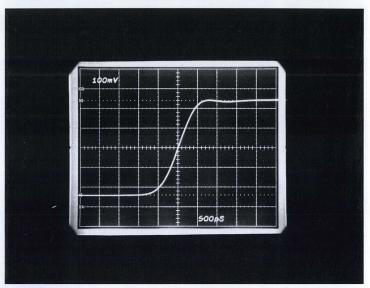


C-51 CAMERA MAXIMUM WRITING SPEED

(f/1.2, 0.5 magnification)

C-51/7904 (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 full-size oscilloscopes where maximum single-sweep writing speed is desired. Its f/1.2, 0.5 lens has a light-gathering power 3.6 times that of the C-53 lens (f/1.9, 0.85 mag).



500mV >100µS 20µS

C-52 CAMERA FULL-SIZE IMAGE HIGH WRITING SPEED (f/1.4, unity magnification)

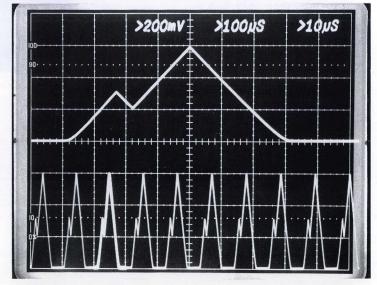
C-52/7704A (8 x 10-cm CRT, 4 x 5-Film)

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 1.5 times that of the C-53 lens (f/1.9, 0.85 mag). Polaroid Pack Film and Roll Film Backs can be used with the C-52 but the 3½ x 4½-size film can only record 7.3 x 9.5 cm of an 8 x 10-CRT display.

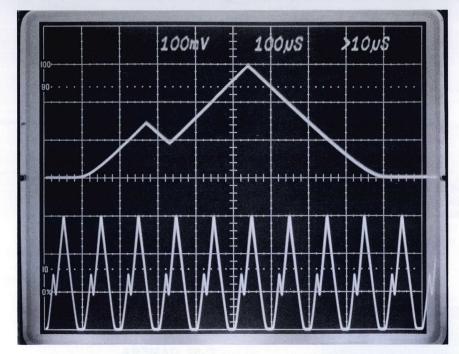
C-53 CAMERA GENERAL PURPOSE (f/1.9, 0.85 magnification)

C-53/7704A (8 x 10-cm CRT)

The C-53 f/1.9 lens has adequate writing speed for most general-purpose applications. Its 0.85 magnification lens provides the largest practical image of an 8 x 10-cm CRT display that will fall within the available recording area of Polaroid $3\frac{1}{4}$ x $4\frac{1}{4}$ -size film.







C-58 CAMERA FULL-SIZE IMAGE (f/2.8, 1.0 magnification)

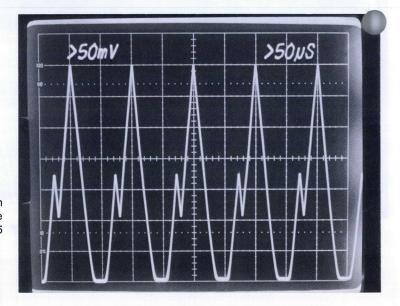
C-58/7704A

The C-58 Camera, using a 4×5 Graflok Back, provides a full-size image without vignetting on 4×5 film. Its f/2.8, unity-magnification lens has a light-gathering power of 0.4 times that of the C-53 lens (f/1.9, 0.85 mag). Polaroid Pack Film and Roll Film Backs can be used with the C-58 but $3\frac{1}{4}\times4\frac{1}{4}$ -size film can only record 7.3×9.5 -cm of an 8×10 -cm CRT display.

C-59 CAMERA LOW COST GENERAL PURPOSE

C-59/7603 (6½-inch CRT)

The C-59 Camera can record $6\frac{1}{2}$ -inch CRT displays on Polaroid $3\frac{1}{4}$ x $4\frac{1}{4}$ -film without vignetting of the graticule corners. Its f/2.8, 0.67 lens has a light-gathering power 0.65 times that of the C-53 lens (f/1.9, 0.85 mag).





C-59 Camera.

graticule.

Dimensions and Weights-With standard back and viewing nnel installed.

DIMENSIONS		P and 3-P	C-51-R C-52-G		C-58-G		C-59-P			
	in	cm	in	cm	in	cm	in	cm	in	cm
HEIGHT	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2	11.5	29.2
WIDTH	7.5	19.1	9.8	24.8	7.5	19.1	7.7	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
WEIGHT (approx)	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
NET	7.5	3.4	9.5	4.3	8.0	3.6	6.0	2.7	7.0	3.2
DOM SHIPPING	12.0	5.4	15.0	6.8	15.0	6.8	10.0	4.5	11.0	5.0
EXPORT-PACKED	24.0	10.9	27.0	12.2	27.0	12.2	22.0	9.9	23.0	10.4

ORDERING INFORMATION

	C-50	
	C-50-P CAMERA, Pack-Film Back	\$750
	C-50-P CAMERA, Pack-Film Back	
	C-50-G CAMERA, 4 x 5 Graflok Back	
	C-50-N CAMERA, No Back	
	0-30-14 UNIVERN, 140 Dack	. ψυυυ
	C-51	
	C-51-R CAMERA, Roll-Film Back (Recommended)	\$1085
	C-51-P CAMERA, Pack-Film Back	\$1050
	C-51-G CAMERA, 4 x 5 Graflok Back	\$1015
	C-51-N CAMERA, No Back	\$965
	who do not properly the series .	
	C-52	
1	C-52-G CAMERA, 4 x 5 Graflok Back (Recommended)	
Į	52-R* CAMERA, Roll-Film Back	
	C-52-P* CAMERA, Pack-Film Back	
	C-52-N CAMERA, No Back	\$1012
	C-53	
	C-53-P CAMERA, Pack-Film Back	\$825
	C-53-R CAMERA, Roll-Film Back	
	C-53-G CAMERA, 4 x 5 Graflok Back	\$790
	C-53-N CAMERA, No Back	\$740
	C-58	
	C-58-G CAMERA, 4 x 5 Graflok Back (Recommended)	
	C-58-R* CAMERA, Roll-Film Back	
	C-58-P* CAMERA, Pack-Film Back	
	C-58-N CAMERA, No Back	\$540
	C-59	
	C-59-P CAMERA, Pack-Film Back	\$450
	C-59-R CAMERA, Roll-Film Back	
	C-59-G CAMERA, 4 x 5 Graflok Back	
	C-59-N CAMERA, No Back	
	Eight AA alkaline cells (006-0513-00) are included with	
	- Committee of the comm	

*These cameras use 31/4 x 41/4 film and will not record a full 8 x 10 cm



Optional battery pack installed on C-53-P Camera

C-50-SERIES OPTIONAL ACCESSORIES

Writing Speed Enhancer-Provides automatic-controlled filmfogging to increase writing speed at least 4 times for 3000 ASA film and 2.5 times for 10,000 ASA film. For C-50, C-51, C-53 and C-59 only. Please refer to page 206 for details and ordering information.

Battery Pack-Provides an auxiliary power source for the C-50-Series Cameras (C-58, C-59 excluded) when using oscilloscopes without camera power outputs. In addition to its own power (12 AA size batteries) the battery pack has provisions to allow the camera to be powered from a 7000-Series oscilloscope or an external $+15\,\mathrm{V}$ source. Net weight of pack, including batteries, is 1.2 pounds. Order 016-0270-00 \$85

Carrying Case-Holds a C-50-Series Camera. Order 016-0177-00 \$80

Optional film backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing any film.

Pack-Film Back-Accepts Polaroid 31/4 x 41/4 3000-speed pack film. Order 122-0926-00 \$85 Roll-Film Back-Accepts Polaroid 31/4 x 41/4 10,000 or 3000-

speed roll film. Order 122-0929-00 \$120

Graflok Back, 4 x 5-Accepts Polaroid Land 4 x 5 film holder, standard cut-film holders, film-pack adapters, roll-film (120) holders (see page 201). Order 122-0931-01 \$50





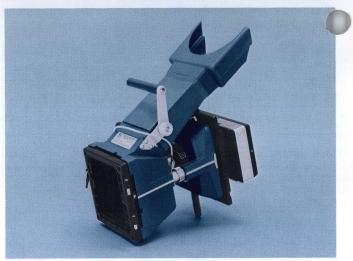
COMMON FEATURES

- LIFT-OFF MOUNTING, SWING-AWAY HINGING
- EASILY-ACCESSIBLE CONTROLS
- ROTATING AND SLIDING BACK
- LENS AND ELECTRIC SHUTTER OPTIONS

The C-12 and C-27 are general-purpose trace-recording cameras suitable for use with most TEKTRONIX full-size oscilloscopes.

C-12 CAMERA

A special beam-splitting mirror in the C-12 (and a conventional mirror) reflects an uninverted image through the viewing tunnel, giving the operator a straight-on view of the CRT. This is especially desirable when the oscilloscope has an external graticule, since parallax errors are reduced. The beam-splitting mirror also allows use of the Projected Graticule accessory. The beam-splitting mirror transmits approximately 65% of the CRT light to the film.



C-27 CAMERA

The C-27 provides a direct binocular view of the CRT, and maximum light transmission from CRT to film. The viewing tunnel can be easily removed, and the carrying handle folded out of the way. This allows camera mounting on two 7-inch rack-model oscilloscopes placed one over the other. In addition the camera frame can be rotated 90° or 180°, thus positioning the viewing tunnels at either side or at the bottom of the camera. The large aperture at the camera front allows full photographic coverage of CRT displays up to 10 x 10 cm depending on the film size and lens magnification.

An Electric Shutter and SPEEDCOMPUTER are available for both cameras, replacing the standard mechanical shutter; all other features remain the same.

Either camera may be ordered with a Polaroid Pack-Film Back, Roll-Film Back, Graflok Back, or no back. See price lines for specific ordering information.

SPECIFICATIONS

CAMERA	C-12	C-27				
PERFORMANCE FEATURE	Straight-On Binocular Viewing via Beam- Splitting Mirror, plus projected graticule	Adjustable Viewing Positions, plus Removable Viewing- Tunnel for Compact Stacking on Rack- mount Oscilloscopes				
LENS	75 mm					
1/STOP	f/1.9 to f/16					
MAGNIFICATION	0.85					
**RELATIVE LENS SPEED	0.65† (f/1.9)	1.0 Reference (f/1.9)				
STANDARD SHUTTER	Mechanically actuated, and Time	1 to 1/100 s, plus Bulb				
OPTIONAL ELECTRIC SHUTTER AND SPEED COMPUTER	Electrically actuated, 4 to 1/60 s (within 20% from 0°C to 40°C) plus Bulb/Time. Remote actuation is obtained with single ground clo sure. Power requirements are 115 VAC ±10% or 230 VAC ±10%, 50 to 60 Hz.					
PRICE (Standard Back)	\$590 (Pack)	\$590 (Pack)				

^{**}This is a comparative figure of the relative speeds (i.e. their light gathering power) of different camera lens systems. The C-12, f/1.4 (custom camera) and C-27, f/1.9 lenses are references.

Dimensions and Weights—With standard back and viewing tunnel installed.

DIMENSIONS	C-1	2-P	C-27-P		
	In	cm	in	cm	
HEIGHT	15.4	39.1	17.2*	43.6	
WIDTH	7.5	19.1	7.5	19.1	
LENGTH	17.3	43.9	13.4*	34.1	
WEIGHT (approx)	lb	kg	lb	kg	
NET	12.3	5.5	10.5	4.7	
DOMESTIC SHIPPING	16.0	7.2	14.0	6.3	
EXPORT-PACKED	33.0	13.6	36.0	16.3	

*Without the viewing-tunnel, height is 8 inches, length is 12 inches.

Included Accessories—For C-12 and C-27, cable release (122-0586-02); focus plate for Polaroid Pack-Film Back (387-0893-02); focus plate for Polaroid Roll-Film Back (387-0893-01).

ORDERING INFORMATION

All C-12 and C-27 Cameras are sold without mounting adapters, see table on page 205 for oscilloscope compatibility.

	-	
	C-12	
C-12-P CAMERA,	Pack-Film Back	 \$590
C-12-R CAMERA.	Roll-Film Back	 \$625
	4 x 5 Graflok Back	
	No Back	
•	C-27	
	C-21	
C-27-P CAMERA,	Pack-Film Back	 \$590
	Roll-Film Back	
	4 x 5 Graflok Back	
	No Back	
• • • • • • • • • • • • • • • •		

⁺With light loss through beam-splitting mirror taken into account.

¹Registered Trademark Polaroid Corporation



CUSTOM C-12 and C-27 CAMERAS

There are four optional lenses (in addition to standard lens) available for the C-12 and C-27 cameras which add to the flexibility of these cameras.

LENS Relative speed†	ES/ SC*	POLAROID	ORDER NUMBER		PRICE
compared to Standard f/1.9, 0.85 mag lens)	SC*	BACK	C-12	C-27	
FILM ECONOMY— f/1.9 0.7 mag lens) Records two 6 x 10- cm, three 4 x 10-cm or (one 10 x 10-cm graticule on 31/4 x 41/4 film, C-27 only). Relative speed X1.2 Standard Lens.	No	Pack Roll Graflok None	C-12-547-P C-12-547-R C-12-547-G C-12-547-N	C-27-547-P C-27-547-R C-27-547-G C-27-547-N	\$610 \$645 \$575 \$525
	Yes	Pack Roll Graflok None	C-12-547-PE C-12-547-RE C-12-547-GE C-12-547-NE	C-27-547-PE C-27-547-RE C-27-547-GE C-27-547-NE	\$880 \$915 \$845 \$795
MEDIUM WRITING SPEED—f/1.9, 0.5 mag lens. For re- cording medium-fast	No	Pack Roll Graflok None	C-12-549-P C-12-549-R C-12-549-G C-12-549-N	C-27-549-P C-27-549-R C-27-549-G C-27-549-N	\$630 \$665 \$595 \$545
single-shot waveforms. Records two 8 x 10-cm CRT displays on 31/4 x 41/4 size film.	Yes	Pack Roll Graflok None	C-12-549-PE C-12-549-RE C-12-549-GE C-12-549-NE	C-27-549-PE C-27-549-RE C-27-549-GE C-27-549-NE	\$900 \$935 \$865 \$815
FULL-SIZE IMAGE— f/1.4, 1.0 mag lens. Records full-size Im- age of 8 x 10-cm grat- icule on 4 x 5 film with optional Graf- lok** Back. Relative speed X1.75.	No	Pack Roll Graflok None	C-12-608-P C-12-608-R C-12-608-G C-12-608-N	C-27-608-P C-27-608-R C-27-608-G C-27-608-N	\$795 \$830 \$760 \$710
	Yes	Pack Roll Graflok None	C-12-608-PE C-12-608-RE C-12-608-GE C-12-608-NE	C-27-608-PE C-27-608-RE C-27-608-GE C-27-608-NE	\$1065 \$1100 \$1030 \$980
HIGH WRITING SPEED—f/1.3, 0.5 mag lens. Records extremely-fast single-	No	Pac k Roll Graflok None	C-12-662-P C-12-662-R C-12-662-G C-12-662-N	C-27-662-P C-27-662-R C-27-662-G C-27-662-N	\$770 \$805 \$735 \$685
shot waveforms. Records two 8 x 10-cm CRT displays on 31/4 x 41/4 size film.	Yes	Pack Roll Graflok None	C-12-662-PE C-12-662-RE C-12-662-GE C-12-662-NE	C-27-662-PE C-27-662-RE C-27-662-GE C-27-662-NE	\$1040 \$1075 \$1005 \$955

^{*}Denotes Electric Shutter with SPEEDCOMPUTER.

†Light-gathering power relative to f/1.9, 0.85 mag lens.

OPTIONAL ACCESSORIES ELECTRICALLY-ACTUATED CAMERAS

All C-12 and C-27 Cameras are available with an Electric Shutter and SPEEDCOMPUTER, replacing the standard mechanical shutter, all other features remain the same. See Specification Chart on preceding page for details.

ORDERING INFORMATION C-12

C-12-PE CAMERA Pack-Film Back\$8	360
C-12-RE CAMERA, Roll-Film Back\$8	395
C-12-GE CAMERA, 4 x 5 Graflok Back\$8	325
C-12-NE CAMERA, No Back\$7	75
C-27	
C-27-PE CAMERA, Pack-Film Back\$8	60
C-27-RE CAMERA, Roll-Film Back\$8	95
C-27-GE CAMERA, 4 x 5 Graflok Back\$8	25
C-27-NE CAMERA, No Back\$7	75

Writing Speed Enhancer—Provides automatic-controlled film-fogging to increase writing speed at least 4 times for 3000 ASA film and 2.5 times for 10,000 ASA film. Please refer to page 206 for details and ordering information.

Carrying Case—Holds one C-12 or C-27 Camera, S85

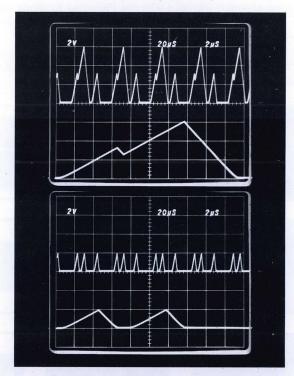
C-12 Projected Graticule—Eliminates parallax and provides an area that can be used for write-in data. For more information, see next page.

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes and some non-TEKTRONIX Oscilloscopes. See page 205 for oscilloscope compatibility.

Optional Film Backs—Provide flexibility of performance and film. Dark slides are included with all backs to permit changing backs without exposing film. See page 201 for ordering information. (Additional accessories for Graflok Backs are readily available from local camera stores.)

C-12-662/C-27-662 FILM ECONOMY HIGH WRITING SPEED

(f/1.3, 0.5 magnification)



C-27-662/7704A 8 x 10-cm CRT

The C-12 and C-27 film backs can be oriented vertically or horizontally thru nine detent positions. This enables multiple exposures on one photo, resulting in film savings. The high writing speed lens above (f/1.3, 0.5) is available from the selection of C-12 and C-27 custom cameras. The C-27-662 has a light-gathering power 2.6 times that of the standard C-27 (f/1.9, 0.85 mag.).

^{**}Registered Trademark Graflex, Inc.

Projected Graticule for C-12



The Projected Graticule provides a parallax-free graticule and a means of recording write-in data on the photograph along with the CRT display.

Parallax is the apparent displacement between an external graticule and the CRT trace because the graticule is separated from the CRT phosphor plane by the thickness of the CRT faceplate.

The Projected Graticule works in conjunction with the beam-splitting mirror in the C-12 to present a virtual image of a graticule at the object plane of the camera. Thus the graticule is always in focus at the camera's film plane, and lies in the same optical plane as that of the CRT phosphor screen when the camera is focused on the CRT trace. Accordingly, the camera photographs the graticule and the CRT display in exactly the same relationship as viewed by the operator through the C-12 viewing tunnel.

Special graticules, reference waveforms, or any image that can be recorded on a film transparency, can be imposed on the CRT display. The graticule film is held in a slide assembly and is easily slipped in and out of the Projected Graticule case, making possible rapid change of graticules.

The slide assembly included with the Projected Graticule has a clear window. Additional slide assemblies are available in several colors so that the graticule image can match or contrast the CRT phosphor.

The Projected Graticule provides an 8×10 -cm image area, a portion of which can be used for write-in data.

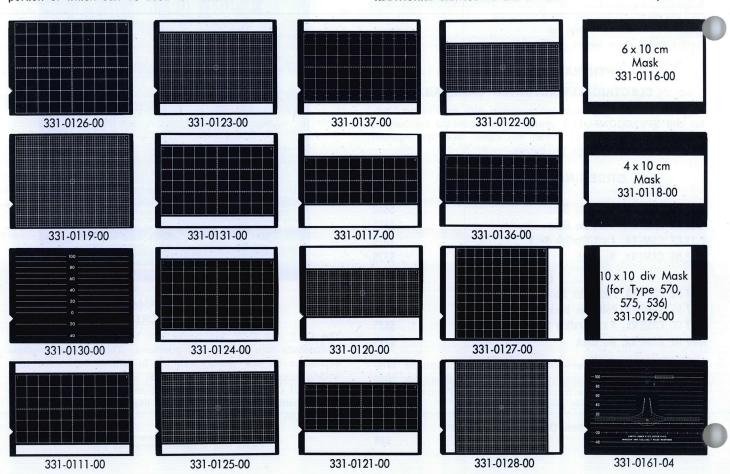
The light-source intensity control is indexed in approx ½-f/stop increments for use as a film exposure guide. This source ca also be used for prefogging the film to increase sensitivity in fast writing-speed applications.

Operates on 90 to 130 V, or 180 to 260 V; 50 to 440 Hz.

Although the Projected Graticule case is small (it adds only 2½ inches to camera height), clearance problems exist with the Type 81A Adapter and a few plug-in unit/probe combinations. If in doubt about compatibility, please consult your TEKTRONIX Field Engineer, Representative or Distributor.

Included Accessories—Power cable (161-0015-01); 6 x 10-cm graticule with write-in area and short minor lines (331-0111-00); 8 x 10-cm graticule without write-in area, but with full minor lines (331-0119-00); 6 x 10-cm graticule mask (331-0116-00); clear-window graticule slide assembly (122-0659-00).

PROJECTED GRATICULE for 115 volts. Order 016-0204-00	\$175
PROJECTED GRATICULE for 230 volts. Order 016-0234-00	\$175
Additional GRATICULE SLIDE ASSEMBLIES	\$3 each
Clear Window	Green Window
122-0659-00	122-0668-00
Blue Window	Amber Window
122-0667-00	122-0669-00
ADDITIONAL GRATICULES and MASKS	\$1.40 each



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MECHANICAL SHUTTER/LENS

hutter speeds from 1 to 1/100 second, plus Bulb and	Time.
f/1.9—0.7 lens, film economy; No. 3 shutter.	
Order 122-0547-00	\$200
f/1.9—0.5 lens, medium writing speed; No. 3 shutter.	
Order 122-0549-00	\$220
f/1.4—1.0 lens, full-size image; No. 3 shutter.	
Order 122-0608-00	\$385
f/1.3-0.5 lens, high writing speed; No. 3 shutter.	
Order 122-0662-00	\$360
f/1.9—0.85 lens, general purpose; No. 3 shutter.	
Order 122-0692-00	\$180





ELECTRIC SHUTTER/LENS

Requires SPEEDCOMPUTER for operation. SPEEDCOMPUTER and electric shutter are included with all C-12-E and C-27-E Cameras.







Polaroid Land¹ 3¼ x 4¼ Pack-Film Back, 8 exposures. Order 122-0671-00\$85
Focus Plate for above. Order 387-0893-02 \$1.15
Polaroid Land 3¼ x 4¼ Roll-Film Back, 8 exposures. Order 122-0603-00
Focus Plate for above. Order 387-0893-01
4 x 5 Graflok ² Back with Focusing Screen accepts standard cut- lm holders, film-pack adapters, roll-film (120) holders, Polaroid x 5 Film Holder. Order 122-0604-00
21/4 x 31/4 Graflok Back with Focusing Screen accepts standard

Order 016-0233-00 \$50

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cut-film holders, film-pack adapters, roll-film (120) holders.

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 Back to allow use of sheet film, roll film, film packs, and Polaroid 4×5 Film. Order these accessories from the manufacturer or from your local camera store.





Graphic² **Cut-Film Holder**—Darkroom load 2 sheets of cut film. (Two dark slides required). Graflex Catalog #1212 for $2\frac{1}{4} \times 3\frac{1}{4}$ Graflok Backs. Graflex Catalog #1284 for 4×5 Graflok Backs.

Graphic Film Pack Adapter—For daylight loading of 16-exposure film packs. Graflex Catalog #1232 for 2½ x 3½ Graflok Backs. Graflex Catalog #1234 for 4 x 5 Graflok Backs.





Grafmatic² Film Holder—Darkroom load-6 sheets of cut film. Graflex Catalog #1266 for 2½ x 3½ Graflok Backs. Graflex Catalog #1284 for 4 x 5 Graflok Backs.

RH/8 120 Roll-Film Holder—8 exposures, $2\frac{1}{4} \times 3-1/16$, use with 0.7 lens. Graflex Catalog #1252 for $2\frac{1}{4} \times 3\frac{1}{4}$ Graflok Backs. Graflex Catalog #1255 for 4×5 Graflok Backs.

RH/10 120 Roll-Film Holder—10 exposures, $2\% \times 2\%$, use with 0.5 lens. Graflex Catalog #1253 for $2\% \times 3\%$ Graflok Backs. Graflex Catalog #1256 for 4×5 Graflok Backs.

RH/12 120 Roll-Film Holder—12 exposures, $2\frac{1}{4} \times 2\frac{1}{4}$, use with 0.5 lens. Graflex Catalog #1254 for $2\frac{1}{4} \times 3\frac{1}{4}$ Graflok Backs. Graflex Catalog #1257 4×5 Graflok Backs.

RH/20 220 Roll-Film Holder— 20 exposures, $2\frac{1}{4}$ x $2\frac{3}{4}$, use with 0.5 lens. Graflex Catalog #1258 for $2\frac{1}{4}$ x $3\frac{1}{4}$ Graflok Backs. Graflex Catalog #1259 for 4 x 5 Graflok Backs.



RH/50 70 mm Film Holder—50 exposures, 21/4 x 23/4, use with 0.5 lens. Graflex Catalog #1240 for 4 x 5 Graflok Backs.

Polaroid Land #545 4 x 5 Film Holder—For Polaroid 4 x 5 single exposure Film Packets.

¹Registered Trademark Polarold Corporation

²Registered Trademark Graflex, Inc.









C-30A

C-31

C-32

COMMON FEATURES

- COMPACT, LIGHTWEIGHT
- EASILY-ACCESSIBLE CONTROLS
- OPTIONAL ELECTRIC SHUTTER AND SPEEDCOMPUTER

The C-30-Series Cameras are designed for TEKTRONIX Portable Oscilloscopes¹. They mount directly to the 422, 453A, and 454A Oscilloscopes and 491 Spectrum Analyzer (no additional adapter required). Camera adapters are available for other portable and full-size oscilloscopes (see page 205 for Oscilloscope compatibility). The C-30A provides an option that allows direct mounting to the 432, 434, 465, and 475 oscilloscopes. All cameras swing open from left or right, as desired, and can be quickly lifted

off when not needed. As an option, all cameras can be ordered with an Electric Shutter and SPEEDCOMPUTER in place of the standard mechanical shutter; all other features remain the same.

All cameras may be ordered with either a Polaroid² Pack-Film or Roll-Film Back, or a Graflok³ 2½ x 3½ Back, or no back. See price lines for specific ordering information.

SPECIFICATIONS

CAMERA	C-30A	C-31	C-32		
PERFORMANCE FEATURE	General Purpose Variable Magnification	Fastest Writing Speed with 0.5 Magnification	High Writing Speed with Full Size Image		
LENS	56 mm	56 mm	60 mm		
f/STOP	f/1.9 to f/16	f/1.2 to f/16	f/1.4 to f/16		
MAGNIFI- CATION	10 indexed steps, 1.5 to 0.7	Fixed 0.5	5 indexed steps, 1.2 to 0.85		
*RELATIVE LENS SPEED	1.0 Reference (f/1.9)	3.4 (f/1.2)	1.5 (f/1.4)		
STANDARD SHUTTER	Mechanically actuated, 4 to 1/50 s, plus Bulb and Time				
OPTIONAL ELECTRIC SHUTTER AND SPEED COMPUTER	Electrically actuated, 4 to 1/60 s, (within 20% fr 0°C to 40°C) plus Bulb and Time. Remote actuat is obtained with switch closure. Power requireme are 115 VAC $\pm 10\%$ or 230 VAC $\pm 10\%$, 50 to 60				
PRICE (Standard Back)			\$715 (Pack)		

*This is a comparative figure of the relative speeds (i.e. their light gathering power) of different camera lens systems. The C-30A, f/1.9 lens is the reference.

 $^1\mathrm{The}$ 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.

²Registered Trademark, Polaroid Corporation.

Option 1, C-30A only—An adapter-frame corrector-lens is installed on the C-30A. This increases the camera's field-of-view so that the full 8 x 10-cm CRT display area of the 432, 434 (8 x 10 div 0.9 cm/div), 465 and 475 Oscilloscopes can be recorded.

Dimensions and Weights-With standard back installed.

DIMENSIONS	C-30	DA-P	C-3	1-R	C-3	32-P	
	in	cm	in	cm	in	cm	
HEIGHT	5.5	14.0	5.5	14.0	5.5	14.0	
WIDTH	7.5	19.1	9.1	23.3	7.5	19.1	
LENGTH	10.0	25.5	10.6	27.1	10.0	25.5	
WEIGHT (approx)	lb	kg	lb	kg	lb	kg	
NET	4.8	2.2	6.8	3.1	5.0	2.3	
DOMESTIC SHIPPING	9.0	4.1	12.0	5.4	9.0	4.1	
EXPORT-PACKED	14.0	6.4	17.0	7.7	14.0	6.3	

Included Accessories—For all camera models, light seal for 8 x 10-div oscilloscopes (354-0279-00); light seal for 6 x 10-div oscilloscopes (354-0280-00); focus plate for Polaroid Pack-Film Back (387-0893-02); focus plate for Polaroid Roll-Film Back (387-0893-01); (Graflok Backs include a focusing screen).

³Registered Trademark, Graflex, Inc.



ORDERING INFORMATION

C-30A
C-30A-P CAMERA, Pack-Film Back
C-30A-R CAMERA, Roll-Film Back\$560
C-30A-G CAMERA, Graflok Back \$490
C-30A-N CAMERA, No Back
Option 1, ADPT-FRAME CORR-LENS Add \$10
C-31
C-31-R CAMERA, Roll-Film Back\$675
C-31-P CAMERA, Pack-Film\$640
C-31-G CAMERA, Graflok Back \$605
C-31-N CAMERA, No Back\$555
C-32
C-32-P CAMERA, Pack-Film Back \$715
C-32-R CAMERA, Roll-Film Back \$750
C-32-G CAMERA, Graflok Back \$680
C-32-N CAMERA, No Back

OPTIONAL ACCESSORIES ELECTRICALLY-ACTUATED CAMERAS

All C-30-Series Cameras are available with an Electric Shutter and SPEEDCOMPUTER, replacing the standard mechanical shutter; all other features remain the same. See Specification Chart on preceding page for details.

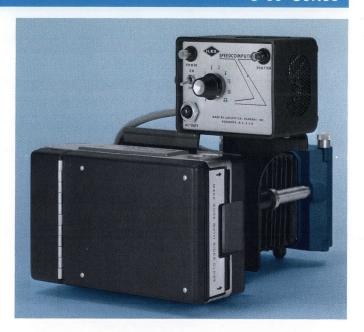
ORDERING INFORMATION C-30A

C-30A-PE CAMERA Pack-Film Back\$795

C-30A-RE CAMERA, Roll-Film Back\$83	80
C-30A-GE CAMERA, Graflok Back \$76	60
C-30A-NE CAMERA, No Back\$71	
Option 1, ADPT-FRAME CORR-LENS Add \$1	10
C-31	
C-31-PE CAMERA, Pack-Film Back\$91	10
C-31-RE CAMERA, Roll-Film Back\$94	
C-31-GE CAMERA, Graflok Back\$87	
C-31-NE CAMERA, No Back\$82	
C-32	
C-32-PE CAMERA, Pack-Film Back\$98	35
C-32-RE CAMERA, Roll-Film Back \$102	0
C-32-GE CAMERA, Graflok Back\$95	0
C-32-NE CAMERA, No Back \$90	0
C-30A Portra Lens-Extends the front focal length of the C-30A	
lens for photographing test setups. The depth of field whe	
using the portra lens will vary with the f/stop and magnificatio setting used. At f/1.9 there is very little depth of field; whil	
at f/16, the depth of field is several feet. At a distance of 2	
,	

inches, a subject area 22 inches in diameter can be covered.

der 016-0246-00 \$11



C-31-PE Shown with Speed Computer

Writing Speed Enhancer—Provides automatic-controlled film-fogging to increase writing speed at least 4 times for 3000 ASA film and 2.5 times for 10,000 ASA film. For C-30A and C-31 only. Please refer to page 206 for details and ordering information.

Camera Mounting Adapters—Available for most TEKTRONIX Oscilloscopes and some non-TEKTRONIX Oscilloscopes. See

page 205 for oscilloscope compatibility.

Optional film backs provide flexibility of performance and films. Dark slides are included with Polaroid backs to permit changing backs without exposing film.

 Pack-Film
 Back—Accepts
 Polaroid
 3¼ x 4¼
 3000-speed
 pack film,

 film,
 Order
 122-0752-00
 \$85

 Focus
 Plate—For
 Pack
 Back,
 Order
 387-0893-02
 \$1.15

Focus Plate—For Roll Back, Order 387-0893-01 \$1.15





- EASY TO USE
- LIGHTWEIGHT
- FIXED FOCUS
- LOW COST

The C-5 Camera is specifically designed for use with TEK-TRONIX 5100-Series Oscilloscopes. It is mechanically compatible with all 7000-Series Oscilloscopes, 601, 602, 603 and 604

Display Units, 528 TV Waveform Monitor and 4501 Scan Converter. A mounting adapter is not required.

The C-5 Camera features a battery-powered variable-intensity graticule illuminator for oscilloscopes with nonilluminated graticules. This illumination feature allows photography of documents, etc. A hinged door in the top of the camera housing provides a convenient view of the CRT.

The C-5 lens system is slow and should not be used where moderate- to high-writing speeds are required. The rear lens can easily be removed to extend the focus to infinity for indoorscene photography of objects at a distance of four feet and beyond with ordinary room light.

Lens— 60 mm, f/16 (fixed) trace-recording lens with a magnification of 0.68. Records $6\frac{1}{2}$ -inch CRTs on standard $3\frac{1}{4}$ x $4\frac{1}{4}$ Polaroid Film.

Shutter—Mechanically actuated with speeds of 1/5, 1/10 and 1/25 second plus Bulb and Time.

Film Back—Permanently attached Polaroid¹ Pack-Film back accepts 3000-speed film which develops outside the camera in about 15 seconds.

DIMENSIONS	in	cm	WEIGHTS (approx)	lb	kg
HEIGHT	5.2	13.3	NET	2.9	1.3
WIDTH	7.5	19.1	DOMESTIC SHIPPING	5.0	2.3
LENGTH	10.0	25.5	EXPORT-PACKED	10.0	4.5

Includes—Two 9-V batteries (146-0017-00).

C-10



LIGHTWEIGHT

FIXED FOCUS

The C-10 is a fixed-focus, light-weight, trace-recording camera designed for use with all TEKTRONIX Information Display Products which have an 11-inch CRT. Hand grips allow the C-10 to be held directly against the CRT for quick convenient photography. The fixed focus lens has sufficient depth-of-field to provide a sharp photo of the CRT display even at the largest aperture opening of f/8.

The C-10 is furnished with a Polaroid 4×5 Film Holder which attaches to 4×5 Graflok 2 Back permanently affixed to the camera body. The Graflok Back also accepts Graflex 4×5 Sheet-Film Holders and Film-Pack Adapters.

Lens— $64.4 \, \text{mm}$, f/8 trace-recording lens stops down to f/22. Magnification of 0.5, records entire 11-inch CRT on a standard 4 x 5 Polaroid film.

Shutter—Mechanically actuated with speeds from 1 to 1/125 second plus Bulb and Time.

Film Back—Graflok back with Polaroid 4 x 5 film holder mounted. Cut-film holder accepts Polaroid 4 x 5 film packets which develop outside the camera in about 15 seconds.

Mechanical—Hand held via convenient hand grips on each side. Camera housing of die-cast high-impact plastic.

DIMENSIONS	İn	cm	WEIGHTS (approx)	lb	kg
HEIGHT	8.8	22.3	NET	5.5	2.5
WIDTH	10.4	26.4	DOMESTIC SHIPPING	8.0	3.6
LENGTH	13.8	34.9	EXPORT-PACKED	16.0	7.2

Order C-10 CAMERA\$450

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²Registered Trademark Graflex, Inc.







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	ADAPTER FRAME/CORRECTOR LENS FOR C-12 OR C-27 CAMERA
			(\$16	each except where n	oted)	
321A	C-30A			016-0242-00		This adapter allows a C-12 or
422	C-30A			Integral with camera		C-27 Camera to photograph dis-
4321	C-30A			016-0301-00 ³ (\$35)		plays and adjacent scale-factor
4342	C-30A			Adapter Frame Corrector Lens		readout on the 576 Curve Tracer,
				For C-30A Only		5030 and 5031 Oscilloscopes. A
453A	C-30 Series			Integral with		corrector lens is included to com-
454A	C-30 Series			camera		pensate for the increased dis-
465	C-30A			016-0301-00 ³ (\$35) Adapter Frame	The second second	tance (2% inches) from CRT to
475	C-30A		G (45)	Corrector Lens For C-30A Only		film. Object-to-image ratio with a
485	C-30 Series			Integral		standard camera (1:0.85 lens) is about 1:0.45. The adapter frame
491	C-30A			with camera		requires use of a standard cam-
502A	C-59					era adapter (016-0226-01 for
503	C-12 or C-27	016-0226-01	016-0225-03	016-0243-00	016-0225-03	C-12, or 016-0225-03 for C-27),
504	C-12 or C-27		Integral		Integral	not included.
519 520A	C-27-662 or C-51.		with 519		with 519	Order 016-0264-01 \$35
521	C-59		016-0295-00			
522	C-59		0.0 0200 00		016-0295-00	
528	C-59	016-0263-00	016-0249-03	016-0248-00	016-0249-03	
529	C-59	016-0217-00 ²	016-0224-00	016-0244-00	016-0224-00	ADAPTER FRAME/CORRECTOR LENS
544 545B	C-12 or C-27 C-12 or C-27					SYSTEMS for
545B 546	C-12 or C-27					C-50 and C-59 CAMERAS
547	C-12 or C-27	016-0226-01	016-0225-03	016-0243-00	016-0225-03	These adapter systems expand
549	C-12	(II.I).		016-0243-005		the field-of-view of the C-50 and
556	C-12 or C-27		25	016-0243-00		C-59 Cameras so they can photo-
561B	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00	graph the large-screen CRT and
564B 565	C-12 or C-27 6 C-59	016-0226-01	016-0225-03	016-0243-00	016-0225-03	adjacent scale-factor display on
568	C-12 or C-27	016-0217-00	016-0224-00	016-0244-00	016-0224-00	the 576 Curve Tracer, and the
575	C-12	016-0226-01	016-0225-03	016-0243-00	016-0225-03	5030 and 5031 Oscilloscopes. To
576	C-12, C-27, C-50 or C-59	See A	dapter Frame/Corre	ctor Lens Systems at	right	achieve the larger field-of-view, the Adapter Frame places the
601	C-30A	016-0263-00	016-0249-03	016-0248-00	THE STATE OF THE S	camera back from the CRT an
602	C-30A	010-0200-00	010-02-43-00	010-0240-00	016-0249-03 (integral	additional 1% inches. The cor-
603 ⁶	C-5 or C-59				with camera)	rector lens compensates for this
6046	C-5 C-27-662 or C-51		016 0000 00		040 0000 00	added distance to the CRT
647A	C-27-002 OF C-51		016-0223-00		016-0223-00 016-0249-03	screen, and reduces the lens-
4501	C-30A	016-0263-00	016-0249-03	016-0248-00	(integral with camera)	system magnification so it will fully record the CRT and readout
5030	C-12, C-27	See A	dapter Frame/Corre	ctor Lens Systems at	right	display on Polaroid 31/4 x 41/4
5031	C-50 or C-59	556 7		c.c. Lone Systems at	9111	size film. Since the adapter
5100 Series ⁶ 7313	C-5 C-53	016-0263-00				frame places the camera 1% inches back from the CRT screen.
7313 7403N ⁶	C-53 C-59 or C-50	016-0263-00				the Range-Finder-Focusing sys-
7503	C-53	010-0200-00	April 100 and 100 a		a landamin had	tem of the C-50 and C-59 Cam-
7504	C-53	016-0263-00	DOMEST BY			eras cannot be utilized to indi-
7514	C-53	ka				cate when the camera is focused
7603 ⁶	C-59 or C-50	016-0299-00				on the CRT screen. Instead, use
7603N Opt 11 7613	C-53		016 0040 00	016 0040 00	016-0249-03	a Graflok Back or a Focus Plate.
	C-53		016-0249-03	016-0248-00	(integral with camera)	
7623 7704A	C-53 C-51	016-0263-00				For C-50 Camera,
7704A 7904	C-51				E / 1	Order 016-0271-00 \$50
Telequip- ment D836	C-59 or C-5	nmagen id	his den			For C-59 Camera, Order 016-0288-00 \$50
some Hewlett- Packard	call TEKTRONIX Field Office	016-0229-00	016-0228-00		016-0228-00	Focus plate for Polaroid roll-film back, Order 387-0893-01 . \$1.15
some Fairchild	or Representative	MARKE SHITH	016-0227-00		016-0227-00	Focus plate for Polaroid pack-film

Graticule is nonilluminated and will not photograph.

raticule is nonilluminated and will not photograph except when CRT is in the stored mode.
Increases camera's field-of-view so that the full 8 x 10-cm CRT display area can be recorded.

4C-50, C-51, C-52, and C-53 Cameras require Battery Pack 016-0270-00 for power when not used with 7000-Series Oscilloscopes.

5C-30-Series Cameras can only be mounted and removed from the 549 by means of the camera hinges. 6Only the C-5 and C-59 Cameras can entirely record the 6½-inch CRT display without cropping.

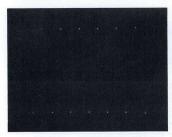
Note: Camera adapters for mounting other commercially available cameras on TEKTRONIX Oscilloscopes can be ordered from the Accessories Section of the General TEKTRONIX Catalog. NEW

Writing Speed Enhancer



This camera accessory increases photographic writing speed by accurate and repeatable film fogging. The writing speed increase for 3000 ASA film is \approx 4 times and 10,000 ASA film is \approx 2.5 times as compared to front illumination of the print without enhancement. The battery-powered unit is simple to install and easy to use. It is available for several TEKTRONIX Cameras. See price lines for specific ordering information.

The control/battery box is mounted on the side of the camera. A pulsed, diffused light source is installed between the lens and film. The exposure intensity is variable and can be initiated either manually or remotely. Automatic initiation may be accomplished by +gate, camera X-sync contacts or a ground closure. Thus fogging with this device can be accomplished three different ways: post-, pre-, or simultaneous-fogging. The latter method mentioned is the recommended mode of operation. Simultaneous fogging means concurrent with CRT phosphor decay, which is simultaneous with most of the exposure delivered to the film by the camera lens. Simultaneous fogging is accomplished by using the oscilloscope + gate pulse or camera X-sync.





Without enhancement

With enhancement

The film in the above photos was exposed with the same waveform and camera settings.

The following table lists the approximate relative writing-speed factors of three Polaroid* Film types, and the effect of controlled fogging.

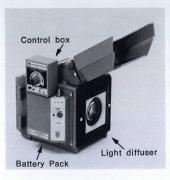
Polaroid Film	Relative Film Speed**												
Туре	No Enha	ALC: U											
	With Front Illumination of Print for Viewing	With Back Illumination of Print for Viewing	With Fogging by Writing Speed Enhancer										
107 (3,000 pack)	1.0 (Reference)	Print Base is Opaque	4.0										
47 (3,000 roll)	1.0	1.2	4.0										
410 (10,000 roll)	1.8 - 2.0	2.2 - 2.4	4.0 - 5.0										

The following table lists the approximate relative light-gathering power of most TEKTRONIX camera lenses.

Came	ras and Le	enses	Relative Lens Speeds
C-5	f/16	1:0.68	0.02
C-12†	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	0.65 1.0 1.7
C-27	f/1.9 f/1.4 f/1.3	1:0.85 1:1 1:0.5	1.0 1.5 2.6
C-30A	f/1.9	1:0.7	1.0
C-31	f/1.2	1:0.5	3.4
C-32	f/1.5	1:1	1.5
C-50	f/1.9	1:0.7	1.2
C-51	f/1.2	1:0.5	3.6
C-52	f/1.4	1:1	1.5
C-53	f/1.9	1:0.85	1.0
C-58	f/2.8	1:1	0.4
C-59	f/2.8	1:0.67	0.65

^{*}Registered Trademark Polaroid Corporation

†With light loss through beam-splitting mirror taken into account.









Examples show various TEKTRONIX Cameras with control box mounted. Clockwise from upper left: C-53, C-30A, C-12, C-27.

By using the two preceding tables and the formula below, it is possible to arrive at an approximate relative writing speed of any TEKTRONIX Camera System.

Relative Writing Speed Formula:

Relative Lens Speed X Relative Film Speed \cong Relative Writing Speed**

Example:

1.2 (C-50) X 4.0 (107 Enhanced) ≈4.8

CHARACTERISTICS

 $\begin{tabular}{ll} \textbf{Triggering--} \textbf{Manual push button or automatic when connected} \\ \textbf{to camera X-sync, or oscilloscope} + \textbf{gate.} \\ \end{tabular}$

Exposure Time—Approximately 0.5 seconds.

Repeatability-Within 5%.

Illumination—Four red, light emitting diodes, and a specially designed diffuser.

Power-Two 9-V batteries, life expectancy approx 1 year.

Exposure Indicator—Light emitting diode on panel (will not light if batteries are low).

Environment—Operating temperature range, 0° C to $+50^{\circ}$ C.

DIMENSIONS	in	lb	kg		
HEIGHT	3.0	7.6	NET	0.6	0.27
WIDTH	1.3	3.3	DOMESTIC SHIPPING	2.0	0.9
LENGTH	2.5	6.4	EXPORT-PACKED	2.0	0.9

Included Accessories—Cable for triggering from oscilloscope + gate; cable for triggering from camera X-sync; two 9-V batteries (146-0017-00).

ORDERING INFORMATION WRITING SPEED ENHANCER for:

WILLIAM O. 222 2	
C-12 and C-27 Cameras, Order 016-0280-00	\$175
C-30A and C-31 Cameras, Order 016-0284-00	
C-50 Camera, Order 016-0278-00	\$12
C-51 Camera, Order 016-0279-00	\$125
C-53 Camera, Order 016-0300-00	\$175
C-59 Camera, Order 016-0290-00	\$175

^{**}Although these average values are based upon the analysis of many photographs, they are considered tentative.



- LOW COST PER FUNCTION
 - INTERCHANGEABLE PLUG-INS
 - SMALL SIZE for EASY SETUP and REDUCED CLUTTER
 - DESIGNED for BENCH, RACK, or MOBILE USE
 - REAR PANEL ACCESS to PLUG-IN INTERFACE
 - INTRA-COMPARTMENT PLUG-IN INTERFACE for Specific applications
- FRONT PANELS COLOR CODED by FUNCTION
- RELIABLE, EASY to MAINTAIN



The TM 500 Test and Measurement System is a totally new concept for test bench equipment. It is not a scope, but is there to complement it. In the three-compartment mainframe one can combine the instrumentation required to do a job which previously required three times as much bench space and at a significantly greater cost. An added benefit of this modular plug-in approach is interface capabilities in multifunction application, i.e., connecting the output of the ramp generator to VCF input of the function generator for frequency sweeps, or monitoring the output of a signal source with the digital counter or digital voltmeter.

PRODUCT	PAGE	FEATURES
		MAINFRAMES
TM 501	216	Easy to carry; for any one of 14 plug-ins
TM 503	216-7	Compact, multi-function (accepts any three TM 500 plug-ins)
203-3	217	Mobile test station powers up to three TM 500 Series plug-ins
		DIGITAL MULTIMETER
DM 501	210	4½ digit. 0.1% DC voltage accuracy
		DIGITAL COUNTERS
DC 501	211	7 digit 100 MHz direct counting
DC 502	211	7 digit 100 MHz direct counting, 550 MHz with prescaler
DC 503	211	7 digit Universal Counter, 100 MHz direct counting
		POWER SUPPLIES
PS 501	212	Floating output 0-20 V, current limit 0-400 mA
PS 501-1	213	Same as PS 501, readout by 10 turn potentiometer
PS 501-2	213	Same as PS 501, readout by dual-range meter
PS 502	213	Dual-Tracking power supply, 10-20 V or 20-40 V
PS 503	213	Dual power supply 0-20 V or 0-40 V
		GENERATORS
FG 501	209	Function Generator, 5 waveforms, .001 Hz to 1 MHz
PG 501	214	Pulse Generator, 5 Hz to 50 MHz
RG 501	214	Ramp Generator, 10 μ s ramp duration
SG 502	215	RC Oscillator, 500 kHz sine and squarewaves
	More t	o come all in convenient plug-in format for more value



14 PLUG-INS FOR ANY OF THESE CONFIGURATIONS:



With the **TM 501** compact easy-to-carry module for any one of the 14 plug-ins currently offered.

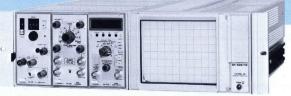


With the **TM 503** three-compartment power module for compact, multi-function installations.

With one or two **TM 503s** in a rack installation for up to three or six functions in 51/4 inches of rack height.



With a TM 503 and 604 Monitor or 603 Storage Monitor. Either monitor available with internal time base or may be swept with the RG 501 plug-in module.





ADVANTAGES OF THE TM 500 SYSTEM

Low cost per function using the plug-in concept.

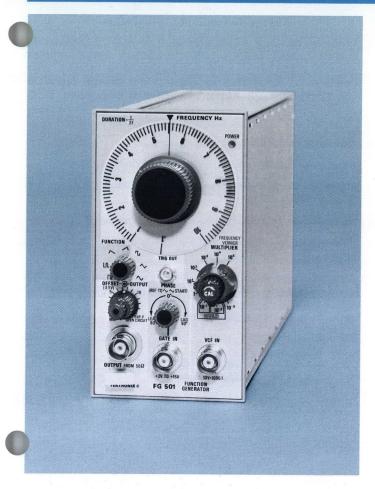
Compact and neat for reduced bench clutter.

Intra-compartment interface and auxiliary outputs for specific applications (see mainframe options).

Simplified construction, plug-in design for ease of maintenance—less down time.

Mobile Test Station powering up to 3 TM 500 Series plug-ins. The 203-3 SCOPE-MOBILE® cart also stores up to 4 additional plug-ins for use in the TM 500 System. A scope or other instrument mounts on the tilting platform.





- 5 WAVEFORMS—SINE, SQUARE, TRIANGLE, PULSE, RAMP
- .001 Hz to 1 MHz
- VCF and GATED BURST
- HOLD MODE
- TRIGGER OUT

Output Waveforms—Sinusoidal, square, triangle, positive pulse, negative pulse, positive ramp and negative ramp. Also a fixed squarewave trigger from the TRIG OUT connector. Pulses and ramps have a 20% or 80% duty cycle; occurs at \approx 1.6X dial frequency (X1 or greater); 2X dial frequency (less than X1), limited to <1 MHz.

Frequency Range—0.001 Hz to 1 MHz in decade steps.

Dial Range—X1 to X10 calibrated; accurate within 3% of full scale. (0.1 to less than 1, uncalibrated).

Time Symmetry-Within 1% from 0.001 Hz to 1 MHz.

Amplitude— 15 V P-P open circuit; 7.5 V P-P into 50 Ω load. 0.5 V P-P minimum open circuit; 0.25 V P-P minimum into 50 Ω load.

Offset Range— ± 5 V open circuit, ± 2.5 V into 50Ω load.

Hold Mode—Holds output DC level to instantaneous value present when control is actuated. Level is constant to within 5% for 1 hour at 25°C on 0.001 Hz range.

Frequency and Amplitude Stability (including offset)—Drift with temperature; within 2% from 0.1 Hz to 1 MHz; within 10% from 0.001 Hz to less than 0.1 Hz. Drift with time; within 0.5% for 10 minutes; within 5% for 24 hours.

Sinewave Distortion—Less than 0.5% from 0.001 Hz to less than 100 kHz; less than 2.5% from 100 kHz to 1 MHz.

Squarewave and Pulse Response—Less than 100 ns rise and fall times; within 5% total aberrations.

Triangle and Ramp Linearity—Within 1% from 0.001 Hz to less than 100 kHz; within 2% from 100 kHz to 1 MHz.

Voltage Controlled Frequency (VCF)—External DC or AC voltage control of output frequency; 0 to $+10\,\text{V}$ change at VCF input changes output frequency upward 1000:1 from minimum dial setting; 0 to $-10\,\text{V}$ change at VCF input changes output frequency downward 1000:1 from maximum dial setting; within any multiplier range. Bandwidth is at least 50 kHz; input impedance is $10\,\text{k}\Omega$.

Burst/Gate—Input signal requirement is at least $+2\,\text{V}$, not to exceed $+15\,\text{V}$. Squarewave input impedance is $1\,\text{k}\Omega$. Burst length is determined by the selected output frequency and gate pulse width. Bursts are synchronous with the gate. Phase is continuously variable from -90° to $+90^{\circ}$.

Trigger Output Amplitude— $+2.5\,\mathrm{V}$ squarewave into a 600- Ω load. TTL compatible.

Order FG 501\$325

TM 500-SERIES TEST and MEASUREMENT SYSTEM

NEW DM 501 Digital Multimeter



- 0.1% DC VOLTAGE ACCURACY
- 41/2-DIGIT LED DISPLAY
- AUTO POLARITY
- MEASURES VOLTS, CURRENT, RESISTANCE, TEMPERATURE

DC VOLTAGE

Range— 2 V, 20 V, 200 V and 1 kV full scale (19999 max reading), accurate within 0.1% of reading ± 1 count.

Resolution— $100 \mu V$.

Input R— 10 M Ω , 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 ± 1 count from 40 Hz to 10 kHz.

Resolution— $100 \mu V$.

Input— 10 M Ω , constant.

AC & DC CURRENT

Range— 2 mA, 20 mA, 200 mA, 2 A full scale (19999 max reading), AC RMS calibrated, average responding.

Resolution-100 nA.

Accuracy—DC Amps, 0.2% of reading ± 1 count; AC Amps, 0.6% of reading ± 1 count from 40 Hz to 10 kHz.

RESISTANCE

Range— $2~k\Omega$, $20~k\Omega$, $200~k\Omega$, $2~M\Omega$, $20~M\Omega$ full scale (19999 max reading). Accuracy within 0.3% to $2~M\Omega$, 0.5% on $20~M\Omega$ scale.

Resolution— 0.1Ω .

TEMPERATURE MEASUREMENT

Range— -55° C to $+125^{\circ}$ C (-67° F to $+257^{\circ}$ F selected by internal switch), using included temperature probe, accurate within 2° C (3.6° F). If temperature probe is not desired, order Option 1. If temperature capability is not desired, order Option 2; this capability cannot be ordered at a later date.

OTHER CHARACTERISTICS

Overrange Indication—Blinking display.

Measurement Rate-5 measurements/second.

Maximum Common-Mode Voltage— 1.5 kV isolation to ground (except interface connection).

Normal-Mode Rejection Ratio— 40 dB min at 60 Hz.

Common-Mode Rejection Ratio—With a 1-k Ω imbalance it is at least 80 dB at 60 Hz.

Ambient Temperature—Performance characteristics are valid over a temperature range of $+15^{\circ}$ C to $+40^{\circ}$ C.

ORDERING INFORMATION

DM 501\$495

DM 501 OPTIONS

Option 1 W/O TEMP PROBE (P6059) Sub \$60
Option 2 W/O TEMP CAPABILITY AND PROBE Sub \$100

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

NEW DC 500-Series Digital Counters

COMMON CHARACTERISTICS

Bright LED Displays— 7-digit stored display with automatic decimal point positioning. Leading zeroes (those to the left of the most significant digit or decimal point) are blanked. Register overflow is indicated by a flashing display in the DC 503 Universal Counter, and by a front panel LED in the DC 501 and DC 502 Counters. Other LEDs are used to indicate kHz or MHz units, and gate open.

Display Time—Continuously variable from approx 0.1 s to approx 10 s, plus hold mode for infinite viewing.

Measurement Accuracy—Within \pm 1 count \pm time-base accuracy.

Standard Time Base—Internal 1-MHz crystal oscillator accurate within 1 part in 10⁵ over 0-50°C temperature range. Long-term drift within 1 part in 10⁵ per month after 1 month.

Optional Time Base (Option 1)—Internal 5-MHz crystal oscillator accurate within 5 parts in 10⁷ over 0-50°C temperature range. Long-term drift within 1 part in 10⁷ per month.

Input R and C—Approx 1 M Ω , approx 20 pF. (Except DC 502 additional prescale 50- Ω input). 50 Ω , approx 20 pF when optional interface connection is wired to INT (DC 501 only).

Maximum Input Voltage— $500 \, \text{V}$ (DC + peak AC, or peak-to-peak AC) at 1 kHz or less.

Totalizing—Counts events from 0 to 10^7 at a maximum rate of 100 MHz. Stop, start, and reset commands are via front panel pushbuttons.

Measurement Intervals (Count Time)—Selectable in decade steps.

Measurement Intervals	Resolution
10 ms	100 Hz
100 ms	10 Hz
1 s	1 Hz
10 s	0.1 Hz
Manual	1 count

Data Inputs/Outputs—Available at plug-in connector for rouing to optional rear-panel connectors on all Power Modules, of or intra-compartment routing in the TM 503 Power Module. BCD serial-by-digit (parallel data for one digit at a time), plus lines for MHz light and decimal point (except DC 503), timing, and control functions.







- DIRECT COUNTING TO 100 MHz
- 7-DIGIT LED DISPLAY
 - MANUAL START/STOP (TOTALIZE)
 - AUTO RANGE AND TIME BASE OPTIONS

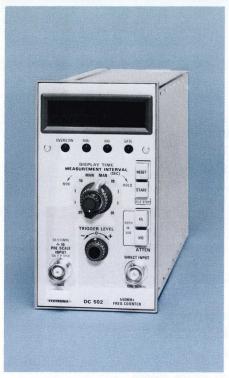
Order	DC	501						 							\$550
Order	DC	501	O p	ti	0	n	1								\$645

DC 501 Option 2

Same as DC 501 except:

Auto Measurement Interval—Automatically selects the optimum measurement interval for the input, and displays the appropriate MHz or kHz indication. Overflow is only indicated for frequencies in excess of 99.99999 MHz.

Order DC 501 Option 2 \$615



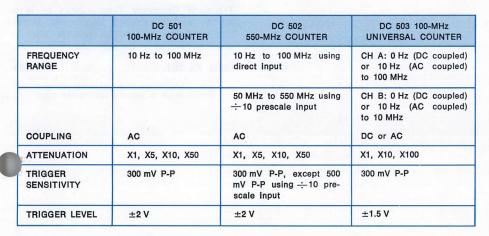
DC 502

- ullet Counts to 550 MHz with 10x prescale (50- Ω input)
- DIRECT COUNTING TO 100 MHz
- 7-DIGIT LED DISPLAY
- MANUAL START/STOP (TOTALIZE)
- TIME BASE OPTION

Same as DC 501 except:

Prescale \div 10 input—50 MHz to 550 MHz. 50- Ω impedance, 10 V P-P maximum input, 500 mV P-P sensitivity.

Order	DC	502												\$895
Order	DC	502	Option	n	1	L								\$990





DC 503

- DIRECT COUNTING TO 100 MHz
- SIX FUNCTIONS—FREQUENCY, PERIOD, RATIO, TIME A-B, TIME MANUAL, TOTALIZE
- PERIOD AND RATIO AVERAGING
- 7-DIGIT LED DISPLAY
- TIME BASE OPTION

All features of DC 501 plus:

Dual Channels—Separate inputs, attenuators, coupling and trigger level controls.

Ratio A/B—Measures the ratio of channel A signal to channel B signal averaged over N cycles of B. N selectable from 1 to 10⁶ in decade steps.

Period B—Measures the period of the channel B signal, averaged over N cycles of B. N selectable from 1 to 10^6 in decade steps. Resolution is $1 \mu s/cycle$ B.

Time A—B—Measures the time between channel A trigger (start) and channel B trigger (stop). Clock rates selectable from 1 s to 1 μ s in decade steps.

Time Manual—Measures the time between start/stop commands from front panel pushbuttons. Clock rates selectable from 1 s to 1 μ s in decade steps.

Order	DC	503														\$695
Order	DC	503	0	D	ti	0	n	1								\$790



PS 500 Series Power Supplies COMMON CHARACTERISTICS +20 V Floating Supply

Primary Power Input—Determined by power module (TM 501 or TM 503).

Output—Floating, isolated from ground, 350 V DC + peak AC.

Stability—(0.1% +5 mV) or less drift in 8 hours at constant line, load and temperature.

Indicator Lights-Voltage variation and current limit.

+5 V Ground-Referenced Supply

Output- 4.8 to 5.2 VDC at 1 A (20°C to 30°C).

Load Regulation-Within 100 mV with a 1 A load change.

Line Regulation-Within 50 mV for a 10% line voltage change.

Ripple and Noise (1A)-5 mV P-P or less.

Stability-0.5% or less drift.

Overload Protection—Automatic current limiting and over-temperature shutdown.

Data Inputs/Outputs—Available at plug-in connector for routing to optional rear-panel connectors on all Power Modules, or for intra-compartment routing in the TM 503 Power Module.

Supply output through rear connection

Remote sense

Remote analog voltage control (Except PS 502)

Remote analog current limit control (Except PS 502)

Front-panel controls and connections should be disabled if interface access is desirable.



PS 501 POWER SUPPLY

- FLOATING OUTPUT, 0 20 V
- 0 TO 400 mA
- PRECISE REGULATION
- LOW RIPPLE AND NOISE

Output— 0 V to ± 20 VDC.

Current Limit-0 mA to 400 mA.

Minimum Resolution-10 mV.

Regulation, Line—Within 5 mV for a $\pm 10\%$ line voltage change.

Regulation, Load—Within 1 mV with a 400 mA load change.

Ripple and Noise— 0.5 mV P-P or less; 0.1 mV RMS or less.

Temperature Coefficient— 0.01% / $^{\circ}$ C or less.

Transient Recovery Time— $20~\mu s$ or less for a constant voltage to recover within 20~mV of nominal output voltage after a 400~mA change in output current.

Order PS 501\$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.

Order PS 501-1\$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.

Order PS 501-2 \$150

PS 502 DUAL TRACKING POWER SUPPLY

- 10 20 V SUPPLY
- SIMPLE AND COMPACT
- IDEAL FOR BREADBOARDS AND CLASSROOM USE

Output— 10 V to 20 VDC with respect to the common terminal or 20 to 40 VDC across the + and - terminals.

Current Limit—Fixed, 400 mA.

Minimum Resolution— 7 mV.

Regulation, Line—Within 5 mV for a 10% line voltage change.

Regulation, Load—Within 50 mV with a 400 mA change.

Ripple and Noise— 3 mV P-P or less; 1 mV RMS or less.

Temperature Coefficient— 0.02% / °C or less.

Transient Recovery Time— $50 \mu s$ or less for a constant voltage to recover within 10 mV of nominal output voltage after a 300 mA change in output current.

Order PS 502 \$130

PS 503 DUAL POWER SUPPLY

- + and INDEPENDENT CONTROLS
- TRACKING VOLTAGE CONTROL
- PRESET VOLTAGE BOOST OR DROP
- OTHER FEATURES OF PS 501

Output— 0 V to 20 VDC with respect to the common terminal or 0 V to 40 VDC across the + and - terminals. Outputs can be varied independently or at a constant ratio.

Current Limit— 0 to 400 mA on each supply.

Order PS 503 \$180





- 5 Hz-to-50 MHz PLUS TRIGGERED MODE
- SIMULTANEOUS PLUS and MINUS OUTPUTS
- 5 V and 5 ns INTO 50 Ω
- INDEPENDENT PERIOD AND DURATION CONTROLS
- TRIGGER OUT

Pulse Period— 20 ns or less to 20 ms (within 5% from $0.2\,\mu s$ 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 μ s 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 $0.2 \, \mu s$ or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Risetime and Falltime-5 ns or less.

Aberrations- Within 5% at maximum output.

Pulse Amplitude—0.5 V or less to at least 5 V into 50 Ω load.

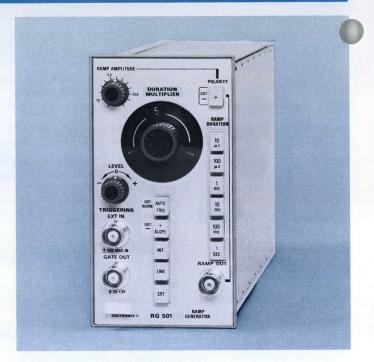
Pulse Coincidence (+ and - outputs)—Leading edge of pulse outputs within 1 ns of each other (measured at 50% amplitude points).

Trigger Output—At least $+1~\rm V$ 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.

Output Locked On—Simultaneous + and - DC outputs locked to a level determined by pulse amplitude controls.

Order PG 501 \$295



- 10 µs to 10 s RAMP DURATION
- PLUS OR MINUS OUTPUT
- 10-V AMPLITUDE
- SCOPE-TYPE TRIGGER FUNCTIONS
- GATE OUT, TTL COMPATIBLE

CHARACTERISTICS

RAMP

Ramp Duration—Decade ranges of 10 μ s 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 k Ω ; 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 k Ω . 50 V (DC + peak AC) maximum input.

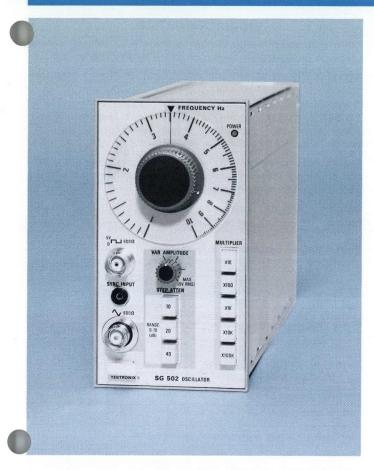
Internal Triggering—Same as external except that the trigger source is via the rear interface.

Line Trigger—Triggers at line frequency.

Trigger Level Range—±1 V.

Order RG 501\$1





SG 502 RC OSCILLATOR

- 5 Hz to 500 kHz SINE and SQUARE WAVES
- LOW DISTORTION SINE
- 5 V RMS OPEN CIRCUIT—600 Ω SOURCE
- 0-40 db continuously variable Plus 0 - 70 db in 10-db steps

SINEWAVE

Frequency Range— 5 Hz to 500 kHz in 5 decade steps. Accurate within 5% of selected frequency.

Amplitude Response—Flatness is 0.1 dB at 5 Hz to at least 50 kHz and 0.3 dB at 50 kHz to 500 kHz with 10, 20 or 40 dB of step attenuation.

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.

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 $k\Omega$.

Order SG 502 \$295

Measurements made at rated output and terminated in 600 Ω .





The TM 503 Power Module is a three-compartment mainframe for any combination of up to three 500-Series plug-in modules. It is supplied with a carrying handle, and tilt stand for convenient bench-top use.



The TM 501 houses any single 500-Series plug-in module.

CHARACTERISTICS

Power Requirements—Quick-change line voltage selector allows operation from 110 V \pm 10% or 120 V \pm 10%, 58 to 400 Hz. Specify Option 1 (no extra charge) for operation from 100, 110, 120, 200, 220 and 240 V (\pm 10% on each range), 48 to 400 Hz.

Power Consumption—Maximum primary power approx 120 W (TM 503) and 35 W (TM 501) at high line (with plug-ins). Actual power consumption depends on plug-in selection and operating modes.

Operating Temperature— 0° to 50° C. Includes power modules and all plug-in combinations. Power module contains a thermal cutout for overtemperature protection.

Operating Altitude Range—To 15,000 feet. Includes power modules and all plug-in combinations.

Power Module Dimensions and Weights

		CABINET				RACKMOUNT	
Dimensions	TM	501	ТМ	503			
	In	cm	in	cm	in	cm	
Height	6	15.2	6	15.2	5.3	13.5	
Width	3.9	9.9	8.7	22.1	19.0	48.0	
Length	15.3	38.8	15.3	38.8	15.6	39.6	
Weight (approx)	Ib	kg	lb	kg	7		
Net	5.4	2.4	9.5	4.3			
Domestic Shipping	13	5.9	17	7.7	1		
Export Packed	20	9.1	24	10.9			

500-Series Plug-in Dimensions and Weights

Dimensions	in	cm	Weights (approx)	lb	kg
Height	5.0	12.5	Net	2.2	1
Width	2.6	6.7	Domestic Shipping	10.0	4.5
Length	12.0	30.5	Export Packed	15.0	6.9

STANDARD INTERFACE

The TM 500 Series is designed so that connections between modules and/or external equipment can be made via the mainframe rear interface board and optional rear panel connectors.

Each plug-in has selected lines brought to its interface. Some of these are parallel to front panel connections, others are present only at the interface. Normally, these lines are left open, but they may be connected by the user to reduce front panel clutter or to perform functions not otherwise available. For example, digital counters have serial BCD outputs which may be brought out for data logging or processing.

A typical example of interface connection between modules is to connect the ramp output of the RG 501 to the VCF input of the FG 501 for frequency sweep, or the output of the function generator to the input of the DC 503 universal counter for frequency monitoring.

Line and terminal assignments are common for each family of modules. Today, there are three family designations: Power Supplies; Signal Sources; Digital instruments. Each family has its own pattern of circuit board notches at the interface. Interface terminal barriers may be inserted in the mainframe sthat 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).



ines Available at the Module Interface connector Digital Counters

BCD serial by digit Range code (Except DC 502) Scan clock out Scan clock in and internal scan disable Reset Time slot zero Data good

Signal in (selected by front panel switch)

These lines allow for external data logging and processing via the BCD output and associated signals. They also allow the external system to initiate the taking of a measurement, and control the rate at which the BCD serial data is scanned.

Power Supplies

Supply output through rear connection Remote sense Remote analog voltage control (Except PS 502) Remote analog current limit control (Except PS 502)

Front-panel controls and connections should be disconnected if interface access is desirable.

Signal Sources

FG 501 and FG 502

Trigger out Signal out Gate in VCF in

PG 501

+ or - Signal out selected by internal switch; suitable for DC amplitude monitor. Trigger out suitable for frequency monitor

RG 501

Ramp out Gate out Trigger in

SG 502

Sinewave out Squarewave out Sync in

OPTIONAL INTERFACE

If the power module is ordered with Option 2, it will be delivered with a rear panel multi-pin connector, mating cable connectors, and one BNC connector per plug-in compartment installed. The user may wire these to the interface board as desired. Option 2 is also supplied with square pin connectors on the rear interface board for connection between modules using the supplied jumpers terminated with square-pin receptacles. However, it is feasible to solder the desired connections without the square pins installed. Also, it is feasible to install the rear panel connectors at a later date.

ORDERING INFORMATION

TM	501	Power	Module	(without plug-in)		 \$115
M	501	Power	Module	Option 2 (without	plug-in)	 add \$55
TM	503	Power	Module	(without plug-ins)		 \$150
TM	503	Power	Module	Option 2 (without	plug-ins)	 add \$75



MOBILE TEST STATION

203-3 SCOPE-MOBILE® cart is an easy to move test station. It accepts any TM 503 Power Module and can store four additional plug-ins for use in the TM 500 System. Order 203-3 \$155



RACKMOUNTING FOR TM 503

Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount a TM 503 in a standard rack width. This includes securing hardware and a blank front panel when only one instrument is utilized. Order 040-0617-00 \$60 Cabinet-to-rackmount conversion kit, equipped with slide-out assembly, required to rackmount two TM 503s side-by-side in a

standard rack width. Order 040-0616-00 \$40 Rackmount-to-cabinet conversion kit equipped to convert a

rackmount TM 503 to a cabinet style. Order 040-0618-00

MONITOR ORDERING INFORMATION

603 STORAGE MONITOR	\$1100
603 OPTION 4, with time base	
604 MONITOR	\$ 700
604 OPTION 4, with time base	\$ 825

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 \$40



- 1-ns RISETIME
- 10 Hz-to-1 MHz REPETITION RATE
- HI-AMPLITUDE OR FAST-RISE OUTPUTS
- SYNC INPUT, TRIGGER OUTPUT

This general-purpose generator provides simultaneous positive-and negative-going output transitions with 1-ns or less risetime into $50\,\Omega$, or positive-going, hi-amplitude output with 12-ns or less risetime into $50\,\Omega$. A clean transition and flat top make the 106 ideal for checking oscilloscope transient response. It can be used in such applications as diode recovery, core testing, digital and analog design.

OUTPUT CHARACTERISTICS

CHARAC- TERISTICS	+ and — FAST-RISE OUTPUTS (terminated in 50-Ω load)	HI-AMPLITUDE OUTPUT
Risetime	\leq 1 ns at 0.5 V	\leq 12 ns at 12 V \leq 20 ns at 0.5 V \leq 120 ns with no load
Repetition Rate		from 10 Hz to at least with symmetry control
Symmetry	Duty cycle variable fro	m \leq 45% to \geq 55%
Amplitude	\leq 50 mV to \geq 500 mV	\leq 0.5 V to \geq 12 V, (\leq 7 V to \geq 120 V with no load)
Aberrations	+2%, -2% or +6 mV, -6 mV (which-ever is greater) for first 5 ns following leading edge. Typically +0.5%, -0.5% for remainder of pulse top	+2%, -2% for first 100 ns following leading edge. Typically +0.5%, -0.5% for remainder of pulse top



OTHER CHARACTERISTICS

Sync Input—Accepts sinewaves, squarewaves, or pulses. Accepts 5 V-to-100 V peak-to-peak sinewave, 2.5 V-to-50 V pulse or squarewave, 100 Hz to 1 MHz.

Trigger Output—Positive- and negative-going triggers occur within 50 ns of the rise and fall of the HI-AMPLITUDE square-wave. Positive triggers occur within 50 ns of leading edge of fast-rise outputs. Risetime is 50 ns and amplitude is 0.1 V or more into 50 Ω . Time jitter is less than 300 ps.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C.

Power Requirements— 103.5 V to 126.5 V or 207 V to 253 V, 50 to 60 Hz. Low or high range selected by rear-panel switch. Approx 85-watts maximum power consumption at 115 VAC.

Dimensions	and	Weights
פווטופוופווטוס	allu	M CIGILIS

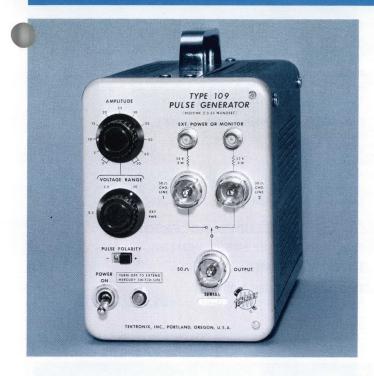
Difficitoriono una reciginte			
Height	6	in	15.2 cm
Width	9	in	22.8 cm
Depth	14	3/4 in	40.0 cm
Net weight	18	lb	8.2 kg
Domestic shipping weight	≈22	lb	\approx 9.9 kg
Export-packed weight	≈29	lb	\approx 13.2 kg

INCLUDED ACCESSORIES

5-ns, 50- Ω RG213 cable (017-0502-00); GR-to-BNC, 50- Ω thruline termination (017-0083-00); (Power cord for MOD 146B is 161-0031-00).

106 SQUAREWAVE GENERATOR	\$750
106 SQUAREWAVE GENERATOR MOD 146B	\$725
As above, but less cabinet for mounting in Rack Adapter.	





250-ps RISETIME PULSES

- ALTERNATE PULSES OF EQUAL OR DIFFERENT TIME DURATION
- 0-55 V CALIBRATED VARIABLE AMPLITUDE
- SELECTABLE POLARITY

The 109 is intended for use with fast-rise sampling or conventional oscilloscopes that generate their own internal sweep trigger. The 109 is transistorized and requires no warmup time before operating.

PULSE CHARACTERISTICS

CHARACTERISTICS	PERFORMANCE
RISETIME	Less than 250 ps
AMPLITUDE	Adjustable from 0 through 50 V
REPETITION RATE	Preset between 550 p/s and 720 p/s (using two charge lines)
PULSE DURATION	0.5 ns to max of 100 ns at full rep rate; 300 ns at half rep rate
DECAY	approx 10% in 300 ns
POLARITY	Positive or negative
OUTPUT IMPEDANCE	50 Ω

Charge Lines—Either one or two charge lines can be used to provide alternate equal or unequal pulses as desired. Equal charge lines produce a repetition rate of 550 pulses per second to 720 pulses per second.

External DC Charge Voltage Inputs—Use of external charge voltages allows alternate pulses to be of different amplitude and polarity. Maximum external charge voltage is 600 volts. With up to 100-volts input, the output amplitude will be half the external input amplitude. At voltage inputs over 100 volts, the output amplitude will be less than half the input amplitude. At pulse outputs over 50 volts, irregularities may occur.

Power Requirement—Wired for 105 to 125 V, may be ordered with the taps connected for 210 to 250 V. 50 to 800 Hz, 60 watts maximum.

Dimensions and Weights

Height	7	3/4	in	19.7 cm
Width	4	7/8	in	12.2 cm
Length	11	7/8	in	30.2 cm
Net weight	8	1/4	lb	3.8 kg
Domestic shipping weight	≈17	lb		\approx 7.7 kg
Export-packed weight	≈28	lb		\approx 12.7 kg

Included Acessories—Charge network (017-0067-00); three 5-ns $50-\Omega$ RG123 cables (017-0502-00); 3-conductor power cord (161-0010-03).

109 PULSE GENERATOR

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

10-ns Pulse Generator 114



PULSES OR SYMMETRICAL SQUAREWAVES 10-ns risetime and falltime variable pulse period, width, and amplitude \pm 10 V into 50 Ω short-proof output

The 114 is a general-purpose pulse and squarewave generator designed for laboratory and production test facilities. The broad operating range of the 114 makes it well suited for applications such as studying network response to changes in pulse period and/or width, or determining the step response of systems.

\$550

SIGNAL SOURCES

114 10-ns Pulse Generator



OUTPUT CHARACTERISTICS

(terminated in 50- Ω load)

Risetime and Falltime- 10 ns or less.

Pulse or Squarewave Periods— 5 ranges from 1 μ s to 10 ms continuously variable from 1 μ s to 100 ms.

Pulse Width (Duration)—5 ranges from 100 ns to 1 ms continuously variable from 100 ns to 10 ms.

Amplitude— 1 V to 3 V and 3 V to 10 V, positive or negative polarity. Variable within each range.

Polarity-Positive or negative.

Aberrations— +5%, -5%, total of 5% P-P (at maximum amplitude).

OTHER CHARACTERISTICS

External Trigger Input Requirement—Trigger signals $+2\,\mathrm{V}$ to $+20\,\mathrm{V}$ having a risetime of 1 $\mu\mathrm{s}$ or less. Signals up to 2 MHz may be used.

Trigger Output— 2 V or greater, open circuit; approx 0.5 V into $50-\Omega$ load. Front-panel switch sets trigger output pulse to occur at leading or trailing edge of output pulse.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C (risetime or falltime may increase to 12 ns or less at 50° C).

Power Requirements—94.5 V to 137.5 V or 189 V to 275 V, 48 to 440 Hz. Low or high range selected by rear-panel switch. 15-watts maximum power consumption.

Dimensions and Weights (with cabinet)

Height	6	in	15.3 cm
Width	9	in	22.8 cm
Depth	12	7/8 in	33.6 cm
Net weight	12	lb	5.4 kg
Domestic shipping weight	≈15	lb	\approx 6.8 kg
Export-packed weight	≈25	lb	\approx 11.3 kg

INCLUDED ACCESSORIES

Power cord for MOD 146B (161-0031-00).

114 PULSE GENERATOR	\$350
114 PULSE GENERATOR MOD 146B	\$325
As above, but less cabinet for mounting in rack adapter	

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

115 10-ns Pulse Generator with Delay



- 100 Hz-to-10 MHz REPETITION RATE
- VARIABLE DC OFFSET
- VARIABLE RISETIME AND FALLTIME
- PAIRED, BURST, GATED, UNDELAYED, AND DELAYED PULSES
- CLEAN PULSES—TOTAL ABERRATIONS
 3% OR LESS P-P
- \pm 10 VOLTS INTO 50 Ω
- SHORT-PROOF OUTPUT

The 115 is a 10-MHz, 10-V, general-purpose pulse generator with separately variable risetime, falltime, width, delay, period, amplitude, and baseline offset. It is intended for use in applications where a variety of pulse amplitudes, polarities, shapes, and other characteristics are required.

OPERATING MODES

Gated—Provides output pulses for the duration of input gate. First pulse is nearly coincident with input gate and recurs at a repetition rate determined by PERIOD control setting.

Burst—Provides output pulses for the duration of the burst time when initiated by external triggering pulse. Pulse repetition rate determined by PERIOD control. The first pulse in the burst will lag the trigger pulse initiating the burst by an amount dependent upon risetime selected.

Paired Pulses—Provides pairs of pulses; one at the time of normal undelayed pulse, and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Delayed Pulse-Provides pulse at the end of delay time.

Undelayed Pulse—Sequence of pulses with repetition rate set by PERIOD control.

OUTPUT CHARACTERISTICS (terminated in 50-Ω load)

Risetime and Falltime— 10 ns to 100 μs in four ranges, continuously variable.

Period— 100 ns to at least 10 ms in five ranges, continuously variable. (MINIMUM PULSE SEPARATION 50 ns or less, between the 50% amplitude points of any two adjacent pulses, with risetime and falltime set to minimum.)

Duty Factor—At least 75%, limited by minimum pulse separation.



Width— 50 ns to at least 500 μs in four ranges, continuously variable.



Delay or Burst Time— 50 ns to at least 500 μ s in four ranges, ontinuously variable (refer to pulse separation performance limit above).

Amplitude—Three ranges, continuously variable. At least \pm 10 V to less than \pm 200 mV with MULTIPLIER at X1, \pm 5 V to \pm 50 mV with MULTIPLIER at X0.5 and \pm 2 V to \pm 20 mV with MULTIPLIER at X0.2.

Aberrations— +3%, -3%, total 3% P-P, or 200 mV times the DC OFFSET AND AMPLITUDE MULTIPLIER settings, whichever is greater.

DC Offset—Three ranges, continuously variable. At least ± 5 V with MULTIPLIER at X1, at least ± 2.5 V with MULTIPLIER at X0.5, and at least ± 1 V with MULTIPLIER at X0.2.

TRIGGERING

A two-position, front-panel switch provides selection of internal or external trigger source. A manual push button provides a means to trigger a single undelayed pulse, delayed pulse, pulse pair, or burst of pulses.

INPUTS

+ TRIGGER

	PULSE	SINEWAVE
FREQUENCY	At least $0.5\text{-V}/\mu\text{s}$ rate of rise	1 kHz to 10 MHz
MINIMUM AMPLITUDE	+2 V	2-V peak
MAXIMUM AMPLITUDE	\pm 20 V, decreasing to \pm 4 V at 10 MHz	20-V peak, decreas- ing to 4-V peak at 10 MHz

+ Gate—Accepts gate from +2 V to +20 V.

AUXILIARY OUTPUTS

- + Pretrigger—At least 2 V into 1 k Ω .
- + Delayed Trigger—At least +2 V into $1 \text{ k}\Omega$.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of $+20^{\circ}$ C to $+30^{\circ}$ C.

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 115 watts at 115 VAC, 60 Hz. Rear panel selector provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights

Height	6	in	15.3 cm
Width	9	in	22.8 cm
Depth	15	7/8 in	42.0 cm
Net weight	15	lb	6.8 kg
Domestic shipping weight	\approx 20	lb	\approx 9.1 kg
Export-packed weight	\approx 27	lb	\approx 12.2 kg

INCLUDED ACCESSORIES

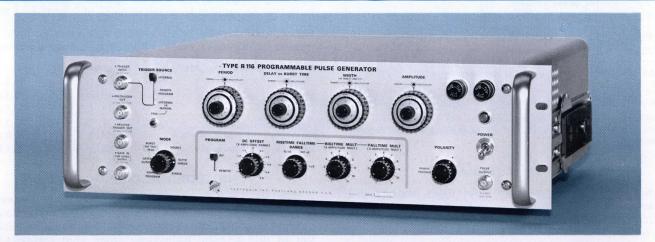
50- Ω , 5-W termination (011-0099-00); 50- Ω BNC cable (012-0057-01).

115 PULSE GENERATOR MOD 146B (without cabinet) \$1075

Same accessories as above with the addition of a detachable power cord (161-0031-00).

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

10-ns Programmable Pulse Generator with Delay R116



CALIBRATED AND PROGRAMMABLE PARAMETERS

- MODE
- TRIGGER SOURCE
 - PERIOD
 - DELAY OR BURST TIME

- WIDTH
- POLARITY
- AMPLITUDE
- DC OFFSET
- RISETIME AND FALLTIME

SIGNAL SOURCES

R116 10-ns Programmable Pulse Generator with Delay



The R116 is a broad-range, programmable pulse generator intended primarily for applications where various combinations of pulse amplitude, width, polarity, and other features are required in rapid sequence.

All functions and parameters are easily programmable with no need for extra-cost modifications. The R116 can also be operated manually from calibrated front-panel controls for initial test setup and for applications not requiring external programming. Full programming capability requires 21 bits and 7 analog lines.

PULSE CHARACTERISTICS (at 10-volts amplitude)

CHARAC- TERISTICS	RANGE	BASIC ACCURACY (% of dial)	REQUIRED PER PROGRAM
*RISETIME AND FALLTIME	10 ns to 110 μs	\pm 5% (except \pm 10% on 1 and 10 ns range. $<$ 10 ns uncalibrated.)	3 bits + 2 resistors
*PERIOD	100 ns to 11 ms	$\pm 3\%$, except shortest period range is $\pm 5\%$	4 bits + 1 resistor
*WIDTH	50 ns to 550 μs	\pm 3%, except shortest width is \pm 5%.**	3 bits + 1 resistor
*DELAY OR BURST TIME	50 ns to 550 μs	±3% +10 ns	3 bits + 1 resistor
*AMPLITUDE (into 50 Ω)	0.4 to 2 V 1 to 5 V 2 to 10 V	±3% ±15 mV ±3% ±25 mV ±3% ±50 mV	2 bits + 1 resistor
*DC OFFSET (continuous)	—5 V to +5 V	±5% ±200 mV	1 resistor
POLARITY	positive or negative		1 bit
DUTY FACTOR	At least 75	% †	
ABERRA- TIONS	+3%, -3% pulse.	%, total of 3% P-P f	or a ±10 V

^{*}These parameters are calibrated and continuously variable.

PROGRAM ACCURACY

Accuracy of the remote program when using recommended program resistor values is the same as the corresponding front-panel control plus 2%, plus any error in the value of the program resistor. For example, the period which has a basic accuracy of $\pm 3\%$ from the front panel would have a maximum error of $\pm 5\%$, plus the error in the programming resistor when it is remotely programmed. Accuracy of remote programming may be improved by calibrating the instrument for remote programming rather than for front-panel operation.

OPERATING MODES

Single-Undelayed pulses.

Delayed Single-Pulses occurring at the end of the delay time.

Double—Pairs of pulses: one occurring at the time of the normal, undelayed pulse, one occurring at the end of the delay time. 100-ns minimum pulse separation.

Burst—Output pulses obtained for the duration of Burst Time when initiated by external triggering pulse. Pulses occur at internal repetition rate.

Gated Output—Output pulses obtained for the duration of input gate. Pulses are synchronous with input gate and occur at repetition rate set by period control.

Remote Program—Permits remote programming of the operating mode. Programming requires 4 bits.

INPUTS

- + Trigger—Accepts pulses with 0.5-V/ μ s minimum rate of rise or sinewaves from 1 kHz to 10 MHz. Pulse amplitude may be +2 V to +20 V, decreasing to a maximum of +4 V at 10 MHz. Sinewave amplitude may be 2 to 20 V peak-to-peak, 1 kHz to 5 MHz, decreasing to 4 V peak-to-peak at 10 MHz.
- + Gate—Accepts gate from +2 V to +10 V. Output pulses start approx 100 ns after gate reaches +2-V level and continue until gate drops to 0 V. Output pulses synchronous with gate. DC-coupled input.

AUXILIARY OUTPUTS

- + Pretrigger— 2 V minimum into 1 k Ω .
- + Delayed Trigger— 2 V minimum into 1 k Ω .

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of $+20^{\circ}$ C to $+30^{\circ}$ C.

Power Requirements— 94.5 V to 137.5 V or 189 V to 275 V, selectable by rear-panel switch. 48 to 66 Hz, 100 watts maximum.

Dimensions and Weights

Height	5	1/4 in	13.3 cm		
Width	19	in	48.3 cm		
Depth	17	1/2 in	44.5 cm		
Net weight	47	lb	21.3 kg		
Domestic shipping weight	≈64	lb	\approx 29.0 kg		
Export-packed weight	≈86	lb	≈39.1 kg		

INCLUDED ACCESSORIES

30-inch, $50-\Omega$ BNC cable (012-0057-01); $50-\Omega$ BNC termination (011-0099-00); 36-pin remote program connector (131-0293-00); slide-out assembly (351-0084-00); set mounting hardware, cabinet feet kit (016-0052-00); 3-conductor power cord (161-0024-03).

R116 PULSE GENERATOR\$2100

^{**}Accurate only when risetime and falltime are set at minimum; if set equal width, reading is approx correct.

 $[\]dagger$ Limited by a minimum pulse separation of 100 ns between the 50% amplitude points of any two adjacent pulses with the rise and falltimes set to minimum.





- 350-kHz to 100-MHz SINEWAVES
- 5-mV to 5.5-V CONSTANT AMPLITUDE
- 50-kHz AMPLITUDE REFERENCE

The 191 is a variable-frequency, sinewave generator with a constant-amplitude output over the entire frequency range. Both output amplitude and frequency are calibrated. Amplitude is held constant during frequency variations by continuous sampling of peak-to-peak voltage.

OUTPUT CHARACTERISTICS

requency Range—Continuously variable and calibrated in 7 ranges from 350 kHz to 100 MHz, plus 50-kHz reference output. Accuracy within $\pm 2\%$ of selected frequency with output terminated in 50 Ω or unterminated (except $\pm 5\%$ on 0.5-5 V range with output unterminated).

Amplitude Range— 5 mV to 5 V peak-to-peak in 3 ranges (10 calibrated steps per range) into 50 Ω termination. Unterminated output is 2X indicated output. Amplitude is continuously vari-

able (uncalibrated) between steps and to 10% over the top of each range.

Amplitude Accuracy— 50-kHz reference output accurate within $\pm 3\%$ of indicated amplitude on 0.5-5 V range, $\pm 4\%$ on 50-500 mV range, and $\pm 5\%$ on 5-50 mV range, into $\pm 1\%$ 50 Ω termination. Accuracy improved with a more accurate termination. Unterminated output is 2X indicated amplitude, at same accuracy. When the frequency is varied from 350 kHz to 100 MHz, the output amplitude into 50 Ω (at the output connector or through no more than 5 ns of RG8 cable) will not vary more than $\pm 3\%$ from actual amplitude at 50 kHz, except when using the 5-mV range the output may vary +3%-5% on frequencies from 42 MHz to 100 MHz.

Harmonic Content-Typically less than 5%.

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C.

Power Requirements— $103.5\,\mathrm{V}$ to $126.5\,\mathrm{V}$ or $207\,\mathrm{V}$ to $253\,\mathrm{V}$, low or high range selected by rear-panel switch. 50 to 400 Hz, approx 25 watts.

Dimensions	and	Weights

Height	6	in	17.1 cm
Width	9	in	22.8 cm
Depth	15	3/4 in	40.0 cm
Net weight	16	lb	7.2 kg
Domestic shipping weight	≈21	lb	\approx 9.5 kg
Export-packed weight	\approx 32	lb	\approx 14.5 kg

INCLUDED ACCESSORIES

5-ns, $50-\Omega$ RG213 cable (017-0502-00); $50-\Omega$ GR to BNC thru-line termination (017-0083-00); right-angle, 3-conductor power cord (161-0024-03); (power cord for MOD 146B is 161-0031-00).

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

70-ps Pulse Generator 284



PULSE OUTPUT WITH 70-ps OR LESS RISETIME SINEWAVE AND SQUAREWAVE OUTPUTS COMPACT, SOLID-STATE DESIGN

The 284 Pulse Generator provides the facility for verifying the performance of Sampling Oscilloscopes. This generator offers, in one small instrument, all of the signals required to check the risetime, vertical deflection factors, and horizontal sweep rates. A pretrigger output is also provided.

In addition to checking the transient response of sampling oscilloscopes, the fast-rise step of the pulse output is an excellent $50\text{-}\Omega$ 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. Aber-

SIGNAL SOURCES

284 70-ps Pulse Generator



rations immediately following positive-going transitions are less than $\pm 3\%$, 3% total peak-to-peak; after 2 ns, less than $\pm 2\%$, 2% total peak-to-peak. Pulse amplitude is more than +200 mV into $50~\Omega$. Source resistance is $50~\Omega$.

Squarewave Output—Periods of 10 μ s, 1 μ s, 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	AMPLITUDE ACCURA			
OUTPUT	PERIOD	ACCURACY	1 V	100 mV	10 mV
Pulse	20 μs	±10%		- alling	
Square-	10 μs	±0.5%	±0.5%	±1%	±1.5%
wave 1 μs	_ 0.070	= 0.070	- 170	_ 1.5 /6	
MID:01325	100 ns	±0.05% *	±2%†	±2.5%†	±3%†
Sine-	10 ns	± 40/		± 000/	d. L.Av. S
wave 1 ns	±1%	3 2	±20%		

^{*} crystal controlled

OTHER CHARACTERISTICS

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0° C to $+50^{\circ}$ C.

Power Requirements—6.5 watts, 48 Hz to 440 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V.

Dimensions and Weights

Height	6	in	15.3 cm
Width	4	1/2 in	11.4 cm
Depth	15	in	38.1 cm
Net weight	8	lb	3.6 kg
Domestic shipping weight	≈16	lb	\approx 7.2 kg
Export-packed weight	≈24	lb	\approx 10.9 kg

INCLUDED ACCESSORIES

 $50\text{-}\Omega,$ BNC coaxial cable (012-0057-01); right angle, 3-conductor power cord (161-0024-03).

284	PIIISE	GENERATOR	 \$700

284 PULSE GENERATOR MOD 146B

As above, but less cabinet for mounting in rack adapter (power cord is 161-0031-00).

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

2101 5-ns Pulse Generator with Delay



- 2.5 Hz-to-25 MHz REPETITION RATE
- VARIABLE BASELINE OFFSET
- 5-ns RISETIME AND FALLTIME
- PAIRED, UNDELAYED, DELAYED, AND OUTPUT LATCHED ON MODES
- EXTERNAL GATE INPUT
- SIMULTANEOUS POSITIVE- AND NEGATIVE-GOING PULSES—10 VOLTS INTO 50 Ω
- SHORT-PROOF OUTPUTS

The 2101 is a compact, 25-MHz, 10-V, general-purpose pulse generator with simultaneous positive- and negative-going pulse outputs. Switch positions are provided for selection of a specific pulse period, duration, and delay, within the calibrated range of the respective control. Ranges may be extended by user-supplied capacitors to reduce the repetition rate and to increase the duration and delay. The only limiting factor in extending the range is the physical size of the user-supplied timing capacitors.

An external gate input permits output pulses for the duration of the gate signal, useful for all pulse modes, except OUTPUT LOCKED ON mode. Independent baseline offset controls are provided for the positive-going and negative-going pulse outputs.

OUTPUT CHARACTERISTICS (terminated in 50-Ω load)

Risetime and Falltime 5 ns or less.

Period— 40 ns to 400 ms in 7 ranges, continuously variable (MINIMUM PULSE SEPARATION— 20 ns or 20% of DURATION, whichever is greater, between the 50%-amplitude points of any two adjacent pulses).

Duty Factor—At least 80% for periods 100 ns or greater; at least 70% for the 0.2 s DURATION position. As the period is decreased below 100 ns, the duty factor decreases to 50% at 40 ns period. Minimum off time is 20 ns.

^{+ 20} ns after transition



Duration— 20 ns to 400 ms (to 4 s with external trigger) in 7 anges, continuously variable.

Delay— 20 ns to 4 s in 8 ranges, continuously variable (refer to pulse separation performance limit above).

Amplitude— $50-\Omega$ Internal Termination Switched Out: $0.3\,\text{V}$ or less to $10\,\text{V}$, continuously variable. Current output is $6\,\text{mA}$ or less to $200\,\text{mA}$, continuously variable. $50-\Omega$ Internal Termination Switched In: $0.2\,\text{V}$ or less to $5\,\text{V}$.

Baseline Offset— $50-\Omega$ Internal Termination Switched Out: At least + and -2 V, + and -40 mA, continuously variable around zero. $50-\Omega$ Internal Termination Switched In: At least + and -1 V, continuously variable around zero. Control calibrated for external load impedance of 50 ohms.

Aberrations— +3%, -3%, or total of 3% P-P, or +100 mV, -100 mV, or total of 100 mV P-P, whichever is greater.

OPERATING MODES

Undelayed—Sequence of pulses with repetition rate set by PERIOD control.

Delayed—Pulse output is delayed for a time interval determined by DELAY controls. Delay time is the time between leading edges of an undelayed pulse and the delayed pulse.

Paired—Provides pairs of pulses, one at the time of normal undelayed pulse and one at the end of delay time. Pairs recur at repetition rate set by PERIOD control.

Output Latched On—A DC output is provided which is locked to a level determined by PULSE AMPLITUDE and OFFSET controls.

TRIGGERING

PERIOD switch provides selection of internal or external trigger source. A manual push button provides a means to produce one pulse generation cycle when the PERIOD switch is set for EXT TRIG.

INPUTS

- + Trigger— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC to peak AC. Input resistance 200 Ω .
- + Gate— +1 V to +3 V, to a maximum frequency of 25 MHz. Maximum safe input, 5 V DC + peak AC. Input resistance 200 Ω .

OTHER CHARACTERISTICS

+ Pretrigger Out—At least 1 V into 50 Ω .

Export-packed weight

Source Resistance— $50~\Omega$ within 5% with the internal termination switched in.

Operating Temperature—Instrument operating specifications are valid over an ambient temperature range of 0°C to +50°C.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 440 Hz, 55 watts maximum at 115 VAC and 60 Hz. A rear-panel selector provides accommodation for 6 line voltage ranges.

Dimensions and Weights		
Height	4 1/4 in	10.9 cm
Width	8 in	20.3 cm
Depth	14 3/4 in	37.5 cm
Net weight	8.1 lb	3.6 kg
Domestic shipping weight	\approx 15 lb	\approx 6.8 kg

INCLUDED ACCESSORIES

Two 50- Ω , 5-W terminations (011-0099-00); three 50- Ω BNC cables (012-0117-00).

2101	PULSE	GENERATOR		\$800
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U.S. Sales Prices FOB Beaverton, Oregon Please refer to General Information page

5-ns Pulse Generator PG 501 NEW

 \approx 25 lb

 \approx 11.3 kg

- 5 Hz-to-50 MHz PLUS TRIGGERED MODE
- SIMULTANEOUS PLUS and MINUS OUTPUTS
- \bullet 5 V and 5 ns INTO 50 Ω
- INDEPENDENT PERIOD AND DURATION CONTROLS
- TRIGGER OUT

Pulse Period— 20 ns or less to 20 ms (within 5% from $0.2\,\mu s$ 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 μ s 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 μ s or more. Duty factor decreases to 50% at 20 ns period. Minimum off time is 10 ns.

Pulse Risetime and Falltime - 5 ns or less.

Aberrations- Within 5% at maximum output.

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 $+1~\rm V$ 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.

Output Locked On—Simultaneous + and - DC outputs locked to a level determined by pulse amplitude controls.

Order PG 501 \$295

See page 214 for complete description.

The TM 503 Power Module is a three-compartment mainframe for any combination of up to three 500-Series plug-in modules. It is supplied with a carrying handle, and tilt stand for convenient bench-top use.

2901 Time-Mark Generator





- 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES
- 500-MHz SINEWAVE OUTPUT
- CRYSTAL-CONTROLLED OSCILLATOR

The 2901 is a compact, wide-range, time-mark generator. It is CRYSTAL-CONTROLLED and provides 16 MARKER INTERVALS, 4 SINEWAVE FREQUENCIES, and 8 TRIGGER-PULSE INTERVALS.

Marker push buttons are self-canceling so that when any marker button is pushed other buttons are automatically released. More than one marker interval can be obtained at one time by pushing the desired buttons simultaneously. Triggers are time-coincident with the corresponding markers.

The 2901 is fully solid-state, utilizing digital integrated circuits extensively. Outputs are derived from a temperature-stabilized, 10-MHz, crystal oscillator. A rear-panel connector is provided to allow the 2901 to be used as a divider for external oscillator inputs. This instrument offers great versatility for many laboratory or production-line applications.

OUTPUT CHARACTERISTICS

Crystal-Controlled Oscillator— 10 MHz ± 10 P/M from 20° C to 30° C, 10 MHz ± 20 P/M from 0° to 50° C. Frequency stability is within 3 P/M in any 24-hour period from 20° C to 30° C. Accuracy and stability specifications are valid only after the instrument has been plugged in for 2 hours and turned on for at least 30 minutes.

Marker Output—Positive-going markers with 16 intervals from 0.1 μs to 5 s in 1-5-10 sequence, 0.5 V minimum peak amplitude into 50 Ω .

Marker Amplifier Output—Positive- or negative-going markers with 14 intervals from 1 μ s to 5 s in 1-5-10 sequence. 25-V minimum amplitude into 1 kΩ from 5 μ s to 5 s; at least + or -22 V into 1 kΩ at 1 μ s.

Sinewave Outputs—5-ns, 10-ns, and 50-ns sinewave signals at Marker Output connector with 0.5-V minimum peak-to-peak amplitude into 50 Ω . 2-ns sinewave signal at Marker Output connector with 0.3-V minimum peak-to-peak amplitude into 50 Ω .

Trigger Output—Positive-going pulses with 8 intervals of 0.1 μ s to 1 s in 1-10 sequence, 0.5-V minimum amplitude into 50 Ω , 1-V minimum amplitude into 1-M Ω .

External Clock Input—Required signal amplitude is at least 2-V peak-to-peak for sinewaves, or at least 2-V peak for pulses into 50 Ω . Frequency range is 50 kHz or less, to at least 10 MHz. The 2 ns, 5 ns, 10 ns, and 50 ns sinewaves are operative only when the external oscillator input is 10 MHz.

OTHER CHARACTERISTICS

Operating Temperature Range— 0° C to $+50^{\circ}$ C.

Dimensions	and	Weights	

Height	4	1/4 in	10.9 cm
Width	8	in	20.3 cm
Depth	10	7/8 in	27.6 cm
Net weight	9	lb	4.1 kg
Domestic shipping weight	\approx 13	lb	\approx 5.9 kg
Export-packed weight	≈21	lb	\approx 9.5 kg

INCLUDED ACCESSORIES

Two 50- Ω , BNC coaxial cables (012-0057-01); 50- Ω , BNC termination (011-0049-01).

2901	TIME-MARK	GENERATOR	\$740
			T

OPTIONAL ACCESSORIES

Rack Adapter for TEKTRONIX Generators

Adapts the generators for rackmounting in a 19-inch rack, in 5¼ inches of panel height. The 106 occupies half-rack width. Two 106's can be mounted side by side, or alongside other half-rack width generators such as the 114 Pulse Generator, 191 Constant Amplitude Generator, 115 Pulse Generator, 2101 Pulse Generator, and 2901 Time-Mark Generator. The 106 may also be mounted with a quarter-rack width 284 Pulse Generator.

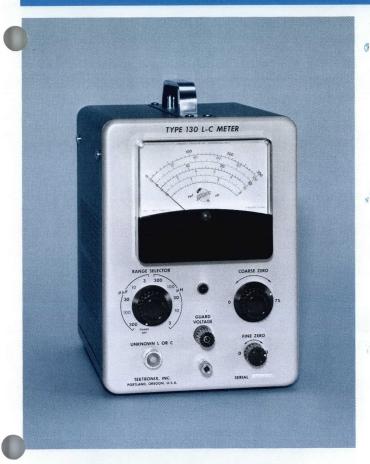
The Adapter provides forced air ventilation and rear-panel cable access. A blank panel is provided to cover the unused opening when the Adapter is not filled.

Mounting kits must be ordered separately for each instrument to be mounted. Refer to Accessories section for mounting kits for other instruments.

106, 114, 115, & 191 MOUNTING KIT, order 016-0186-00 . . . \$10 284 MOUNTING KIT, order 016-0187-00 \$15 Includes a quarter-rack width blank panel (016-0109-00).

2101 & 2901 MOUNTING KIT, order 016-0188-00\$5





- 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 $100-k\Omega$ shunt.

Inductance: as low as $20-k\Omega$ shunt, up to $10-\Omega$ series.

Correction tables in instruction manual indicate needed corrections for other values of load resistance. Actual corrections determined for each instrument at time of each recalibration.

RANGE SELECTION

Microhenrys—0 to 3, 10, 30, 100, and 300. Picofarads—0 to 3, 10, 30, 100, and 300.

ACCURACY

Meter indicates within 3% of full scale. Full scale accuracy of any one range can be improved by special calibration at the time measurement is made.

POWER REQUIREMENTS

40 watts, 50 to 60 Hz. Instrument factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V to 250 V (234 V nominal). Instrument can be ordered factory wired for 210 V to 250 V operation.

DIMENSIONS AND WEIGHTS

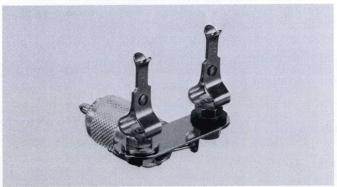
Height	$10^{5}/_{8}$ in	27.0 cm
Width	7 in	17,8 cm
Depth	111/ ₈ in	28.3 cm
Net weight	9 lb	4.1 kg
Domestic shipping weight	\approx 14 lb	\approx 6.4 kg
Export-packed weight	pprox21 lb	\approx 9.5 kg

INCLUDED ACCESSORIES

P93C Probe package (010-0003-00); black output lead (012-0014-00); red output lead (012-0015-00); 3-conductor power cable (161-0010-03).

130 DIRECT-READING L-C METER \$350

OPTIONAL ACCESSORY



PRODUCTION TEST FIXTURE

MODULAR INSTRUMENT SYSTEM 2600-Series Reference Information



The 2600 Series is a modular instrumentation system of signal generators and signal conditioners. Plug-In Modules permit a building block approach to specialized systems.

These major components, described fully on the following pages, comprise the system:

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

26A1 Operational Amplifier Plug-In, easily adapted for many uses, including processing of signals generated by other plug-ins.

26A2 Differential Amplifier Plug-In, capable of amplifying low-level signals up to 100,000 times with up to 50,000:1 CMRR.

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

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

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

2620 Stimulus Isolator, allowing true differential stimulation for biophysical applications.

The interconnection system stresses flexibility and ease of set-up change. The plug-in unit front-panel pin connectors are duplicated at the rear connector, permitting interconnection through the pull-out interconnection board system. An optional interconnection board is available which, in addition, has integrated circuit sockets to permit the easy addition of logic gates, buffers, amplifiers, etc. Spare connectors, lines, and power sources are available in anticipation of future and specialized requirements.

The characteristics of the input and output signals maintain compatibility not only with each other, but with other units such as the 7000 Series, 4501, 601, 602, 611, etc. Where applicable, inputs and outputs from the units are fully compatible with commercial logic such as DTL, TTL, etc.

2620 Stimulus Isolator

- PHYSIOLOGICAL STIMULUS ISOLATION True differential stimulation
- CONSTANT CURRENT OUTPUT
- BIPHASIC or MONOPHASIC OUTPUT
- UP to 30 mA with 100 V COMPLIANCE

The 2620 Stimulus Isolator is a tristable pulse generator designed to provide positive or negative stimulus current for biophysical applications. The output is highly isolated, conductively and capacitively, from ground-referenced generators connected to the input, thus permitting true differential tissue stimulation.

Pulse polarity and timing are determined by the input signal via an optical coupler and may be supplied from a 2600-Series pulse generator or other suitable source. The output pulse amplitudes are controlled independently at the Isolator control panel.

Power is provided by two nickel-cadmium "D" cells, operating a DC-to-DC converter. Recharging is provided by an external charger.

INPUT

Required Current for + Output— +10 mA to +20 mA.

Required Current for - Output--- 10 mA to -20 mA.

OUTPUT

Isolation, Output to Input—Impedance, 1 x 10 $^{10}\,\Omega$ or greater, shunted by 10 pF or less. Voltage, 500 V maximum.

Ranges— 0 to $\pm 300~\mu\text{A}$, 0 to $\pm 3~\text{mA}$, or to $\pm 30~\text{mA}$. +current and — current are independently variable and continuously calibrated.

Output impedance is greater than 10 $\text{M}\Omega$ shunted by approximately 25 pF.

Accuracy—30 mA range, within 3% if indicated current $\pm 600~\mu$ A. 3 mA range, within 3% of indicated current $\pm 60~\mu$ A. 300 μ A range, within 4% of indicated current $\pm 6~\mu$ A.



Voltage Compliance—At least 100 V.

Indicator-Lamp indicates the presence of an output signal.

Risetime, Falltime—Less than 2 μ s when load resistance is 3.3 k Ω or less.

DIMENSIONS AND WEIGHTS

Height	3-1/8 in	7.9 cm
Width	8 in	20.4 cm
Depth	5-7/8 in	15.0 cm
Net weight	2-3/4 lb	1.25 kg

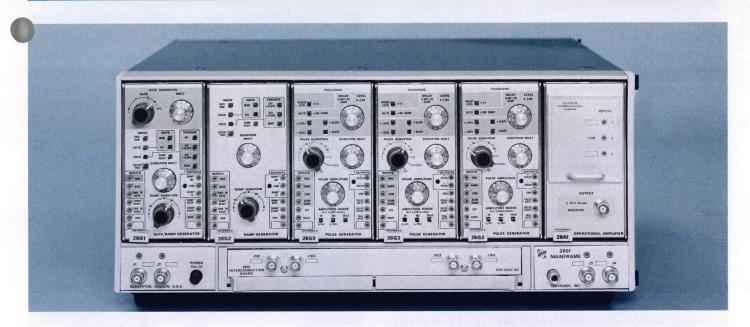
INCLUDED ACCESSORIES

Dual banana plug (103-0142-00); two nickel-cadmium batteries (146-0010-00).

 Order 2620 STIMULUS ISOLATOR
 \$450

 Extra Batteries, 146-0010-00
 \$8





- POWERS UP TO SIX PLUG-IN UNITS
- PULL-OUT INTERCONNECTION BOARD
- REAR PANEL INPUT/OUTPUT CONNECTORS

The 2601 Mainframe is a power supply and interconnection system for 2600-Series plug-in units. Its electronically-preregulated power supplies require no fan or vent holes for cooling. Further regulation, when necessary, takes place in each individual plug-in unit, thus enhancing the overall system accuracy.

Interconnection between the six plug-ins and the front- and rear-panel connectors can be made on the pull-out interconnection board, which improves appearance, reduces accidental removal, and improves control accessibility. It also allows each plug-in to be removed without interference. Additional boards may be ordered to permit different interconnection formats to suit various requirements.

CHARACTERISTICS

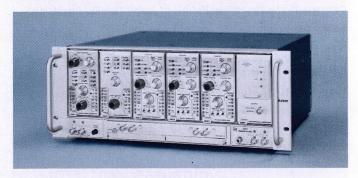
Interconnection System—Inputs and outputs to plug-ins are duplicated through the plug-in connector and the 2601 internal wiring to the pull-out interconnection board. Interconnection on the board (as well as on the front panels) is by a 0.040-inch pin-and-jack system. Low-level inputs, high-level outputs, and high-frequency signals are connected via front panel BNC connectors to maintain maximum transmission fidelity.

Preregulated Power Supplies— $+17 \, \text{V}$ at 1.25 A, $-17 \, \text{V}$ at 1.25 A, $+7 \, \text{V}$ at 6.5 A. These supplies are typically regulated within each module to $+15 \, \text{V}$, $-15 \, \text{V}$, and $+5 \, \text{V}$. Supplies are available on the pull-out interconnection board, as well as to each plug-in.

Power Requirements—Quick-change line voltage selector permits operation from nominal line voltages of 100 V, 110 V, 115 V, 127 V, 220 V, 230 V, 240 V, 250 V; \pm 10%. 95 W maximum. Line frequency range, 48 Hz to 440 Hz.

DIMENSIONS AND WEIGHTS

	260	01	R2601	
	in	cm	in	cm
Height	7 7/8	20.1	7	17.9
Width	17 5/8	44.8	19	48.4
Depth	16 1/2	42.0	15 1/2	39.5
	Ib	kg	lb	kg
Net weight	22 1/4	10.1	23	10.4
Domestic shipping weight	≈34	≈15.4	≈35	≈15.9
Export-packed weight	≈41	≈18.6	≈42	≈19



RACKMOUNT VERSION

Electrically identical to the 2601, the R2601 has the feet and handle replaced with flanges for mounting in a 7-inch space in a standard 19-inch rack. A slide-out assembly is available as an optional accessory.

INCLUDED ACCESSORIES

6 two-inch patch cords (012-0200-00); 4 six-inch patch cords (012-0201-00). R2601 also includes rackmount hardware (016-0164-00).

2601 MAINFRAME	\$495
R2601 MAINFRAME (rackmount)	\$495
2601 MAINFRAME, Option 1, without pull-out	
interconnection board and patch cords	\$450
R2601 MAINFRAME, Option 1, without pull-out	
interconection board and patch cords (rackmount)	\$450
Refer to the last page of this section for optional access	ories.

1000 M

- ± 50 V, 50 mA OUTPUT
- OPEN LOOP GAIN 10,000
- 5 MHz UNITY-GAIN BANDWIDTH

The 26A1 is an operational amplifier with a wide output voltage swing, wide common-mode range, and high slewing rates suited to a broad range of applications, including final processing of signals generated in the 2600-Series system. Plug-in terminal access adapters provide space for the necessary operational amplifier input and feedback elements; the characteristics of the operational amplifier can be altered by simply replacing adapters or the clip-on components.

OPERATIONAL AMPLIFIER

Open Loop Gain—At least 10,000 into 1 k Ω load. Unity-Gain Bandwidth—At least 5 MHz into 1 k Ω load. Common-Mode Rejection Ratio—At least 10,000:1 at 60 Hz. Slew Rate—At least 50 V/ μ s into 1 k Ω load.

INPUT

Common-Mode Input Voltage Range—At least ± 50 V. Input Leakage Current— 300 pA or less at 25° C. Equivalent Input Drift— $100 \, \mu\text{V}/^{\circ}\text{C}$ or less. Equivalent Input Noise— $10 \, \mu\text{V}$ RMS or less. Maximum Safe Differential Input— $100 \, \text{V}$.

OUTPUT

Voltage Range—At least ± 50 V. Current Limit—At least ± 50 mA. Output Resistance— $150~\Omega$ or less.

WEIGHTS

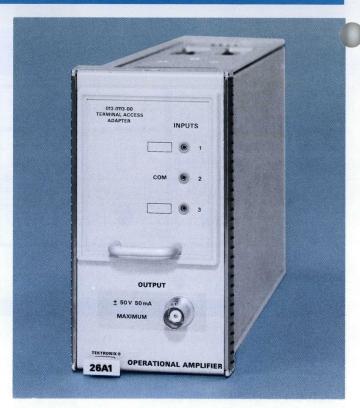
Net weight	1 1/2 lb	0.7 kg
Domestic shipping weight	≈5 lb	≈2.3 kg
Export-packed weight	≈12 lb	\approx 5.4 kg

INCLUDED ACCESSORIES

3 two-inch patch cords (012-0200-00); terminal access adapter (013-0113-00); resistor-capacitor kit (020-0039-00).

26A1 OPERATIONAL AMPLIFIER \$280

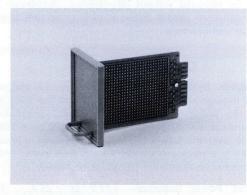
Please refer to the last page of this section for optional accessories.



OPTIONAL ACCESSORIES



Additional Terminal Access Adapters—Order 013-0113-00 . . \$15



Terminal Access Adapter Kit

Contains mechanical parts for custom-building terminal access adapter. One section of the etched circuit board mates the adapter connector in the plug-in unit; the remainder of the board is a construction area for passive or active circuitry.

Order 013-0114-00 \$8



- 100-to-100,000 GAIN
- 50,000:1 CMRR
- SELECTABLE UPPER AND LOWER 3 dB POINTS
- DC-to-1-MHz BANDWIDTH AT ALL GAIN SETTINGS

The 26A2 is a DC-coupled differential amplifier designed for use in the 2600-Series modular instrument system. Excellent common-mode rejection, high gain, and selectable high- and low-frequency —3 dB points, make the 26A2 suitable for low-frequency, low-level applications.

There are many factors which affect the usability of highgain, wideband differential amplifiers. Noise (if excessive) can make the high-gain positions unusable. Since noise is related to bandwidth, noise can be greatly reduced with a HF -3 dB POINT selector when the application allows. DC drift can also hinder measurements causing the trace to move offscreen rapidly. A small signal DC component, perhaps a few millivolts, would also place a DC-coupled display offscreen at $10~\mu\text{V/div}$. There are three ways to reject this DC voltage: (1) AC coupling the input if the signal frequency is high enough to be unaffected (2 Hz, LOWER -3 dB POINT). (2) AC coupling with the LF -3 dB POINT selector which allows lower bandwidth selection down to 0.1 Hz. (3) DC OFFSET which supplies an internal DC voltage to offset, or reject, the DC signal component.

A guard signal derived from the common-mode signal within the amplifier is available on the front panel for driving cable shields. ± 15 volts DC is also available to permit use of special active probes, transducer adapters, etc.

A front-panel lamp and a coincident logic signal output indicates most over-range conditions of excessive input signal (either differential or common-mode), excessive gain, or excessive offset.

All front-panel output connections are duplicated at a rear connector for interconnecting with other modules via the 2601 Mainframe.

AMPLIFIER

Gain—100 to 100,000 in 10 steps in a 1-2-5 sequence, accuracy within 2%. Uncalibrated variable gain between steps.

Frequency Response—DC-to-1 MHz within 15%, direct-coupled. 2 Hz or less (low-frequency —3 dB point) with input AC-coupled.

HF -3 **dB POINT**—Selectable in 9 steps (1-3 sequence) from 100 Hz to 1 MHz, accurate within 15% of selected frequency.

LF —3 dB POINT—Selectable in 6 decade steps from 0.1 Hz to 10 kHz, accurate within 20% of selected frequency.

DC Offset—At least + or - 1 V to offset signal DC component.

Common-Mode Rejection Ratio— 50,000:1 or greater, DC to 50 kHz. Range, ±5 V (DC-coupled input).

Maximum Safe Inputs—Direct coupled, 15 V (DC + peak AC); AC-coupled, 500 V DC plus 15 V peak AC.



Input R and C— 1 M Ω paralleled by approximately 20 pF.

Differential Signal Range— 50 μ V at 100,000 gain, increasing to -50 mV to +50 mV at 100 gain.

OUTPUT

High-Amplitude Output— ± 5 V, ± 20 mA maximum, short-proof to ground or ± 15 V. Output resistance 5Ω or less.

Low-Amplitude Output— $\pm 0.5 \, \text{V}$ maximum. Output resistance 50 Ω within 2%.

Maximum Voltage Drift— 10 μ V P-P per minute; 20 μ V P-P per hour; 100 μ V per °C.

Maximum Noise— 25 μ V or less (tangentially measured).

Overrange—Lamp and coincident logic signal indicates most overrange conditions.

WEIGHTS

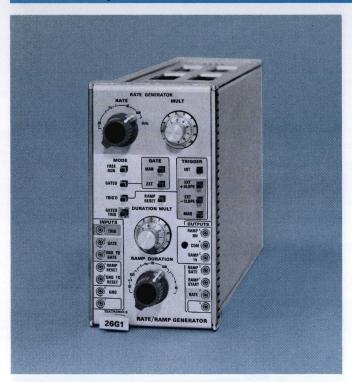
Net weight	1 3/4 lb	0.8 kg
Domestic shipping weight	\approx 5 lb	\approx 2.3 kg
Export-packed weight	≈12 lb	\approx 5.4 kg
26A2 Differential Amplifier		\$550
OPTIONAL A	COECCODIEC	

OPTIONAL ACCESSORIES

6-pin connector for the auxiliary input.

Order 131-1065-00\$10





- 0.01 Hz to 11 kHz CONTINUOUSLY CALIBRATED RATES (26G1 Only)
- 10 μs to 110 s CONTINUOUSLY CALIBRATED RAMPS
- FREE-RUN, GATED and TRIGGERED RAMP MODES

The 26G1 and 26G2 Generators produce a ramp voltage well suited to analog timing applications such as delayed triggering of pulse generators. The ramp can be triggered or gated, or both. In the 26G1 the ramp can be triggered externally, manually, or from its rate generator; the 26G2 does not have the rate generator and can be triggered externally or manually.

All front-panel connections are duplicated at the rear connector for interconnecting with other modules via the main-frame.

RATE GENERATOR (26G1 Only)

Repetition Rate—Continuously calibrated from 0.01 Hz to 11 kHz.

Output—Amplitude, +3 V within 20%; pulse width, 1.5 μ s within 30%; risetime, 100 ns or less. Output resistance is approximately 50 Ω .

RAMP GENERATOR

Ramp Duration—Continuously calibrated from 10 μ s to 110 s. Output Indicator—Indicates ramp in progress or has just occurred.

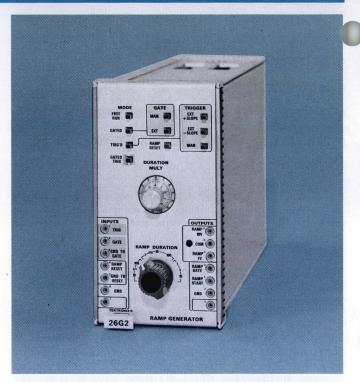
MODES

Free Run-Provides successive ramps.

Gated—Successive ramps are generated for the duration of gate signal. Last ramp is not terminated at end of gate. Internal connector permits gate to also control rate generator.

Triggered—One ramp cycle is generated for each trigger.

Gated Triggered—Allows ramp to be generated by triggers only during the time a gate signal is present.



Ramp Reset—Terminates ramp and resets circuitry for generation of new ramp (locks out ramp until released).

INPUTS

Trigger—Requires at least 1 V to generate ramp. Positive or negative slope is selectable.

Gate—Ramp generated while gate is elevated to at least 1 V (26G1 and/or rate generator with internal jumper).

Ground to Gate-Closure to ground provides ramp gating.

Ramp Reset—Ramp is reset upon receipt of at least 1 V signal.

Ground to Reset—Closure to ground initiates ramp reset.

Ground—Provides reference ground (as opposed to high current or shield ground).

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

OUTPUTS

Ramp, 10 V—Provides 10 V ramp into at least $3 \text{ k}\Omega$.

Common—Reference ground for ramp outputs.

Ramp, 1 V—Provides 1 V ramp with 50 Ω output resistance.

Ramp Gate—Provides +3 V signal during ramp generation.

 $\textbf{Ramp Start} \color{red} - \textbf{Provides} + \textbf{3 V pulse coincident with start of ramp.} \\$

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

Net weight	1	3/4 lb	0.8 kg
Domestic shipping weight	≈5	lb .	\approx 2.3 kg
Export-packed weight	≈12	lb	\approx 5.4 kg

INCLUDED ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00).

(5.12 525 7 55), 12 mon pater 5514 (5.12 5252 55).	
26G1 RATE/RAMP GENERATOR	\$430
26G2 RAMP GENERATOR	\$300



- 1 μs to 11 s continuously calibrated Pulse widths
- 1 V, 10 V, or 20 ma maximum amplitudes, continuously calibrated
- SIMULTANEOUS POSITIVE AND NEGATIVE PULSES

The 26G3 generates precise rectangular pulses whose duration and amplitude are selected by the calibrated front panel controls. The generator has accurately-controlled voltage level selection of the triggering point; when a 10-V ramp is used as a triggering source the 26G3 can pick off a voltage proportional to time, thus providing a calibrated time delay.

PULSE GENERATOR

Pulse Duration—Selects calibrated pulse durations of $1\,\mu s$ to 1 s in decade steps. Also selects Bistable mode where each succeeding trigger reverses the output state, and DC mode which provides a continuous output as determined by amplitude controls.

Duration Multiplier—Selects continuously calibrated pulse durations from 1.00 to 11.00 times pulse duration.

Output Indicator—Indicates pulse is in progress or has just occurred.

Output—Simultaneous (within 50 ns) positive and negative pulses, continuously calibrated over three ranges: 0 to 1 V, 0 to 10 V, or 0 to 20 mA.

Accuracy—Amplitude, within 1% of full scale after the first 10%. Within 3% of indicated duration from 1 μ s to 100 ms, within 5% on 1 s range.

Source Resistance—1 V range, 50 Ω within 1%. 10 V range, 500 Ω within 1%.

Risetime, Falltime— 200 ns or less for pulse amplitudes of 10% to 100% of full scale.

Delay After Trigger - 250 ns or less.

TRIGGER MODES

Preset Level, 1 V—Triggering level passing +1 V initiates output pulses.

Delayed, +10 V Ramp—Triggering occurs as the +10 V ramp passes the amplitude level selected by the calibrated Delay control.

+ or - Triggering—Occurs at a selectable level and slope between 0 and + or -10 V.

INPUTS

Trigger—Accepts input signals for preset level, plus level and minus level modes.

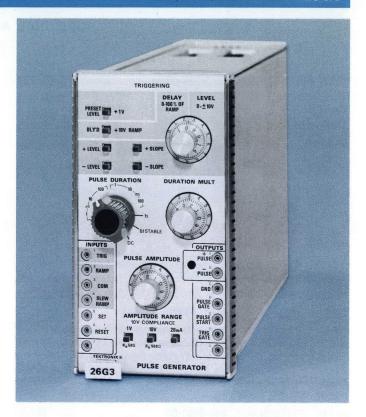
Ramp—Accepts +10 V ramp for delayed trigger mode.

Common—Reference ground for ramp inputs.

Slew Ramp—Accepts signal to algebraically sum with ramp. **Set**—At least +1 V required to set output to high state independent of other inputs.

Reset—At least +1 V required to reset output to low state independent of pulse width control.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.



OUTPUTS

+ **Pulse**, — **Pulse**—Provides simultaneous positive- and negative-going pulses.

Ground-Provides reference ground for output signals.

Pulse Gate—Provides $+3\,\mathrm{V}$ gate signal, coincident with output pulse.

Pulse Start—Provides $+3\,\mathrm{V}$ trigger signal, coincident with leading edge of pulse.

Trigger Gate—Provides a signal that is 0 V before triggering level is reached and +3 V after triggering level is passed.

Spare—No internal connection. May be wired for specific signal input or output. Connected through to rear connector.

WEIGHTS

Net weight	1	3/4 lb	0.8 kg
Domestic shipping weight	≈5	lb	\approx 2.3 kg
Export-packed weight	≈12	lb	≈5.4 kg

INCLUDED ACCESSORIES

2 two-inch patch cords (012-0200-00); 2 six-inch patch cords (012-0201-00); 12-inch patch cord (012-0202-00).

26G3 PULSE	GENERATOR	\$485



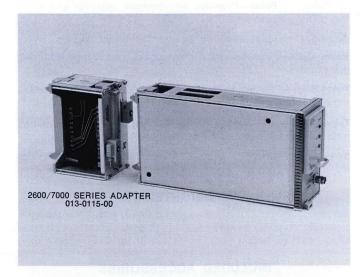
OPTIONAL ACCESSORIES





Provides mechanical parts and instructions for construction of specialized plug-ins. The kit includes a short board to mate the plug-in to the mainframe connector; also available is a long board which has an area for circuitry construction, and a regulator board which provides $+15\,\mathrm{V}$, $-15\,\mathrm{V}$, and $+5\,\mathrm{V}$ when installed in the blank plug-in.

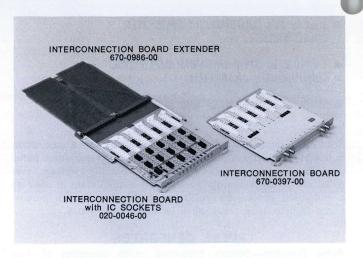
BLANK PLUG-IN KIT, 040-0561-00	\$27.50
LONG BOARD, 670-0972-00	\$25.00
REGULATOR BOARD, 670-0971-00	\$60.00



2600/7000-SERIES ADAPTER

Permits the 2600-Series Plug-ins to be operated in 7000-Series Oscilloscopes. The adapter provides regulated power to the plug-in and extends the plug-in length for mechanical compatibility. It also permits limited input or output interconnections between the plug-in and oscilloscope.

0.4 010 0115 00	\$50.00
Order 013-0115-00	 φου.υυ



INTERCONNECTION BOARD

INTERCONNECTION BOARD with IC SOCKETS

In addition to the interconnection area, this board has 14 sockets for 16-pin dual in-line package integrated circuits, and a regulated 5-V supply. Each socket pin is connected to a 40-mil pin jack. Construction is possible of virtually unlimited combinations of plug-in functions with DIP IC logic gates, pulse transformers, resistor networks, operational amplifiers, etc.

Order 020-0046-00 \$125.00

INTERCONNECTION BOARD EXTENDER

Allows access to board connectors while instrument is in operation.

Order 670-0986-00 \$60.00

CABLES, CORDS, AND CONNECTORS

BNC-to-0.040 inch Pin Adapter Cable, 175-1178-00	\$10.00
2-inch Red Patch Cords (package of 25), 012-0200-01	\$20.00
6-inch Blue Patch Cords (package of 25), 012-0201-01	\$20.00
12-inch Black Patch Cords (package of 25), 012-0202-01	\$25.00
Pin/Jack Combination (package of 50), 020-0036-00	\$15.00
Panel Jacks (package of 25), 020-0037-00	. \$7.50
Board Jacks (package of 25), 020-0038-00	. \$4.00

R2601 SLIDE-OUT ASSEMBLY

Order 351-0296-00 \$16.20



- DISPLAYS ECG, EEG, or PULSE WAVEFORMS
- SOLID-STATE RELIABILITY, QUICK TURN-ON
- HEART RATE BEEP and ARREST ALARM
- UP to 8 HOURS OPERATION on INTERNAL BATTERY PACK

The 410 provides dynamic displays of the electrocardiogram, electroencephalogram, or pulse. It is especially useful to the anesthesiologist during surgery, and battery operation allows its continuous use as the patient moves into recovery and special care area.

Ease of operation, with a minimum of controls, contributes to the usability of the 410, as do its other features: 4-second recovery after overdrive by defibrillator or cauterizer, output for strip-chart recorder, and a cabinet finish that is durable and washable.

ECG Measurements:—Heart rates from 35 beats/min to 180 beats/min can be directly read by observing the point on the CRT graticule scale where the second R wave occurs. A beep sound coincides with each R wave. Thus a sudden change in heart rate can be quickly detected, without constant observation of the display.

The 410 is supplied with a heavy-duty limb lead cable intended for use during surgery and in general ECG monitoring applications. Six commonly-used lead configurations can be selected: I, II, III, aV $_{\rm R}$, aV $_{\rm L}$, and aV $_{\rm F}$. Disposable, pre-gelled electrodes are supplied. Common needle electrodes, plate electrodes, Ag/AgCl electrodes and other miscellaneous types, including the V. Mueller back pad, may also be used.

EEG Measurements (Optional)—The optional EEG electrode cables (+ and -) accept the same electrodes and use the same attachment methods as mentioned for ECG measurements. The EEG cables require the optional multi-purpose patient cable (012-0120-00). See PATIENT INTERFACE ACCESSORIES listing.

Pulse Measurements (Optional)—The optional photosensitive pulse sensor, containing a light source and photoresistor, is attached to the patient's finger. As the pulse occurs, the amount of blood in the finger changes the amount of light reaching the photoresistor. The resulting display provides a quick indication of heart rate. A beep sounds coincident with each pulse, giving an audible as well as visible indication of the patient's heart activity. The sensor requires the optional multi-purpose patient cable (012-0120-00). See PATIENT INTERFACE ACCESSORIES listing.

Audio Signal—Beep sounds at heart rate, providing audible indication of normal or arhythmic heart rate. Automatic alarm sounds if there is a loss of signal for 2 to 4 seconds. Loudness is adjustable. Using the audio output jack disconnects the internal speaker. Signal is disabled in the EEG mode.



Battery Operation—Removable battery pack contains 10 size "C" NiCd cells, provides 6 hours operation with full accessory load when display baseline stays within 3 divisions of graticule center, increasing to 8 hours in ECG or EEG with baseline kept within 1 division of graticule center. Time decreases above 25°C. Internal charger provides recharge in 14 to 16 hours, operates from 90 V to 136 VAC or 180 V to 272 VAC, 48 Hz to 440 Hz, requires 7 W or less at 115 V, 60 Hz. Monitor can also be operated from line (with reduced charge to battery pack).

The battery pack incorporates an automatic battery disconnect that terminates discharge before batteries are harmed. The disconnect is activated if the instrument is operated for a prolonged period with the battery condition indicator in the red area.

Portability—During surgery the Monitor can be conveniently positioned (using the optional mounting stand) at the five-foot level on the anesthesiologist's gas machine for easy viewing, then lifted off and carried with the patient to the recovery room. The 12½-pound weight and battery operation permit ease of use during ambulance transport, and continuous monitoring as patients are moved through emergency, surgery, and recovery areas.





Bandwidth—ECG and Auxiliary modes— 0.1 Hz or less to 250 Hz, \pm 15%. EEG mode— 0.1 Hz or less to 100 Hz, \pm 15%.

Sensitivity—ECG mode— 20 mm/mV, $\pm 5\%$. EEG mode— 10 mm/50 μ V, $\pm 5\%$. Auxiliary mode— 2 mm/mV, $\pm 5\%$.

Common-Mode Rejection Ratio—At least 100,000:1 in ECG and EEG modes, at 60 Hz, and with 5-k Ω source impedance unbalance. Good rejection reduces the effects of electrostatically coupled or magnetically induced interference which may otherwise be displayed along with the patient's signal.

Common-Mode Dynamic Range— +3 V to -3 V.

Differential Dynamic Range—Monitor gain characteristics are valid with an input terminal DC potential difference (offset) of up to 50 mV. Typically less than 10 mV difference exists between Ag/AgCl electrodes. At least 100 mV of either polarity can be applied with no more than 5% reduction in amplifier gain.

Differential Input Resistance— $2\,M\Omega~\pm15\%~$ in EEG and ECG mode, $20\,M\Omega~\pm15\%~$ in Auxiliary mode.

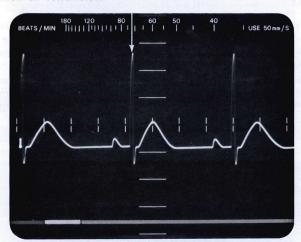
Drift-0.5 cm or less per hour after 10-second warm-up.

Display Noise— 0.1 cm or less in the calibrated EEG mode, input shorted.

Sweep Speeds— 25, 50, and 100 mm per second; accurate within 5%. Sweep is triggered in ECG and AUX operating modes.

Waveform Size—Vertical size of ECG, EEG, and pulse waveforms is continuously variable from $\frac{1}{3}$ to 3 times the height of the calibrated display.

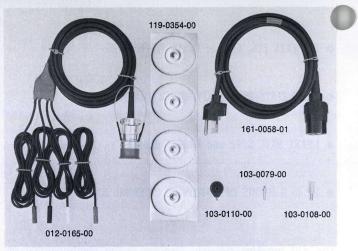
Cathode-Ray Tube—5-inch rectangular CRT as 8 x 10-cm viewing area. P-7 phosphor has long decay time for convenient viewing at slow sweep speeds. The external graticule has a graduated heart-rate scale at the top, a battery-condition scale at the bottom, and a vertical and horizontal center-line scale marked in centimeters.



Simulated ECG display-approx 72 beats/minute

Dimensions and Weights

Height	5.4 in	13.7 cm
Width without handle	8.5 in	21.6 cm
Width with handle	9.1 in	23.2 cm
Depth without handle	10.8 in	27.3 cm
Depth with handle	12.9 in	32.7 cm
Weight without accessories	12.5 lb	5.7 kg
Domestic shipping weight	≈23 lb	\approx 10.4 kg
Export-packed weight	≈34 lb	\approx 15.4 kg



REPRESENTATIVE ACCESSORIES

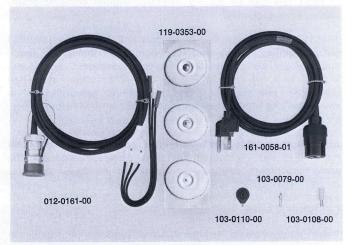
Included Accessories—Limb lead cable (012-0165-00); 12 GEL-PAD* disposable pregelled Ag/AgCl electrodes, 3 packs of 4 each (119-0354-00); 4 electrode snap adapters (103-0110-00); 4 plate adapters (103-0079-00); 4 needle adapters (103-0108-00); power cable (161-0058-01).

*TM NDM Corporation

Order 410 PHYSIOLOGICAL MONITOR\$975

INSTRUMENT OPTIONS

The 410 may be purchased with different accessories, or without the full complement of included accessories. These options allow maximum flexibility and value for the user. I requirements are expanded subsequent to initial purchase, additional accessory packages are available. See next page.



Chest Lead Option—The chest lead option includes a heavy-duty chest lead cable intended for patient monitoring in an intensive care environment (012-0161-00); 9 GEL-PAD disposable pregelled Ag/AgCl electrodes, 3 packs of 3 each (119-0353-00); 3 electrode snap adapters (103-0110-00); 3 plate adapters (103-0079-00); 3 needle adapters (103-0108-00); power cable (161-0058-01).

Basic Accessory Option—Includes power cable (161-0058-01) Select patient interfaces from next page.

Order 410 OPTION 2 PHYSIOLOGICAL MONITOR \$875



ELECTRODE ADAPTERS

All mate with #4/40 threaded ends of limb lead cable, chest lead cable, and electrode leads





For use with plate electrodes, suction cup, V. Mueller back pad, etc.



Needle Adapter 103-0108-00

103-0108-00 \$1.10 Supplied with 410 and with 410 Option 1

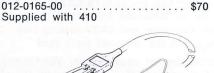
For use with hypodermic needles, etc.



Bare Wire Adapter 103-0080-00

\$3.40

PATIENT CABLES Limb Lead Cable







Multi-purpose Cable 012-0120-00\$77 For use with pulse sensor, ECG and EEG electrode leads

Electrode Leads all leads \$8 Use only with cable 012-0120-00



LA 012-0169-00 LL 012-0170-00 RA 012-0171-00

+EEG 012-0174-00 RL 012-0172-00 -EEG 012-0175-00 C 012-0173-00

ELECTRODES

Reusable Ag/AgCI Electrodes

ATTACHMENT METHODS

For TEKTRONIX reusable electrodes

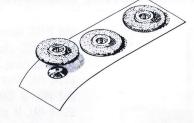


Adhesive RingsPacks of 102 ea
006-1099-00 ... \$3.70





Surgical Tape or Self-Adhering Foam Pads (use 3M Reston No. 1560 or 1561) can also be used.



GEL-PAD disposable pregelled Ag/AgCl

NDM catalog #1030 packs of 3 each. Sold only in boxes of 10 packs, order 10 ea 119-0353-00 \$2.10

NDM catalog #1040 packs of 4 ea. Sold only in boxes of 10 packs, order 10 ea 119-0354-00 \$2.70

GEL-PAD and other compatible brands of disposable electrodes can be purchased from local hospital supply outlets.

OPTIONAL ACCESSORIES



Mounting Bracket—Mounts the 410 to flat surface, permits tipping the Monitor for convenient viewing. Mounting screws not included. Order 407-0393-01\$5

Battery Pack—Extra battery pack, in addition to the one supplied with the 410, allows one pack to charge while the other is powering the Monitor. Pack contains 10 size "C" NiCd cells and battery charger.

Order 016-0107-02 (for SN B100000 and ABOVE) \$140 Order 050-0478-00 (for SN B099999 and BELOW) \$146

7-Pin Plug—Used on pulse sensor, order 134-0090-00 ... \$3.50



INFORMATION ABOUT PRODUCTS FOR TELEVISION

This section gives an overview of TEKTRONIX products useful to people concerned with engineering, operating and maintenance of any television system. A full description of the products shown here is available in the TEKTRONIX TELEVISION PROD-UCTS CATALOG which is sent to those on our Television and CATV Mailing Lists and will be sent to you at your request. There is a reply card enclosed for requesting a copy of the TELEVISION PRODUCTS CATALOG. Other material of interest, such as Television Application Notes, is mailed periodically to our Television and CATV Mailing Lists. To receive these mailings, use the enclosed reply card.

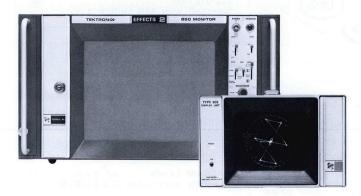
There are, of course, other TEKTRONIX products that are of interest to people concerned with the television signal. These products are described in full on pages preceding and following this section. The following products are of particular interest:

Spectrum Analyzers; Time Domain Reflectometers (cable fault finding); and 7B53A Option 5 and 465 Option 5 Oscilloscop We also suggest that you review the 7000-Series listings of mainframes and plug-ins for information on specialized applications.

Television Signal Quality

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. We are proud to be one of the leaders in advancing the state-of-the-art.

COLOR PICTURE MONITORS



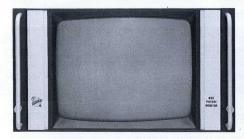
650 Series Monitor with 602 MOD 174 V

The 650-Series Color Picture Monitors are measurement quality monitors with the features and accuracy required to reliably assess signal quality. The construction of a 650-Series Monitor allows us to economically produce monitors for any standard used anywhere in the world. Multistandard, RGB and Vector Display versions all maintain a uniform quality of performance previously unavailable.

The 650 Series

650 NTSC Color Picture Monitor	\$2500
650-1 NTSC plus RGB Color Picture Monitor	2600
651 PAL Color Picture Monitor	2700
651-1 PAL plus RGB Color Picture Monitor	2800
652 PAL M Color Picture Monitor	2700
652-1 PAL M plus RGB Color Picture Monitor	2800
654 RGB Color Picture Monitor	2500
654-1 RGB plus RGB Color Picture Monitor	2600
655 NTSC plus PAL Color Picture Monitor	2900
655-1 NTSC plus PAL plus RGB Color Picture Monitor	3000
658 PAL M plus NTSC Color Picture Monitor	2900
658-1 PAL M plus NTSC plus RGB Color Picture Monitor	3000
659 PAL M plus PAL Color Picture Monitor	2900
659-1 PAL M plus PAL plus RGB Color Picture Monitor	3000
For Vector Display Option	
Option 2 (single standard) add	35
Option 2 (dual standard) add	100
602 MOD 174 V	975
604 MOD 174 V	725

MONOCHROME PICTURE MONITORS



631 Monochrome Picture Monitor .. \$735 632 Monochrome Picture Monitor .. \$750





633 Monochrome Picture Monitor .. \$800

The 631, 632 and 633 Monochrome Picture Monitors are designed for measurement and qualitative evaluation of 525/60 and 625/ 50 standards. The monitors have many features in common such as a choice of D6500 or W9300 K phosphors. High resolution is maintained at full drive. Bandwidth is 6 MHz within 0.5 dB with 100% white amplitude.

The monitors are all solid-state (except kinescope) and require only 101/2 inches (14 inches for 633) of rack space. A rectangular kinescope with 3:4 aspect ratio is used.





NTSC TEST SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

SIGNAL	140	144	146	147	149	1430
EIA Color Bar	X	Х	X			
Color Bar/Luminance Signal		7	Х			
Full-Field Color Bar	Х*	Χ*	Χ*		X*	
Modulated 5 Step Staircase ¹	Χ*	X*	Χ*	X*	X*	
Modulated 10 Step Staircase ¹	Х*	Χ*	X*	X*	X*	1 10
Modulated Ramp ¹	THE LINE		1	X*	X*	- HATE
Modulated Pedestal ²	Х*	X*	X*		X*	
Composite Test Signal ³				X*4	X*5	
Convergence Pattern	Х	Х	X			Pullan.
Full Amplitude Multiburst ⁶				X*	X*	
Sin ² Pulse & Bar				X*	X*	
Sin ² Pulse & Window		1 1		Х	Х	
Field Square Wave				X	X	
Noise Measuring Capability				X*		X*
Vertical Interval Reference Signal (VIRS)	7- 4			VITS only	VITS only	
Flat Field (Variable Level)	X*	Χ*	Х*	X	Х	
Flat-Field Bouncing APL	The same			Х	Х	

A few signals may require reprogramming and some signals may not be available simultaneously.

X Full-Field Signal

May be programmed as a VITS.

Modulation may be turned off.

- ² Modulated pedestal meets requirements of Satellite Technical Operating Committee (STOC). Signal II.
- ³ 5 step staircase, 2T, 12.5T White Bar.
- ⁴ Standard programmed for STOC Signal I; Option 1 programmed for FCC 73.699.
- ⁵ Standard programmed for FCC 73.699; Option programmed for STOC I.
- ⁶ Reduced amplitude M.B. on 147 Option 1/149 meets FCC 73.699.
- ⁷ In Multiple Mode Only.

NTSC TIMING SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

	140	144	146	147	149
Gen-lock Input			Х	Х	Х
Comp Sync	Х	Х	Х	Χ*	Χ*
Subcarrier	Х	Х	Х	Χ*	Χ*
Comp Blanking	Х	Х	Х		Total Control
Burst Flag	Х	Х	Х		
H Drive	Х	Х	Х		
V Drive	X	Х	Х		
External Comp Sync Input	Х	Х		a las	RIT
External Subcarrier Input	Х	Х	Х		

^{*} When Gen-locked



R140 NTSC Signal Generator (rackmount) \$2150



R144 NTSC Signal Generator (rackmount) \$25



R146 NTSC Signal Generator (rackmount) \$2



PAL TEST SIGNALS AVAILABLE FROM TEKTRONIX GENERATORS

SIGNAL	141A	142	148
EBU Colour Bars	FF I	FF I	
Colour Bars/Luminance Reference		FF	
Modulated Staircase 5 Step ¹	FF I	FF I	FF I
Modulated Staircase 10 Step ¹		-17/-	FF I
Modulated Ramp ¹	J-P		FF I
Modulated Pedestal ¹		FF I	
Composite Test Signal ²			FF I
Sin ² Pulse and Bar		X	FF I
Sin ² Pulse and Window			FF I
Field Square Wave			FF
Flat Field			FF
APL Bounce			FF
Noise Measuring Capability			FF I
Convergence Signal	Order Mod 703Z	FF	
ITS, International Per EBU Line 17	in a real and a real a	la State	FF** I
Line 18	Marine P	h"	FF** I
Line 330			FF** I
Line 331			FF** I

Signals are not necessarily simultaneous and a few require simple reprogramming.

FF Full Field

- I ITS
- Modulation may be turned off
- ² Bar, 2T, 20T, 5 step staircase
- ** Any two of these may be time shared with 6 lines of flat field to set APL



R147 NTSC Signal Generator (rackmount) \$2900



R149 NTSC Signal Generator (rackmount) \$3900

PAL SYNC & TIMING

SIGNAL OUTPUTS	141A	142	148
Composite Sync	х	Х	Х
Composite Blanking	Х	Х	
Subcarrier	X	Х	Х
Burst Flag	X	Х	dune!
PAL Pulse	х	X	auto 1
Line Drive	Х	Х	hibol
Field Drive	X	Х	201190-
1 MHz Reference	Х		P P S
25 Hz	Х	T. S. Ball	Ci. chi
12.5 Hz	X	T. R. Tabili	9 701
SIGNAL INPUTS			
Gen-lock Input	tion or staff - I	Wishii I	Х
External Sync Input	Kle Ke Y pider	Х	X
External Subcarrier Input	ding Alf	Х	10-16
Pal Pulse	Maria de la compansión de	il s Min elec	Х
Burst Flag		Angelia b	Х
4.43 MHz	THE ROPE HISTOR	Internation of	Х

SIGNAL GENERATORS

The 140-Series Signal Generators are compact solid-state sources of high-quality television test, drive and convergence signals. Combined in compact units are the test signals needed to accurately test, evaluate and adjust closed circuit and standard broadcast color video equipment. Each test signal conforms with industry standards, and provides additional refinements to enhance both the accuracy and range of measurements which can be made. Complete information will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.



R141A PAL Signal Generator (rackmount) \$2150



R142 PAL M Signal Generator (rackmount) \$235



R148 PAL Signal Generator (rackmount) \$3500



VECTORSCOPES



R520A NTSC Vectorscope (rackmount) \$2850

Vector presentations of relative phase and gain of the chrominance signal are just one function of TEKTRONIX Vectorscopes. Additional functions include linear sweep display at line rate of the luminance (Y) component as well as the chrominance signal and the measurement of differential phase and gain. Test signals in the vertical interval can be displayed using the digital line selector.

R521A	PAL	Vectorscope (rackmount)	\$2850
R522A	PAL	M Vectorscope (rackmount)	\$2850

WAVEFORM MONITORS



528 Waveform Monitor . \$1000



529 Waveform Monitor . \$1560



RM529 Waveform Monitor (rackmount) \$1575

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.

OTHER TELEVISION INSTRUMENTS



137 Chrominance/Luminance Gain Normalizer \$ 345

A TEKTRONIX 137 or 138 Chrominance/Luminance Gain Normalizer simplifies the measurement of chrominance to luminance gain differences and the calculation of delay when testing with modulated sine-squared pulses. The Normalizer is a passive, signal-quality measurement tool. It is not a device for improving the quality of the signal and is not designed for in-line testing.



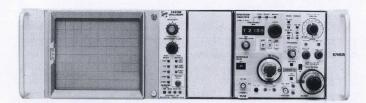
1430 Random Noise Measuring Set \$1400

The 1430 Random Noise Measuring Set provides random noise measurement capabilities on an in-service basis using the spatially-adjacent noise-matching technique. A program channel is provided for deletion of VITS and/or on selected lines in the vertical blanking interval and a monitor channel is provided for making measurements with a waveform monitor.

Complete details will be found in the TEKTRONIX TELEVISION PRODUCTS CATALOG.

OTHER INSTRUMENTS OF INTEREST

Full descripitions are located in other sections of this catalog.



7L12 Plug-in Spectrum Analyzer shown in a R7403N Oscilloscope



1401A-1 Portable Spectrum Analyzer shown with a 324P7 Oscilloscope



1501 Time Domain Reflectometer (Cable fault locator)



SYSTEMS CAPABLE OF MEETING YOUR TESTING REQUIREMENTS



TEKTRONIX Systems are capable of meeting a wide variety of testing requirements whether it be for discrete semiconducters, IC's (DTL, RTL, ECL, MOS/LSI, etc.), hybrid IC's, circuit boards, modules, subsystems or final assembly test. The modular construction of TEKTRONIX Automated Systems enables each system to be custom tailored to its specific application or applications. Through ten years of experience in building automated systems we have discovered that each system requirement is unique and that variations of the "catalog system" are necessary to meet various testing requirements. Standard catalog systems or subsystems are used wherever possible, but a skilled staff of experts is available to configure a custom system whenever necessary.

TEKTRONIX Automated Systems offers to manufacturers and users of electronic equipment a means of completely automating many of their test and checkout procedures. Many manufacturers

have already recognized the virtues of automation includingincreased thru-put, improved quality control and reduction in personnel cost.

However, when a manufacturer or user decides to automate his procedures, questions such as cost effectiveness and implementation become a major concern. The question of whether to build the test system in-house or to purchase from an outside systems manufacturer is usually the first one to arise. Purchase of an automated system from Tektronix, Inc. offers the following advantages:

- (1) Tektronix, Inc. is oriented toward producing the state-of-theart electronic test equipment and is geared to production of systems for a small fraction of what an in-house build program would cost you.
- (2) Quality, reliability and support are of crucial concern in a complex automated system, especially when your production schedule depends on its productivity. Excessive down time on an automated system will greatly reduce the cost effectiveness of an automation program. Tektronix, Inc. uses its standard quality assurance procedures to assure quality and reliability. A staff of specially-trained System Specialists assists you from prepurchase consultations through programming and maintenance phases of systems operation.
- (3) Each TEKTRONIX Automated System is fully documented with operating manuals, parts lists and schematics to provide vital information when and where it is needed. Inhouse test systems usually depend on a resident "expert for information. Will he be there when that information is needed?
- (4) In many cases, creative engineering talent and the substantial assets involved in the design and building of in-house test systems can be freed for other programs.

Tektronix, Inc. welcomes the opportunity to assist you in meeting your testing needs. Expert field engineering and systems engineering assistance is available to help find a solution to your automation problem. Please contact your local TEKTRONIX Field Office for more details.

THREE FAMILIES OF SYSTEMS

Three families of automated systems are available to suit special requirements:

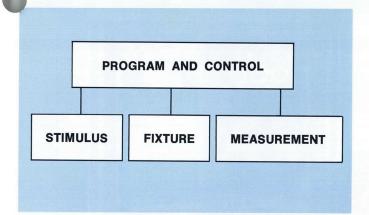


The S-3000 Series takes full advantage of DEC PDP-11 Controller in applications where sophisticated system control and arithmetic capability are required. Typical applications include complex waveform analysis, linear testing, data reduction & display, etc.

The S-3100 Series emphasizes measurements via the 230 Digital Readout Unit with system programming and control being provided by the 241 Programmer or the 240 Program Control Unit which uses disc file or paper tape as the program storage media.



A SYSTEM CONSISTS OF FOUR BASIC BLOCKS



The basic automated system in its simplest form contains a stimulus block, a fixture block, a measurement block and a program and control block. Each of these become considerably more complex since multiple stimuli, multiple measurement devices and multitest stations are common requirements of automated testing.

FIXTURING

Fixturing is one of the most critical blocks in an automated test system. Sophisticated and accurate measurement and stimulus equipment can be completely degraded through an inept fixture. Fixturing, usually not critical for DC and low frequency measurements, can become the most sophisticated and complex portion of a test system when high frequency signals and fast pulses are involved.

Tektronix, Inc. has a wide variety of test fixtures, test stations and test drawers to choose from. The 1803 Test Station for the S-3260 is presently capable of multiplexing up to 128 pins at 20-MHz data rates. The 1801 or 1802 stations, normally supplied in the S-3150 or S-3000 Series Systems, has an up to 40 pin capacity and is capable of transmitting clean 1-ns signals. A less expensive version of the 1801 or 1802 is available in the 1840 Test Drawer. Other special test fixtures for IC (discrete and hybrid), module and board testing have been supplied.

MEASUREMENT

The measurement block of a TEKTRONIX Automated System is truly flexible. In many applications the 568 Digital Readout Oscilloscope and 230 Digital Readout Unit or S-3003 Waveform Digitizing System are capable of making all AC, DC and pulse measurements. However, in some cases when accuracies of

better than 1% are necessary or measurement speeds of greater than 100/sec become mandatory, DC subsystems, Delta Time subsystems, counters, or DVM's or other programmable measurement equipment may be added (to most systems) to enhance specific testing areas.

STIMULUS

A variety of programmable power supplies and pulse generators are available for TEKTRONIX Automated Systems. The S-3260 has a special type of stimulus which supplies programmable bit patterns with high and low levels being individually programmable at each pin. Programmable function generators, sweepers, or waveform synthesizers may be added to most systems depending on the particular application.

PROGRAM AND CONTROL

Programming and control of an automated system is the portion which is most visible to the user. Test engineers and technicians, who know testing rather than programming, require an easy-to-use but flexible programming language.

Tektronix, Inc. offers two forms of program and control media. One being the DEC PDP-11 Controller and the other being the TEKTRONIX 240 or 241 Programmers and Controllers. Program and control via the DEC PDP-11 Computer permits interaction with the test system in a higher level language such as TEKTEST, BASIC or FORTRAN.

The type of language used depends on its appropriateness for the application. BASIC offers the features of simplicity. However, BASIC's interactive programming features generally make it too slow and inefficient for complex waveform analysis and logic function testing. FORTRAN is considerably faster and more flexible than BASIC and is easily adaptable to complex waveform analysis. WAFORM, a group of FORTRAN subprograms developed by Tektronix, Inc. for waveform analysis, is available to those systems users who wish to use FORTRAN as their programming language. For specific system applications Tektronix, Inc. offers an interactive interpreter which has the features of WAFORM together with the advantages of BASIC and FORTRAN, but which is fast and does not require batch compilation.

TEKTEST is a high-level test programming language specifically designed for large scale test systems, such as the S-3260 which include logic function testing, DC and AC testing. Components of this software system include an executive with background/foreground capability, and interpreter with an interactive and stored program modes, algorithmic test pattern generator and an editor for generating complex logic test patterns.



The S-3200 Series places equal emphasis on logic function testing, DC (parametric) testing and dynamic testing. System program and control is provided by the DEC PDP-11 Controller with a disc file being used for test pattern storage. Test programs and data may be stored on disc or on magnetic tape.







S-3260 AUTOMATED TEST SYSTEM

- 128 ACTIVE PINS—64 INPUT, 64 OUTPUT
- FUNCTIONAL (TRUTH-TABLE) TESTS
- DYNAMIC (TIMING) TESTS
- PARAMETRIC (DC) TESTS
- GO NO-GO OR ANALYTICAL TESTS
- DATA-LOGGING, DATA-REDUCTION
 WITH COMPUTER-GRAPHICS DISPLAYS
 AND OPTIONAL HARD COPY CAPABILITY

The TEKTRONIX S-3260 performs parametric, functional and dynamic tests on all types of MOS and bipolar shift registers, random-access memories, read-only memories and complex logic arrays. The system configuration includes a two-bay rack, a separate graphic computer terminal (TEKTRONIX 4010), and a test station (TEKTRONIX 1803).

Devices with up to 64 pins may be tested with input-output facilities at each pin. Devices with up to 128 pins may be tested by splitting the input-output connections.

The standard S-3260 configuration provides one 1803 Test Station with a manual test fixture. Options include wafer prober, auto handler, environmental handler and circuit board test fixures—fully interfaced. Up to four 1803's can be time-shared on a single system.

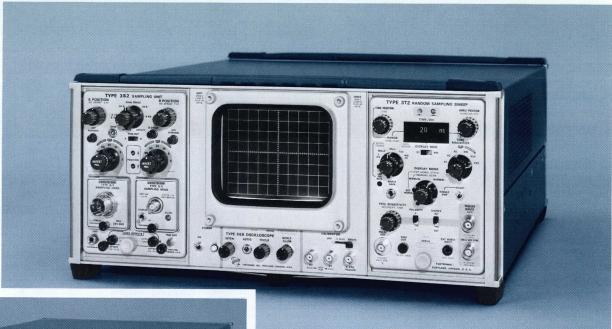


S-3003 WAVEFORM DIGITIZER

The S-3003 is a computerized waveform measurement and analysis system. Waveform Analysis by computer offers measurement capability, limited only by the imagination of the system's programmer and the capabilities of the associated computer system.

This system, and its options, offers the versatility of a computer-controlled programmable oscilloscope, capable of acquiring signals from DC to 14 GHz, and adds the processing power a computer. All time and amplitude measurements are store programs making functions, such as smoothing, signal averaging, fast Fourier transforms, integration, differentation, etc., a matter of software.







- PROGRAMMABLE SIGNAL ACQUISITION WITH PROGRAMMABLE PLUG-INS
- ANALOG DISPLAYS OF ANALOG/DIGITAL MEASUREMENT SYSTEM
- PROVIDES MEASUREMENT INFORMATION FOR 230 DIGITAL UNIT

568 and R568 Readout Oscilloscopes are designed for use with 2-Series and 3-Series Plug-In Units in both the vertical and horizontal deflection systems. When used together with the 230 Digital Unit, digital readout of measurements (in addition to the analog display on the CRT) makes the measurements faster, more convenient, and more accurate.

Connectors on the rear provide measurement information for the 230 Digital Unit, couple trace-brightening information from the 230 to the 568, and provide input and programming information for programmable plug-in units.

The 568/R568 are designed mainly for use in digital measurement systems, but through use of amplifier, spectrum analysis, and time-base plug-in units, they may be used in other applicaons that do not require digital readout.

Through use of solid-state components, the 568/R568 offer reliable operation with low-heat dissipation.

Amplitude Calibrator— 5 V and 0.5 V into $100 \text{ k}\Omega$ or more or 500 mV and 50 mV into 50 Ω . Repetition rate is 100 kHz or 1 kHz.

TEKTRONIX CRT - 5-inch rectangular CRT with 3.5-kV accelerating potential. A P2 phosphor is normally supplied; P7, P11, or P31 are optional without extra charge. Consult your Field Engineer, Representative, or Distributor for application information and availability.

Power Requirements-90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 210 watts maximum. Rear-panel selector provides rapid accommodation for six line-voltage ranges.

	568		R568		
	in cm		in	cm	
Height	8	20.3	7	17.8	
Width	16-13/16	42.7	19	48.3	
Depth	21-7/8	55.5	21-1/4	54.1	
	lb	kg	lb	kg	
Net weight	35	15.9	67	30.4	
Domestic shipping weight	53	24.0	75	34.0	
Export-packed weight	76	34.4	99	44.9	

INCLUDED ACCESSORIES

Implosion shield (337-0539-00); 18-inch patch cord, BNC-to-BNC (012-0087-00); 18-inch patch cord, BNC-to-banana plug (012-0091-00); patch cord, post jack-to-BNC (012-0092-00); R568 also includes slide-out assembly (351-0086-00) and mounting hardware.

568 OSCILLOSCOPE, without plug-in units	\$1250
R568 OSCILLOSCOPE, without plug-in units (rackmount)	\$1300



- PROGRAMMABLE VOLTS/DIV
- PROGRAMMABLE DC OFFSET
- CHOICE OF SAMPLING HEADS

The 3S5 and 3S6 Dual-Trace Sampling Units extend the automated measurement capabilities of the 568/230 Oscilloscope Digital Readout System by allowing remote programming of deflection factor, DC offset, and smoothing.

External programming of the 3S5 can be accomplished by either a front- or rear-panel connector; signal inputs are on the front. The 3S6 has its program and signal inputs on the rear and can be used only in the 568 Oscilloscope.

Sampling heads feature a choice of measurement capabilities and may be mixed or matched to meet specific measurement needs. A front-panel control allows adjustment of the interchannel time relationship to compensate for external delays.

CHARACTERISTICS

Deflection Factor— 2 mV/div to 200 mV/div in 7 calibrated steps 1-2-5 sequence. Each step accurate within 3% in normal mode, within 4% smoothed. Vertical outputs to the 230, each channel programmed with 3 program lines or by manual front-panel controls.

DC Offset Range— +1 V to -1 V. Allows signals between +1 V and -1 V limits to be displayed at 2 mV/div. Continuously variable and calibrated with front-panel controls +1 V and -1 V, accurate within 10 mV of same offset voltage obtained in the external program mode. Programmable between +995 mV and -995 mV in 5-mV steps. The programmable accuracy is within 2% or 5 mV (whichever is greater) of the programmed value. Programming is accomplished with 9 program lines per channel in modified BCD code, plus one program line per channel for + or - polarity.

B-Delay Range—Channel B display can be continuously positioned in time from +5 ns to -5 ns with respect to Channel A. Accommodates up to 3-foot difference in signal cables.

Programming—The 3S5 and 3S6 use negative logic with true being ground, or less than 2 V, and false being open, or more than 6 V. 27 program lines plus ground are required to externally program all measurement functions.

Display Modes—A only, B only, dual trace, and algebraic addition of A and B signals. In the external program mode, dual-trace operation is automatically provided. Independent controls for each channel permit positioning and inverting displays.



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Net weight	11	lb	5.0 kg
Domestic shipping weight	≈19	lb	≈8.6 kg
Export-packed weight	≈25	lb	≈11.3 kg

3S5 Included Accessories—Connector (131-0422-00); connector cover (200-0660-00); circuit board connector (388-0805-00).

3S5 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads \$2100

3S6 Included Accessories—6-ft sampling-head extender (012-0130-00); two circuit board connectors (388-0805-00).

3S6 PROGRAMMABLE SAMPLING UNIT, without Sampling Heads \$210

3S5 OPTIONAL ACCESSORIES

3-ft	sampling-head	extender,	order	012-0124-00	 \$64
6-ft	sampling-head	extender.	order	012-0125-00	 \$66

SAMPLING HEADS

Sampling heads may be plugged into the 3S5 or located remotely on the optional 3-ft or 6-ft sampling-head extenders. The 3S6 uses sampling heads located remotely on included 6-ft sampling-head extender that connects to the rear of the 568 Oscilloscope. 568 Oscilloscopes below serial number B110000 require a modification. Consult your Field Engineer, Representative, or Distributor.

SAMPLING HEAD	RISETIME	INPUT	MINIMUM DEFLECTION FACTOR	DISPLAYED NOISE
S-1	350 ps	50 Ω, GR874*	2 mV/div	≤2 mV
S-2	75 ps	50 Ω, GR874	2 mV/div	≤6 mV
S-3A	350 ps	100 kΩ, 2.3 pF	2 mV/div	≤3 mV
S-4	25 ps	50 Ω, SMA	2 mV/div	≤5 mV
S-5	1 ns	1 MΩ, 15 pF	2 mV/div	≤500 μV
S-6	30 ps	50 Ω, SMA	2 mV/div	≤5 mV

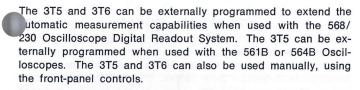
For complete descriptions refer to Sampling Head pages.



^{*}Registered Trademark General Radio Company



- PROGRAMMABLE TIME/DIV, SWEEP DELAY AND SAMPLES/SWEEP
- 100 ps/DIV to 500 ms/DIV CALIBRATED SWEEP RANGE
- EXTERNAL AUTOMATIC TRIGGER



Real-time sampling (1 ms/div to 500 ms/div) and digital delay are provided. An external automatic trigger mode eliminates the need for adjustments over a wide range of trigger signal characteristics.

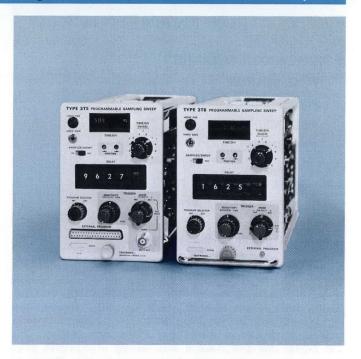
Sweep Time/Div— 100 ps/div to 500 ms/div in 30 calibrated steps, 1-2-5 sequence. Accuracy is within 3% (within 5% from 100 ps/div to 500 ps/div), except for non-linearities at the beginning of the sweep. Switch selected or programmed by BCD 2-bit and 4-bit code.

Samples/Sweep— 1 sample/sweep, externally programmed only. 100 or 1,000 samples/sweep, switch selected or programmed by BCD 2-bit code. Can be programmed to scan quickly (100 samples/sweep) when not making a measurement, then provide maximum resolution (1,000 samples/sweep) when making a measurement.

Delay Range— 0 to 999.9 ns in 100-ps increments from 100 ps/div to 500 ps/div. 0 to 9.999 μ s in 1-ns increments from 1 ns/div to 1 μ s/div. 0 to 999.9 μ s in 100-ns increments from 2 μ s/div to 500 μ s/div. Switch selected or programmed by BCD 16-bit code.

Delay Jitter (all sweep speeds)—0.1 division or less, independent of the amount of delay.

iggering—SOURCES: Internal, if sampling unit contains a trigger pick-off; External, $50-\Omega$ terminated input. JITTER: External automatic, pulse, 30 ps or less with 300-mV pulse, 2 ns or less wide; sinewave, 200 ps or less with 300 mV P-P signal at 30 MHz.



Pulse Triggering

SOURCE	FREQUENCY	AMPLITUDE
Internal	1 Hz to 100 MHz	100 mV to 2 V
External	DC to 100 MHz	5 mV to 250 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

Sinewave Triggering

SOURCE	FREQUENCY	AMPLITUDE
		peak-to-peak
Internal	100 kHz to 100 MHz	100 mV to 2 V
External	1 Hz to 100 MHz	10 mV to 500 mV
External Sync	100 MHz to 1 GHz	10 mV to 150 mV
External Automatic	DC to 100 MHz	100 mV to 500 mV

Weights

Net weight	7	lb	3.2 kg
Domestic shipping weight	10	lb	4.5 kg
Export-packed weight	14	lb	6.3 kg

3T5 Included Accessories— 5-ns, $50-\Omega$ RG58 cable with BNC connectors (012-0057-01); 10X $50-\Omega$ BNC attenuator (011-0059-01); GR-to-BNC female adapter (017-0063-00); GR-to-BNC male adapter (017-0064-00); electrical connector (131-0422-00); electrical connector cover (200-0660-00); circuit board connector (388-0805-00).

3T5	SAMPLING	SWEEP	UNIT		\$2100
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3T6 Included Accessories—Circuit board connector (388-0805-00).

3T6 SAMPLING SWEEP UNIT\$2100

Field Modification Kit, order 040-0577-00

For Computer-controlled External Sweep and Trigger. D/A and A/D converters permit computer scanning and digitizing of a waveform through the R1340 Data Coupler.

AUTOMATED TEST SYSTEMS 230 Digital Unit

230 Digital Unit

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- PRESENTS OSCILLOSCOPE MEASUREMENTS IN DIGITAL FORM
- DIGITAL READOUT PARAMETERS
 PULSE AMPLITUDE
 PULSE RISETIME AND FALLTIME
 PULSE WIDTH
 TIME INTERVAL
- UP TO 100 MEASUREMENTS PER SECOND WITH OPTIONAL PROGRAMMERS
- PARALLEL GROUND-CLOSURE PROGRAMMING

The 230 and R230 Digital Units provide digital measurements of signals displayed on the 568 Oscilloscope. The 230 has flexible measurement capabilities with up to 100 measurements per second, easy programming, BCD data outputs, and solid-state circuitry with extensive use of integrated circuits. The 230 Digital Unit can make a wide variety of repetitive pulse measurements on the signals displayed on the 568. The digital presentations can designate voltage measurements, time-difference measurements between similar pulses, and time-difference measurements between voltages or percentages of pulse amplitudes. The 230 can be externally programmed for use in high-speed, automatic measurement systems. Data output connectors provide measurement results in convenient BCD code. Programming is easily accomplished with the use of new Tektronix Program Units.

MEASUREMENT MODES

The 230 Digital Unit's four basic measurement functions (Channel A volts, Channel B volts, Time, and External Program) are selected by the Measurement Mode switch.

VOLTAGE measurements are made on either Channel A or Channel B between the 0% and the 100% reference zones. The signal polarity is determined and read out automatically on the digital readout.

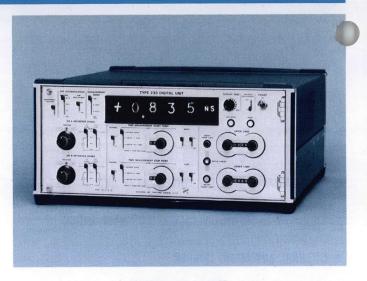
TIME measurements are made on either Channel A, Channel B, or between the two channels. The time measurements are made from a predetermined start point to a predetermined stop point that can be referenced to the 0% and 100% reference zones or to the start of the sweep.

EXTERNAL PROGRAM—All of the front-panel functions required to make voltage and time measurements can be easily programmed externally. The variety and flexibility of measurements possible with external programming are even greater than those possible through use of the 230 front-panel controls, and measurements and limits can be changed more rapidly.

DIGITAL READOUT

The measurements made by the 230 are read out directly on six NIXIE* tubes. Decimal point and unit of measure (ns, μ s, ms, s, mV, V) are automatically presented. The polarity of the measurement (+ or -) is also read out automatically.

*Registered Trademark Burroughs Corporation



DISPLAY TIME

The digital readout display time may be varied from $\approx 10 \text{ ms}$ to 10 s. EXTERNAL HOLD light indicates when the measured data is being held until the recording device has had sufficient time to record the measurement. External hold does not prevent the next measurement from being made. In TRIGGERED MEASUREMENT operation, a measurement is started after receipt of a trigger (+ or -) and after DISPLAY TIME has been completed. The READY light indicates a ready condition for a trigger.

REFERENCE ZONES

The 0% and the 100% zones establish the reference points from which all measurements are made. The reference zones can be brightened on the oscilloscope by means of the CRT Intensification Reference Zone switch. The switch brightens both zones, 100% zone only, 0% zone only or disables the zone intensification.

The 0% POSITION and 100% POSITION controls determine the start position of the 0% and 100% zones to any 1/2-cm point from the start of the sweep by means of a 20-position switch. Five external program lines are required for each position control.

LEVEL WIDTH controls select the width of the reference zone and select the type of voltage reading, average or peak.

The AVERAGE 0.3-cm WIDTH position of the control is normally used for average voltage and most time measurements.

The three PEAK positions (2-cm, 4-cm, 10-cm WIDTH) are used for average-to-peak, or peak-to-peak voltage measurements. Two program lines are required for each 0% LEVEL or 100% LEVEL width controls.

TIME MEASUREMENT START POINT

The start of the time measurement is selected to start on either Channel A or Channel B and on the first or second positive-going or negative-going slope. The time measurement starts when the signal reaches one of the 99 predetermined levels. Four different modes of start point level selection are available: (1) % between 0% and 100% zones, (2) mm above 0% zone, (3) mm below 100% zone, and (4) Horizontal mm from sweep start. Eleven BCD program lines are required for external programming the time measurement start point. There are 15 predetermined levels available in the external programming mode



RT intensification during the time measurement portion of the reep is selected by means of the CRT Intensification Time Measurement On-Off switch.

TIME MEASUREMENT STOP POINT

All functions of the Time Measurement Stop Point controls are similar to the Time Measurement Start Point controls. The count is stopped on a selected point Ch A or Ch B. If the Stop Point occurs before the Start Point, a negative reading is indicated.

RESOLUTION

DOTS/MEASUREMENT Time measurements are performed by gating and counting clock-pulses during the measurement interval. If a measurement interval occupied 2.5 div and the sweep speed was 10 ns/div with 100 samples/div, then 250 samples would be registered in the digital readout counter and reading would be 25.0 ns.

The TIME MEASUREMENT START and STOP comparators have ± 0.1 mm pick-off resolution capabilities. This gives the 230 the ability to scale a 1-cm display in 1% steps.

MEASUREMENT AVERAGING permits selection of measurements to be a statistical average of eight sweeps or to be a measurement of only one sweep. One program line is required for Measurement Averaging selection.

LIMIT CONTROLS

he Limit Controls select the UPPER and LOWER measurement Limits. Measurement limit results can be quickly determined, on the front panel, by means of three lights (ABOVE UPPER LIMIT, WITHIN LIMITS, BELOW LOWER LIMIT) and the information is available on the rear panel for stopping automatic measurement sequences or for automatic sorting. Fifteen BCD lines are required for programming each limit control.

EXTERNAL READOUT

Data outputs are available on the rear panel of the 230 that permit the recording of measurement polarity, displayed digits, units of measure, decimal point, and measurement limit results. The information is in BCD code.

The 230 can be synchronized to a data recorder. Regulated power is available for use in systems applications.

EXTERNAL PROGRAMMING

All of its measurement functions can be programmed by means of ground closures or logic levels. The programming is achieved with 105 program lines using negative logic with true being ground or 2 V or less and false being open or 6 V or more. Suitable programming devices include: The 241 Programmer, 240 Program Control Unit, card readers, block readers, computers, etc.

When using the 3T5 or 3T6 Programmable Sampling Sweep Units for the oscilloscope time base, the 230 Digital Unit can program the sweep to provide increased measurement speeds. It is to be time base can be made to run fast (10 dots/div) during the mon-measurement part of the sweep and then run at normal speeds (100 dots/div) for maximum resolution during the measurement. This function is obtained by externally programming the high-speed program line.

Measurement speed can be increased by externally programming the position of the 0% and/or 100% Reference Zones start point to 12 cm. This puts the reference zones into a memory hold position of up to 10 seconds and permits several different measurements to be made without a zone charging sweep. This gives an additional feature of permitting measurements referenced to reference zones that are not on the CRT display.

OTHER CHARACTERISTICS

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 130 watts maximum at 115 V and 60 Hz. Rear-panel selector provides rapid accommodations for six line-voltage ranges.

Dimensions and Weights

	230		R230)
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16-13/16	42.7	19	48.3
Depth	21-7/8	55.5	22-3/4	57.8
	lb	kg	lb.	kg
Net weight	56	25.4	61	27.6
Domestic shipping weight	73	33.1	79	35.8
Export-packed weight	94	42.6	100	45.3

INCLUDED ACCESSORIES

230 to 568 48-inch interconnection cable (012-0119-01); Automated Measurement Systems Concept Book (062-1106-01). R230 also includes slide-out assembly (351-0086-00) and mounting hardware.

230 DIGITAL UNIT	\$4100
R230 DIGITAL UNIT (rackmount)	\$4150
Field Modification Kit, order 040-0489-00	

SIGNAL CHOPPERS

With the signal choppers, the 230 Digital Unit can make DC and pulse voltage measurements with respect to ground.

Probe Chopper Q	luad (set of 4) for S-3A Pro	bes, includes case
and accessories,	order 015-0155-01	\$375

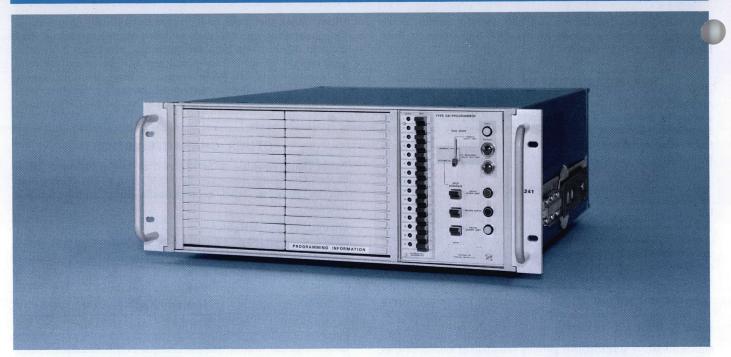
Probe Chopper for two S-3A Probes, order 015-0128-01 \dots \$190 Includes: two 10X attenuators (010-0367-00)

Probe Chopper for two P6045 Probes, order 015-0129-01 . \$110 $50-\Omega$ Quad Signal Chopper, order 015-0185-00* \$400

50- Ω Dual Signal Chopper, order 015-0184-00* \$250

*When using $50-\Omega$ signal choppers (015-0185-00 or 015-0184-00) with 230 or R230 serial number including or below B240000 a MOD 040-0580-00 will be needed.





- PROGRAMS UP TO 15 MEASUREMENTS
- AUTOMATIC OR MANUAL MEASUREMENT SEQUENCE
- AUTOMATIC TEST LIMITS STOP
- 14 ADDITIONAL PROGRAM LINES

The 241 Program Unit is designed for use with the 568 Oscilloscope; 3T5, 3T6, 3S5, or 3S6 Programmable Plug-In Units; and the 230 Digital Unit. The 241 has 14 lines available for programming other equipment.

15 programmed measurements can be selected by front panel push buttons or external control lines and automatic or manual sequencing is provided. In the automatic sequence mode, out-of-limit conditions can stop the measurement sequence.

Each measurement is programmed with quick-insertion diode logic. Changing programs is a simple, plug-in operation.

OPERATING MODES

Single Test—Any one measurement can be selected, in any order, by push button or by grounding external control lines.

Manual Sequence—Up to 15 measurements are sequenced, one each time the ADVANCE button is pushed or external line is grounded.

Automatic Sequence—All programmed measurements (1 thru 15 are sequenced once on command from the ADVANCE button. Measurements outside of programmed limits stop sequencing. The ADVANCE button resumes sequence. The RESET button readies the sequence to restart the first measurement. ADVANCE and RESET command external control-lines are activated by ground closure.

OTHER CHARACTERISTICS

Power Requirements-Supplied by the 230 Digital Unit.

Dimensions and Weights

	241		R241	
	in	cm	in	cm
Height	8	20.3	7	17.8
Width	16 3/4	42.7	19	48.3
Depth	21 7/8	55.5	22 3/4	57.8
100 AGESTIE STREET WAS ENGLISCHE	lb	kg	lb	kg
Net weight	33	14.9	35 1/2	16.1
Domestic shipping weight	52	23.5	51	23.1
Export-packed weight	72	32.6	71	32.2

INCLUDED ACCESSORIES

36-pin cable J202 (012-0131-03); 36-pin cable J203 (012-0131-04); 36-pin cable J214 (012-0131-05); 36-pin cable J224 (012-0131-06); 36-pin cable J201 (012-0131-07); interconnecting cable, 6 feet long (012-0131-01); 15 program circuit cards (670-0285-00); 30 blank labels (334-1337-01); 3 diode packages with 150 diodes each (016-0254-00); 3 diode insertion tools (003-0611-00); test format tablet (070-0908-00). R241 also includes slide-out assembly (351-0086-00) and mounting hardware.

241 PROGRAMMER	\$2800
R241 PROGRAMMER (rackmount)	\$2850

OPTIONAL ACCESSORIES

Program Card— 15	additional	program cards	can be stored
in the 241. Cards			
order 670-0285-00 .			\$44

Diode Package— 150 diodes, order 016-0254-00 \$60



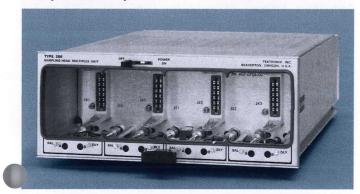


SAMPLING-HEAD MULTIPLEXING

A Sampling-Head Multiplexer system allows the signals from up to 64 test points to be measured by a two-input sampling unit. The measurements are made from a sampling head coupled to each test point. The signals sensed by these sampling heads are then electronically switched (multiplexed) into the sampling unit, two signals at a time.

The following Sampling Heads can be used with the 286, 287, R288 Multiplex Systems: S-1, S-2, S-3A, S-4, S-5, S-6 and pulse generator heads S-50, S-51, S-52, S-53, and S-54.

Three TEKTRONIX programmers may be used to program sampling head multiplexer systems: the 241 Programmer, the 240 Program Control Unit, or the R250 Auxiliary Control Unit. The programmer provides head selection commands to control the operation of the 286's, 287's, and R288. If an R250 is chosen to program the multiplexer system, a special R250 program assembly is necessary.



286 SAMPLING-HEAD MULTIPLEX UNIT

The 286 Sampling Head Multiplexer is the basic unit of a sampling-head multiplexer system. The 286 can operate four sampling heads. When operated singly, a 286 receives head selection commands directly from the external programmer and signal data directly from the selected sampling head. Head selection commands are digital information that determine which sampling heads are operated with the sampling unit. Signal data is analog information consisting of strobe driver pulses, offset and feedback voltages, signal samples (from the sampling heads) and reference voltages.

A 286 may be installed in a 287 or R288. In this case, the 286 receives its head selection and signal data from the R288 and/ or the 287.

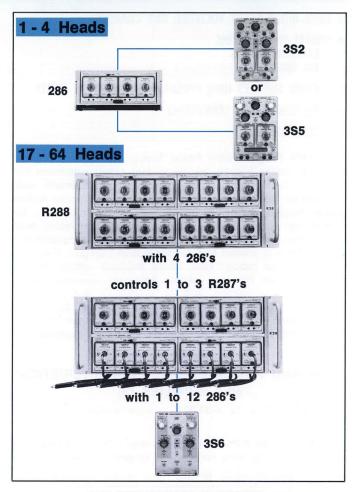
Power Requirements—Quick-change, line-voltage selection permits operation from any of the following voltages: 90 V to 110 V, 104 V to 126 V, 112 V to 136 V, 180 V to 220 V, 208 V to 252 V, 224 V to 272 V. The 286 will operate over a line-frequency range from 48 Hz to 440 Hz with a power consumption of approximately 25 watts at 115 VAC.

Dimensions ar	nd Weights
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Height	2	1/2 in	6.4 cm
Width	8	in	20.4 cm
Depth	12	in	30.5 cm
Net weight	6	lb	2.7 kg
omestic shipping weight	9	lb	4.1 kg
Export-packed weight	17	lb	8.0 kg

286 SAMPLING HEAD MULTIPLEX UNIT\$825

Does not include manual.



287 MULTIPLEX CONTROL

The 287 controls up to four 286's, thus allowing the multiplexing of up to 16 sampling heads. The 286's are installed in compartments in the 287. If only one 287 is being operated, it receives head selection commands directly from the external programmer and signal data directly from the sampling unit.

A 287 may be controlled by an R288. In this case, the 287 receives head selection and signal data from the R288. A rackmount version of the 287, called an R287, is also available.

INCLUDED ACCESSORIES

Cable labels for 287 (334-1527-00).

287 MULTIPLEX CONTROL UNIT \$850

R288 MULTIPLEX MASTER CONTROLLER

The R288 controls up to four 287's, thus allowing the multiplexing of up to 64 sampling heads. To conserve space, the circuitry of one 287 is built into each R288. The R288 controls the 287 circuitry within its own physical unit and up to three other 287's. The R288 receives head selection commands from the external programmer, and signal data from the sampling unit. This data is then distributed to the 287's and 286's.

INCLUDED ACCESSORIES

Cable labels for the R288 (334-1528-00); mounting tracks (351-0086-00).

AUTOMATED TEST SYSTEMS

NEW 1140A Programmable Power Supply

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- FOUR INDEPENDENT VOLTAGES; ONE CURRENT
- DIGITAL PROGRAMMING LATCHING INPUTS TTL COMPATIBLE
- VOLTAGE SUPPLIES HAVE PROGRAMMABLE CURRENT LIMITS
- SAFE, CONTROLLED TRANSITIONS
- 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-selected manual or programmable current limits. No over-voltage spikes appear during program transitions, even when changing polarity. Current supply has programmable voltage limits to protect test devices if load changes. Four-wire (Kelvin) voltage supply leads assure accurate voltage at load. All outputs are inhibited during power-up, ensuring correct output after stabilization, with no overshoots during turn-on. Single or multiple 1140A's may be programmed by a 1340 Data Coupler. Options are available for programming the 1140A using the 1340 Data Coupler, or a user-supplied program unit.

STANDARD POWER SUPPLY CHARACTERISTICS* 40-V SUPPLIES (3)

Range— $+39.99\,\mathrm{V}$ to $-39.99\,\mathrm{V}$, programmable in steps as small as 10 mV.

Accuracy—Within 0.2% of programmable voltage $\pm\,10\,\,\text{mV}$ over rated line voltage, load current and temperature range.

Programming—Requires 16 bits, plus strobe for each of the 40-V supplies.

Current Sourcing— 450 mA (Imax) or less; Sinking, 100 mA or less.

Programmable Current Limiting— 16 values including 1/16 Imax and 16/16 Imax.

Manual Current Limiting—Switch selected, internally adjustable from 0 to 450 mA.

Regulation—Load, within 0.01% or 1.5 mV, whichever is greater. Line, within 0.001% or 100 μ V, whichever is greater, over specified operating line-voltage range. Line frequency ripple and noise, 3 mV RMS or less.

Settling Time—(Time from active edge of data strobe for output to change to within 1% of new programmable value.) Level change, 2.5 ms or less; polarity change, 4.5 ms or less.

CURRENT SUPPLY

High Range	Medium Range	Low Range	
$+$ 199.9 mA to $-$ 199.9 mA, programmable in steps as small as 100 μ A.	$+$ 19.99 mA to $-$ 19.99 mA, programmable in steps as small as 10 μ A.	+1.999 mA to -1.999 mA, programmable in steps as small as 1 μA.	
Accuracy			
Within 0.2% of programmed current, $\pm 20 \mu\text{A}$	Within 0.2% of programmed current, $\pm 2 \mu A$	Within 0.2% of programmed current, \pm 0.2 μ A	

^{*}Other voltage and current options available.



Programming—Requires 20 bits, plus strobe to program the current supply.

Compliance Voltage—Programmable from 0 to $\pm 70 \, \text{V}$ in 5-V increments. Additional $\pm 100 \, \text{V}$ limit programmable.

Regulation (High Range Only)—Load, within 0.005% or 1 μ A. Line, within 0.001% or 0.5 μ A. Ripple and noise, 5 μ A RMS or less.

Settling Time— $100 \mu s$ or less to settle to within 0.2% of programmed current or within 2% of programmed voltage.

100 V SUPPLY

Range— +100 V to -100 V, programmable in steps as small as 10 mV.

Accuracy—Within 0.2% of programmed voltage, ±5 mV.

Programming—Requires 17 bits plus strobe.

Current-Sourcing 120 mA or less, sinking, 100 mA or less.

Regulation-Same as 40-V supplies.

Settling Time-Same as 40-V supplies.

OTHER CHARACTERISTICS

Power Requirements— 105 to 125 V AC or 210 to 250 V AC, 48 to 66 Hz, 250 W maximum.

Temperature Range— 0° - 50°C.

Dimensions and Weights		
Height	7 in	17.8 cm
Width	19 in	48.3 cm
Rack depth	20.5 in	52.2 cm
Net weight	≈50 lb	\approx 22.7 kg
Domestic shipping weight	≈65 lb	≈29.5 kg
Export-packed weight	≈95 lb	≈43.1 kg

INCLUDED ACCESSORIES

20-ft cable with 41-pin connector (012-0291-00); slide assembly (351-0086-00); rackmount rear-support kit (016-0097-00); rackmounting hardware (016-0099-00).

Order 1140A	PROGRAMMABLE	POWER SUPPL	Υ	\$5000
Order Option	1		Ad	d \$500
	systems using the			Div July



- ALLOWS ON-LINE COMPUTER CONTROL
- COUPLES SYSTEMS TO DATA-LOGGING EQUIPMENT
- DIGITIZES HIGH-SPEED WAVEFORMS FOR COMPUTER USE
- INTERFACES COMPUTER TO REGISTERS, DVM's, PROGRAMMABLE INSTRUMENTS, TEST FIXTURES, ETC.

The R1340 Data Coupler is a multi-purpose instrument intended to interface a wide variety of digital measurement, processing and recording equipment. The eight interface options presently available provide computer control, data logging and dot-by-dot waveform digitizing for the standard instruments normally used in TEKTRONIX Automated Measurement Systems as well as for other instruments having digital inputs and outputs. More interface options to come.

The R1340 consists of a rackmount cabinet with power supply, space for 12 plug-in cards and wired connectors for 18 interconnecting cables.

DATA LOGGING

Data logging from a measurement system using the 230 Digital Unit and 240 Program Control Unit can proceed without requiring a computer. Measurement results from the 230, measurement address number from the 240, and device type and serial nformation from the test station or other source may be logged on computer-compatible magnetic or paper tape. Duplication of paper tapes is allowed without computer control by the combined tape reader/punch interface.

COMPUTER CONTROL

A TEKTRONIX Automated Measurement System may be computer controlled through the R1340 in two different ways: (1) the computer can select predetermined measurement programs stored on individual program cards in the 241 Programmer or stored in magnetic-disc memory used with the 240 Program Control Unit, or (2) the computer can store and manipulate the measurement program directly through the 240 without disc memory. No computer software is supplied with the R1340.

WAVEFORM DIGITIZING

The R1340 operates with any 3-Series Sampling Unit, such as the 3S1, 3S2, 3S5 or 3S6, and the 3T5 or 3T6, to digitize waveforms for computer use. Waveform scanning is digitally controlled from the computer by a 10-bit horizontal address which may be incremented for sequential scanning or directly set to a predetermined location. Samples from both channels of the sampling unit are digitized by independent, 10-bit, analog-to-digital converters. Trigger-gating and signal-chopper operation can also be computer-directed. While the R1340 is intended for repetitive signal conditions, one sample of a single event, such as the response of an integrated circuit under functional test, can be digitized.



INTERFACING

Interface cards within the R1340 perform such functions as input/output level conversion, serial-to-parallel and parallel-to-serial format conversions, and temporary data storage in latching registers. A common TTL bus within the R1340 makes all data and control information available to each card where it is interfaced to a computer, other data source or data logger.

INFORMATION ABOUT OPTIONS

The R1340 requires plug-in cards to perform the function or functions you require. Your TEKTRONIX Field Engineer or Representative can provide information or arrange a discussion about interfaces to meet your systems needs.

OTHER CHARACTERISTICS

Rear Panel—Eighteen 36-pin connectors provide interface between the R1340 and peripherals via control cards in the R1340.

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 102 W max. Rear-panel selector provides rapid accommodations for six line-voltage ranges.

Dimensions and Weights			
Height	7	in	17.8 cm
Width	19	in	48.3 cm
Rack depth	20	1/2 in	52.2 cm
Net weight	32	lb	14.5 kg
Domestic shipping weight	≈47	lb	\approx 21.3 kg
Export-packed weight	≈67	lb	\approx 30.4 kg

INCLUDED ACCESSORIES

Rackmounting kit (016-0097-00); hardware kit (016-0099-00); slide-out tracks (351-0086-00); extender card (670-1263-00).



INFORMATION GENERATION AND CONDITIONING



4701 Eight-Channel Multiplexer

Display the inputs from as many as eight different signal sources on a single display unit with the 4701 8-channel multiplexer. See details on page 266.





4501 Scan Converter

Alphanumeric and graphic data in analog form are converted to video displays with the 4501 Scan Converter. For full details on performance and price, refer to page 264.



4551 Light Pen Unit

The 4551 Light Pen Unit is the quick, modern way to point out areas of TV displays, or write or draw new information on TV display screens. Complete information about the Light Pen is found on page 265.

DISPLAY



602 Monitor

Bright, sharp X, Y, and Z axis displays are yours with the high-resolution 1-MHz bandwidth 602 Display Unit. Specifications and price information on page 256.



603 Monitor

Choose bright, flicker-free stored displays, or non-stored conventional displays with the low-cost big screen 603 Storage Display Monitor. Details on page 257.



604 Monitor

A big CRT in a small package. That's the low-cost 604 Display Monitor. See page 258.



630 Series Monitors





MONITORS



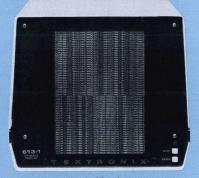


611 Monitor

611 MOD 162C Monitor

Fill the big 8¼ by 6% inch display screen of the 611 Storage Monitor with as many as 4000 alphanumeric characters, or graphic displays of great complexity. Page 260 has the full story on price and specifications.

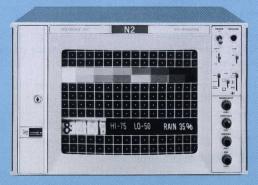




613 Monitor

613-1 Monitor

This year's big news in storage tubes is the brightness of the 613 bistable storage CRT. See page 262 for price and specification information.



650 Series Monitors

HARD COPY



4601 Hard Copy Unit

Sharp, legible permanent dry copies of your computer terminal displays are yours in seconds at low cost with the 4601 Hard Copy Unit. See page 268 for performance and price details.



4610 Hard Copy Unit

The 4610 is a worthy partner for the popular 4010-1 Computer Display Terminal, making legible, high-resolution permanent hard copies directly from the 4010-1 display. Price and performance information is found on page 272.



4602 Video Hard Copy Unit

The 4602 is a high-speed video hard copy unit which produces high-resolution gray scale copies of pictures, graphs, notes or drawings directly from the screen of your video monitor. See page 270 for details.





- 1-MHz X AND Y BANDWIDTH
- 100-mV/cm X AND Y DEFLECTION FACTORS
- X-Y PHASE DIFFERENCE WITHIN 1° TO 1 MHz
- UNIFORMLY SMALL SPOT SIZE
- DC-COUPLED Z AXIS

The Type 602 Display Unit is a compact, solid-state instrument with excellent resolution providing accurate displays of information from X, Y, and Z signal inputs. Application areas are: phase shifts and frequency ratios using *Lissajous* figures, graphic and alphanumeric displays from computers, high-resolution raster displays, with intensity modulation, and Y-T plots of amplitude versus time displays.

Permanent records of the Type 602 display are provided on Polaroid* prints using the Tektronix C-30A Camera with adapter. Two Type 602's may be mounted side-by-side using an optional rack adapter.

CRT DISPLAY

Tektronix CRT—5-inch flat-faced rectangular CRT with P31 phosphor standard, P7 phosphor optional.

Display Size-8 cm vertically and 10 cm horizontally.

Graticule—Standard graticule: Internal, parallax-free, variable illumination. Supplied with standard 602, as shown above. Optional graticule: Internal 8 x 10-cm outline (no graticule lines). Supplied with 602 MOD 174K.

Trace Width—Maximum trace width within the 8 x 10-cm display area is 14 mils at 0.5-µA beam current.

Display Linearity—The voltage required to produce a 2-cm deflection at any point on the CRT will not vary more than 2% in the vertical direction, and 6% in the horizontal direction.

*Registered Trademark Polaroid Corporation

VERTICAL AND HORIZONTAL AMPLIFIERS

The X (Horizontal) and Y (Vertical) differential amplifier inpucircuits 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 k Ω $\pm 10\%$ paralleled by 30 pF or less.

Maximum Input Voltage— ±10 V DC plus peak AC.

Recommended Source Impedance— 1 $k\Omega$ 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 \pm 1 V range. Signal input is a BNC connector on the rear panel.

Input R and C— 100 k Ω $\pm 10\%$ paralleled by 70 pF or less.

Maximum Input Voltage- ±10 V DC and peak AC.

Recommended Source Impedance— 1 k Ω 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 $+50^{\circ}$ C ambient.

Finish—Blue vinyl painted cabinet, aluminum construction.

Dimensions and Weights (cabinet included)-Height 6 in 15.3 cm Width 81/2 in 21.6 cm Depth 17% in 44.1 cm Net weight 171/2 lb 7.9 kg Domestic shipping weight ≈22 lb $\approx 9.9 \, \mathrm{kg}$ Export-packed weight ≈28 lb \approx 12.7 kg

Included Accessories-smoke-gray filter, installed.

Optional Accessories— 51/4-inch rack adapter; panel assembly; C-30A camera; Type 602 to C-30A camera adapter; C-30A camera carrying case.

If optional P7 phosphor is ordered, smoke-gray filter is deleted and orange filter is added.

ORDER INFORMATION

602 DISPLAY UNIT	\$950
602 MOD 174K DISPLAY UNIT	\$950
Standard instrument with optional internal 8 x 10-cm	outline
graticule.	

602 MOD 146B DISPLAY UNIT\$925

Standard instrument, without cabinet, for mounting in rack adapter. Requires 51/4-inch vertical rackmounting space.

NEW



- LOW-COST X-Y MONITOR
- TIME BASE OPTION
- 6-1/2-INCH STORAGE CRT
- 1 MILLION DOTS/SEC WRITING SPEED
- VARIABLE STORED BRIGHTNESS
- VIEW FOR EXTENDED PERIODS
- DIFFERENTIAL INPUTS

The 603 is an X-Y monitor for displaying alphanumeric and graphic data in either a refreshed or stored mode on a 61/2-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-61/2-inch flat-faced bistable storage tube. Phosphor is similar to P1. 3.5-kV accelerating potential. Two storage tubes are available (standard CRT for a brighter stored display or Option 2 for a faster writing speed). When used in the nonstore mode, both tubes exhibit characteristics of a conventional CRT.

*Registered Trademark Polaroid Corporation



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.

NEW



Input R and C-1 M Ω ±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 μ sec or less for distances of 1 div or less. 1 µsec or less from any point on the CRT to within one spot diameter of final position.

Maximum Input Voltage-±100 V DC plus peak AC.

Linear Common-Mode Signal Range—±3 V, ±15 V in 5X fixed attenuator position.

Common-Mode Rejection Ratio-At least 100:1 to at least 100 kHz.

Recommended Source Impedance—10 k Ω or less.

Optional Horizontal Time Base-1 µsec/div to 0.1 sec/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 sec/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam in nonstored mode. Positive input to + input increases the display intensity.

To insure storage of each written dot the Z-axis on-time should be at least $4 \mu s$ with the standard CRT and at least $0.5 \mu s$ 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 $\pm 5 \text{ V}$.

Input R and C-1 M Ω ±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).

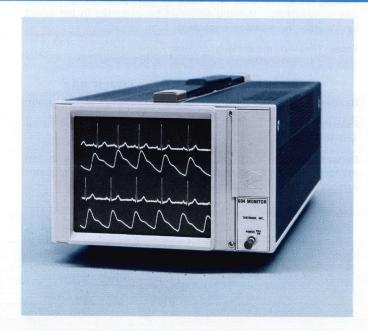
Optional Accessories—51/4-inch rack conversion kit, C-5 Camera.

ORDER INFORMATION

603 STORAGE MONITOR\$1100 Standard instrument is without graticule. (External 8 x 10 div graticule provided for test purposes.)
OPTION 1
OPTION 2 \$1125 Standard instrument with fast-writing CRT.
OPTION 3
OPTION 4
Field Modification Kit, order 040-0623-00

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

NEW **Display Monitor** 604



- 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 61/2-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 equency ratios using Lissajous figures, raster displays with intensity modulation and apparent dynamic three-dimensional illustrations. Calibrated horizontal sweep rates, available optionally, provide a convenient extension of the 604 measurement field. Visual display of computer-processed data enhances understanding of the processed information. Permanent records of the 604 display can be obtained on Polaroid* prints using the TEKTRONIX C-5 Camera. Differential inputs are available via BNC connectors on the rear panel. Plus inputs are also available via a 25 pin connector.

CRT DISPLAY

Cathode-Ray Tube—6½-inch flat-faced rectangular CRT with P31 phosphor. Optional phosphors; P7 (includes orange filter) and P4.

Display Size—Internal parallax-free, nonilluminated graticule marked in 8 vertical and 10 horizontal divisions (½ in/div). Option 1 is without graticule.

Display Linearity—The voltage required to produce 1 inch deflection at any point on the CRT will not vary more than 5%.

VERTICAL AND HORIZONTAL AMPLIFIERS

Bandwidth—DC to 2 MHz at 3-dB down (80% full screen scan).

Polarity—Positive signal to both + inputs moves the beam up and to the right.

Deflection Factor—Vertical and horizontal: ≈50 mV/div to 250 mV/div, internally adjustable, 5:1 fixed internal attenuator extends range to at least 1.25 V/div.

Input R and C—1 M Ω ±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 $k\Omega$ or less.

Optional Horizontal Time Base— 1 μ sec/div to 0.1 sec/div in six calibrated steps (decade sequence), accurate within 3%. Uncalibrated, continuously variable between steps and to approximately 1 sec/div. TRIG SLOPE/LEVEL control for stable, triggered displays. For non-triggered operation, an internal switch selects bright base-line or no sweep.

Z AXIS

Linear Z-axis amplifier permits intensity modulation of the writing beam. Positive input to + input increases the display intensity.

Bandwidth—DC to 5 MHz over usable range, sensitivity is adjustable from 1 to 5 V.

Differential Input—CMRR at least 100:1 and common-mode range at least $\pm 5 \, \text{V}$.

Input R and C—1 M Ω ±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 (\pm 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).

Optional Accessories—51/4-inch rack conversion kit, C-5 Camera.

ORDER INFORMATION

604 MONITOR	\$700
OPTION 1	\$700
OPTION 2	\$690
OPTION 4	\$825
Field Modification Kit, order 040-0623-00	

RACKMOUNTING FOR 603 AND 604

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

603/604 DIMENSIONS AND WEIGHTS

Dimensions	Cabinet		Rackmount	
	in	cm	in,	cm
Height	6.0	15.25	5.25	13.5
Width	8.5	21.5	8.5	21.5
Length	20.0	50.9	19.0	48.0
Weights (approx)	lb.	kg	lb :	kg
Net	17.5	7.9	17.5	7.9
Domestic shipping	22.0	9.9	22.0	9.9
Export shipping	28.0	12.7	28.0	12.7

^{*}Registered Trademark Polaroid Corporation





- HIGH RESOLUTION ALPHANUMERIC AND GRAPHIC DISPLAYS
- FLICKER-FREE BISTABLE STORAGE
- ELIMINATES COSTLY MEMORY DEVICES
- HARD COPY COMPATIBLE
- REMOTE PROGRAMMING OF DISPLAY FUNCTIONS

The 611 Storage Display Unit provides stored displays of combined alphanumeric and graphic information from analog sources, digital computers and other data transmission systems. The TEKTRONIX-developed bistable storage CRT used in the 611 eliminates the need for costly memory devices for refreshing the information display and provides high information density without flicker or drift and with excellent resolution. The standard instrument provides a vertical format display area with the same aspect as a typewritten page. A horizontal display format is available in the 611 MOD 162C.

OPERATING FUNCTIONS

Operating functions are View, Erase, Non-Store, and Write-Thru. View and Erase are under manual or programmable control; Non-Store and Write-Thru are under programmable control. The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to "ready-to-write" mode. As new information is written, it is retained on

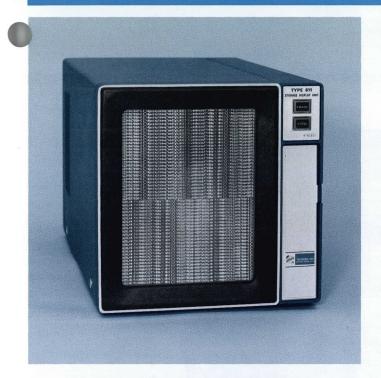
the CRT in the "view" mode. Within 90 seconds after the display is written, the 611 will automatically switch to a "hold" mode. This holds data stored on the CRT at a low brightness to extend storage time. Pressing the VIEW switch while in the "hold" mode, returns the display to the "view" mode for at least 60 but not more than 90 seconds. The "view" mode may be programmed for continuous viewing.

A special "write-thru" feature is provided for displaying additional information on a screen already containing stored information. In the "write-thru" mode the CRT beam is unblanked and a cursor, or any generated pattern, may be displayed without destroying previously stored data and without storing new data. This function is useful for positioning cursors and locating the CRT writing beam. In the "write-thru" and "non-store" modes the display remains on screen as long as it is refreshed.

The Intensity, Focus, Operating Level, Power Switch and Test Spiral controls are located behind a front-panel access door. Pushing the Test Spiral switch causes the instrument to complete an erase cycle and store a single-shot test pattern presentation. Pulling Test Spiral switch provides a "non-store" mode with repetitive test pattern for focusing and other tests.

The Erase, Non-Store, Write-Thru and View operating functions are remotely programmable through contacts at the remote program connector on the rear panel. An Erase Interval signal is also provided at this connector. X, Y, Z inputs are provided through rear BNC connectors or the remote program connector. Manual control of Erase and View is provided on the front panel.





CHARACTERISTICS CRT DISPLAY AND STORAGE

Cathode Ray Tube—11-inch flat-faced bistable storage tube, phosphor similar to P1.

Display Size-Vertically: 21 cm. Horizontally: 16.2 cm.

Resolution— 4,000 characters based on a 90 x 70-mil matrix, clearly legible with good spacing. Equivalent to 400 vertical x 300 horizontal stored line pairs.

Viewing Time—At least 15 minutes without loss of resolution. Viewing time may be extended to one hour; however, several erasures may be required to fully remove previously stored data.

Dot Writing Time— $5\,\mu s$ or less is required to write (store) one bit of information.

Erase Time-500 ms or less.

VERTICAL AND HORIZONTAL AMPLIFIERS

Deflection Factor—Vertical:1-V full scale (16.2 cm for square format or 21 cm for rectangular format), accuracy within 2%.

Horizontal: 1-V full scale (16.2 cm), accuracy within 2%.

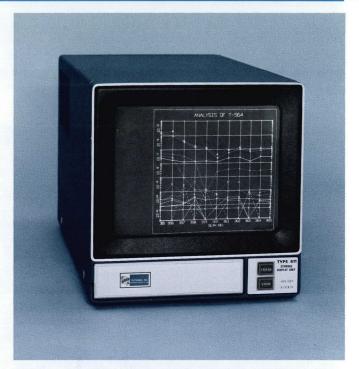
Initial Beam Position—Any one of 9 initial beam positions can be selected by internal switches. Each position is adjustable.

Settling Time— 3.5 $\mu {\rm s/cm}~+~5~\mu {\rm s},$ to within 1 spot diameter of final position.

Positional Drift— 0.16 mm (or less)/hour with 75- Ω source impedance at 20°C to 30°C. Within 1.6 mm/hour with 75- Ω source impedance at 10°C to 50°C, reference 25°C.

Polarity—Positive input to the vertical and horizontal inputs moves the beam up and to the right.

Input R and C— $100 \text{ k}\Omega$ shunted by approx 70 pF.



Type 611 MOD 162C features a horizontal display format.

Z AXIS

Input—Turn-on level (unblanked) is +1 V. Turn-off level (blanked) is +0.5 V or less.

Input R and C— 100 k Ω paralleled by approx 70 pF.

Maximum Input Voltage— ±50 V combined DC and peak AC.

OTHER CHARACTERISTICS

Erase Interval Pulse—A negative-going erase pulse is provided at the rear connector to inhibit external equipment during an erase cycle. Amplitude change is approx $+10\,\mathrm{V}$ to $+0.3\,\mathrm{V}$, source impedance approx $2\,\mathrm{k}\Omega$.

Remote Control—Contacts at the remote program connector on the rear panel provide remote control of the Erase, Non-Store, Write-Thru, and View operating functions.

Power Requirements—90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 250 watts maximum at 115 V and 60 Hz. Rear panel selection provides rapid accommodation for six line-voltage ranges.

Dimensions and Weights		
Height	11% in	30.1 cm
Width	11% in	29.5 cm
Depth	22% in	56.8 cm
Net weight	≈51 lb	≈23.1 kg
Domestic shipping weight	≈62 lb	≈28.1 kg
Export-packed weight	≈72 lb	≈32.6 kg

Included Accessories-Program connector; connector cover.

ORDER INFORMATION

611 STORAGE DISPLAY UNIT	\$3175
611 MOD 162C STORAGE DISPLAY UNIT	

NEW





- BRIGHT FLICKER-FREE VIEWING
- LOW COST
- STORAGE ECONOMY
- HARD COPY COMPATIBILITY

The 613 Storage Display is a bright, low cost, large screen data storage and display unit. Use includes any environment where a substantial amount of data is stored and presented in a single display.

Applications Versatility

The 613 Storage Display provides digital and analog displays in business, education, banking, electronic data processing, medicine, and process control.

Use of a newly-designed storage cathode-ray tube provides a bright trace for easy viewing of high density alphanumeric and graphic displays in high ambient light conditions. The 613 Storage Display provides high information density without flicker.

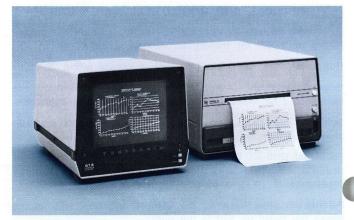
Permanent hard copies of the displayed information are available by using the fully compatible 4610 Hard Copy Unit, which provides full screen copies in eighteen seconds. Storage technology eliminates expensive components required in refreshed information display.

Multiplexing Option

A 4610 Hard Copy Unit, Option 1 is available. This is a multiplex unit that allows from one to four 613's to operate into a single 4610 Hard Copy Unit thereby reducing copy costs.

Operating Functions

613 operating functions are View, Erase, Non-Store and Cursor. View and Erase are under manual or programmable control. Non-Store and Cursor are under programmable control only.



The 613 Storage Display is fully compatible with the 4610 Hard Copy Unit.



Remote programming of the 613 is achieved by grounding the ppropriate program lines of a program connector on the rear panel.

The Erase function, when initiated, removes all previously stored data from the display area and returns the CRT to a "ready-to-write" mode. Within ninety seconds after the display is written, the 613 will automatically switch to a "Hold" mode, storing data on the CRT at a low brightness to extend the storage time. Pressing the VIEW switch while in the "Hold" mode returns the display to the "View" mode for at least 60, but not more than 90 seconds. The "View" mode may be programmed for continuous viewing.

In the "Non-Store" mode the display remains on the screen as long as it is refreshed.

The Intensity, Focus and Power switch controls are located on the rear panel. The View and Erase switches are located on the front panel. X, Y, and Z BNC connectors are available on the rear panel.

CRT DISPLAY & STORAGE

Cathode-Ray Tube- 11-inch flat faced storage tube.

Display Size-Vertically: 15 cm. Horizontally: 20 cm.

Resolution - 200 vertical x 266 horizontal stored line pairs.

Display Linearity—Full Scale—spot will settle within 1.5% proper position along center axes for voltage applied.

Incremental—less than 15% difference between any 2 cm deflection, at any position in the display.

Viewing Time—Nominally 15 minutes. Longer viewing may require more than one erasure.

Dot Writing Time— $5\,\mu s$ or less is required to write (store) one bit of information.

Erase Time-800 ms or less.

VERTICAL AND HORIZONTAL AMPLIFIERS

Deflection Factor—Horizontal: 1 V/20 cm rectangular format, accuracy within 2%. Vertical: 1 V/15 cm, within 2%. Either input driven differential or single ended.

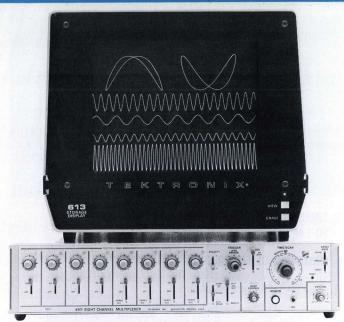
Initial Beam Position—Any one of 9 initial beam positions may be selected by two internal connectors. Each position is adjustable $\pm 10\%$ of full scale vertically and horizontally.

Settling Time— 14.0 μ s/cm + 6 μ sec/cm up to 2 cm to within 1 spot diameter of final position.

Polarity—Positive input to the vertical moves beam up; positive input to the horizontal moves beam to the right.

Input R and C-20 k minimum. Shunted by less than 60 pF.

Maximum Input Voltage— \pm 18 V DC plus peak AC.



Bright, easily-viewed traces from as many as eight sources can be portrayed on the 613 Storage Display when used with the 4701 Eight-Channel Multiplexer.

Z AXIS

Input—At least +1 V turns beam on; +0.5 V or less turns beam off.

Input R and C-10 k shunted by ≈50 pF.

OTHER CHARACTERISTICS

Remote Control—All 613 operating modes can be controlled by applying appropriate ground closures to the remote program connector. All control signal inputs are TTL compatible (2 TTL per input). Modes which may be controlled remotely are: Erase, View, Non-Store and Cursor.

Power Requirements—90 VAC to 132 VAC or 180 VAC to 264 VAC, 48-66 Hz. 180 watts maximum, 115 VAC, 60 Hz.

Dimensions and Weights

cm 11.100 in.
cm 13.250 in.
cm 21.000 in.
g \approx 43 lbs.

ORDER INFORMATION

613 STORAGE DISPLAY Horizontal Display format	\$2200
613-1 STORAGE DISPLAY Vertical display format	\$2200

Optional Accessories

An optional EMI Filter is available for use in high electrical noise environments. Order TEKTRONIX part number 337-1743-00.





- LINKS DATA AND SIGNAL SOURCES TO LARGE SCREEN TV MONITORS
- CONFORMS TO EIA OR CCIR STANDARDS
- REMOTELY PROGRAMMABLE

The 4501 Scan Converter Unit accepts alphanumeric and graphic data—in the form of analog inputs—and converts it to displays on TV receivers and monitors. The hi-contrast TV displays are ideal for individual or group viewing—even under bright light conditions. The displays may be viewed as light data on a dark background or as dark data on a light background, selected from the 4501 front panel.

CHARACTERISTICS VERTICAL AND HORIZONTAL AMPLIFIERS

The DC coupled X (horizontal) and Y (vertical) differential input amplifiers provide cancellation of common-mode signal components, permit convenient polarity inversion, and provide a means for mixing of two signals from separate sources.

Bandwidth—At least 10 MHz within center 7.5-cm scan area, $+20^{\circ}\mathrm{C}$ to $+30^{\circ}\mathrm{C}$.

Deflection Factor—Vertical: 0.75-V full screen (7.5 cm), variable from 0.375-V full screen to 1.125-V full screen. **Horizontal:** 1.0-V full screen (10 cm), variable from 0.5-V full screen to 1.5-V full screen.

Phase Difference-Within 10° between X and Y at 10 MHz.

Dot Settling Time—0.15 μ s or less to within 1% of final position.

Gain Stability—Within 1% of setting, $+20^{\circ}$ C to $+30^{\circ}$ C; within 4%, 0° C to $+50^{\circ}$ C. (+) Y input moves the beam up, (-) Y input moves the beam down, (+) X moves the beam right, (-) X input moves the beam left.

Input R and C-1 M Ω within 2%, paralleled by 47 pF.

Maximum Input Voltage-200 V, (DC plus peak AC).

Differential Input—Linear common mode signal range: + and -2.5 V, total not to exceed 5 V P-P. Common mode rejection ratio: $\geq 500:1$ at 10 kHz; $\geq 100:1$ at 1 MHz; $\geq 10:1$ at 10 MHz.

Z-AXIS AMPLIFIER

The differential DC-coupled Z-axis amplifier provides cancellation of common-mode signal components, permits convenient polarity inversion and provides a means for mixing of two signals from separate sources. In all WRITE modes, the display intensity is determined by the Z-axis input and the INTENSITY control. Access to (+) and (_) inputs is through BNC con-

nectors on the rear panel. Simultaneous access to the (+) input is available through the remote program connector.

The Z amplifier input has two operating modes: LINEAR and LIMITING.

Linear Amplifier (Single-ended or differential)

Bandwidth—≥5 MHz with 1-V input.

Risetime—<75 ns with 1-V input step.

Moduluation Amplitude—Maximum intensity is achieved at 1.0 V P-P. Input writing intensity is produced by 0.5 V P-P and minimum usable intensity is 0.05 V P-P.

Polarity—Positive signal on the (+) input increases intensity, negative signal on the (-) input increases intensity.

Input R and C-1 M Ω , $\pm 2\%$ paralleled by 47 pF.

Maximum Input Voltage-200 V (DC plus peak AC).

Linear Common Mode Signal Range— + and - 2.5 V, not to exceed 5 V P-P.

Common Mode Rejection Ratio— \geq 500:1 at 10 kHz; \geq 100:1 at 1 MHz; \geq 10:1 at 5 MHz.

Limiting Amplifier

A single-ended signal at the (+) input connector can be routed through an amplitude limiting stage by moving an internal switch. The drive signal to the Z-axis amplifier is automatically limited to 1 V P-P.

Input Requirements—Voltage levels of $+1\,\mathrm{V}$ or more turn the beam on to a fixed level. Voltage levels of $+0.5\,\mathrm{V}$ or less keep the beam turned off.

Maximum Input Voltage - 200 V (DC and peak AC).

STORAGE CRT

Cathode Ray Tube— 5-inch, flat-faced bistable storage tube, phosphor similar to P1.

Aspect Ratio-Three units vertically by four units horizontally.

Resolution—Equivalent to 100 vertical/125 horizontal stored line pairs.

Display Time—At least 15 minutes without loss of resolution. Display time may be extended to one hour.

Dot Writing Time-8 µs or less.

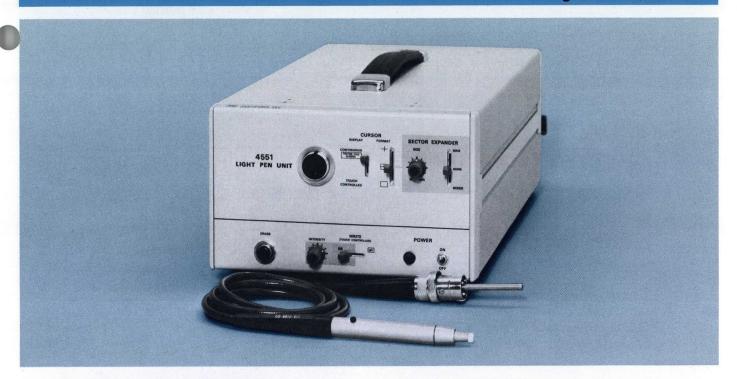
OTHER CHARACTERISTICS

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 48 to 66 Hz, 125 watts maximum at 115 V 60 Hz. Rear-panel selector provides rapid accommodation for 6 line voltage ranges.

Temperature—Performance characteristics are valid over an operating temperature range of 0°C to $+50^{\circ}\text{C}$.

Included Accessories—25-pin connector; connector cover; 25-ft, 75- Ω , BNC cable; 37-pin connector; connector cover; UHF to BNC adapter; 3-conductor power cord. R4501 also includes rackmounting hardware.





- POINT, DRAW, AND WRITE ON TV MONITORS AND RECEIVERS
- USE IN BROADCAST TV, CCTV AND CATV SYSTEMS
- MAGNIFY SELECTED AREAS OF TV DISPLAYS

Add to, change, direct viewer attention to, or highlight TV displays by writing on, pointing to, or drawing on TV monitors, using the 4551 Light Pen Unit with a scan converter.

The 4551 Light Pen Unit is an interactive device for video displays which interface to standard 525 line/60 Hz or 625 line/50 Hz video systems. The 4551 Light Pen Unit has a number of useful outputs which allow transfer or retrieval of information from a computer being used with a video display system. The Light Pen Unit outputs both analog and digital signals which represent the display address at the intersection of its cross-hair cursor.

Analog and digital signals corresponding to the cursor's X-Y coordinates are generated within the Light Pen Unit and available to the user. These signals may be fed into a data system for use in computer-aided instruction and limited data reduction applications. With the hand-held 4551 Light Pen, viewer attention can be directed to any point on a TV display and can supplement the information viewed with drawings, sketches and words.

The location and path of the cursor is determined with a light pen held and moved by the operator's hand, just as an ordinary pen is used. The cursor's position is defined as a set of X-Y coordinates. You can elect to display or not display a cursor, and to cause the cursor to track the pen's movement

or remain stationary. You can cause the pen to write, or not to write, as it is moved or held stationary.

As the pen is moved to write or draw, its movements are converted to stored images on a scan converter. The scan converter then displays the written image on the monitor or receiver. To the viewer, the image appears as if it is written directly on the TV screen.

To remove written information from the screen, simply press the ERASE button on either the light pen or the 4551 Light Pen Unit front panel. The mixed video picture written upon remains unchanged by erasure of the written information.

LIGHT PEN CHARACTERISTICS

Output Signals—For analog applications the voltage-output level varies from 0-to-5 V (nominal) as a function of the cursor position. Output is 1 mA or less. The recommended load impedance should be at least $5\,\mathrm{k}\Omega$. In digital applications, both the vertical and horizontal coordinates are provided by 9 parallel lines of binary information. The lines are TTL compatible and each has a fan-out capability of 5 TTL loads.

OTHER CHARACTERISTICS

Power Source—Line-voltage selector switch provides 2 ranges as follows: 95 V to 132 V, 190 V to 264 V. Line frequency range is 50 Hz to 440 Hz. Power requirement is approximately 50 watts.

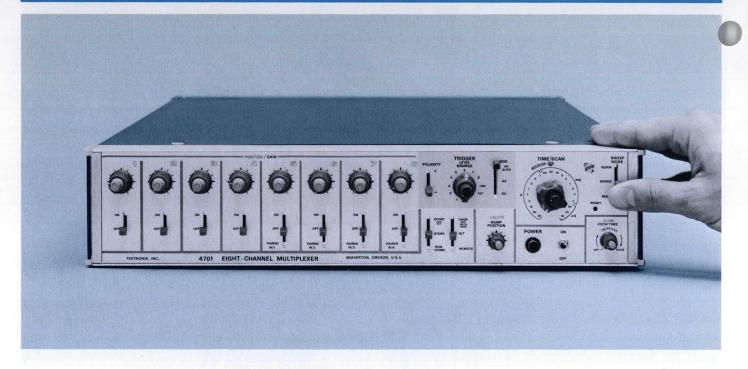
Dimensions and Weights-

Height	5 in	12.7 cm
Width	8 in	20.4 cm
Depth	16 in	40.7 cm
Net Weight	$\approx 4.5 \mathrm{kg}$	≈10 lb

Included Accessories—Light Pen Unit to Scan Converter interconnecting cable (012-0314-00).

4551 LIGHT PEN UNIT\$1800





- DISPLAYS 8 CHANNELS Y-T or 4 CHANNELS X-Y
- REMOTE CHANNEL SELECTION
- CALIBRATED TIME BASE

Display signals from as many as eight separate sources on a single screen with the 4701 Eight-Channel Multiplexer and a TEKTRONIX Display Unit. The 4701's calibrated Time Base makes possible as many as 8 simultaneous Y-T displays; up to four X-Y displays are possible using the channels in pairs; or a mixture of X-Y and Y-T displays can be selected.

Automatic erase for TEKTRONIX Storage Display Units is provided by the 4701. Operating modes for the 8 channels include Alternate, in Channel 1 through Channel 8 sequence; Chopped, with individual-channel viewing time selected according to the Display Unit in use; and Remote, as programmed from an external source.

INPUT CHARACTERISTICS

The eight channels have identical characteristics. Differential inputs provide for noise cancellation where long lines are used. This is an advantage in areas where the point of signal acquisition is at some distance from the 4701. Conventional 1-M Ω impedance minimizes circuit loading, and allows use of signal probes if further isolation or attenuation is desired. Front panel controls provide a continuously variable 10:1 attenuation.

APPLICATION AREAS

Medical

Operating Rooms and Intensive Care—Monitoring the level of anesthesia, blood pressure, heart rate and ECG signals.

Medical Schools—Monitoring actual and simulated ECG's, EDG's, EEG's, EMG's, etc. The 4701/611/4601 and 4701/4501/TV monitors fill needs here.

Medical Clinics—Multi-signal tests performed on blood and other biophysical elements.

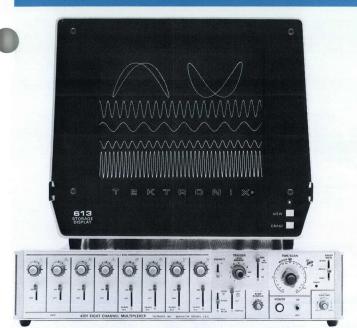
Education

The 4701 finds a variety of use in Engineering, Physics, Psychology, Veterinarian Departments and Technical Schools in lecture, labs and research applications.

Petroleum/Chemical

Research and refinery process control applications monitoring pressure, temperature, oxygen, etc. often occur in oil company and chemical plants. Auto erase and the externally-programmed channel selection feature are particularly significant when used with computers. Hard copy capability is a plus in this environment.





The 4701 Eight-Channel Multiplexer and the 613 Storage Display comprise a system capable of portraying eight different signal sources.

CHARACTERISTICS VERTICAL CHARACTERISTICS

Deflection Factor— 1 V to 10 V, continuously variable.

Bandwidth-DC to 1 MHz.

Input Impedance— 1 M Ω paralleled by \approx 20 pF.

Common-Mode Rejection Ratio-at least 100:1.

Output— 1 V into 50 Ω with 1 V input.

Operating Modes—Alternate: in sequence 1 thru 8. Chopped: internal switch selects chopping rates of approximately 2.5 kHz, 30 kHz or 300 kHz. Remote: 3 lines of TTL compatible binary code select the output channel.

X-Y Plots—Selector switches on channels 5, 6, 7 and 8 select channels 1, 2, 3 and 4 respectively for their X displays.

TIME-BASE CHARACTERISTICS

Sweep—Provides full screen normal or single sweep displays at 20 different Time/Scan settings from 10 μ s to 50 s in a 1, 2, 5 sequence. A non-calibrated mode is continuously variable between steps. Either repetitive or single sweeps can be selected.

Triggered Modes—Automatic peak-to-peak, AC coupled and DC coupled, plus and minus slope.

Trigger Inputs—Can be internal from each selected channel, external, or from the power line.

View Time—Provides automatic control of a TEKTRONIX storage display unit and permits the 4701 to retain the display in a view mode from 0.1 s to 30 s, (continuously variable) after all channels are displayed.

OTHER CHARACTERISTICS

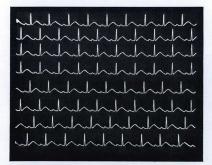
Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 440 Hz, 21 watts maximum.

Dimensions and Weights—Height 3½ inches, width 16% inches, depth 20% inches, and weight approximately 15 pounds.

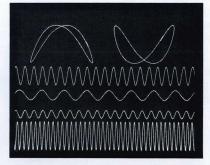
Included Accessories— 6-foot interconnecting cable; 25-pin male connector.

4701 EIGHT-CHANNEL MULTIPLEXER	\$1500
R4701 EIGHT-CHANNEL MULTIPLEXER	\$1525
613 STORAGE DISPLAY Horizontal Display format	\$2200
613-1 STORAGE DISPLAY Vertical display format	\$2200

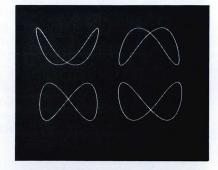
U.S. Sales Prices FOB Beaverton, Oregon Please refer to General Information page



8-Channel Y-T Displays—Full-Screen normal or single sweep displays are swept at 10 μ s to 50 s full scale, from a time base internat to the 4701. Oscilloscope-type triggering is also provided. Simulated ECG is shown.



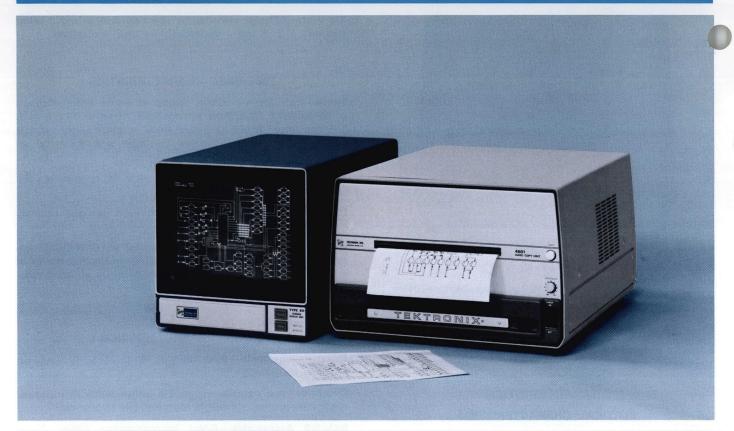
MIXED X-Y and Y-T Displays—Simultaneous display of four frequencies versus time and two frequencies versus two other frequencies. Other display combinations include 1 X-Y with 6 Y-T displays and 3 X-Y with 2 Y-T displays.



4-CHANNEL X-Y Displays—Format can be horizontal or vertical, depending on the display unit ordered.

The above displays were photographed on a 611 MOD 162C Display Unit.





- A NEW STANDARD OF USER CONVENIENCE
- PERMANENT COPIES OF STORED DISPLAYS
- COPY COSTS AS LOW AS 5 CENTS A COPY
- ACCURATE 8½" x 11" INFORMATION COPY

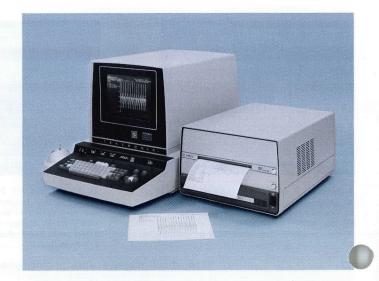
The 4601 Hard Copy Unit is a convenient, economical way of permanently copying alphanumeric and graphic displays. High resolution displays obtained on the 611 Storage Display or 4002A Graphic Computer Terminal are copied by the 4601, providing an accurate representation of the stored display on 3M* Type 777 Dry-Silver Paper.

Installation and operation are quick and simple. Installation is just a matter of connection to the power line and the appropriate TEKTRONIX Display Unit. Copy command is initiated manually by pressing a front panel control, or by supplying an external command under program control.

THE COPY PROCESS

The signal source is "looped through" the 4601 to the TEK-TRONIX display device. When the copy command is received, the signal source is automatically disconnected from the display device.

Hard Copy is produced by systematically scanning the target of the storage unit. Scanning ramps are generated by scan generators located in the Hard Copy Unit. An electrical signal is taken from the target electrode and fed to the Z axis of a line scan CRT. A fiber-optic faceplate couples the light output from the phosphor to the recording material. Heat development of the latent image takes place after this exposure. Hard Copy is available about 18 seconds after initiation of the copy command.



The 4601 Hard Copy unit copies stored displays of the 4002A Graphic Computer Terminal and the 611 Storage Display Unit.

^{*}Registered Trademark of Minnesota Mining and Manufacturing Company

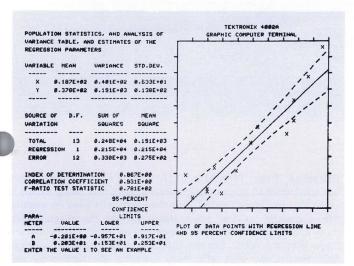


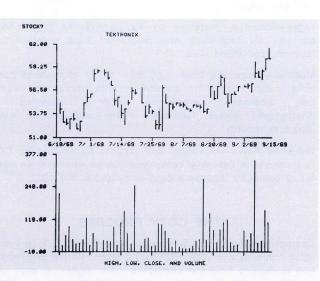
THE COPY MEDIUM

he processing unit in the 4601 uses 3M Brand Type 777 Dry-Silver Paper.

Type 777 Paper provides the high image contrast required for high-resolution copies of complex graphics and alphanumerics. It offers the stability normally associated with wet-process photosensitive paper, plus the convenience of dry print-out papers. Cost is low: 5 to 8 cents per 8½ by 11-inch copy, depending on quantity purchased. Further economies can be realized using smaller copies. Copy size may be set from 8½ by 6 inches to 8½ by 14 inches. Roll size is 8½ inches by 500 feet.

Dry-Silver prints can be handled much like any conventional paper. Records can be written upon with pencil or pen. Pencil marks are erasable. Shelf life for unexposed paper is six months, providing the paper is not removed from its protective wrapper and is stored at room temperatures.





The 4601 Hard Copy Unit provides permanent, 8½ x 11 inch copies of a wide range of alphanumeric and graphic displays as viewed on the TEKTRONIX 4002A Graphic Computer Terminal and 611 Storage Display Unit.

CHARACTERISTICS

Copy Size—Adjusted to $8\frac{1}{2}$ x 11 inches at factory, variable between $8\frac{1}{2}$ x 6 inches and $8\frac{1}{2}$ x 14 inches.

Copy Time-18 seconds for first copy.

Warmup Time-20 minutes.

Remote Copy Command—Closure to ground for at least $5 \mu s$.

Resolution (with 3M Brand Type 777 Paper)—Essentially the same as displayed on the 611 or 4002A Display Devices. Actual-size copies of a 4000-character display, based on a 90 x 70-mil matrix, are clearly legible.

Capability—Designed for use with TEKTRONIX 4002A Graphic Computer Terminal, and Type 611 Display Unit serial numbers B142240 and above. Type 611's below this serial number require a modification; contact your local TEKTRONIX Field Office for additional information.

Power Source (factory-wired options)— 90 to 136 VAC, 115 V nominal, 50 to 60 Hz. Maximum power consumption at 115 V, 60 Hz is 1450 W for first 40 seconds after turn on, 220 to 520 W for normal operation, 100 W standby.

Dimensions and Weights

Height	11	in	27.9 cm
Width	17	in	42.7 cm
Length	≈24	in	\approx 61 cm
Weight	≈69	lbs	≈31 kg

Included Accessories—two 6-foot interconnecting cables; 8-foot detachable power cord.

ORDER INFORMATION

4601 HARD COPY UNIT

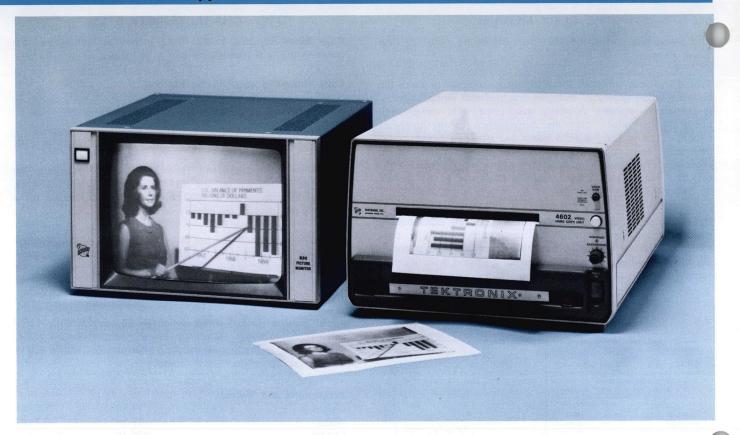
115 volt, 50-60 Hz power
4601-1 HARD COPY UNIT
The 4601 and 4601-1 have light tan cabinets and are set up for use with the TEKTRONIX 4002A Graphic Computer Terminal.
4601 or 4601-1 HARD COPY UNITS, Option 1 \$3750
Option 1 provides blue cabinets and setup for use with the TEKTRONIX 611 Storage Display Unit.
Optional Accessories Copy Catcher, order 016-0298-00\$95
Paper—One roll is included with the 4601. Refills are available from Tektronix, Inc.
For one roll, order 006-1603-00

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

For one carton of 4 rolls, order 006-1603-01

\$3750





PERMANENT HARD COPIES OF TV DISPLAYS

GRAY SCALE PORTRAYAL

The 4602 Video Hard Copy Unit makes permanent facsimile copy from static television signals. The TV signal is copied on 3M* Dry-Silver Paper by the 4602, providing an accurate gray scale representation of the television inputs.

Since the 4602 is completely self-contained, installation consists merely of connection to the power line and to the video information to be copied. Front-panel controls allow the user to standardize the copy video signals in the range of 0.2 V P-P to 3 V P-P. Copy command is initiated by pressing a front-panel control, or by supplying an external command. Contrast and Density are adjusted by the operator with simple to use front-panel controls.

APPLICATIONS

Easy-to-handle $8\frac{1}{2}$ x 11 inch dry copies are convenient for communication, documentation, recording and filing uses in unlimited applications, a few of which are:

Education—Permanent hard copy of pictures, graphs, notes, and drawings from video tapes or TV assisted lectures.

Banking and Finance—Account information for clients directly from CRT displays; signatures and identification are easily and accurately verified.

Law Enforcement—High-resolution copies of criminal identification, fingerprints, sketches, handwriting, and crime records.

*Registered Trademark of Minnesota Mining and Manufacturing Company

Refreshed Video Terminals—Alphanumerics, graphics or gray scale information appearing on display terminals using standard video signals. Most TV CRT refreshed terminals have an acquisition connector to the video signal driving the display unit. Hard copies of any display appearing on these terminals are made with the 4602. Several terminals may timeshare a single 4602 Hard Copy Unit, effectively lowering the hard copy unit cost per setup.

Legal—Microfilm projected by TV cameras to remote video monitors for immediate and permanent hard copy of case histories and dated files.

Medical—Permanent hard copy from CCTV of medical operations, patient monitoring, medical records, accounting information, biophysical waveforms, anatomy sketches and photographs, X-rays, laboratory charts and medical supply inventory records.

Industrial Firms—Messages and records transmitted by CCTV to locations in industrial complexes copied whenever an operator or computer initiates a copy command to the 4602.

THE COPY PROCESS

Composite television picture video is applied to a loop-through input connection on the 4602 rear panel. Internal synchronization is derived from the composite video signal. A copy command, provided by a front-panel pushbutton or via remot electrical input, initiates a sampling process. The video signals are sequentially sampled, providing information to modulate the line-scan CRT intensity. A fiber-optic faceplate couples the light output to the recording material, producing



gray scale copy. This latent image is heat-developed in the 602, cut to 8½ x 11 inch sheets. Video information must be unvarying during a brief sampling period. An additional 20 seconds is required to process the hard copy.

THE COPY MEDIUM

The processing unit in the 4602 is designed to be used with 3M Brand Type 777 Dry-Silver Paper.

Type 777 Paper provides the high image contrast required for high-resolution copies of complex graphics and alphanumerics. Cost is low: 5 to 8 cents per 8½ x 11 inch copy, depending on quantity purchased. Roll size is 8½ inches by 500 feet.

Dry-Silver prints can be handled much like any conventional paper and can be easily written upon with pencil or pen. Pencil marks are erasable. Shelf life of unexposed paper is six months, providing the paper is not removed from its protective wrapper and is stored at room temperature.



Clear, full gray scale hard copies are available from the 4602 Video Hard Copy Unit.

CHARACTERISTICS

Video Input—Two rear-panel BNC connectors arrayed for loop-through connection of 75 ohm coax video cable. Response is within 3 dB from 50 Hz to 30 MHz. Common-mode rejection ratio is 40 dB at 50 to 60 Hz with a common-mode signal range up to 5 V P-P. Return loss is greater than 46 dB from 50 Hz to 5 MHz.

Video Monitor Output—Composite video output with 75 Ω source impedance allows use of a video picture monitor as a setup aid. Output amplitude is 1 V P-P when video gain is properly adjusted for copy.

Copy Size—Adjusted to 81/2 x 11 inches at factory.

Copy Time— 40 seconds for first copy. Additional copies of the same display take about 20 seconds each.

Warmup Time-20 minutes.

Remote Copy Command—Closure to ground for at least $5 \mu s$.

Ambient Temperature—0°C to +35°C is recommended.

Power Source (factory-wired options)— 90 to 136 VAC, 115 V nominal, 50 or 60 Hz. Maximum power consumption at 115 V, 60 Hz is 1450 W for first 40 s after turn-on, 220 to 520 W for normal operation, 100 W standby.

	D	imension	5 8	and '	W	eig	hts	
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For one roll, order 006-1603-00 .

Height	11	in	27.9 cm
Width	17	in	42.7 cm
Leigth	24	in	61 cm
Weight	≈69	lbs	\approx 31 kg

Included Accessories—75 $\Omega,$ BNC Termination, 25 ft., 75 Ω BNC Video cable.

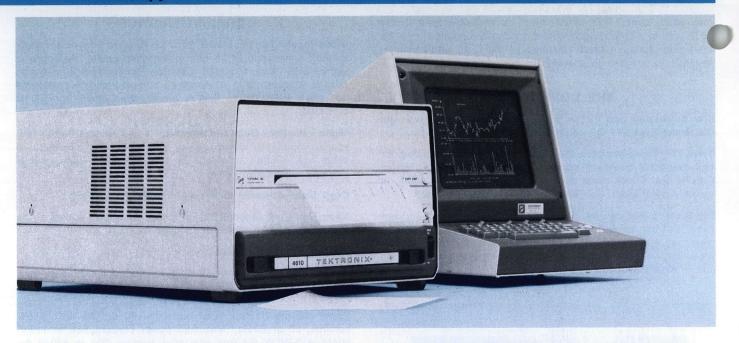
ORDER INFORMATION

4602 Video Hard Copy Unit Standard
4602-1 Video Hard Copy Unit
4602 or 4602-1 with Option ONE
Optional Accessory Copy Catcher (Part No. 016-0298-00)
Paper —One roll is included with the 4602. Refills are available from Tektronix, Inc.

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

For one carton of 4 rolls, order 006-1603-01





- DRY-PROCESS HARD COPY FROM GRAPHIC COMPUTER TERMINALS AND STORAGE DISPLAY UNITS
- SAME RESOLUTION AS STORAGE CRT
- COPIES IN ONLY 18 SECONDS

Sharp, permanent hard copies are made from the CRT display of the new 613 Storage Display, or any 4010-Family Computer Display Terminal by the 4610 Hard Copy Unit. And the 4610 can be multiplexed to provide a copying capability of from one to four 4010-1 Computer Display Terminals and/or 613 Storage Displays.

Operation is simple. A single pushbutton control on the 4610 front panel or a rocker switch on the computer terminal initiates copy-making manually, or program control will accomplish it from the computer.

Installation is equally simple—just a power line connection from the nearest 115-volt 60-Hz AC outlet, and one cable connection to the computer terminal or display unit.

The 4610 processor unit uses 3M* Brand Type 777 Dry-Silver paper, which gives the high image-contrast needed for the most complicated graphic and alphanumeric displays. Type 777 paper provides the same long-term stability you expect from wet-process papers, with all the convenience of dry process. Copies can be handled like any other paper—write on them with pen or pencil, and erase pencil marks without smearing or damaging the paper. Stored under prescribed conditions of temperature and humidity, the paper has a shelf life of six months or better.

Copy size may be set from $8\frac{1}{2}$ by 6 inches to $8\frac{1}{2}$ by 14 inches. Roll size is $8\frac{1}{2}$ inches by 500 feet.

*Registered Trademark of Minnesota Mining and Manufacturing Company

CHARACTERISTICS

Copy Size—Adjusted to $81/2 \times 11$ inches at factory, variable between $81/2 \times 6$ inches and $81/2 \times 14$ inches.

Copy Time- 18 seconds for first copy.

Warmup Time— 20 minutes.

Dimensions and Weights			
Height	11	in	27.9 cm
Width	17	in	42.7 cm
Length	24	in	61 cm
Weight	≈69	lbs	≈31 kg

Resolution (with 3M brand Type 777 paper)—Essentially the same as the display.

Power Source (factory-wired options)—115 Volt nominal, 50 to 60 Hz. Maximum power consumption 1450 watts for first 40 seconds after turn-on, 220 to 520 watts for normal operation, and 100 watts standby.

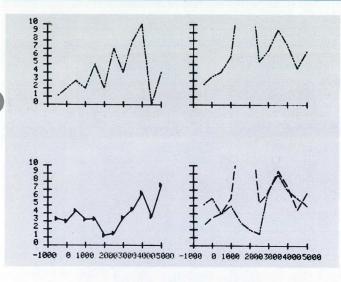
Operating Ambient Temperature—Between $+0^{\circ}\mathrm{C}$ and $+35^{\circ}\mathrm{C}$ is recommended. If operation is necessary in extreme environmental conditions, see your TEKTRONIX Field Engineer or Application Engineer.

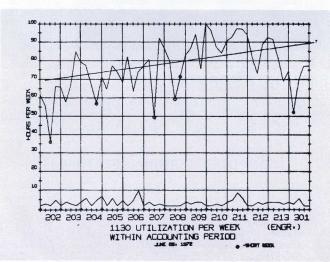
Included Accessories— 8-foot detachable power cord, interconnecting cable.



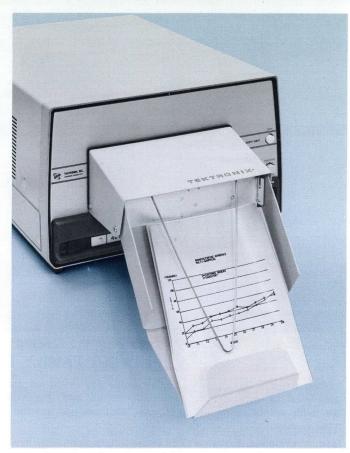


INEV





The 4610 provides clear copies of graphic and alphanumeric data.



The Copy Catcher pulls and stacks hard copies from all Tektronix 4600-series Hard Copy units.

Optional Accessories	
Copy Catcher, order 016-0298-00	 \$95

ORDER INFORMATION

Product Price
4610 HARD COPY UNIT\$3550
4610-1 HARD COPY UNIT
4610 HARD COPY UNIT, Option 1
4610-1 HARD COPY UNIT, Option 1
Paper—One roll is included with the 4610 or 4610-1. Refills are available from Tektronix, Inc.
For one roll, order 006-1603-00





4002A 4010-1 4012 4013 A GROWING FAMILY OF TEKTRONIX TERMINALS

Interactive graphic display capability has vastly increased the usefulness of computer-processed information, and improved the utility of computers in educational, business and scientific environments.

Now a complete family of TEKTRONIX Computer Terminals has been developed, providing a model for nearly every purpose. Included are (1) the 4002A, a versatile general-purpose display terminal with both storage display and refreshed scratch pad sections (for on-line editing), a full ASCII character set, with 96 printing characters and three distinct graphic modes in addition to alphanumeric operation; (2) the 4010, a low-priced terminal combining alphanumeric and graphic mode operation, and 64 printing characters; (3) the 4012, with Alphanumeric, Graphic Display, and Interactive Graphing operating modes and the complete ASCII character set; and (4) the 4013, offering all of the features of the 4012, plus the complete APL character set. Additional information about each of these terminals will be found on pages 274-276.

The PLOT-10 Software system makes the fully software supported terminals useful for hundreds of business, educational, scientific, and industrial applications-and the terminal can be

interfaced with many different data communication systems and computer configurations. Consult with your TEKTRONIX Applications Engineer for complete details. PLOT-10 is described on page 277.

COMPUTER TERMINAL FEATURES

The 4010, 4012 and 4013 are designed in a convenient deskheight stand-alone pedestal configuration, making them excellent for use in any office, laboratory or industrial location.

Further operational versatility is added to all TEKTRONIX terminals with a wide variety of optional accessories. Graphic mode operation of the 4002A can be augmented with 4901 and 4903 Interactive Graphic Units and 4951 Joystick. The 4010-Family terminals offer such auxiliaries as a Display Multiplexer, an Audio Recorder card, and accessory instruments including the 4911 Reader/Perforator and the 4912 Digital Cassette Tape Unit.

Price information on all of the above-mentioned accessories is found in this section. For complete information on these and other Computer Display Products, just check and return the reply card at the back of this catalog.

4002A **Graphic Computer Terminal**

- FULL SCREEN GRAPHING CAPABILITY
- STORAGE TUBE GRAPHICS WITH REFRESHED TUBE EDITING
- **FULL ASCII CHARACTER SET**

The 4002A is a self-contained computer terminal which provides a high-resolution, flicker-free display of both complex graphics and high-density alphanumerics.

This graphic computer terminal provides benefits of both storage tube graphics and refreshed tube editing. A split screen, direct-view storage tube eliminates the need for a separate refreshed memory for the main display. This minimizes the information rate requirements of the data source. A one line refreshed scratch pad enhances editing. The full ASCII character set is provided, including 96 printing characters.

Three separate modes of graphic display are offered-Point Plot, Linear Interpolate, and Incremental Plot. In any of the graphic modes 1024 points can be addressed in either horizontal or vertical planes. 761 points can be viewed in the vertical plane, 1024 in the horizontal.

Added performance in graphics is provided by the use of the 4951 Joystick in combination with the 4901 or 4903 Interactive Graphic Units. The 4901 or 4903 fit directly into the 4002A, and generate a cross-hair cursor, which can be positioned to any point on the display screen by the Joystick. The Inter-

274

KY Y

active Graphic Unit then digitizes the graphic address at the cross-hair intersection and sends the X and Y address components to the computer.

CHARACTERISTICS

Jisplay Medium—11-inch (diagonal) direct-view, bistable storage CRT with refreshed scratch pad area.

Display Area—8.3-inches horizontal by 6.1-inches vertical.

Alphanumeric Mode

Format—39 lines of 85 normal or italic characters in main area, one line of 84 characters in scratch pad area.

Character Set— 96 upper and lower case printing characters (ASCII code).

Character Size—70 x 90 mils (approx) can be made double size

Character Generation-7 x 9 dot matrix.

Cursor-Pulsating 7 x 9 matrix.

Graphic Modes

Linear Interpolate, Incremental Plot, Point Plot. 1024 x 1024 addressable points, 1024 x 761 viewable points.

Graphic Input Mode—1024 (X), 761 (Y) points. Joystick controlled. Cross-hair cursor.

Input Power—110/120 VAC with line voltage selector. HI, MED, or LOW line voltage switch selectable.

Operating Temperature—+10°C to +40°C.

Dimensions—19% inches high, 19 inches wide, 34% inches deep.

Weight—130 pounds (approx).

4002A GRAPHIC COMPUTER TERMINAL, without Interface ... \$8800

Graphic Computer Terminal Interfaces 4002A

Part Number 4002A with DAT	Description TA COMMUNICATIONS INTERFACE\$9400	021-0038-00 021-0039-00	Honeywell H316 Interdata Computers and G. E. Process Computers with Teletype Control Card
021-0033-00	This interface transfers data in a serial asynchronous format either full-duplex or half-duplex mode. It conforms to EIA Standard RS-232-C and CCITT V24. Internal clocks or external timing signals may be used. Transmit and receive rates are independent of each other and easily selected on back panel switches. Standard selectable rates are 110, 150, 300, 600, 1200, 2400, 4800, 9600 bits/sec inclusive. Two positions of each switch are provided for user chosen rates.	021-0039-01 021-0040-00 021-0041-00 021-0043-00 021-0045-00 021-0045-01 021-0046-00 021-0047-00	Type 32-062 F01 Interdata Computers and G. E. Process Computers with Teletype Control Card Type 32-120 F01 DEC PDP-11 Varian 620F Raytheon 703, 704, 706 DEC PDP-9 DEC PDP-8 (S/N 150 & up) DEC PDP-8 (S/N 149 & below) DEC PDP-15 DEC PDP-8/e with Module M865
4002A with TEL	ETYPE PORT INTERFACE\$9550	021-0047-01 021-0051-00	DEC PDP-8/e with Module M8650 Honeywell DDP 516
021-0034-00 021-0035-00 021-0036-00	DEC PDP-8/i, 8/L and 12 Data General Computers HP 2100 Series & 2000A (12531 card)		TIVE GRAPHIC UNIT \$525 TIVE GRAPHIC UNIT \$1000

Computer Display Terminal 4010, 4010-1 NEW

- SUPPORTS ALPHANUMERIC PLUS LOW-COST INTERACTIVE COMPUTER GRAPHICS
- CONVENIENT PEDESTAL DESIGN FOR USER ENVIRONMENTS

Varian 620/i, 620/L, 620/R

FLICKER-FREE STORAGE DISPLAY

021-0037-00

COMPLETE SOFTWARE SUPPORT—PLOT-10

The 4010 Computer Display Terminal is a low-cost computer terminal for use in business, educational and scientific environments. Until recently, cost was a major barrier to the use of graphic terminals in many applications. The 4010 has broken the cost barrier, with complete interactive graphics and alphanumeric display at a new, economical price. Direct-view bistable storage makes the CRT display clear and flicker-free, with excellent resolution on all parts of the screen.

For alphanumeric operation, the full TTY ASCII character set of 64 printing characters is featured, with a format of 35 lines

of 72 characters each—a total of 2520 characters maximum on the display screen.

4951 JOYSTICK

For graphics, the 7.5 by 5.6-inch display area includes 1024 addressable points in both X and Y planes. Viewing limits are 1024 points in the X plane, and 780 in the Y plane.

Permanent hard copies can be made quickly and inexpensively by mating the 4010-1 version of the terminal with the 4610 Hard Copy Unit.

4010-FAMILY CHARACTERISTICS

Display Medium-11-inch direct-view bistable storage CRT.

Display Area - 7.5 inches wide by 5.6 inches high.

Alphanumeric Mode

Format—72 characters per line, 35 lines; 2520 characters per screen.

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

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4010 Character Set— 64 printing characters (TTY ASCII Code). **4012** and **4013** Character Set— 96 printing characters, full ASCII set (upper and lower case).

4013 APL Character Set-Full APL character set.

4010 Cursor—Pulsating 5 x 7 dot matrix.

4012 and 4013 Cursor-Pulsating 7 x 9 dot matrix.

Graphic Mode—Vectors only. Vector drawing time 2.6 ms. 1024 x 1024 addressable points; 1024 x 780 viewable points.

Graphic Input Mode— 1024 (X), 780 (Y) points. Thumbwheel controlled cross-hair cursor.

4010 COMPUTER DISPLAY TERMINAL	\$3950
4010-1 COMPUTER DISPLAY TERMINAL	\$4250

NEW 4012 Computer Display Terminal

- LOW COST FULL RANGE PERFORMANCE
- UPPER AND LOWER CASE ALPHANUMERICS
- GRAPHIC CAPABILITY WITH HIGH RESOLUTION
- FULL ASCII CHARACTER SET

New operating versatility in low-cost computer graphics is offered by the 4012 Computer Display Terminal. TEKTRONIX direct-view bistable storage provides clear, flicker-free CRT display with excellent resolution on every part of the display screen. High-density alphanumeric and graphic displays contain as many as 2520 alphanumeric characters on 35 lines of

72 characters each. Addressable points for graphic operation are 1024 in X and 1024 in Y planes, with 780 in the Y plane and 1024 in the X viewable on screen.

The full ASCII character set of 96 printing characters is included, with both upper and lower case letters.

Three modes of operation are provided. In addition to alphanumeric mode, Graphic Display (Graf) and Interactive Graphics (Gin) can be used.

Hard copies of all 4012 displays can be made with the 4610 Hard Copy Unit mated to the terminal.

4012 COMPUTER DISPLAY TERMINAL\$4950

NEW 4013 Computer Display Terminal

- PROGRAMMING EASE FOR SCIENTISTS, MATHEMATICIANS, EDUCATORS
- APL CHARACTER CAPABILITY WITH HIGH RESOLUTION
- FULL ASCII CHARACTER SET

APL (A Programming Language) makes computer graphics a faster, more effective procedure and makes programming easier for scientists, mathematicians and educators. APL operation is a feature of the new 4013 Computer Display Terminal. This versatile new terminal, utilizing the TEKTRONIX direct-view bistable storage CRT, offers, in addition to the APL character

set, the complete ASCII character set of 96 printing characters, including both upper and lower case letters.

The 4013 is an even more effective tool of data communication when used with the new TEKTRONIX PLOT-10 APL/Graph software or with the PLOT-10 software developed for the 4010-series Computer Display Terminals.

As with other TEKTRONIX Computer Display Terminals, hard copies of all displays can be made in seconds, and at minimum cost by using the 4013 with the 4610 Hard Copy Unit.

4013 COMPUTER DISPLAY TERMINAL \$5450

NEW 4010-Family Computer Display Terminal Interfaces

(specify interface at time of order.)

4010 WITH STANDARD INTERFACE	\$3950
4010 WITH ANY OPTIONAL INTERFACE	\$4250
4010-1 WITH STANDARD INTERFACE	\$4250
4010-1 WITH ANY OPTIONAL INTERFACE	\$4550
4012 WITH STANDARD INTERFACE	-
4012 WITH ANY OPTIONAL INTERFACE	\$5250
4013 WITH STANDARD INTERFACE	\$5450
4013 WITH ANY OPTIONAL INTERFACE	\$5750
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Data Communication Interfaces

Standard

Standard Data Communication Interface included with the 4010-Family is RS-232-C compatible. Strap selectable input/output data rates of 150, 300, 600, 1200, 2400, 4800 and 9600 bits/sec.

Option 1

Optional Data Communication Interfaces with convenient switch selectable functions including: local-echo, full-duplex, half-duplex and independent transmit and receive rates of 110, 150, 300, 600, 1200, 2400, 4800 and 9600 bits/sec.

Teletype Interfaces

Option 2 DEC PDP-11

Option 3	DEC PDP-8/i, 8/L, 12, 15
Option 4	Data General Computers
Option 5	DEC PDP-8/e with Module M865
Option 5A	DEC PDP-8/e with Module M8650
Option 6	HP 2100 Series, 2000A (12531 card)
Option 7	Varian 620/i, 620/L, 620/R
Option 9	Raytheon 703, 704, 706
Option 10	DEC PDP-8 (S/N 150 & up), PDP-9
Option 10A	DEC PDP-8 (S/N 149 & below)
Option 11	Honeywell H316
Option 12	Honeywell DDP 516
Option 13	Interdata Computers and G.E. Process
	Computers with Teletype Control
	Card Type 32-062 F01
Option 13A	Interdata Computers and G.E. Process
	Computers with Teletype Control Card
	Type 32-120 F01
Option 14	Varian 620F
DISPLAY MILLT	IPLEXER CARD, order 018-0067-00

 DISPLAY MULTIPLEXER CARD, order 018-0067-00
 \$195

 AUDIO RECORDER CARD, order 018-0066-01
 \$295



- SAVES MONEY AND TIME
- SAVES COMPUTER CORE

Punched tape capability greatly expands the limited memory capacity of a mini-computer. With the 4911 Reader/Perforator Unit, programs that would otherwise consume valuable space in core storage are kept in permanent off-line form, ready to be read into the computer at 200 characters per second.

With a 4911 Reader/Perforator Unit, the programs and data normally filed in a timesharing or in-house computer system can be converted to 8-channel punched tape and used for file maintenance through the 4010-Family Computer Display Terminal.

The 4911 Reader/Perforator Unit uses standard, easily-obtained one-inch paper, paper-mylar, or aluminum-mylar tapes with a thickness range of 0.0030 to 0.0043 inch.

4911 READER/PERFORATOR \$2950

- MAKES OFF-LINE DATA STORAGE SIMPLE
- PERMITS OFF-LINE EDITING
- SAVES TIME AND MONEY

The 4912 Digital Cassette Tape Unit, connected to a TEKTRONIX 4010-Family Computer Display Terminal, makes off-line program and data storage a simple error-free process.

The 4912 Digital Cassette Tape Unit enhances off-line storage by capturing data in peak activity periods and permitting file updating and manipulation in slack periods.

Installing, loading and operating the 4912 is simple and fast. All data access and tape manipulation can be accomplished under program control from the computer.

4912 DIGITAL CASSETTE TAPE UNIT\$1950

SOFTWARE PRODUCTS NEW

- MOST EXTENSIVE GRAPHING SOFTWARE AVAILABLE ANYWHERE
- INTERFACES TO MORE THAN TWENTY MAJOR MINIS
- COMPATIBLE WITH MAJOR TIMESHARING SYSTEMS
- SOFTWARE ACCESSIBILITY TO 360/370 SYSTEMS

Tektronix, Inc. has expanded its programs of total software support to provide the most extensive graphing software ever offered. This graphing software is compatible with most timesharing systems, with IBM 360/370 O/S and TSO and with numerous mini-computers. PLOT-10 offers a series of modules from which can be selected those elements that best suit the operating environment and application.

PLOT-10/Mini-Computer

The PLOT-10/mini-computer package lets the operator easily use the TEKTRONIX terminals on his mini-system. PLOT-10 consists of assembly-language subroutines supporting graphics input/output and special functions of the terminal.

PLOT-10/360/370 Graphics Software

The PLOT-10/360/370 software module provides the capability to access TEKTRONIX terminals from within application programs. Written in assembler language using IBM's Execute Channel Program I/O facility, modules can be assessed from any of the IBM programming languages by subroutine calls. Special facilities are provided for PL/I compatibility. The module will handle multiple terminals, and operates under O/S MFT or MVT, or MVT with TSO.

PLOT-10/Terminal Control System

This package sets a new standard for interactive graphics terminal software. It provides a comprehensive base of graphic software to support user application programs.

The software is written in FORTRAN IV. These routines allow all or part of your picture to be displayed on any region of the terminal screen. All clipping and scaling are automatic.

Routines are included for erasing the screen; making a hard copy; determining character size and font, plotting absolutely or relatively; handling and formatting alphanumeric output; and performing graphic input of screen points.

PLOT-10/Advanced Graphing—Scientific Routines

This set of routines allows the user to display data graphically without concerning himself with programming details. Alphanumeric data tables can be converted to graphs with a single subroutine call. Routines are included for data plotting in cartesian, semi-log, log-log, and polar-coordinate systems, with automatic or specified scaling. One curve or several curves can be drawn on the same set of coordinates.

PLOT-10/Advanced Graphing—Business Routines

These routines provide support for users of all levels in the business environment.

An extensive set of routines are available to allow an easy and flexible graphic presentation of user data in commonly accepted formats (e.g. pie charts, histograms, time series scales). Routines are included to allow the user to create his graph from utilizing the interactive graphics facility of the terminal.

PLOT-10/Application Interface

This series of graphing modules permit the user to obtain graphs directly from existing applications packages.

A modular approach has been adopted for the application interfacing packages. Computations required are isolated from the graphics that display their results, which allows flexibility in future development.

PLOT-10/APL/Graph Software

APL/Graph is an integrated collection of user oriented APL functions adapted from the popular Terminal Control System and Advanced Graphing Routines. They are designed to allow highly interactive, easy to use computer graphics. The package includes functions to control all utilities of the terminal itself, including screen erasure, windowing, clipping, hard copy generation, and alphanumeric handling.

An extensive set of functions is also available to provide support for users in all facets of business, scientific, mathematical, and educational work. These include functions for creation of pie charts, histograms, time-series scales, and all types of X, Y plotting. Functions are also included to allow polynomial curve fitting. Normal X, Y plotting can be done on cartesian, semi-log, log-log, and polar coordinate systems with any number of curves drawn on the same set of coordinates.





The 1791 N/C Program Verifier is a unique and versatile tool for the numerical control programmer. The operator's console, tape reader, and storage CRT display unit make up the complete package necessary to check machine control programs on standard one-inch wide, eight-level punched tapes. The display unit plots the programmed tool path and quickly reveals programming errors before actual machining takes place. Alphanumeric listings of program data permit the programmer to locate erroneous blocks and to see what corrections will have to be made. Additionally, as each block of program data is read and plotted on the storage screen, a refreshed, line-buffer display area displays the active block contents.

Tape programs are verified fast. The display is plotted at tape reader speeds of up to 500 characters per second, or at selected slower rates. Tapes can be advanced automatically through the reader or stepped singly, block-by-block.

The 1791 works on all common N/C tape codes and formats. The 1791 can also accomodate special formats and programs by way of a special patchboard which can be wired to the customer's specifications. These special programs are then selected by front panel switches.

The savings gained by graphic verification can justify use in even a modest programming activity. More than one user can share a 1791 (remember it verifies fast), enabling many programs to be verified in one day.

Even more programs can be checked daily with the addition of a TEKTRONIX 4601 Hard Copy Unit. Instead of examining dis-

plays on screen, examine permanent paper copies "off-line" and let others get to the 1791. Permanent copies are also useful for program files and for operator set-up charts.

To obtain further information and to make arrangements for a demonstration of the 1791 N/C Program Verifier, contact a TEKTRONIX Field Office. Machine Control Specialists are available for sales and support help including training, maintenance and application assistance.

CHARACTERISTIC SUMMARY

Tape Reader—Photo-optical, bi-directional sprocket drive, up to 500 characters per second. Reel diameter of 7½ inches.

Tape Formats—WORD ADDRESS and eight choices of TAB SEQUENTIAL (the eight chosen by the customer and selected via front panel switch).

Tape Coding—EIA (RS-244A), ASCII/ISO (RS-358), and NON-PARITY ASCII.

Motion Word Formats—LEADING ZERO SUPPRESSION, TRAILING ZERO SUPPRESSION or FULL ZERO format.

Motion Word Length-4, 5, 6, or 7 digits.

Motion Word Dimensions—ABSOLUTE, INCREMENTAL, INCREMENTAL ARC or INCREMENTAL IJK.

Motion Word Resolution—0.0001 inch, 0.001 inch, 0.001 mm or 0.01 mm.

Special Programs—An eight-position switch selects one of eight special programs wired to the customer's specification on a special patchboard.

CRT Display Modes—PLOT (tool path display) and LIST (alphanumeric listing of program).

CRT Plot Mode Views—OBLIQUE, three ORTHO views (XY, YZ, XZ), and LATHE (ZX).

CRT Plot Mode Scale Factors—Full screen scale factors of 1.56 inches (cm) to 200 inches (cm), in eight increments.

CRT Plot Mode Zoom—Any one of 64 fixed areas on the screen can be enlarged 64 times to full screen size.

CRT List Mode—31 lines (one block per line) can be listed and stored for viewing. Erasing the display allows the next 31 blocks to be listed.

Line Length-Maximum of 63 characters (83 optionally) per line.

Line Buffer Display Area—One line of 63 characters (83 optionally) of refreshed (non-stored) data.

Power Requirements—95 to 130 VAC or 190 to 260 VAC, (factory wired), 48 to 60 Hz. Maximum power consumption 400 W at 115 VAC.

Operating Temperatures— $+10^{\circ}$ C to $+45^{\circ}$ C.

Dimensions and Weight

	1791	Display Unit
Height	20.5 in	12 in
Width	20.5 in	11.5 in
Depth	22 in	22.5 in
Shipping Weight	≈90 lb	≈51 lb

Included Accessories—Display Unit interconnecting cable (012-0333-02); mating twistlock power cord (161-0036-00); test tape (016-0522-00); circuit card extender (670-1329-00); wire wrap tool (003-0691-00); wire (175-0920-00); extender cables (175-1307-03, 175-1307-04, 175-1307-05).

Order 1791 N/C Program Verifier \$11,500

NEW



The 1781 Editor is an integral part of the TEKTRONIX N/C Editor System. The N/C Editor System consists of a 1781 Editor, a 1791 N/C Program Verifier, and a 4601 Hard Copy Unit, all housed in a mobile 207-1 Cart.

The N/C Editor System is a stand-alone N/C tape preparation center. It provides: graphics-assisted tape program generation with keyboard input and tape punch; graphic verification of tape programs; fast, simple tape editing with graphics; convenient tape duplication and code conversion; permanent copies of N/C tool path and program data listing in seconds.

The 1781 Editor cabinet houses the power supply, a tape punch, tape punch control circuitry and a pull-out TTY Style 33 typewriter keyboard. The 1781 interfaces with the 1791 Program Verifier.

The 1781 N/C Editor System is a significant advance in the N/C industry. For the first time, tool path and program errors on machine tapes can be instantly viewed and corrected without a computer. On-the-spot tape program modifications, insertions and deletions are quickly and easily carried out. The N/C Editor System keeps production machines producing parts. N/C tape preparation time is notably reduced by eliminating transcription errors and turn around delays normally occurring in computer facilities. Thus productivity is increased and N/C tape preparation costs are significantly reduced.

To obtain further information and to make arrangements for a demonstration of the N/C Editor System, contact a TEKTRONIX Field Office. A Machine Control Specialist will soon be in touch with you.

1781 EDITOR CHARACTERISTIC SUMMARY

Punching Speed— 66 characters per second.

Tape Types- 0.003 to 0.0045-inch thick paper, paper-mylar, aluminum-mylar that complies to EIA standard RS-227.

Tape Drive—Bi-directional (back space capability, 20 characters).

Blank Tape Supply- 8-inch diameter roll.

Bit Format— 8-channel, EIA (RS-244A) or ASCII (RS-358), switch selectable.

Keyboard-Pull-out, TTY Style 33, including special keys for: REWIND STOP, TAB, BACK SPACE, DELETE, LINE BUFFER RESET, COPY and TAPE FEED.

Power Requirements-Line voltage ranges, 90 to 136 VAC and 180 to 272 VAC, switchable. Line frequency, 48 to 60 Hz. Maximum power consumption, 110 W at 115 VAC, 60 Hz.

Operating Temperatures— +10°C to +49°C and up to 95% humidity after 15 minute warm-up.

Dimensions and Weights	1781	207-1
Height	9 in	25.5 in
Depth	22 in	43.5 in
Width	20 in	26.5 in
Shipping Weight	pprox73 lb	pprox50 lb

Included Accessories-One roll of blank paper tape (002-1073-00); 1791 punch interface card (670-2246-00).

Order 1791 N/C PROGRAM VERIFIER	\$11,500
Order 1781 EDITOR	3,750
Order 4601 HARD COPY UNIT (Optional)	3,750
Order 207-1 CART (Optional)	250
1781 N/C EDITOR SYSTEM	





NUMERICAL CONTROL

Numerical control (N/C) has been defined by the Electronics Industries Association as: "A system in which actions are controlled by the direct insertion of numerical data at some point. The system must automatically interpret at least some portion of it." Generally, numerical control systems have been employed as a versatile, and accurate, method of controlling the operations of machines. Hence, the term Machine Control Unit (MCU) is often used synonymously with N/C. TEKTRONIX Machine Control Units conform to the standards of the machine industry and can be interfaced to a large variety of machines. These machines include those which have been designed as numerically-controlled machines as well as those which can be adapted to N/C.

There are two basic types of machine controls. The simplest is a point-to-point (PTP) or *positioning* control, in which a tool or part is directed to a position and a machine operation such as drilling or punching is performed. The path to that point is of consequence only in terms of time required for movement or obstacles that may exist along that path. PTP control applications are many. Some examples are optical comparator positioning, wire-wrapping, a wide variety of assembly machines, as well as drilling, tapping and boring machines.

A more sophisticated N/C concept is continuous path or *contouring* control. The contouring MCU continuously controls the tool path by a coordinated simultaneous motion of two or more axes. Applications for a contouring control would include milling machines, automatic welding machines as well as numerically-controlled lathes and turning centers.

Tektronix, Inc. offers a complete spectrum of Machine Control Units ranging from the simplest of positioning controls to complex multi-axis contouring controls. Specifically, the following MCU types are available:

Two Axis Positioning

Three Axis Positioning

Two Axis Contouring

Three Axis Contouring

TEKTRONIX Machine Control Units are closed-loop, digital control devices. The basic controls consist of TTL integrated logic circuitry on plug-in circuit boards, power supply, operator's control panel and photo-electric tape reader. The complete control unit is exceptionally compact.

The functional-design concept of TEKTRONIX MCU's permits the flexibility to be able to adapt to most machine applications. Within our MCU Application Engineering and Manufacturing areas, control capabilities and features may be tailored to suit the individual application.

GRAPHIC TAPE VERIFICATION

Unique to TEKTRONIX Contouring Control Units is the ability to graphically preview the programmed tool path. These controls can interface directly with the TEKTRONIX 611 Storage Display Unit and require no other equipment, such as computers. The 611 graphically plots the programmed tool path and automatically displays it on the storage cathode ray tube. The ability to quickly and easily verify the actual machine tool path prior to machining the first part is very important. This results in both timesaving and cost-saving benefits.

Tape verification is fast. The display is generated at the maximum reading rate of the tape reader, usually 300 characters per second. Verification is accomplished in just a fraction of the time required for an on-the-machine tape check at programmed feed rates. And delays typically encountered in computer assisted graphic verification are eliminated, as are the higher costs which are associated with computer systems. Tapes can be checked on-site, at the machine.

Since the tape is checked on the same control unit which will be used for making parts, no special programming is necessary. This means that the programmer need not be burdened with special codes or techniques in order to utilize the graphic verification feature. He simply programs according to the standards associated with the particular control unit. The graphic interface automatically interprets the program data into a meaningful display. During the verification process, machine tool functions under programmed control are automatically inhibited. Incorrect tape programs can do costly damage. It may be limited to a ruined part or a broken tool. In some instances the machine itself may be damaged. By graphically verifying each tape be-

PROGRAMMING

resulting in a savings of both time and money.

fore cutting begins, this type of damage can be eliminated,

Part programming is significantly simplified with TEKTRONIX Machine Control Units. The many programming features offered relieve the part programmer of much of the tedious calculations required in other N/C systems.

Part programming is the process of converting a part description, such as a drawing, into a form that can be readily processed by an N/C system. Dimensioning of parts typically follows classical drafting procedures, based upon drafting convenience and manual machining requirements. They bear little resemblance to techniques required for contemporary N/C system programming. TEKTRONIX Machine Control Unit programming flexibility permits tailoring to the classical drafting procedures, thereby simplifying the programming efforts.

Tape format used is the word address, variable block system. Tapes are shorter since only words which change from block to block need to be programmed. There are no block length restrictions and either leading or trailing zeroes may be dropped Tape character coding may be either EIA or USASCII.

Programming directly from part drawings, without redimensioning, is made possible by unique tape codes which switch the control logic to adapt to absolute and incremental dimensions. Part programs can be mixed, containing dimensions in absolute or incremental terms at the programmer's discretion. Programming is further simplified by tape-coded position preset. This permits the programmer to redefine the floating zero point, or add an offset, from the tape to permit programming in absolute coordinates that are referenced to different points.

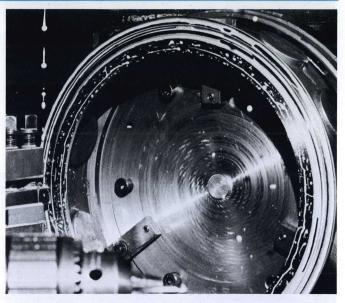
Feedrate programming is direct, in inches-per-minute (IPM), and inches-per-revolution (IPR) for turning equipment. *Direct feedrate programming* provides significant advantages for TEK-TRONIX MCU users including simplified part programming, simplified program checkout, and reduced tape length.

Typical hard-wired N/C systems require some calculations be made by the programmer to compensate for the inability of these controls to compute velocities along vector paths. The computational capability of TEKTRONIX MCUs provides relief for the part programmer by eliminating these tedious, and error-prone, calculations. The feedrate is commanded directly in IPM or IPR. The control constantly calculates the corrections necessary to maintain the programmed feedrate along any vector path. When programming with circular interpolation, the programmed feedrate is automatically maintained along the programmed arc. The required feedrate is programmed only once and need never be reprogrammed until a change in feedrate is required.

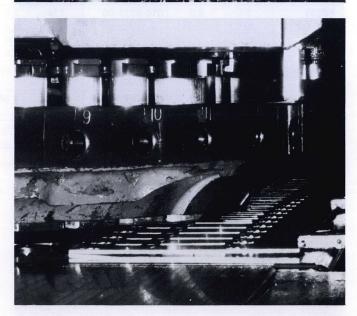
Programming of complex contours containing circles and arc sections is simplified with *circular interpolation*. A minimum amount of data is required to program circular arcs lying in a single plane of machine motion. Programmers need only program the end point of the arc and coordinates of the arc center along with the appropriate code to command arc direction.

TEKTRONIX Machine Control Units feature automatic control of acceleration and deceleration with no special programming required. Acceleration and deceleration rates are selected when the system is first set-up and the control automatically determines the point at which deceleration begins at the completion of each block of commands. However, for contouring work it is often desirable to inhibit deceleration between blocks in order to maintain a smooth and constant motion along the tool path. TEKTRONIX MCUs provide this added flexibility. In both linear and circular interpolation modes of contouring, the programmer utilizes special tape codes to inhibit or allow deceleration between blocks. These codes need not appear in each block, but only when a change in operation is required. Fully buttered data input ensures smooth and continuous operation, particularly in the inhibit deceleration mode.

TEKTRONIX Machine Control Units feature many other capabilities, many of which are either not available on other control systems or are available only as extra cost options. Because of the wide variety of applications for TEKTRONIX MCUs and the belief that each application deserves special attention, these features are not completely identified in this catalog. Full, detailed information on each type of Machine Control is available in the form of feature bulletins, data sheets and standard proposals. To obtain further information and assistance with your applications, please contact a TEKTRONIX Field Office. A Machine Control Specialist will soon be in touch with you.









Tektronix, Inc. offers a wide variety of probes to help accomplish a wide variety of measurements. The principal factors that need to be considered to choose the best probe for your job are contained in the following charts. More details on any probe are given on the pages indexed in the charts. Probe recommendations are given throughout the catalog with the description

of specific scopes and plug-ins. A wide variety of probe tips, adapters and ground leads are pictured near the back of the catalog. Some of those accessories are included as a standard part of each probe package. For a picture or listing of which accessories are included with any particular probe package refer to the catalog page where that probe is described.

CURRENT PROBES

	USEFUL BANDWIDTH Hz to MHz		CURRENT/DIV	SATURATION		MAXIMUM CURRENT					e i kulin
ТҮРЕ			SCOPE AT 50 mV/DIV	DC	AMP ms	MAX RMS	PEAK PULSE	DERATE BELOW ABOVE		PRICE	PAGE
P6021 with Term	450	50	.1 A or .5 A	.5 A	.5	5.3 A	250 A	300 Hz	5 MHz	\$ 129.00	293
with 134	12	35	1 mA to 1 A	.5 A	.5	5.3 A	15 A	230 Hz	5 MHz	352.00	294
P6022 with Term	8.5 k	100	50 mA or .5 A	.2 A	.009	2.1 A	100 A	3 kHz	10 MHz	\$ 170.00	293
with 134	100	60	1 mA to 1 A	.2 A	.009	2.1 A	15 A	1.3 kHz	10 MHz	383.00	294
P6042	DC	50	1 mA to 1 A	10 A	1 <u>- 1</u> 30 a	10 A	10 A	min os t k	1 MHz	\$ 725.00	296
CT-1 with P6040	30 k	1000	10 mA	.2 A	.001	.5 A	100 A	reaten reco	al hamm	\$ 50.00	294
CT-2 with P6041	1.2 k	85	50 mA	.2 A	.05	2.5 A	100 A	idi aselling	isu njugm	\$ 55.00	295
CT-3	30 k	1000	10 mA	.2 A	.001	.5 A	100 A	ANTONIA IIV	III. Ist Allin	\$ 38.00	299
CT-5 with P6021/134	12	20	20 mA to 1 kA	20 A	500	700 A	15 kA	230 Hz	1.2 kHz	\$ 802.00	295
with P6042	.5	20	20 mA to 1 kA	20 A	8000	700 A	20 kA	20 Hz	1.2 kHz	1175.00	296

VOLTAGE PROBES for 50 Ω inputs, or 1 M Ω inputs

TYPE	ATTEN	LENGTH IN FEET	PACKAGE NUMBER	LOAD	LOADING		DC MAX	CON- NECTOR	READ- OUT	PRICE	PAGE	
P6034	10X	1.5	Obsolescent	USE	USE P6056 and		USE P6056 and GR ADAPTER 017-0063-00			NO		ir al ig
P6035	100X	1.5	Obsolescent	USE	P6057 an	d GR ADAP	TER 017-0	063-00	NO	Inter the	/ -	
P6045	1X 10X 100X	6.0	010-0204-00*	10 M	5.5 pF 2.5 1.8	1.5	1.5 V 15 100	BNC	NO	\$325.00*	288	
P6046 DIFF/AMP	1X 10X	6.0	010-0213-00*	1 M 10 M	10 pF	3.5	25 V 250	BNC	NO	\$470.00*	289	
P6051 FET	5X 20X 100X 200X	6.0	010-0227-00*	1 M	2.8 pF 3.3 2.0 1.8	0.35	7.5 V 30 150 200	GR	NO	\$375.00*	289	
P60561	10X	6.0 9.0	010-6056-03 010-6056-05	500 Ω	1 pF	0.1	16 V	BNC	YES	\$ 45.00 \$ 45.00	291	
P6057 ¹	100X	6.0 9.0	010-6057-03 010-6057-05	5 ΚΩ	1 pF	0.25	50 V	BNC	YES	\$ 45.00 \$ 45.00	291	
P6201 FET	1X 10X 100X	6.0	010-6201-01*	100 K 1 M 1 M	3.0 pF 1	0.4	5.5 55 100	BNC	YES	\$375.00*	285	

^{*}Without Power Supply

^{**}PN & Description

 $^{^{1}\}text{Must}$ be shunted by 50 Ω (011-0049-01) on a 1-M Ω system.



VOLTAGE PROBES for 1 $\text{M}\Omega$ inputs

TYPE	ATTEN	IN FEET		LOA	LOADING		DC MAX	SCOPE C IN pF	READ OUT	PRICE	PAGE
P60061	10X	3.5	010-0127-00	10 mΩ	7.5 pF ²	35	600 V	15 to 55	NO	\$ 31.00	286
		6	010-0160-00	- 1,11	8.5	25		10 10 00	110	31.00	
		9	010-0146-00	-	11	25	- 12	eliminia u	WAY AND	31.00	-
		12	010-0148-00		13	12	-	HOLDINI A	10	31.00	-
P60071	100X	3.5	010-0150-00	10 MΩ	2 pF ²	25	1.5 kV	15 to 55	NO	\$ 35.00	286
	100%	6	010-0150-00	10 10122	2.2	20	1.5 KV	15 10 55	NO	35.00	200
		9	010-0152-00	-	2.4	15	-	7.56	- A	35.00	
		12	010-0152-00	-	2.6	13	-			35.00	-
P6008	10X	3.5	010-0134-00	10 10	7.5 pF ²		200.1/	10 1- 17	NO		200
F0000	10%	6	010-0129-00	10 MΩ		100	600 V 60°C to +1	12 to 47	NO	\$ 50.00	286
DCCCC	1007									80.00	
P6009	100X	9	010-0170-00	10 MΩ	2.5 pF ²	120	1.5 kV	12 to 47	NO	\$ 66.00	286
		9	010-0264-01		2.5 pF	100			YES	66.00	
P6010	10X				Furnished	with S-5 (P	age 80) For	other uses s	ee P6054	or P6061	
P6011	1X	3.5	010-0193-00	1 ΜΩ	48 pF ²	17	600 V	ANY	NO	\$ 25.00	287
		6	010-0190-00		68	10				25.00	
		9	010-0229-00		95	7	1			25.00	
P6012	10X	3.5	010-0203-00	10 MΩ	11.5 pF	35	500 V	15 to 47	NO	\$ 40.00	287
		6	010-0209-00	10 1012	14.5	30	300 V	10 10 47	140	40.00	207
		9	010-0231-00	-	17.5	22				40.00	
P6013A	1000X	10	010-0177-01	100 MΩ			10 10/	45 to 55	NO	7	007
POUISA	10007	25	A STATE OF THE PARTY OF THE PAR	100 1012	3 pF	80	12 kV	15 to 55	NO	\$200.00	287
	10001		010-0175-01		3.5	13				200.00	
P6015 ¹	1000X	10	010-0172-00	100 MΩ	3 pF	75	20 kV	12 to 47	NO	\$275.00	287
P6023 ³	10X		Obsolescent	See P	6055			20 to 55	NO	\$ 65.00	
P60271	1X		Obsolescent	SAME	AS P6028	B BUT WIT	H UHF CO	NNECTORS		\$ 20.00	288
P6028	1X	3.5	010-0074-00	1 ΜΩ	50 pF ²	17	600 V	ANY	NO	\$ 20.00	288
		6	010-0075-00	1 10102	67	10	000 1	74141	110	20.00	200
		9	010-0076-00	-	90	7				20.00	
		12	010-0077-00		112	4				20.00	
P6047	10X	100,100	Obsolescent	SEE F		7				20.00	
		•	TO THE ROOM THE CONTRACT OF THE PARTY OF THE								
P6048	10X	6	010-0215-00	1 kΩ	1 pF	100	20 V	15 to 20	NO	\$ 65.00	289
P6049A	10X	3.5	010-6049-01	SEE 3	23, 324 o	r 326 OSCI	LLOSCOPE	S	in it do	4 smal	mi lece
P6052	10X or	3.5	010-0241-00	10 MΩ	14 pF	20	500 V	15 to 55	YES	55.00	290
	1X			1 ΜΩ		3				\$ 55.00	- 1
	10X or	6	010-0243-00	10 MΩ	15.5	15				55.00	
	1X			1 MΩ	134	2				55.00	- 1
P6053A	10X	3.5	010-6053-01	10 ΜΩ	9.5 pF	250	500 V	15 to 24	YES	\$ 55.00	290
		6	010-6053-03		12.5	250	000 1	.0 10 21	1.20	55.00	
		9	010-6053-05		13.5	88			- 1	55.00	
P6054	10X	3.5	010-6054-01	10 MΩ	9.5 pF	250	500 V	15 to 24	NO	\$ 50.00	291
0054	10%	6	010-6054-03	10 10122	12.5	250	300 V	15 10 24	NO	50.00	291
		9	010-6054-05	PRODUCT CO	13.5	88				50.00	
DCOEE:	107			4 140			500.1/	00 1 47	V/E0		004
P6055 ⁸	10X	3.5	010-6055-01	1 MΩ	10 pF ²	60	500 V	20 to 47	YES	\$ 75.00	291
P6058			010-0260-00	SEE 7	D13 PLUG	I-IN UNIT				\$ 65.00	
P6060 ³	10X	3.5	010-6060-01	10 MΩ	7.5 pF ²	35	600 V	15 to 55	YES ⁴	\$ 35.00	292
		6	010-6060-03		8.5	25				35.00	
26061	10X	3.5	010-6061-01	10 MΩ	9.5 pF	60	500 V	15 to 24	YES ⁴	\$ 38.00	292
	W . W. C.	6	010-6061-03		12	60	300 1	10 10 24	0	38.00	-3-
		9	010-6061-05		13.5	60				38.00	
P6065	10X	6	010-6065-03	10 MΩ	12.5	100	500.1/	00 to 04	VEC		292
					The state of the s		500 V	20 to 24	YES	\$ 43.00	
P6075	10X	6	010-6075-03	10 MΩ	12.5	200	500 V	20	YES	\$ 46.00	292
									the second second second	Property and the second	

¹Available with UHF connectors.

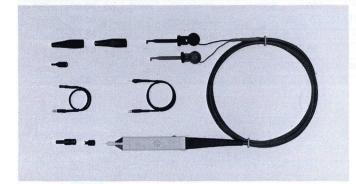
[&]quot;Rating varies with scopes having other than 20 pF inputs.

^{*}Designed for use with scopes having differential inputs.

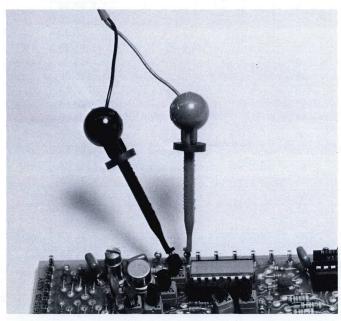
Not compatible with CRT READOUT.



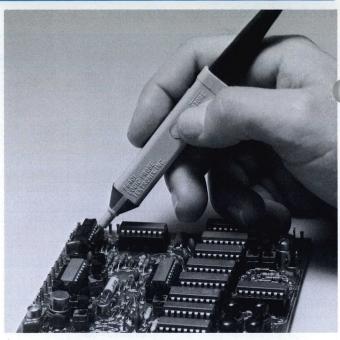
- DETECTS A SINGLE LOGIC PULSE
- DETECTS COINCIDENCE OF TWO LOGIC PULSES
- DETECTS STEADY LOGIC LEVELS
- DETECTS TRAINS OF LOGIC PULSES
- DETECTS ABNORMAL CONDITIONS
- PROTECTED AGAINST OVERVOLTAGE



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.

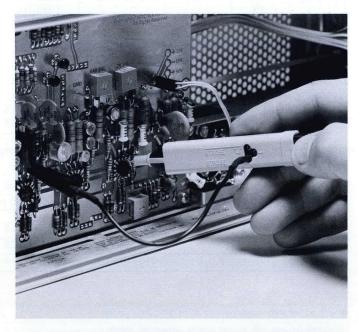


Probe power clips clip to any convenient 5-volt power source.



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	State or Condition	Indication
Steady high state	Steady red light	Excessive input voltage (overvoltage protection	Both red and green
Steady low state	Steady green light	furnished)	
Pulse trains (normal logic switching)	Blinking read and green light at full intensity	Alternating between high state and abnormal levels	Blinking red light
Abnormal Levels		Alternating between low state and abnormal levels	Blinking green light
(Between high and Low)	No lights		Using STORE mode, one
Open circuit	No lights	Single or very low duty cycle logic pulse	light will be on initially Event has occured when second light is lit.

SPECIFICATIONS

Low State-0 V to 0.8 V

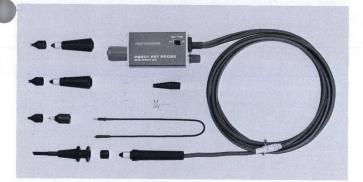
High State-2.0 V to approx 7 V

Abnormal Condition-0.8 V to 2.0 V or High Source Z (open test point)

Minimal Recognizable Pulse Duration-5 ns at threshold level Input Resistance—Approx 7.5 k Ω at all states Power Required-4.75 VDC to 5.25 VDC approx 150 mA P6401 5-FT PROBE, order 010-6401-01 \$75

DC to 900 MHz 1X

P6201 NEW



The P6201 from Tektronix, Inc. is an active (FET) probe providing unity gain and DC to 900 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 P6201 is designed primarily for use with TEKTRONIX 7700and 7900-Series, 475, or 485 Oscilloscopes, but may be used with 50- Ω sampling instruments and conventional oscilloscopes (with 1-M Ω input resistance). The internal 50- Ω termination may be switched in or out to adapt the probe output to either 1-M Ω or 50- Ω inputs.

The probe includes a locking-type BNC connector which provides scale-factor readout information to instruments having the readout capability. The 10X and 100X attenuator heads also couple readout information to the instrument via the output connector.

The P6201 may be powered from the probe power output of the 7500, 7700 and 7900-Series mainframes, the 475 and 485 Oscilloscopes, or by the 1101 Accessory Power Supply.

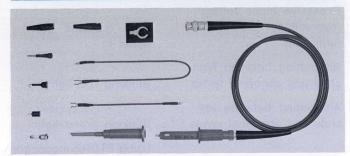
Bandwidth (-3 dB) DC to 900 MHz, Risetime is 0.4 ns or less. **Probe Gain** is 1X within 3%. **Attenuator Accuracy** \leq 4% with probe (10X or 100X). **Input Impedance** (probe only) is 100 kΩ (within 1%) shunted by 3.0 pF. Attenuator Heads are 1 MΩ (within 1%) shunted by 1.5 pF or less. **Dynamic (Signal) Range** is at least \pm 600 mV; extends to \pm 6 V with 10X attenuator; \pm 60 V with 10X attenuator. **DC Offset Range** is at least \pm 5.5 V (with respect to the of probe without the test attenuates. to ± 5.5 V (with respect to tip of probe without attenuator head). Effective offset is extended 10X and 100X by attenuator heads. **Noise** (Tangential) is 300 μ V or less at output. **Maximum Input Voltage** is ± 100 V, 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.

Included accessories as shown, see Accessory page 297.

OPTIONAL ACCESSORIES

P6006 DC to 35 MHz 10X

IODEO MIM MODEOUS



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 $1 M\Omega$.

Attenuation is 10X; Input Resistance is $10 \text{ M}\Omega$; 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 Picetime is approximately 5 as: Typical the 12-ft version; **Probe Risetime** is approximately 5 ns; **Typical Risetime** of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 12 ns; **Voltage Rating** is 600 V DC, AC peak, or DC and AC peak combined;

P6006 3.5-FT PROBE, Order 010-0127-00 BNC or 010-0125-00 UHF	\$31
P6006 6-FT PROBE, Order 010-0160-00 BNC or 010-0158-00 UHF	\$31
P6006 9-FT PROBE, Order 010-0146-00 BNC or 010-0142-00 UHF	\$31
P6006 12-FT PROBE, Order 010-0148-00 BNC or 010-0144-00 UHF	\$31
Included accessories as shown, see Accessory page 297.	

*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

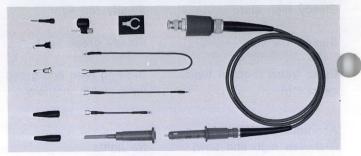
The P6007 low input-capacitance, high-voltage (1.5-kV) probe is designed for use with TEKTRONIX DC-to-33-MHz oscilloscopes. The probe can be compensated to match all TEK-TRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 pF to 55 pF and input resistance of 1 M Ω .

Attenuation is 100X; Input Resistance is 10 MΩ; Input Capaci-Attenuation is 100A; input Resistance is 10 MM; input Capacitance for 3.5-ft probe is approximately 2.0 pF when used with an instrument having a 20-pF input capacitance; 2.2 pF for the 6-ft version, 2.4 pF for the 9-ft version, 2.6 pF for the 12-ft version; Probe Risetime is approximately 7 ns; Typical Risetime of the 3.5-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is approx 12.5 ns; Voltage Rating is 1.5 kV DC or AC RMS, 4.2 kV AC peak to peak.

P6007 3.5-FT PROBE, Order 010-0150-00 BNC or 010-0134-00 UHF	\$35
P6007 6-FT PROBE, Order 010-0165-00 BNC or 010-0162-00 UHF	\$35
P6007 9-FT PROBE, Order 010-0152-00 BNC or 010-0136-00 UHF	\$35
P6007 12-FT PROBE, Order 010-0154-00 BNC or 010-0138-00 UHF	\$35

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 200 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 2 kV. Above 10 MHz, additional derating is required depending on the input capacitance of the plug-in or instrument used.

P6008 DC to 100 MHz 10X



ENVIRONMENTAL PROBE

The P6008 Environmental probe is designed to operate over -50° C to $+150^{\circ}$ C, for the probe body and tip, the compensation box operates from -15° C to $+55^{\circ}$ C. Input capacitance is 9.0 pF when used with an instrument having a 15 pF input capacitance. Probe risetime is less than 4 ns, all other characteristics are the same as for the standard probe.

The P6008 standard probe is designed to use with TEKTRONIX DC-to-100 MHz oscilloscopes. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal Input capacitance of 12 pF to 47 pF and input resistance of 1 M Ω .

Attenuation is 10X; Input Resistance is 10 M Ω ; Input Capacitance is approximately 7.5 pF when used with an instrument having a 20 pF input capacitance; Probe Risetime is less than 3 ns; Typical Risetime of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.6 ns; Voltage Rating is 600 V DC, AC peak, or DC and AC peak combined.

P6008 6-FT ENVIRONMENTALIZED PROBE,

Order 010-0129-01 \$80

Includes: banana plug (134-0013-00); miniature alligator clip (344-0045-00); 12.5-inch ground lead (175-0925-00); probe holder (352-0068-00); retractable hook tip (013-0071-01).

P6008 3.5-FT PROBE (Nonenvironmental), Order 010-0129-00 ... \$50 Included accessories as shown, see Accessory page 297.

*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 M Ω .

A version of the P6009 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. The bandwidth is derated to 100 MHz with the special BNC connector.

Attenuation is 100X. Input Resistance is 10 MΩ. Input Capaci-Attenuation is 100X. Input Resistance is 10 Ms. Input Capacitance is approximately 2.5 pF when used with an instrument having a 20 pF input capacitance; Probe Risetime is approximately 2 ns; Typical Risetime of probe, 1A1 Plug-In Unit, and 547 Oscilloscope is 7.1 ns. Voltage Rating is 1.5 kV DC or AC RMS, 4 kV AC peak to peak*. Cable is 9 ft long, terminated with a BNC connector; Net Weight is approx 16 oz.

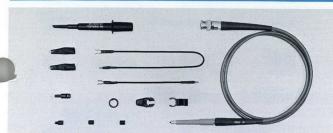
P6009 PROBE	(with readout connector), order 010-0264-01	\$66
P6009 PROBE	, order 010-0170-00	\$66

Included accessories as shown, see Accessory page 297.

*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.

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

KY Y



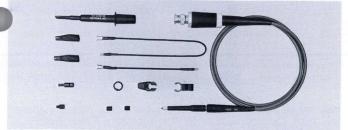
The P6011 1X Passive Probe can be used with all TEKTRONIX general-purpose oscilloscopes. The small size of the probe body makes it ideal for working on compact circuitry.

Attenuation is 1X. Input Resistance is $1\,\mathrm{M}\Omega$, instrument input R included. Input Capacitance for the 3.5-ft probe is approx 28 pF; 48 pF for the 6-ft version, instrument excluded. For total input capacitance of the system add input C of the instruments. Probe Risetime for the 3.5-ft length is less than 12 ns into 15 pF or less than 15 ns into 20 pF. The probe risetime of the 6-ft version is less than 15 ns into 15 pF or less than 17 ns into 20 pF. The probe risetime of the 9-ft version is less than 23 ns into 15 pF or less than 25 ns into 20 pF. Typical Risetime of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 16 ns. Voltage Rating is 600 V DC, AC peak, or DC and AC peak combined.*

P6011 3.5-FT PROBE, order 010-0193-00	\$25
P6011 6-FT PROBE, order 010-0190-00	\$25
P6011 9-FT PROBE , order 010-0229-00	\$25
Included accessories as shown see Accessory page 207	

*Peak voltage derating is necessary for CW frequencies higher than 0.5 MHz. When the probe is used with a plug-in having an input C of 20 pF, the maximum allowable peak voltage at 1 MHz is 510 V. At 5 MHz, the maximum is 100 V; 46 V at 10 MHz.

P6012 DC to 35 MHz 10X



The P6012 is a miniature general-purpose probe designed for use with TEKTRONIX oscilloscopes having bandwidths up to 33 MHz. The probe can be compensated to match TEKTRONIX plug-ins and oscilloscopes with nominal input capacitances of 15 to 47 pF and input resistance of 1 $\mathrm{M}\Omega$.

Attenuation is 10X. Input Resistance is approximately 10 M Ω . Input Capacitance of probe with 3.5-ft cable is 11.5 pF or less; 14.5 pF or less for the 6-ft version; 17.5 pF or less for the 9-ft version. Probe Risetime is 5 ns or less with 3.5-ft cable, 6 ns or less with 6-ft cable, 6.5 ns or less with the 9-ft cable. Typical Risetime of the 3.5-ft probe and 422 is 24 ns. Voltage Rating is 500 V DC and AC peak combined*.

P6012 3.5-FT PROBE, order 010-0203-00	\$40
P6012 6-FT PROBE , order 010-0209-00	\$40
P6012 9-FT PROBE, order 010-0231-00	\$40
Included accessories as shown, see Accessory page 297.	2

*Peak voltage derating is necessary for CW frequencies higher than 4 MHz. At 15 MHz the maximum allowable peak voltage is 210 V; 95 V at 33 MHz.

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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 M Ω . The P6013A is similar to the P6015 shown in photo.

Attenuation is 1000X. Input Resistance is 100 M Ω . Input Capacitance of probe with 10-ft cable is 3 pF; 3.5 pF with 25-ft cable. Probe Risetime is 7 ns or less with 10-ft cable, 13.5 ns or less with 25-ft cable. Typical Risetime of 10-ft probe, 1A1 Plug-in Unit, and 547 Oscilloscope is 13 ns. Voltage Rating is 12 kV DC, peak pulse, or peak AC.* Net Weight is approx 5½ lb.

P6013A 10-FT PROBE, order 010-0177-01 LOCKING BNC or

Includes: compensating box (015-0083-00 BNC) or (015-0081-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); carrying case (016-0129-00).

P6013A 25-FT PROBE, order 010-0175-01 LOCKING BNC or 010-0179-01 UHF

*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 M Ω . Input Capacitance is approximately 3 pF. Probe Risetime is approximately 4 ns. Typical Risetime of the probe, 1A1 Plug-In Unit and 547 Oscilloscope is 8 ns. Temperature Range is 10°C to 55°C Voltage Rating is 40 kV peak AC or pulse, 20 kV DC or RMS continuous at 25°C*.

P6015 10-FT PROBE, order 010-0172-00 LOCKING BNC or

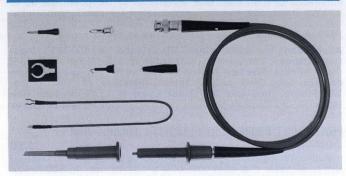
lncludes: compensating box (015-0049-00 BNC) or (015-0039-00 UHF); alligator clip (344-0005-00); probe holder (352-0056-00); can of high-voltage dielectric fluid (252-0120-00); silica-gel† (256-0570-00); carrying case (016-0128-00).

†not shown.

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 100 kHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 13 kV.

P6027 DC to 17 MHz 1X P6028 DC to 17 MHz 1X

HODEO MIM MODEOUTING



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.

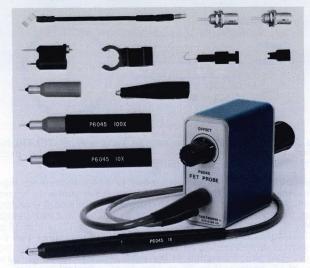
Attenuation is 1X. Input Resistance is $1\,M\Omega$, instrument input R included. Input Capacitance for 3.5-ft version is approx 30 pF, 47 pF for the 6-ft version, 70 pF for the 9-ft version and 92 pF for the 12-ft version, instrument excluded. For total input capacitance of the system, add input C of instrument. Probe Risetime is approximately 10 ns. Typical Risetime of the 3.5-ft probe, 1A1 Plug-in Unit and 547 Oscilloscope is 15 ns. Voltage Rating is 600 V DC or AC peak to peak*.

P6028 3.5-FT PROBE, BNC Connector, order 010-0074-00	\$20
P6028 6-FT PROBE, BNC Connector, order 010-0075-00	\$20
P6028 9-FT PROBE, BNC Connector, order 010-0076-00	\$20
P6028 12-FT PROBE, BNC Connector, order 010-0077-00 Included accessories as shown, see Accessory page 297.	\$20
P6027 3.5-FT PROBE, UHF Connector, order 010-0070-00	\$20
P6027 6-FT PROBE, UHF Connector, order 010-0071-00	\$20
P6027 9-FT PROBE, UHF Connector, order 010-0072-00	\$20
P6027 12-FT PROBE, UHF Connector, order 010-0073-00	\$20

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 1 MHz. At 10 MHz, the maximum allowable peak-to-peak voltage is 60 V.

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P6045 DC to 230 MHz 1X



The P6045 from Tektronix, Inc. 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 TEKTRONIX 454A Oscilloscope and conventional oscilloscopes (with 1-M Ω input resistance). The internal 50- Ω termination may be switched in or out to adapt the probe output to either 1-M Ω or 50- Ω inputs.



The P6045 may be powered from the probe power output of the 454A Oscilloscope, or by the Accessory Power Supply.

BANDWIDTH (—3 dB) DC to 230 MHz, RISETIME is 1.5 ns or less. PROBE GAIN is 1X. 10X to 100X. INPUT IMPEDANCE is 10 MΩ shunted by 5.5 pF. ATTENUATOR INPUT C 10X 2.5 pF, 100X 1.8 pF. DYNAMIC (SIGNAL) RANGE is at least 500 mV. DC OFFSET RANGE is at least -1 V to +1 V (with respect to tip of probe without attenuator head). EFFECTIVE OFFSET is extended 10X and 100X by attenuator heads. NOISE (Tangential) is 600 μ V or less at output. MAXIMUM INPUT VOLTAGE (probe only) is 12 V, derated with frequency. LF RESPONSE (—3 dB) (AC Coupled) is 16 Hz or lower.

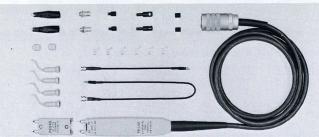
P6045 PROBE WITH ACCESSORY POWER SUPPLY, order 010-0205-00	\$450
P6045 PROBE, order 010-0204-00	\$325
Includes: 10X attenuator head (010-0357-02); 100X attenhead (010-0358-01); AC-coupling capacitor head (010-0360)	uator
2.5-inch ground lead (175-0249-00); bayonet ground ad	apter
(013-0085-00); hook tip (206-0114-00); alligator clip (344-	0046-
00); two test jacks (131-0258-00); probe holder (352-0090 carrying case (016-0090-01).	,-00),

POWER	SUPPLY, order 015-0073-00	\$125
Power	Supply includes: power cord (161-0025-01).	

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 18 MHz. Maximum input voltage at 230 MHz is 20 V.



P6046 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.

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 $50\,\Omega.$ A $50\text{-}\Omega$ termination is supplied with the amplifier for use with 1-M Ω systems.

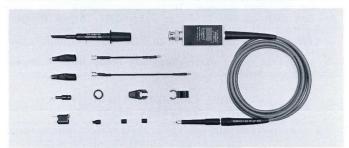
The P6046 Differential Probe may be used with the 1A5 Differential Amplifier with TEKTRONIX 540 and 550 Series Oscilloscopes. The P6046 Probe extends the differential measurement capabilities of the 1A5 to 45 MHz. (CMRR is 1,000:1 at 50 MHz. The 1A5 supplies both probe power and amplification.

CHARACTERISTICS

Probe and Amplifier

Deflection Factor is 1 mV/div to 200 mV/div in 8 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 10 mV/div). Bandwidth is DC-to-100 MHz at 3-dB down. Risetime is 3.5 ns or less. Common-Mode Rejection Ratios with deflection factors of 1 mV/div to 20 mV/div are at least 10,000:1 at 50 kHz, 5,000:1 at 1 MHz, 1,000:1 from 10 MHz to 20 MHz, and 500:1 at 50 MHz. Common-Mode Linear Dynamic Range is ± 5 V. Input RC is 1 MΩ paralleled by 10 pF or less. Input Coupling is AC or DC, selected by a switch on the probe. Low-frequency response AC-coupled is 3-dB down at 20 Hz, 2 Hz with 10X attenuator. Displayed Noise is 280 μV or less (tangentially measured). Maximum Input Voltage is ± 25 V (DC \pm peak AC), ± 250 V with 10X attenuator. Output Impedance is 50 Ω through a BNC-type connector. A 50-Ω termination is supplied with the amplifier for use with 1-MΩ systems. Probe Cable is 6 feet long, terminated with a special nine-pin connector. Amplifier Power Requirements are 10 watts maximum, 48 to 400 Hz. Factory wired for 105 V-to-125 V (117 V nominal) operation. Transformer taps permit operation at 210 V-to-250 V (234 V nominal). Instrument can be ordered factory wired for 210 V-to-250 V operation.

P6048 DC to 100 MHz 10X



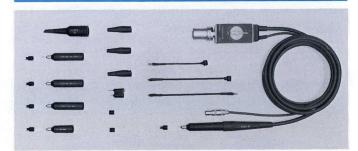
The P6048 is a low-capacitance, miniature probe designed for use with TEKTRONIX 100-MHz Oscilloscopes. It can also be compensated for use with other instruments that have a nominal input capacitance of 15 to 20 pF and inputs resistance of 1 $M\Omega$

The P6048 offers a new level of high-frequency measurement performance with its low 1-pF input capacitance. Its small size makes it easy to use, particularly for applications involving compact circuitry.

ATTENUATION is 10X. Input Resistance is 1 k Ω . Input Capacitance is 1 pF or less. Bandwidth 100 MHz.

AC-coupled low-frequency response is 7 kHz or less. **Voltage Rating** DC coupled is 20 V (DC plus peak AC); AC coupled is 200 V DC.

P6051 DC to 1 GHz 5X



The P6051 from Tektronix, Inc. is an active (FET) probe providing DC to 1 GHz 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.

The P6051 is designed primarily for use with $50\text{-}\Omega$ sampling instruments. An external $50\text{-}\Omega$ termination may be used to adapt the probe output to $1\text{-}M\Omega$ inputs. The probe also features a DC-offset control for measuring small AC signals with DC potentials up to 5 volts (200 V with the 40X attenuator).

PROBES and ACCESSORIES



The P6051 can be powered from the probe power output of the 475, 485, 7500, 7700 and 7900-Series mainframes, also by the 015-0073-00 power supply or by the 1101 Accessory Power Supply.

CHARACTERISTICS

Probe Attenuation— 5X within 4%. Attenuator heads are accurate within 1%. Risetime—0.35 ns or less. Bandwidth—DC to 1 GHz at 3-dB down. Low frequency 3-dB point with ACcoupling capacitor is approximately 175 Hz. Input Resistance—1 M Ω with or without attenuators. Input Capacitance—approximately 2.8 pF. Output Load Impedance— $50~\Omega$. A $50-\Omega$ termination is required when the probe is used with oscilloscopes having 1-M Ω input. DC Offset Range— $\pm 5~\mathrm{X}$ (excluding attenuators), continuously variable coarse and fine controls select the amount of offset desired. Three-position switch turns offset function OFF or selects + or - polarity. Signal Range—Probe Input—At least $\pm 2.5~\mathrm{V}$. Probe Output—At least $\pm 0.5~\mathrm{V}$. Compression—5% or less with an input signal of 50 mV (over signal ranges specified). Noise (tangentially measured)— $700~\mu\mathrm{V}$ or less at probe input. Maximum Probe Input Voltage— $200~\mathrm{V}$ (DC + peak AC.**

PROBE CHARACTERISTICS WITH ATTENUATOR HEADS

	Input C	Effective DC Offset Range	Max-Voltage Input
4X Attenuator 010-0370-00	3.25 pF	±20 V	±200 V*
20X Attenuator 010-0371-00	2.0 pF	±100 V	±200 V*
40X Attenuator 010-0372-00	1.8 pF	±200 V	±200 V*

AC coupler adds 2.0 pF within 10% to input capacitance of either the probe or its attenuators.

 $^{\star}\text{Voltage}$ derating is necessary for CW frequencies higher than 2 MHz for the 4X attenuator, 75 MHz for the 20X attenuator, and 100 MHz for the 40X attenuator.

P6051 6-FT PROBE WITH ACCESSORIES, order 010-0227-00 ... \$375 Included accessories as shown, see Accessory page 297.

**Voltage derating is necessary for CW frequencies higher than 500 kHz. At 1 GHz the maximum allowable peak voltage is 7.5 V.

OPTIONAL ACCESSORIES

Accessory Power Supply, for powering one P6051 Probe (also needed, adapter cable, 012-0187-00). Order 015-0073-00 . \$125

P6052 DC to 40 MHz 1X, 10X Selectable Attenuation



The P6052 is a passive dual-attenuation probe designed for TEKTRONIX low-frequency oscilloscopes that feature CRT READ-OUT and trace-identification functions. A sliding collar on the barrel of the probe selects 1X or 10X attenuation; a push button actuates the trace-identify function. A coding ring on the probe BNC output connector couples the control signals to the mainframe. The P6052 can be compensated for use with instruments having a nominal input capacitance of 15 to 55 pF.

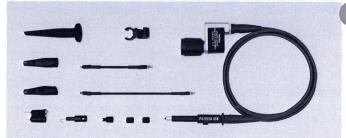
Attenuation 10X. Input Resistance: 1X position, 1 megohm; 10X position, 10 megohms. Input Capacitance for the 3.5-foot probe is 113 pF in the 1X position, 14 pF in the 10X position. For the six-foot version the input capacitance in the 1X position is 134 pF, the 10X position 16 pF. **Probe Risetime** for the 3.5-foot probe is ≤ 60 ns in the 1X position, ≤ 9 ns in the 10X position. For the six-foot version: 1X position ≤ 75 ns, 10X position. For the six-foot version: 1X position ≤ 75 ns, 10X position ≤ 11 ns. **Typical Risetime** of the 3.5-foot probe, 7403 Oscilloscope, and 7A18 Amplifier is 11 ns. **Voltage Rating** is 500 V (DC + Peak AC)*.

P6052 3.5-FT PROBE, order 010-0241-00	\$55
P6052 6-FT PROBE, order 010-0243-00	\$55
P6052 3.5-FT PROBE, (without readout function) order 010-0241-01	\$55
P6052 6-FT PROBE, (without readout function) order 010-0243-01	\$55

*Peak voltage derating is necessary for CW frequencies higher than 500 kHz in the 1X position and above 5 MHz in the 10X position. At 44 MHz the maximum allowable peak voltage is approximately 35 V in the 1X position and approximately 60 V in the 10X position.

P6053A

DC to 250 MHz 10X



The P6053A is a miniature fast-rise 10X probe designed for TEKTRONIX instruments having a nominal input capacitance of 15 to 24 pF. The probe has a push button for actuating the trace-identify function of the oscilloscope mainframe and readout capability.

Attenuation is 10X. Input Resistance is 10 megohms. Input Capacitance for the 3.5-foot probe is 9.5 pF; 12.5 pF for the six-foot version. Probe Risetime is 0.7 ns † or less. Typical Risetime of the 3.5-ft probe, 485 Oscilloscope, 1.4 ns. Voltage Rating is 500 V (DC + Peak AC).*

P6053A 3.5-FT PROBE, order 010-6053-01	\$55
P6053A 6-FT PROBE, order 010-6053-03	\$55
P6053A 9-FT PROBE, order 010-6053-05	\$55

 $\dagger \text{Due}$ to the fast-rise characteristics of this probe, the input capacitance and generator source Impedance must be considered in determining the risetime of the system.

*Peak voltage derating is necessary for CW frequencies higher than 5.5 MHz. At 10 MHz, the maximum allowable peak voltage is 275 V; 23 V at 100 MHz, 18 V at 150 MHz.





The P6054 is a miniature, fast-rise, 10X probe designed for use in conjunction with TEKTRONIX Oscilloscopes having a nominal input capacitance of 15 to 24 pF. The probe does not incorporate CRT READOUT/trace-identify functions.

Attenuation is 10X. Input Resistance is 10 megohms. Input Capacitance for the 3.5-ft probe is 9.5 pF; for the 6-foot version 12.5-pF; for the 9-foot version 13.5 pF. Probe Risetime for 3.5-ft or 6-ft probe is 0.7 ns* or less, the 9-ft probe is 2 ns or less. Typical Risetime of 3.5-ft probe with 454A Oscilloscope is 2.4 ns. Voltage Rating is 500 V (DC + Peak AC).†

P6054 3.5-FT PROBE, order 010-6054-01	\$50
P6054 6-FT PROBE, order 010-6054-03	\$50
P6054 9-FT PROBE , order 010-6054-05	\$50

Included accessories as shown, see Accessory page 297.

*Due to the fast-rise characteristics of this probe, the input capacitance and generator source impedance must be considered in determining the risetime of the system.

 \dagger Peak voltage derating is necessary for CW frequencies higher than 6 MHz. At 10 MHz the maximum allowable peak voltage is 300 V; 25 V at 100 MHz, 22 V at 150 MHz. Values for 3.5-ft probe only.

P6055 20,000:1 CMRR

The P6055 is a miniature low-capacitance, 10X Probe designed for use with TEKTRONIX differential amplifiers having nominal input capacitances from 20 pF to 47 pF. The attenuation ratio is adjustable to 10X to compensate for differences in input resistance of the amplifier (the amplifier input resistance must be 1 $M\Omega$ \pm 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.

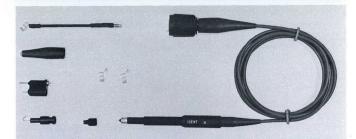
CMRR is 20,000:1 from DC to 1 kHz derating to 100:1 at 20 MHz, measured at probe tip using probe pair with 7A13 or 1A5.

Attenuation is adjustable to 10X. Input Resistance is 1 $M\Omega\pm0.5\%$. 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 Oscilloscopes is 5.4 ns. Voltage Rating is 500 V (DC + peak AC).*

*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.

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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 (017-0063-00).

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 0.7 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. Signal Delay Time is 8.2 ns within 35 ps with the 6-ft probe, and 12.3 ns within 35 ps with the 9-ft probe.

 P6056 6-FT PROBE, order 010-6056-03
 \$45

 P6056 9-FT PROBE, order 010-6056-05
 \$45

 Included accessories as shown, see Accessory page 297.

P6057 DC to 1.7 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 0.7 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. Signal Delay Time is 8.2 ns within 35 ps with the 6-ft probe, and 12.3 ns within 35 ps with the 9-ft probe.

P6057 6-FT PROBE, order 010-6057-03	\$45
P6057 9-FT PROBE, order 010-6057-05	\$45
Included accessories: same as P6056	

OPTIONAL ACCESSORIES



The VP-1 $50-\Omega$ "T" pickoff allows signal pickoff from a closed $50-\Omega$ system with minimum disturbance of the system's characteristics. The VP-1 is used with the P6056 and P6057 probes in a closed, $50-\Omega$ coaxial system with minimum disturbance. Order 017-0073-01\$28.00



P6060 DC to 35 MHz 10X

The P6060 is a precision passive probe with 10X attenuation, for use with TEKTRONIX low- and mid-frequency oscilloscopes used in differential applications. The precise attenuation also provides greater accuracy for single-ended input applications, such as amplitude measurements with a differential comparator. The probe can be compensated for use with any amplifier input having a nominal input capacitance of 15 to 55 pF and input resistance of 1 $\mbox{M}\Omega$.

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 $M\Omega\pm0.15\%$ instrument input will be within $\pm0.4\%$. When used with a 1 $M\Omega\pm2\%$ instrument input the accuracy will be within $\pm2\%$. Input Resistance is 10 $M\Omega$ within $\pm0.25\%$ with a 1 $M\Omega\pm0.15\%$ instrument input; 10 $M\Omega$ within $\pm0.4\%$ when used with a 1 $M\Omega\pm2\%$ instrument input. Input Capacitance for 15 pF instruments is $\approx\!6.0$ pF with 3.5-ft probe and $\approx\!7.7$ pF with 6 ft. On 55 pF we have $\approx\!9.5$ pF with the 3.5 ft, $\approx\!11.5$ pF for the 6 ft. CMRR (Probe Pair)—At least 400:1 (with 5A20N or 5A21N) DC to 30 kHz. Bandwidth— 3.5-foot probe at least 40 MHz (with 453A; 20 mV/div to 10 V/div). 6-foot probe at least 30 MHz (with 453A; 20 mV/div to 10 V/div. Maximum Input Voltage— 600 V (DC + Peak AC).*

P6060 3.5-FT PROBE, order 010-6060-0	
P6060 6-FT PROBE, order 010-6060-03	\$35
Included accessories as shown, see	

*Peak-to-peak voltage derating is necessary for CW frequencies higher than 3 MHz. Maximum input voltage at 50 MHz is 50 V.

P6061	DC to	60 MHz 10X
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	OMB .	
3		PROBLEM.

The P6061 is a miniature 10X attenuation probe designed for use with 60 MHz Oscilloscopes. The probe is terminated with a BNC connector that has a special grounding clip to shift the deflection factor 10X on 432, 434 and 5000 series instruments.

The P6061 is compatible with instruments having 20-pF inputs.

Attenuation is 10X. Input Resistance is 10 M Ω . Input Capacitance for the 3.5-ft probe is approximately 9.5 pF; 6-ft probe, approximately 12 pF; 9-ft probe, approximately 13.5 pF. Maximum Input Voltage is 500 V (DC + peak AC) to 3.5 MHz, derated to 40 V at 60 MHz.

P6061 3.5-FT PROBE, order	010-6061-01		\$38
P6061 6-FT PROBE, order	010-6061-03		\$38
P6061 9-FT PROBE, order			\$38
Included accessories as	shown, see	Accessory page 297	

DC to 100 MHz 10X

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-			Pecesion	

P6065

The P6065 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.

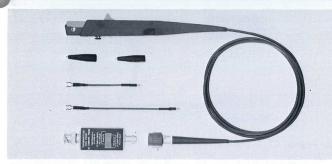
Attenuation is 10X within 0.4% when used with a 1 M Ω \pm 0.15% instrument input and within \pm 2% when used with a 1 M Ω \pm 2% instrument input. Input Resistance is 10 M Ω within \pm 0.25% with a 1 M Ω \pm 2% instrument input. Input Capacitance is 12.5 pF. Bandwidth is 100 MHz when used on the 465 Oscilloscope. Maximum Input Voltage is 500 V (DC + peak AC) to 3.5 MHz derated to 35 V at 100 MHz.

P6075 DC to 200 MHz 10X

The P6075 is similar to the P6065 with the exception of a bandwidth of 200 MHz when used with the TEKTRONIX 475 Oscilloscope and an instrument capacitance input of 20 pF. The maximum input voltage is 500 V (DC + Peak AC) to 0.5 MHz, derated to 30 V at 200 MHz.

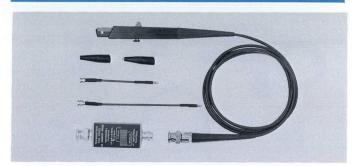


P6021 120 Hz to 60 MHz—AC Current Probe



The P6021 and P6022 are AC current probes, the P6021 has 125 turns and the P6022 has 50 turns. The probes are designed for use with real-time oscilloscopes. Neither the termination nor the amplifier are required to use the probes with the TEKTRONIX 5A21N and 7A14 Plug-in Amplifiers. Both probes provide the facility for accurate current measurements over a wide range of frequencies without breaking the circuit under test. Just open the spring-loaded slide, place the conductor (up to 0.150 inches with P6021 and 0.100 inches with P6022) in the probe slot and release the slide. No electrical connection is required.

935 Hz to 150 MHz—AC Current Probe P6022



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 $1\,\mathrm{M}\Omega$ or greater.

PERFORMANCE CHARACTERISTICS

			022 PROBE TERMINATION	P6021 & P6 WITH 134	
SENSITIVITY	P6021	2 mA/mV or 10 mA/mV; selected by termination switch. Accuracy $\pm 3\%$.		1 mA/div to 1 A/d	implifier steps from iv (with 50 mV/div
	P6022	1 mA/mV or 10 mA/mV, switch. Accuracy ±3%	selected by termination	oscilloscope setting). Accuracy ± 3	
	VIDTH†/RISETIME e Bandwidth	Bandwidth	Risetime	Bandwidth	Risetime
P6021	50 MHz 75 MHz 100 MHz	39 MHz 48 MHz 52 MHz	9.0 ns 7.3 ns 6.7 ns	30 MHz 35 MHz 36 MHz	11.6 ns 10.0 ns 9.6 ns
		1 mA/mV 10 mA/mV	1 mA/mV 10 mA/mV	Bandwidth	Risetime
P6022	50 MHz 75 MHz 100 MHz 150 MHz	47 MHz 48 MHz 65 MHz 70 MHz 80 MHz 90 MHz 100 MHz 120 MHz	7.45 ns 7.2 ns 5.35 ns 5.0 ns 4.36 ns 3.9 ns 3.50 ns 2.9 ns	40 MHz 50 MHz 54 MHz 59 MHz	8.8 ns 7.0 ns 6.4 ns 5.9 ns
LOW FREQUE	NCY 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 P60	21 & P6022	STATEMENT OF THE STATEM	- insussing	≤15	0 μΑ
MAXIMUM CURRENT (CW)*	P6021		vave between 1.2 kHz and tween 300 Hz and 5 MHz	15 A peak-to-peak sinewave betwe 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 1.3 kHz and 10 MH	sinewave between z
MAXIMUM CURRENT (PULSE)*	P6021	100 A Peak, not to exceed 9 A-μs or 2 A RMS		15 A Peak, not to 2 A RMS	exceed 9 A-μs or
	P6022	250 A Peak, not to exce	eed 500 A-μs or 5 A RMS	15 A Peak, not t or 5 A RMS	o exceed 500 A-μs
MAXIMUM	VOLTAGE	600 V (DC	+ peak AC)	600 V (DC	+ peak AC)
NET V	VEIGHT	æ	1 lb	≈!	5 lb

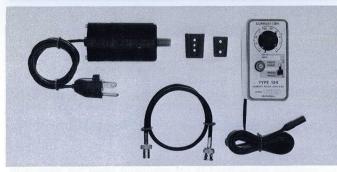
*Decrease oscilloscope sensitivity to make these measurements.

†All bandwidths stated are -3 dB.

P6021 5-FT PROBE , order 010-0237-02	P6022 5-FT PROBE, order 010-0238-00
P6021 9-FT PROBE , order 010-0244-02	P6022 9-FT PROBE, order 010-0238-02
	Additional information on following page.

134

AC Current Probe Amplifier



The 134 is used to extend the measurement capabilities of the P6021 or P6022 Current Probe. A CURRENT/DIV switch provides calibrated current steps from 1 mA/div to 1 A/div (with the oscilloscope or plug-in unit adjusted for a deflection factor of 50 mV/div).

The 134 can also be used as an auxiliary voltage amplifier by placing the current/div switch in the VOLTS position.

Linear Deflection: \pm 15 A Peak at 1 A/div. **Impedance:** (input and output) approx 50 Ω , AC-coupled. **Bandwidth:** 8 Hz to 50 MHz at a gain of 50; 10 Hz to 30 MHz at a gain of 125 (3-dB down). **Net Weight:** approx 4 lb.

134 AMPLIFIER ONLY order 015-0057-01	\$225
POWER SUPPLY ONLY, 115 V order 015-0058-01	\$40
POWER SUPPLY ONLY, 230 V order 015-0059-01	\$40

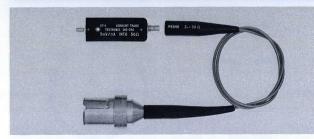
ORDERING INFORMATION

P6021

order 015-0140-02	\$129
P6021 9-FT PROBE WITH PASSIVE TERMINATION order 015-0140-03	\$129
P6021 5-FT PROBE order 010-0237-02	\$98
P6021 9-FT PROBE order 010-0244-02	\$98
P6021 PASSIVE TERMINATION order 011-0105-00	\$37

P6022
P6022 5-FT PROBE WITH PASSIVE TERMINATION order 015-0135-00
P6022 9-FT PROBE WITH PASSIVE TERMINATION order 015-0135-01
P6022 5-FT PROBE order 010-0238-00 \$127
P6022 9-FT PROBE order 010-0238-02 \$127
P6022 PASSIVE TERMINATION order 011-0106-00 \$49
OPTIONAL ACCESSORIES for P6021 and P6022
CALIBRATOR ADAPTER, BNC order 013-0092-00 \$5.00
ADAPTER, BNC to UHF order 103-0015-00 \$2.25

P6040/CT-1 AC CURRENT PROBE



The P6040/CT-1 Current Probe is designed for use with TEK-TRONIX 50- Ω sampling units. With the use of a 50- Ω termination the P6040/CT-1 can be used with wideband, nonsampling oscilloscopes for making fast-risetime current measurements.

Several CT-1 current transformers may be placed throughout the circuit and monitored by one or more P6040 Probes. For a longer length probe, additional $50\text{-}\Omega$ cable can be used in series with the probe. Conductor sizes up to 0.065 inches in diameter can be monitored.

P6040 PROBE

The P6040 Probe is an interconnecting cable for the CT-1, used between the transformer and oscilloscope input.

If several CT-1 Transformers are in a circuit, the P6040 Probe can be used to monitor any one of them.

The P6040 can be used with other test-point connectors, such as Amphenol series 27 Sub-Minax or Sealectro Sub-Miniature

Impedance is 50 Ω . Attenuation is 1X. Output Connector is a GR type. Cable Length is 18 in. Additional 50- Ω cable can be used in series with the probe. RG213/U or RG58A/U is recommended for best preservation of the CT-1 Transformer high-frequency response.

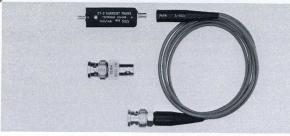
CT-1 CURRENT TRANSFORMER

Sensitivity is $5\,\text{mV/mA}$ into a $50\text{-}\Omega$ load. Accuracy is $\pm 3\%$. Decay Time Constant is $5\,\mu\text{s}$, approximated by 1% per 50 ns; limit, $1\,\mu\text{s}$. Risetime is less than 350 ps. Frequency Response is $35\,\text{kHz}$ to $1\,\text{GHz}$ ($3\,\text{dB}$ down). Insertion Impedance with a $50\text{-}\Omega$ termination is $1\,\Omega$ shunted by approximately $5\,\mu\text{H}$ without a $50\text{-}\Omega$ termination. Capacitance Loading to a bare wire passing through the CT-1 transformer is typically $1.5\,\text{pF}$ for #14 gauge, $0.6\,\text{pF}$ for #20 gauge. Maximum Voltage of Circuit Under Test is $1000\,\text{V}$ DC. Direct Current reduces the L/R time constant by a factor of 2 at $0.6\,\text{A}$. Pulse Current Rating is $100\,\text{A}$ peak, with a max ampsecond product of $1\,\text{A-}\mu\text{s}$. RMS Current Rating is $500\,\text{mA}$ maximum. Temperature Rating is $-25\,^{\circ}\text{C}$ to $+65\,^{\circ}\text{C}$. Physical Dimensions are $3/8\,\text{x}\,\text{y}/16\,\text{x}\,1\text{-}13/16$ in plus $\#6\text{-}32\,\text{x}\,1/4\text{-in}$ mounting stud.

P6040/CT-1 CURRENT PROBE , order 015-0041-00	\$50
CT-1 CURRENT TRANSFORMER, order 015-0040-00	\$30
P6040 PROBE, order 010-0133-00	\$20



P6041/CT-2 AC CURRENT PROBE



The P6041/CT-2 Current Probe is designed for use with TEKTRONIX DC-to-150 MHz Oscilloscopes. A 50- Ω termination is used in conjunction with the P6041/CT-2 for terminating the probe at the input of the oscilloscope.

The insulated case of the CT-2 Current Transformer is convenient to use in applications where limited circuit space exists. Several CT-2 Transformers may be placed throughout the circuit and monitored by one or more P6041 Probes. Conductor sizes up to 0.050 inches in diameter can be monitored.

P6041 PROBE

The P6041 Probe serves as an interconnecting cable between the CT-2 Transformer and the oscilloscope input. A 50- Ω termination is used in conjunction with the P6041 for terminating the probe at the high impedance input of the oscilloscope used.

Although designed for use with the CT-2, the P6041 Probe can be used with other test-point connectors, such as Amphenol Series 27 Sub-Minax or Sealectro Sub-Miniature RF.

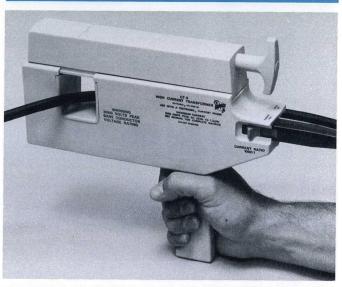
Impedance is 50 Ω . Attenuation is 1X. Output Connector is BNC type. Cable Length is 42 inches. Additional 50- Ω cable can be used in series with the probe. RG213/U or RG58A/U cable is recommended to preserve the high-frequency response.

CT-2 CURRENT TRANSFORMER

Sensitivity is $1\,\mathrm{mV/mA}$ into a $50\,\mathrm{c}\Omega$ load. Accuracy is $\pm\,3\%$. Decay Time Constant is $125\,\mu\mathrm{s}$, approximated by 1% per $1.25\,\mu\mathrm{s}$; limit, $25\,\mu\mathrm{s}$. Risetime is approx $0.5\,\mathrm{ns}$. Frequency Response is 30% down at $1.2\,\mathrm{kHz}$, 7% down at $200\,\mathrm{MHz}$. Insertion impedance with a $50\,\mathrm{c}\Omega$ termination is $0.04\,\Omega$ shunted approx $5\,\mu\mathrm{H}$; $0.08\,\Omega$ shunted by approx $5\,\mu\mathrm{H}$ without a $50\,\mathrm{c}\Omega$ termination. Capacitive Loading to a bare wire passing through the CT-2 Transformer is typically $2.1\,\mathrm{pF}$ for #16 gauge, $0.7\,\mathrm{pF}$ for #22 gauge. Maximum Voltage of Circuit Under Test is $1000\,\mathrm{V}$ DC. Direct Current reduces the L/R time constant by a factor of $2\,\mathrm{at}$ $0.5\,\mathrm{A}$. Pulse Current Rating is $100\,\mathrm{A}$ peak, with a max amp-second product of $50\,\mathrm{A}\,\mathrm{\mu s}$. RMS Current Rating is $2.5\,\mathrm{A}$ maximum. Temperature Rating is $-25\,\mathrm{c}$ C to $+65\,\mathrm{c}$ C.

P6041/CT-2 CURRENT PROBE , order 015-0047-00 Includes: $50-\Omega$ termination (011-0049-01).		\$55
CT-2 CURRENT TRANSFORMER, order 015-0046-	00	\$35
P6041 Probe , order 010-0164-00		\$20
50- Ω TERMINATION , order 011-0049-01		\$10

CT-5 HIGH-CURRENT TRANSFORMER



The CT-5 is a clip-on High-Current Transformer designed to extend the measurement capability of TEKTRONIX clip-on current probes. Maximum low-frequency performance is obtained using the P6042 DC Current Probe. It may also be used with the P6021 (not compatible with P6022) in conjunction with a current probe amplifier for measurements at normal power line frequency and above.

The CT-5 has receptacles for insertion of a current probe in either 20:1 or 1000:1 step-down ratios. The 1.5-inch square opening makes it possible to clip onto large conductors to make current measurements without breaking the circuit under test.

The core and shield assembly is insulated from the windings and the handle. This allows measurements to be made on bare conductors to 3000 volts, and to 10 kV RMS on insulated conductors or by use of a high-voltage bushing.

Use of an optional DC bucking coil assembly, which slips over the front of the CT-5, allows up to 300 amps of DC to be tolerated without appreciably degrading the measurements to be made. This is very useful for measuring AC signals riding on top of DC.

CHARACTERISTICS

Bandwidth—with CT-5/P6042 is 0.5 Hz to 20 MHz; CT-5/P6021/134 is 12 Hz to 20 MHz; CT-5/P6042/DC Bucking Coil is 1 Hz to 1 MHz.

The following are characteristics of the CT-5 using either the P6042 or P6021/134 combination.

Risetime is 17.5 ns or less. Insertion Impedance is $20~\mu\Omega$ or less at 60 Hz, increasing to $20~M\Omega$ at 1 MHz. Current Range is 20~mA/div to 20~A/div (20:1 step-down ratio); 1 A/div to 1000~A/div (1000:1 step-down ratio). Accuracy is within 4%. Maximum Current is 1000~A Peak.* Amp-Second Product is 8~A-s. Maximum 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 101% in, width is 21% in, height is 91% in; net weight is approx 4~lb.

CT-5 HIGH-CURRENT TRANSFORMER, order 015-0189-00 \$450 Includes carrying case (016-0191-00); high-voltage bushing, 10-in (015-0194-00).

OPTIONAL ACCESSORIES

DC Bucking Coil, order 015-0190-00	\$125
High-Voltage Bushing, 4 ft long, inside dia 1 in,	
order 015-0194-01	. \$8

*Maximum current 1000 A peak from 20 Hz to 1.2 kHz derating to 100 A peak at 1 MHz.



P6042

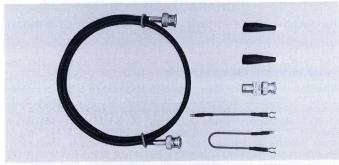
DC to 50 MHz CURRENT PROBE



The P6042 is a DC-to-50 MHz current probe designed for use with all TEKTRONIX Oscilloscopes. Utilizing a variation of the Hall effect, the P6042 offers new capabilities for making both high-frequency and DC current measurements. AC Signals with DC components can be displayed on the oscilloscope with true waveform presentation. The probe is particularly useful for evaluating the performance of semiconductor circuits where a wide range of parameters exist. Fast switching transients, Jow-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-in diameter) in the slot of the probe head and close the spring-loaded slide . . . no need to break the circuit under test. A warning light on the front panel of the amplifier indicates when the slide is in the unlocked position. A compartment is provided in the front panel for use in degaussing, and for convenient storage of the probe head when the system is not in use.



CHARACTERISTICS

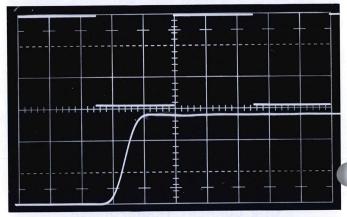
Probe and Amplifier

Sensitivity is 1 mA/div to 1 A/div in 10 calibrated steps, 1-2-5 sequence, accurate within 3% (with an oscilloscope deflection factor of 50 mV/div). Bandwidth is DC to 50 MHz at 3-dB down. Risetime is 7 ns or less. Dynamic Range is + and - 10 divisions of display. Noise (periodic and random deviation) is 0.5 mA or less, plus 0.2 or less major divisions of display. Random trace shift is 1.5 mA or less. Thermal Drift is 2 mA/°C or less, plus 0.2 or less major division of display per °C. Maximum Input Current is 10 A (DC plus Peak AC).* Maximum Voltage of Circuit Under Test is 600 V (DC plus Peak AC). Output Impedance is 50 Ω through a BNC-type connector. A 50- Ω termination is supplied with the probe for use with 1- Ω systems.

Amplifier Power Requirement is approximately 20 W, 50 Hz to 400 Hz. Quick-change line-voltage selector permits operation from 90 V to 136 V or 180 V to 272 V. Dimensions And Weight of the amplifier are 4½ inches (11.4 cm) high by 7½ inches (19.2 cm) wide by 9¾ inches (24.8 cm) deep; 6½ lbs. (3.1 kg). Probe Cable is 6 feet long, permanently connected between the probe head and amplifier.

OPTIONAL ACCESSORIES

*Peak-to-peak current derating is necessary for CW frequencies higher than 10 MHz. At 50 MHz, the maximum allowable current is 2 Å.



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.

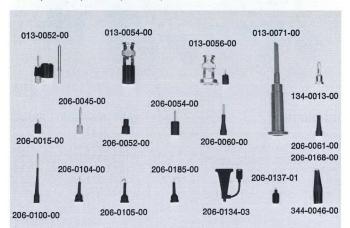


Typical application of the CT-5 clip-on high-current transforme P6042 DC current probe and 7000-Series Oscilloscope measuring the running current of a 1500 hp delta-connected induction motor.



#6-32 PROBE TIPS AND ACCESSORIES

The following tips and adapters can be used on all TEKTRONIX Probes that accept a #6-32 screw-on tip including the P6006, P6007, P6008, P6009, P6027, P6028 and P6060 Probes.



DESCRIPTION	PART NUMBER	PRICE
Bayonet ground assembly (for P6006, P6007, P6008, P6009)	013-0052-00	\$2.50
Probe tip to BNC adapter (for P6006, P6007, P6008, P6009)	013-0054-00	3.00
Probe tip to BNC adapter (for P6027, P6028)	013-0056-00	3.50
Probe retractable hook tip (for P6006, P6007, P6008, P6009, P6027, P6028)	013-0071-00	2.20
Probe banana tip	134-0013-00	.20
Probe straight tip (0.055 in dia)	206-0015-00	.30
robe straight tip (0.080 in dia)	206-0045-00	.85
Probe recessed tip (accepts 0.065 in		.30
dia recessed pin)	200-0032-00	.00
Probe straight tip (0.086 in dia)	206-0054-00	.85
Probe straight tip (0.000 in dia)	206-0060-00	.55
Probe spring tip (accepts 0.065 in dia		.50
pin)		
Probe calibration tip (0.063 in dia)	206-0100-00	1.00
Probe long straight tip (0.032 in dia)	206-0104-00	.30
Probe hook tip	206-0105-00	.30
Probe pin tip (accepts 0.025 in square pin)	206-0134-03	1.75
Probe ground lead adapter (#6-32 to 0.025 in x 0.025 in dia pin)	206-0137-01	.60
Probe spring tip (accepts 0.068 in dia pin)	206-0168-00	.50
Probe right angle hook tip	206-0185-00	.30
Miniature alligator clip	344-0046-00	.25

IDENTIFICATION TAGS



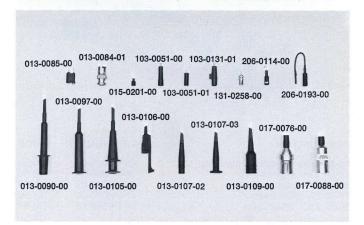
Probe identification tags for multi-probe applications help locate correlating probe ends quickly. The P6006, P6007, P6008, P6009, P6027, P6028 and P6060 have 3/16-inch cable. The P6011, P6012, P6048, P6052, P6053A, P6054, P6055, P6056, P6057 and P6061 have an 1/8-inch cable. One package contains two each of ten colors.

ESCRIPTION	PART NUMBER	PRICE
For 1/8 inch dia cable	016-0130-00	\$1.10
For 3/16 inch dia cable	016-0127-00	1.10

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

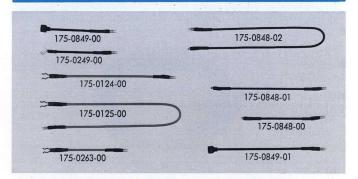
SLIP-ON PROBE TIPS AND ADAPTERS

The following tips and adapters are designed for use with TEKTRONIX Miniature Probes that accept a slip-on tip.



DESCRIPTION	PART NUMBER	PRICE
Probe tip to BNC adapter	013-0084-01	\$5.30
Bayonet ground assembly	013-0085-00	2.75
Retractable hook tip (for P6010, P6011, P6012, P6048, P6049)	013-0090-00	2.20
Retractable hook tip (for S-3A, P6045)	013-0097-00	2.20
Retractable hook tip (for P6052)	013-0105-00	2.20
Retractable hook tip (for 7A11)	013-0106-00	3.25
Retractable hook tip (for P6053, P6054)	013-0107-02	2.20
Retractable hook tip (for (P6055) not shown	013-0107-03	2.20
Retractable hook tip (for P6051)	013-0109-00	4.50
Probe tip cover	015-0201-00	.05
Probe tip to GR adapter	017-0076-00	8.30
Probe tip to GR 50-Ω termination Adapter	017-0088-00	25.00
Miniature Probe to #6-32 adapter (adapts miniature probes for use with	103-0051-00	1.25
all #6-32 screw-on tips)		
Miniature Probe to #6-32 adapter	103-0051-01	.85
Miniature Probe to #6-32 adapter	103-0131-00	2.75
Chassis mount test jack	131-0258-00	1.50
Hook tip	206-0114-00	.90
Probe tip flexible for .025 sq. pin	206-0193-00	2.00

PROBE GROUND LEADS



The following Ground Leads have a #6-32 thread size.

DESCRIPTION	P	ART NUMBER	PRICE
Ground lead	5.5-in	175-0124-00	\$.60
Ground lead	12.5-in	175-0125-00	.60
Ground lead for P6034, P6045, S-3A:	P6035, 2.5-in	175-0249-00	1.10
Ground lead	3.5-in	175-0263-00	.60
Ground leads for P6051	, P6052, 3-in	175-0848-00	.60
P6053, P6054:	5-in	175-0848-01	.60
	12-in	175-0848-02	.60
Ground Leads for P6051	: 3-in	175-0849-00	.60
	6-in	175-0849-01	.60



ATTENUATORS—TERMINATIONS



DESCRIPTION	PART NUMBER	PRICE
$50-\Omega$ feedthrough termination $50-\Omega$ 10X attenuator $50-\Omega$ 5X attenuator $50-\Omega$ 2X attenuator $50-\Omega$ 2.5X attenuator $50-\Omega$ feedthrough termination $(5 \text{ watt})^*$	011-0049-01 011-0059-01 011-0060-01 011-0069-01 011-0076-01 011-0099-00	\$10.00 16.50 16.50 16.50 16.50 18.50

Characteristics (for 50- Ω termination and attenuators above) Accuracy of indicated Attenuation Ratio is $\pm 2\%$ at DC; $\pm 3\%$ at 500 MHz. Power Rating is 2 watts. Voltage Standing Wave Ratio (VSWR) is less than 1.1 up to 250 MHz. *VSWR less than 1.1 up to 100 MHz.

75- Ω feedthrough termination	011-0055-00	\$10.00
93-Ω feedthrough termination	011-0056-00	10.00
50- Ω to 75- Ω min loss attenuator	011-0057-00	13.25
50- Ω to 93- Ω min loss attenuator	011-0058-00	13.25
75-Ω 10X attenuator	011-0061-00	12.00
93-Ω 10X attenuator	011-0062-00	12.00
600- Ω feedthrough termination (1 watt, DC to 1 MHz)	011-0092-00	18.00
75-Ω to 50-Ω min loss áttenuator (AC coupled)	011-0112-00	25.00

CHARACTERISTICS

Accuracy of Indicated Attenuation Ratio is $\pm 2\%$ at DC. Power Rating of attenuators is 1/2 watt and terminations 1 watt. Voltage Standing Wave Ratio (VSWR) not specified.

CABLES

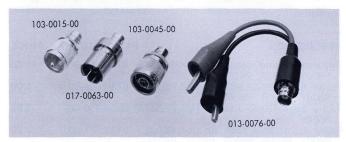


Coaxial, 50 Ω, 42 in	012-0057-01	\$6.00
Coaxial, 75 Ω, 42 in	012-0074-00	6.00
Coaxial, 93 \Omega, 42 in	012-0075-00	6.00
Coaxial, 50Ω , $18 in$	012-0076-00	6.00

ADAPTERS



DESCRIPTION	PART NUMBER	PRICE
BNC Male to GR	017-0064-00	\$10.50
BNC Male to UHF Female	103-0032-00	2.00
BNC Male to Binding Post	103-0033-00	2.20
BNC Male to Dual Binding Post	103-0035-00	6.50
BNC Male to N Female	103-0058-00	2.75
BNC Female to Dual Banana	103-0090-00	3.50



BNC	Female	to clip	leads	01	3-0076-00	\$5.50
BNC	Female	to GR		01	7-0063-00	7.50
BNC	Female	to UHF	Male	10	3-0015-00	2.25
BNC	Female	to N M	ale	10	3-0045-00	2.40



BNC Female to BNC Female	103-0028-00	\$2.10
BNC Male to BNC Male	103-0029-00	4.00
BNC T	103-0030-00	3.70
BNC Elbow Male to Female	103-0031-00	3.00



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



ATTENUATORS—TERMINATIONS



DESCRIPTION	PART NUMBER	PRICE
125- $Ω$ min loss	017-0052-00	\$33.00
50-Ω 10X attenuator	017-0078-00	44.00
50-Ω 5X attenuator	017-0079-00	44.00
50-Ω 2X attenuator	017-0080-00	44.00
50- Ω termination, end-line	017-0081-00	35.75

CHARACTERISTICS

Accuracy of indicated attenuation ratio is $\pm 2\%$ at DC, $\pm 3\%$ at 1 GHz. Voltage standing wave ratio (VSWR) is less than 1.1 up to 1 GHz. Power Rating is 1 watt.

50-OHM POWER DIVIDER



This coaxial tee has a 16.67-ohm resistor in each leg, connected so that the tee looks like 50 ohm if two legs are terminated in 50 ohm. It is designed for use in broad-band 50- Ω systems where the mismatch introduced by ordinary "Tee" connectors is undesirable. It is especially useful in a time-domain reflectometer set-up where test line, pulser, and oscilloscope must be coupled with a minimum of reflection-producing discontinuities.

Order 017-0082-00 \$95.00

COUPLING CAPACITOR—ADAPTERS



The coupling capacitor is a short length of coaxial line having a disk capacitor (4700 pF) in series with the inner connector. High frequencies are transmitted with small reflection, but DC and low frequencies are blocked. Voltage rating is 500 V.

Coupling Capacitor	017-0028-00	\$17.00
GR Insertion Unit	017-0030-00	20.00
GR T	017-0069-00	20.00
GR Elbow	017-0070-00	17.50

ADAPTERS



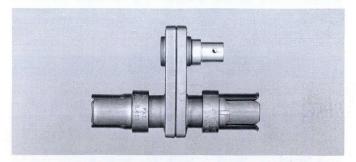
DESCRIPTION	PART NUMBER	PRICE
GR to UHF Female GR to UHF Male GR to BNC Female GR to BNC Male	017-0022-00 017-0023-00 017-0063-00 017-0064-00	\$ 7.00 8.00 7.50 10.50
50- Ω termination, thru-line *(GR to BNC Male)	017-0083-00	33.50

*Upper frequency limit VSWR not specified



GR to N Male	017-0021-00	\$ 8.00
GR to C Male	017-0027-00	10.00
GR to N Female	017-0062-00	7.00
GR to C Female	017-0065-00	10.00

CT-3 SIGNAL PICKOFF



Designed for use with high-frequency oscilloscopes, the CT-3 Pickoff provides a convenient means of picking off a signal in a 50-ohm system. Used with any of the TEKTRONIX sampling instruments, the CT-3 provides the link for use as a trigger source. Sensitivity is 10% of the voltage under test, into a 50-ohm load. Decay Time Constant is 4.5 μ s 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 μ H without a 50-ohm termination. VSWR is less than 1.2 at 1.5 GHz. Voltage Rating at 0 V DC is 25 V RMS, 1-kV pulse peak. The volts-second product is 100 V μ s. If exceeded, the L/R decay will decay rapidly toward zero. \$38.00

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



50-Ω CABLES



DESCRIPTION	PART NUMBER	PRICE
Coaxial 10-ns RG58A/U	017-0501-00	\$17.00
Coaxial 5-ns RG213/U	017-0502-00	17.00
Coaxial 1-ns RG58A/U*	017-0503-00	9.00
Coaxial 20-ns RG213/U	017-0504-00	18.00
Coaxial 2-ns RG58A/U	017-0505-00	17.00
Coaxial 5-ns RG58A/U	017-0512-00	20.00
Coaxial 10-in RG213/U	017-0513-00	14.50
Coaxial 20-in RG213/U	017-0515-00	15.00

^{*}Connector on one end only.

50-OHM AIR LINE



The 20-cm 50- Ω air line is useful as a time-delay device and as an absolute impedance in a time-domain reflectometer system. The characteristic impedance is 50 Ω \pm 0.4%. Time delay is 0.6698 ns \pm 0.4%. Order 017-0084-00 \$18.75

ADAPTERS F



DESCRIPTION	PART NUMBER	PRICE
"F" female to BNC male	013-0126-00	\$ 6.25
"F" female to GR874	017-0089-00	10.00
"F" male to "F" male	103-0157-00	6.25
"F" male to BNC female	103-0158-00	6.25
"F" female to "F" female	103-0159-00	6.25

50-OHM CABLES

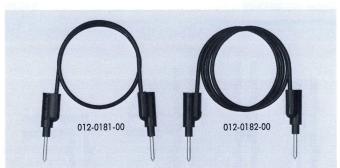


DESCRIPTION	PART NUMBER	PRICE
Coaxial, 10 in, RG58	012-0128-00	\$7.50
BSM Female to BNC Male Coaxial, 18 in, RG58 BSM Female to BNC Male	012-0127-00	7.50

PATCH CORDS



BNC to BNC, 18 in Red Black	012-0087-00 012-0086-00	\$1.65 1.65
BNC to banana plug-jack, 18 in Red Black	012-0091-00 012-0090-00	1.65 1.65
Banana plug-jack to banana plug-jack, Red Black	18 in 012-0031-00 012-0039-00	1.65 1.65



Pin-jack to pin-jack, 0.08 in dia pin		
Red, 8 in	012-0179-00	\$1.95
Red, 18 in	012-0180-00	1.95
Black, 8 in	012-0181-00	1.95
Black, 18 in	012-0182-00	1.95



50-OHM ATTENUATORS



Frequency range is DC to 12.4 GHz. Power rating is 2 W average, 300 W peak. Impedance is 50 $\Omega.\,$

DESCRIPTION	PART NUMBER	PRICE
10-dB attenuator	011-0085-00	\$45.00
20-dB attenuator	011-0086-00	45.00
40-dB attenuator	011-0087-00	55.00

ADAPTERS



N Male to GR	017-0021-00	\$8.00
N Female to GR	017-0062-00	7.00
N Male to UHF Female	103-0044-00	4.25
N Male to BNC Female	103-0045-00	2.40
N Female to BNC Male	103-0058-00	2.75
N Female to UHF Male	103-0059-00	2.50



BSM Male to BNC Female 103-0036-00 \$5.50

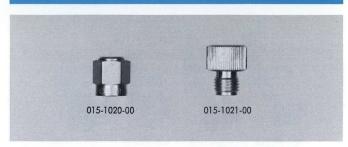
50-OHM CABLE



Coaxial N connectors, 6 feet

012-0114-00

ATTENUATORS—TERMINATORS



DESCRIPTION	PART NUMBER	PRICE
Short-Circuit termination Male Short-Circuit termination Female	015-1020-00 015-1021-00	\$ 6.60 6.60
50-Ω termination Male	015-1022-00	27.50

(Not Pictured)



50-Ω 2X attenuator	015-1001-00	\$66.00
50-Ω 5X attenuator	015-1002-00	100.00
50-Ω 10X attenuator	015-1003-00	72.00
50-Ω termination Female	015-1004-00	40.00

CHARACTERISTICS

	DC — 12.	40 GHz	12.41 — 18	3.00 GHz	Power
	Attenua- tion Accuracy	VSWR	Attenua- tion Accuracy	VSWR	Contin- uous
Termination 2X (6 dB) 5X (14 dB) 10X (20 dB)	$\begin{array}{l} \pm 1~\Omega \\ \pm ~.75~\text{dB} \\ \pm ~.75~\text{dB} \\ \pm ~.75~\text{dB} \end{array}$	1.15 1.40 1.40 1.40	$\begin{array}{l} \pm1~\Omega\\ \pm1.00~\text{dB}\\ \pm1.00~\text{dB}\\ \pm1.00~\text{dB} \end{array}$	1.15 2.00 1.60 1.60	0.5 W 1.0 W 1.0 W 1.0 W

50-Ω POWER DIVIDER



This coaxial tee is designed for use in broad-band, $50-\Omega$, 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 $50-\Omega$ termination). Maximum VSWR is 1.50 from DC to 12.00 GHz and 1.00 from 12.01 to 18.00 GHz 1.90 from 12.01 to 18.00 GHz.

Order 015-1014-00 \$94.00

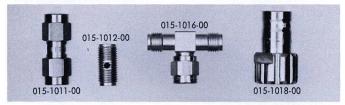
SMA Male to 7-mm APC



ADAPTERS



DESCRIPTION PART NUMBER PRICE SMA Male to GR SMA Female to GR SMA Male to N Female 015-1007-00 015-1008-00 015-1009-00



\$ 20.00

015-1010-00

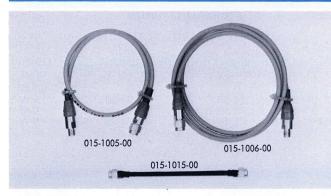
20.00

40.00

105.00

SMA Male to Male	015-1011-00	\$ 9.00
SMA Female to Female	015-1012-00	7.00
SMA T	015-1016-00	18.00
SMA Male to BNC Female	015-1018-00	4.50

50-Ω CABLES



Coaxial 2 ns	015-1005-00	\$40.00
Coaxial 5 ns	015-1006-00	40.00
Coaxial semirigid 500 ps	015-1015-00	24.00
Coaxial semirigid 750 ps	015-1017-00	24.00
Coaxial 1 ns	015-1019-00	22.00

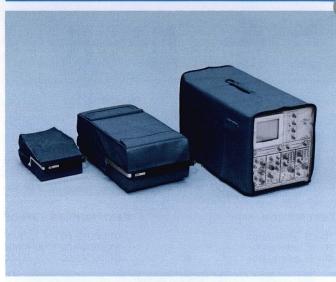
50-Ω COUPLING CAPACITOR



The coupling capacitor is a short length of coaxial line having a disc capacitor (4700 pF, $\pm 20\%$) in series with the inner conductor. Reflection ratio (in 150-ps TDR system), maximum is 0.03. Voltage rating is 200 Volts.

Order 015-1013-00	 \$75.00
01401 010 1010 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, 5100 and 7000 Series Laboratory Oscilloscopes have clear vinyl frontal areas. The cover for all portable instruments, except the small portables like the 323 and 1401A, has a pocket for carrying the manual. The 4002A Computer Terminal Cover is similar to the laboratory oscilloscope cover except tan in color.

INSTRUMENT	PART NUMBER	PRICE
323, 324, 1401A, 1401A-1, 1501	016-0112-00	\$10.00
422 (with battery pack)	016-0075-00	10.00
422 (without battery pack)	016-0076-00	10.00
453A, 454A, 491	016-0074-01	10.00
465, 475	016-0554-00	10.00
529 (with field case)	016-0085-00	10.00
560 Series (except 565, 567, 568)	016-0067-00	10.00
565, 567, 568	016-0069-00	10.00
540 Series	016-0068-00	10.00
5000 Series	016-0544-00	10.00
7300, 7400, 7600 Series	016-0192-00	10.00
7704A, 7900	016-0531-00	10.00
4002A	016-0193-00	30.00

PLUG-IN UNIT CARRYING CASES
CARRYING CASE FOR 7000-SERIES PLUG-IN UNITS Order 437-0106-00
CARRYING CASE FOR 2, 3, 10 and 11-SERIES PLUG-IN UNITS—accommodates two plug-in units. Order 437-0070-00
CARRYING CASE FOR LETTER-SERIES OR 1-SERIES PLUG-IN UNITS—Provides protection for one oscilloscope plug-in unit. Order 437-0065-00



CAMERA CARRYING CASES

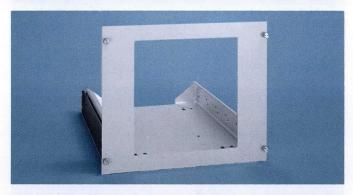


C-12/C-27 CARRYING CASE—C-12/C-27 Camera Carrying Case holds either the C-12 or C-27 Camera and all the standard accessories plus extra film. The case is constructed of heavygage, high-impact plastic and has a foam-rubber liner. Dimensions are 20½ by 20 by 8 in. Net weight is 15½ lb; domestic shipping weight is approx 22 lb.

Order 016-0208-01 \$85.00

C-50 Series/C-70 CARRYING CASE—The carrying case will hold a C-50, C-51, C-52, C-53, C-58, C-59 or C-70 Camera and all standard accessories including a battery pack, extra film, and adapters. The case is constructed of heavy-gage, high-mpact plastic and has a vacuum-formed styrene liner. Dimensions are 16-3/4 x 23-2/3 x 10-1/10 in. Net weight is approx 8 lb. Order 016-0177-00 \$80.00

RACK ADAPTERS



For rackmounting the 7500 and 7700-Series Oscilloscopes and 611 in a standard 19-in wide rack. Rack adapter includes slide-out assemblies. 7500 and 7700-Series mask finish is light gray, 611 mask finish is black.

RACK ADAPTERS



For rackmounting most TEKTRONIX generators in a standard 19-in wide rack. The rack height is 5¼ in, rack depth is 19¾ in. Rack adapter includes slide-out assemblies. Shipping weight is approx 24 lb.

The adapter provides forced air ventilation and blank panels are provided to cover the unused openings. Mounting kits must be ordered separately for each instrument to be mounted.

Rack Adapter includes half-rack width blank panel (333-1384-00). Order 016-0268-00 \$225.00

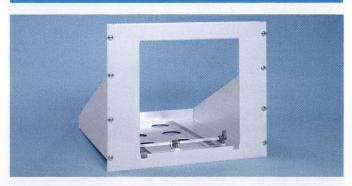
286 Mounting Kit.
Order 016-0190-00 \$10.00
For rackmounting two TM 503s

 Order 040-0616-00
 \$40

 For rackmounting one TM 503
 \$60

 Order 040-0617-00
 \$60

CRADLE MOUNTS



For rackmounting 500, 7500 and 7700-Series cabinet-type oscilloscopes in a standard 19-in wide rack. Cradle mount consists of a cradle (or "shelf") without slide-out assemblies and a mask to fit over the regular instrument panel. 500-Series mask finish is blue vinyl, 7500 and 7700-Series mask finish is light gray.



REAR-SUPPORT CRADLES

Provide rear support for rackmount instruments with slide-out assemblies, when mounted in a 19-in backless rack. Shipping weight is approx 3 lb.

STORAGE CABINETS

Plug-in Preamplifier Storage Cabinet mounts in standard 19-inch rack, available in two types:



For 1-Series and Letter-Series Plug-In Units—Holds a 3 plug-in units. Measures 19 in wide, 8% in high, 9% in deep. Net weight is approx 9 lb.

Order 437-0031-00 \$27.50

For 2 and 3-Series Plug-In Units—holds 4 plug-in units. Measures 19 in wide, 7 in high, 13-5/16 in deep. Net weight is approx 10 lb.

Order 437-0071-00 \$33.00

CAMERA MOUNTING ADAPTERS



Adapters for mounting commercially available cameras on TEKTRONIX Oscilloscopes. Mounting ring measures 5% in outside diameter. Die-cast construction. Net weight of each is approx 1 lb.

INSTRUMENT*	PART NUMBER	PRICE
502A, 503, 504, 540, 550, 565 and 575	014-0018-00	\$10.00
561B, 564B, 567 and 568	014-0016-00	\$10.00
647A	014-0017-00	\$10.00
529	014-0031-00	\$8.50
528, 601, 602, 603, 604, 5100, and 7000	014-0045-00	\$50.00

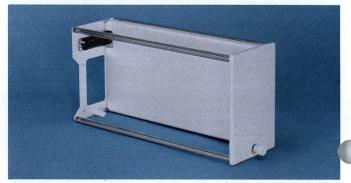
^{*}Also rackmount version.

BLANK PLUG-IN CHASSIS



7000-Series Blank Plug-In Chassis—Provides a blank printed circuit board, plug-in frame and securing hardware for users who wish to construct a special purpose plug-in.

Order 040-0553-00\$46



Blank 560-Series Plug-In Chassis—For special circuit construction of sweep or vertical amplifier. Net weight is approx 2½ lb.

Order 040-0245-00\$27.50

Blank 1-Series and Letter Series Plug-In Chassis—Useful for constructing your own special circuits. Net weight is approx 2 lb.

Order 040-0065-00 \$27.50

BLANK PLUG-IN PANEL



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

Order 016-0155-00 \$6.00





5100-Series Blank Plug-in Panel—When operating the 5100-Series instruments with less than the full complement of plugins, the blank plug-in panel can be used to cover unused compartments.

Order 016-0195-00 \$4.00

VIEWING ACCESSORIES

The viewing accessories listed normally mount on the oscilloscope graticule cover. In many cases, they will also fit cameramounting bezels. If you intend using a camera on your oscilloscope, check with your Tektronix Field Engineer for bezelviewer compatibility before ordering.



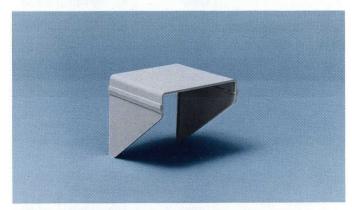
Polarized Viewers—For TEKTRONIX 5-inch Oscilloscopes. The viewers reduce troublesome reflections and glare under high ambient light conditions.



Viewing Hood—For TEKTRONIX 5-inch Oscilloscopes. Includesmolded rubber eyepiece and separate tubular light shield.Order 016-0001-01\$9.00



For 422, 491, 453A, 454A, order 016-0082-00\$9.00 For 549, 561B, 564B, 567, 568, 641A, order 016-0103-00\$9.00



View Hood (folding)—for 576, 5000 and 7000-Series Oscilloscopes. Molded gray polycarbonate with nonreflective finish.



Viewing Hood—for 576, 5000 and 7000-Series Oscilloscopes. Molded gray polystyrene with polyurethane eyepiece.

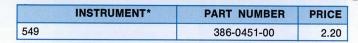


CATHODE-RAY TUBE LIGHT FILTERS

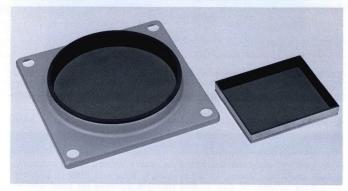
INSTRUMENT*	COLOR	PART NUMBER	PRICE
	Smoke-gray	426-0403-00	\$2.10
323, 324	Blue†	426-0512-00	2.10
	Amber	426-0513-00	2.10
326	Blue†	426-0871-00	2.10
100 101 1501 1511	Smoke-gray	378-0549-00	.90
422, 491, 453A, 454A	Green Blue†	378-0557-00 378-0664-00	.90 .65
	Amber	378-0559-00	.90
465, 475	Blue	337-1674-00	1.60
	Clear	337-1674-01	1.60
	Smoke-gray†	378-0567-00	1.60
540-, 550-Series, 565,	Green	378-0568-00	1.60
575	Blue Amber	378-0569-00 378-0570-00	1.60 1.60
	Smoke-gray†	378-0560-00	1.35
529, 561B, 567, 568	Green	378-0561-00	1.35
	Blue	378-0562-00	1.35
	Amber	378-0563-00	1.35
520A, 521A, 522A	Smoke-gray†	378-0581-00	.90
576	Blue†	378-0616-00	1.60
602	Smoke-gray†	378-0586-00	1.50
7500 7010 7700	Amber	378-0595-00	4.10
7500, 7313, 7700- Series, 7613, 7623	Blue†	378-0625-00	1.60
Series, 7013, 7023	Amber Gray	378-0625-01 378-0625-02	1.60 1.60
	Green	378-0625-03	1.60
	Gray TV Grat		011 199
	CCIR	378-0625-05	3.00
	Gray TV Grat	378-0625-06	3.00
	Clear Implosio	on Shield	0.00
	With Spectrum		4.50
7040 0 7000 (1)	Graticule	337-1159-02	1.50
7613 & 7623 (only)	Spectrum Analyzer	378-0625-07	1.60
	Green (UV)	378-0625-08	1.60
	TV Graticule	378-0625-09	1.60
	CCIR TV Graticule	378-0625-10	1.60
	NTSC	370-0023-10	1.00
7403N, 7603	Blue	378-0684-00	2.00
	Amber	378-0684-01	1.90
	Gray	378-0684-02	1.90
	Green Gray TV Grati	378-0684-03 icule	1.90
	CCIR	378-0684-04	3.50
	Gray TV Grat		0.50
	NTSC Clear Implosio	378-0684-05	3.50
	With Spectrun	n Analyzer	
	Graticule	337-1439-01	1.50
	Blue Implo- sion Shield†	337-1700-01	1.60
	Clear Implo-	337-1700-04	1.60
	sion Shield		der ob
5100 Series	Clear	337-1440-00	.95
	Green	337-1440-01	.95
	Amber Blue	337-1440-02 337-1440-03	.95 .95
	Gray	337-1440-04	.95
5100, 603, 604	Amber	378-0704-00	1.50
	Green	378-0705-00	1.50
432, 434	Clear	378-0677-00	1.60

^{*}For both cabinet and rackmount instruments unless rackmount version is listed.

UNSCRIBED GRATICULES



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	\$15.00
432, 434	378-0682-00	15.00
422, 491, 453A, 454A	378-0648-00	15.00
465, 475	378-0726-01	15.00
540-Series, 565	378-0572-00	18.00
529, 561B, 564B, 568	378-0575-00	18.00
7403N, 7603	378-0696-00	18.00
7500, 7313, 7700- Series, 7613, 7623	378-0603-00	18.00

^{*}For both cabinet and rackmount instruments.

[†]Standard filter supplied with instrument.



SCOPE-MOBILE Usage Chart

				9			
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
200-1B	465, 475, 485, 453A, 454A, 491, 432, 434	None	No	11½ x 16½ in	12 x 12 x 34 in deep	19 lb	\$120
200-2	422	None	No	91⁄4 x 15 in	12 x 12 34 in deep	19 lb	\$120
201-1	540 Series, 564B	Storage drawer only	No	10½ x 18½ in	15½ x 25 in	37 lb	\$165
201-2		Two 2 or 3 series plug-ins	No	10½ x 18½ in	15½ x 25 in	39 lb	\$185
202-1	540 Series, 575, 576	Storage drawer only	No	14 x 21 in	15½ x 25 in	41 lb	\$165
202-1 Mod 52	519	Storage drawer only	No	14¾ x 25 in	18½ x 25 in	44 lb	\$250
202-2	540 Series, 575, 576	Two 1 or letter series plug-ins	No	14 x 21 in	15½ x 25 in	43 lb	\$185
203-2	7503, 7403N, 7313, 7613, 7623, 7603,	Holds four 5 or 7 series plug-ins	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	\$155
203-3	5100 Series	Holds four 5 or 7 series plug-ins and TM-503	Yes	11¼ x 21 in	14¾ x 26¾ in	39 lb	\$155
204-2	7704A, 7504, 7904	Holds five 7 series plug-ins	Yes	14 x 21 in	17½ x 26% in	48 lb	\$225
204-3	7704A, 7504, 7904	No storage drawer or plug-in carrier	Yes	14 x 21 in	17½ x 26% in	45 lb	\$195
205-1	520A, 521A, 522A, 556, 568 & rack- mount instruments	Storage drawer only	No	17¾ x 22¾ in	18½ x 25 in	46 lb	\$190
205-2	2 - 2 - 2	Three 1, or letter series plug-ins	No	17¾ x 22¾ in	18½ x 25 in	49 lb	\$210
205-3		Holds four 2, or 3 series plug-ins	No	17¾ x 22¾ in	18½ x 25 in	49 lb	\$210
206-1	Computer Terminals	Two flat shelves	No	16 x 27 in	16 x 27 in	34 lb	\$ 90
207-1	N/C Editor System	Two shelves	No	26½ x 43½ in	26½ x 21½ in & 21½ x 20 in	50 lb	\$250

^{*}Overall length bottom of tray, includes rear radius bend and front stops.

**Usable dimensions may be limited by height required.

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

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 200-1 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°

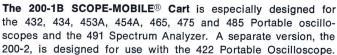
steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

All SCOPE-MOBILE Carts feature sturdy aluminum construction, and a linoleum-covered steel plate for the bottom shelf. The 206-1 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.







These oscilloscope carts occupy less than 18 inches of aisle space. With their large wheels and unique design, they can easily be moved up and down stairs. Friction locks on the oscilloscope tray permit the instrument to be positioned at any angle for convenient viewing. Storage space is provided at the base of the cart for accessories or associated instruments.

Adjustable tray friction-locks in any position from 0° to 60° . A finger-tip latch on the pedestal locks the tray for transporting.

Mechanical features include cast-aluminum construction with six-inch rubber wheels in the rear and two-inch swivel castors in front.

Overall dimensions are approximately 29 inches high by 17 inches wide by 19 inches deep. Storage area in the base measures 12 inches by 12 inches and 34 inch deep.

Pricing information is on page 307.



The 203-2 and 203-3 SCOPE-MOBILE® Carts hold any of the TEKTRONIX 5000 or 7000 Series three plug-in mainframes. The 203-3 Cart becomes an easy-to-use mobile test station when a TM-503 Power Module is installed in the lower storage area.

The 203-2 or -3 can store four additional plug-ins for later use. The Carts have three AC receptacles located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction 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 307.





The 204-2 SCOPE-MOBILE® Cart features tilt-locking in any of nine tray positions. The 204-2 is equipped with a large storage drawer for holding accessory items and a plug-in carrier for storing plug-ins. Three AC receptacles are located at the rear of the storage drawer for supplying power to the oscilloscope and associated instruments.

Adjustable tray tilt-locks in six 4.5° steps in the upward direction and two 4.5° steps in the downward direction from the horizontal axis.

Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes, a linoleum-topped steel shelf at the bottom. A latch-operated hold-down device insures that the oscilloscope is firmly secured to the adjustable tray.

Overall dimensions are approximately 36 inches high by 19% inches wide by 29 inches deep.

Pricing information is on page 307.

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 \$8.50

Either the storage drawer or the storage drawer and plug-in carrier combination can be ordered separately to modernize older SCOPE-MOBILE® Carts.

014-0012-00 drawer for 201-1	\$45
014-0013-00 drawer/plug-in carrier combination for 201-2 .	
014-0014-00 drawer for 202-1	
014-0015-00 drawer/plug-in carrier combination for 202-2 .	\$50
014-0032-00 drawer/1-, letter-series plug-in carrier	
combination for 205-2	\$50
014-0033-00 drawer/2-, 3-, 10-, 11-series plug-in carrier	
combination for 205-3	\$50

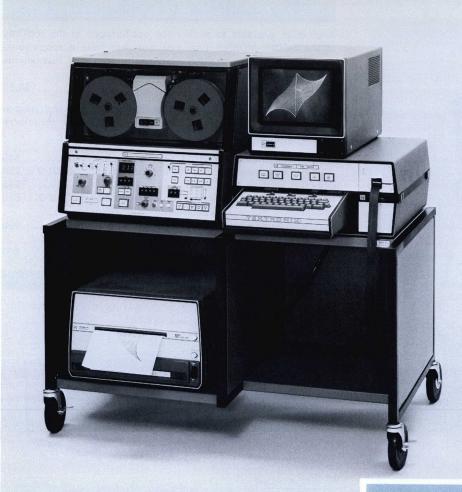
OSCILLOSCOPE PROTECTIVE COVERS



INSTRUMENT	PART NUMBER	PRICE
323, 324, 1401A, 1401A-1, 1501	016-0112-00	\$10.00
422 (with battery pack)	016-0075-00	10.00
422 (without battery pack)	016-0076-00	10.00
453A, 454A, 491	016-0074-01	10.00
465, 475	016-0554-00	10.00
529 (with field case)	016-0085-00	10.00
560 Series (except 565, 567, 568)	016-0067-00	10.00
565, 567, 568	016-0069-00	10.00
540 Series	016-0068-00	10.00
5000 Series	016-0544-00	10.00
7300, 7400, 7600 Series	016-0192-00	10.00
7704A, 7900	016-0531-00	10.00
4002A	016-0193-00	30.00

PLUG-IN UNIT CARRYING CASES





The 207-1 provides mobility to the TEKTRONIX Numerical Control Program Verifier and Editor System. The mobile console allows the Editor System to be moved to where it is needed for fast and efficient use of your Numerical Control Editor System.

Mechanical features include aluminum construction, 5-inch rubber wheels with front wheel brakes and steel shelves.

Overall dimensions are approximately 44 inches long by 27 inches deep by 26 inches high.

Pricing information is on page 307.



The 206-1 Terminal Cart gives portability to the computer terminal, with a lower shelf for a hard copy unit. The 5-inch rubber wheels (two locking wheels) allow easy pushing over carpeted areas. The low-profile rectangular cart has two linoleum covered steel shelves attached to a sturdy aluminum frame. The shelves are 16 x 27 inches with an overall height of 25 inches.

Pricing information is on page 307.



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.

O OPERATIONAL AMPLIFIER

The O contains two identical operational amplifiers and a display amplifier. The gain-bandwidth product is at least 15 MHz. Internal or external components may be selected as Z_i and Z_f . The results can be viewed on the TEKTRONIX 530, 540, 550, and 580 (81A Adapter required) Series Oscilloscopes and/or fed to other devices.

Order O PLUG-IN UNIT\$825

W DIFFERENTIAL COMPARATOR AMPLIFIER

The 1A5 Differential Comparator Amplifier is recommended as a replacement for the W Plug-In Unit.

As a differential input preamplifier, the dynamic range of the W Unit permits common-mode signals up to $\pm 150\,\text{V}$ without attenuation and $\pm 500\,\text{V}$ with front panel attenuator. With a rejection ratio of 20,000 to 1 for DC or low-frequency signals, signals of 1 mV or less on large common-mode signals can be measured.

The W has a bandwidth from DC to 26 MHz when used with the 556 Oscilloscope. The W Unit is compatible with TEKTRONIX 530, 540, 550, and 580 (81A Adapter required) Series Oscilloscopes.

Order W PLUG-IN UNIT\$800

1A2 DUAL-TRACE AMPLIFIER

The 1A1 Dual-Trace Amplifier is recommended as a replacement for the 1A2 Plug-in Unit.

The 1A2 Plug-in Unit provides dual-trace displays in 530, 540, 550, and 580 (Type 81A Adapter required) Series Oscilloscopes. The unit has two identical channels with deflective factors from 50 mV/div to 20 V/div. Bandwidth is DC to 50 MHz when used in the 556 Oscilloscope.

Order 1A2 PLUG-IN UNIT\$460

1A6 DIFFERENTIAL AMPLIFIER

The 1A7A Differential Amplifier is recommended as a replacement for the 1A6 Plug-in Unit.

The 1A6 is a DC coupled differential amplifier designed for TEKTRONIX 530, 540, 550, and 580 (81A Adapter required) Series Oscilloscopes. It features differential input with a high common-mode rejection ratio. Bandwidth is DC to 2 MHz with deflection factors from 1 mV/div to 50 V/div.

Order 1A6 PLUG-IN UNIT\$400

1S1 SAMPLING UNIT

For replacement—see Sampling Reference Page.

Used with any of the TEKTRONIX 530, 540, 550 or 580-Series Oscilloscopes (A 81A Adapter is required). The 1S1 Sampling Unit extends the measuring capabilities to 1 GHz. It features internal triggering with a built-in delay line. Calibrated sweep range is from 100 ps/cm to 50 μ s/cm.

Order 1S1 SAMPLING UNIT\$1400

545B 33-MHz OSCILLOSCOPES

The TEKTRONIX 7403N Oscilloscope is recommended as a replacement for the 545B.

The 545B is designed for use with all TEKTRONIX Letter-Series and 1-Series Plug-in Units. Features include: bandwidth DC to 33 MHz, full bandwidth triggering, and calibrated delayed sweep.

Order 545B OSCILLOSCOPE, without plug-in units \$2100

547 50-MHz OSCILLOSCOPES

For replacement of 547 see TEKTRONIX 7000-Series Oscilloscopes.

The 547 is designed for use with all TEKTRONIX Letter-Series and 1-Series Plug-in Units. Features include: bandwidth DC to 50 MHz, full bandwidth triggering, dual time base, delayed sweep, and horizontal display switching.

Order 547 OSCILLOSCOPE, without plug-in units\$2350

549 STORAGE OSCILLOSCOPE

For replacement see 7000-Series Storage Family.

The 549 is designed to accept all TEKTRONIX Letter-Series and 1-Series Plug-in Units. Features include: bistable split-screen storage with up to $5~{\rm cm}/\mu{\rm s}$ writing speed, auto erase, and conventional displays. Bandwidth and triggering is DC to 30 MHz. The horizontal features delayed and single sweep.

Order 549 OSCILLOSCOPE, without plug-in units \$2700

647A and R647A OSCILLOSCOPES 10A2A DUAL-TRACE AMPLIFIER 11B2A DELAYED SWEEP TIME BASE

The TEKTRONIX 7603N Option 11S is recommended as a rereplacement for the 647A, R647A, 10A2A, and 11B2A.

The 647A, R647A, 10A2A, and 11B2A are built for severe environments. Bandwidth and triggering are from DC to 100 MHz.

The 10A2A is a dual-trace amplifier with two identical channels, with deflection factors from 10 mV/div to 20 V/div. They may be added algebraically, or operated dual trace with alternate or chopped switching.

The 11B2A is a delayed sweep time base with sweep speeds from 10 ns/div to 5 s/div. Two separate time-base generators and a calibrated delayed sweep are provided.

Order 647A OSCILLOSCOPE, without plug-in units	\$1925
Order R647A OSCILLOSCOPE, without plug-in units	
Order 10A2A DUAL-TRACE AMPLIFIER	\$985
Order 11B2A TIME BASE	\$1070

3A2 ANALOG/DIGITAL AMPLIFIER 3B2 ANALOG/DIGITAL TIME BASE

The 3A2 Dual-Trace Amplifier and 3B2 Time-Base Units enable digital readout and analog displays of low- and medium-frequency information. Both types of displays are provided using the 568/230 Digital Readout Oscilloscope System. Analog displays (but not digital readout) are provided using 561B or 564B Oscilloscopes. The 3A2 also provides analog displays in the 565 Oscilloscope.

Order 3A2 DUAL-TRACE AMPLIFIER UNIT \$800 Order 3B2 TIME-BASE UNIT \$950

3C66 AMPLIFIER UNIT

The 3A10 is recommended as a replacement for the 3C66.

The 3C66 Carrier Amplifier with suitable transducer measures mechanical quantities that can be converted to a change in resistance, capacitance, or inductance. This unit may be used in the 561B, 564B and 565 Oscilloscopes.

The 3C66 operates on an AC carrier principle. It uses an AC bridge at the input to convert transducer signals into an amplitude-modulated carrier signal. The carrier signal is amplified by a high-gain AC amplifier and then demodulated to obtain the CRT deflection voltages.

Order 3C66 AMPLIFIER UNIT\$650



122, F122 and R122 LOW-LEVEL PREAMPLIFIERS

The 122, frame-mounted F122 and rackmounted R122 are low-frequency, low-level preamplifiers with a voltage gain of 100 or 1000, single-ended or differential inputs, and a bandwidth of 0.2 Hz to 40 kHz. Common-mode rejection ratio is better than 10,000:1 between 5 Hz and 40 kHz, with a maximum common-mode input signal of 4 V. High- and low-frequency —3 dB points can be set by front-panel switches. Power is supplied by the TEKTRONIX 125 supply or by batteries (not included).

by the TEXTHONIX 125 supply of by batteries (not incit	idea).
Order 122 LOW-LEVEL PREAMPLIFIER	\$230
Order F122 LOW-LEVEL PREAMPLIFIER	\$235
Order R122 LOW-LEVEL PREAMPLIFIER	\$235

125, F125 and R125 POWER SUPPLIES

The TEKTRONIX 125, frame-mounted F125 and rackmounted R125 supply electronically-regulated power for up to four 122 Preamplifiers.

Order	125 POWER SUPPLY	\$400
Order	F125 POWER SUPPLY	\$405
Order	R125 POWER SUPPLY	\$405

127 POWER SUPPLY

The 127 provides power to one or two 1-Series or Letter-Series Plug-in Units. Rear connectors allow alternate trace trigger-signal inputs; push-pull outputs are available on the front as well as the rear. A squarewave calibration voltage is available on the front panel.

129 POWER SUPPLY

The TEKTRONIX 129 provides a regulated power supply for 2- and 3-Series Amplifiers and Time-Base Units in a wide variety of low-frequency instrumentation systems. With this power supply the amplifiers can be used to drive recording equipment, X-Y plotters, oscilloscopes or other indicators. The unit is designed for a 19-inch rack. With a cathode follower output card installed, bandwidth is DC to 1 MHz, bandwidth with a passive-divider output card is DC to 100 kHz.

160-SERIES MODULAR INSTRUMENTS

The 2600 Modular Instrument Series is recommended as a replacement for the 160-Series Instruments.

160A POWER SUPPLY

The 160 provides electronically-regulated power for one 360 Indicator unit with up to six 160-Series Generators.

Order 160A POWER SUPPLY \$300

161 PULSE GENERATOR

The 161 generates rectangular pulses from zero to $\pm 50 \text{ V}$ amplitude and 10 μ s to 100 ms duration when an external trigger is received. Output pulse delay is achieved by triggering at a selectable point on a negative-going sawtooth.

Order 161 PULSE GENERATOR\$225

162 WAVEFORM GENERATOR

The 162 produces pulse, gate, and sawtooth output waveforms which can be externally triggered or gated, recurrent, or manually triggered or gated. The unit will serve as a delay generator in conjunction with the 161 or 163, and will supply a sweep voltage to the 360 Indicator. Pulse duration range is 10 μ s to 0.05 s; gate and sawtooth duration range is 100 μ s to 10 s. Repetition rate is 0.1 Hz to 10 kHz. Pulse and gate amplitudes are at least 50 V; negative-going sawtooth runs from at least 145 V to less than 25 V.

Order 162 WAVEFORM GENERATOR \$225

163 PULSE GENERATOR

The 163 generates rectangular pulses from zero to ± 25 V amplitude and 1 μs to 10 ms duration when an external trigger is received. Output pulse delay is achieved by triggering at a selectable point on a negative-going sawtooth.

Order 163 PULSE GENERATOR \$225

360 INDICATOR UNIT

The 360 provides a CRT display when externally provided with X, Y, and Z input voltages. Bandwidth is DC to 500 kHz; vertical deflection factor is $0.05\,V/div$ to $50\,V/div$. Time-base requirement is compatible with the 162.

Order 360 INDICATOR UNIT \$450

160-SERIES OPTIONAL ACCESSORIES

132 POWER SUPPLY

The 132 provides a regulated power supply and amplifier for TEKTRONIX Letter-Series or "1" Series Plug-in Units. Bandwidth is from DC to 16 MHz, depending on Plug-in Unit and lead impedance.

Order 132 POWER SUPPLY, without plug-in units \$650

601 STORAGE DISPLAY UNIT

The 603 is recommended as a replacement for the 601.

The 601 Storage Display Unit provides stored displays of alphanumeric and graphic information from digital computers and other data transmission systems. The TEKTRONIX-developed bistable Storage CRT used in the 601 eliminates the need for costly memory devices for refreshing the information display. The built-in vertical and horizontal differential amplifiers permit Y versus T plots up to 100 kHz for remote storage monitor applications. All solid-state modular circuit design insures long-term stable performance.

Order 601 STORAGE DISPLAY UNIT\$1400

507 OSCILLOSCOPE

The TEKTRONIX 507 is a specialized oscilloscope, designed primarily for high-voltage surge testing of power transformers, high-voltage insulators, lightning arrestors, etc. Careful design of circuitry grounding points ensures minimum sensitivity to extraneous disturbances caused by large voltage transients often introduced into the grounding system.

Order 507 OSCILLOSCOPE\$4300

519 1-GHz REAL-TIME OSCILLOSCOPE

The TEKTRONIX 7904 Oscilloscope is recommended as a replacement for the 519 Oscilloscope.

The TEKTRONIX 519 Oscilloscope is a calibrated, high speed, laboratory instrument, designed for measurement of fractional nanosecond risetimes. Performance features include: bandwidth from DC to beyond 1 GHz, deflection factor 10 V or less, risetime less than 0.35 ns, sweep delay through 35 ns, and a wideband trigger system.

7514 STORAGE OSCILLOSCOPE

For replacement see 7000-Series Storage Family.

The 7514 is a split-screen bistable storage oscilloscope designed to accept all 7000-Series Plug-in Units. The storage section features: Enhanced mode, write thru mode, auto erase and a writing speed up to 60 cm/ms in normal mode (1 cm/µs enhanced mode). Vertical bandwidth is DC to 90 MHz, depending on vertical plug-ins selected.

Order 7514 STORAGE OSCILLOSCOPE, without plug-in units ... \$3500



There are many field services available through Tektronix Field Engineering Offices and Overseas Representatives. It is our intent to consistently provide unequalled product service and support which are available through local offices staffed by employees of Tektronix, Inc. Some of these many services are described below.

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.

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.

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.

MAINTENANCE

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

PRODUCT SERVICE—RECONDITIONING

To help assure adequate product service and maintenance facilities for our customers, Tektronix, Inc. has established Field Engineering Offices and Service Centers at strategic points throughout the United States. Contact your Field Engineer for details concerning • Warranty • Emergency Repairs • Repair Parts • Scheduled Maintenance • Reconditioning and Overhaul • Pick up and Delivery • Maintenance Contracts • On Site Service for Fixed Installations • Instrument Rental and Other Services available through these local offices and centers.

EMERGENCY REPAIR

This service will help you in situations where products require immediate attention. If your TEKTRONIX product malfunctions, or if you want a particular characteristic optimized, just bring it to your local service center. Work starts when you arrive. In most cases we will solve the problem immediately and get you on your way in a matter of minutes.

Should your oscilloscope need emergency attention during field trips, please contact any of our service centers, they will be glad to assist you with repairs and get you on your way—without costly delays.

REPAIR PARTS

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

SCHEDULED MAINTENANCE, RECONDITIONING AND OVER-HAUL

Proper, scheduled maintenance will enable your TEKTRONIX products to deliver many years of dependable service.

Your older TEKTRONIX Products can be reconditioned or completely overhauled, restoring them to catalog specifications. Our service centers are equipped to clean and completely overhaul, both electrically and mechanically, all TEKTRONIX Products.

Want detailed information?
Contact your nearest Tektronix Field Office.



GENERAL TERMS OF SALE AND WARRANTY

Orders should be placed with your Tektronix Field Engineering Office listed on page 315.

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

NET 30 DAYS

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

EXTENDED TERMS OF SALE

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

RENTAL AGREEMENT

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

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

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

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

LEASE AGREEMENT

All new instruments 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 paid-in rentals will be credited toward the purchase price.

Certain Information Display Products are available under an operating lease program. The minimum fixed term of this lease is 12 months and is available on a declining rate basis during the next succeeding two years of renewal. Equipment leased on this program is maintained by Tektronix, Inc. during the term of the agreement.

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

CONDITIONAL SALES CONTRACT

This program provides monthly installment payment terms while TEKTRONIX products are in use. Accessories and parts are not available unless they are associated with the products being purchased. New and used products may be purchased with a deduction for applicable quantity discounts.

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

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

WARRANTY

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

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

SHIPMENT

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

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



Tektronix, Inc.

P. O. Box 500, Beaverton, Oregon 97005

Telephone: (503) 644-0161 Telex: 36-0485 Cable: TEKTRONIX

FIELD ENGINEERING OFFICES

ALABAMA

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

ARIZONA

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

CALIFORNIA

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

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

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

Palo Alto 94303 3750 Fabian Way Phone (415)326-8500, Telex 34-8411 (Info. Disp. Prod. 415-321-7728)

†Mountain View Service Center 2133B Leghorn Street Mountain View 94040 Phone (415)967-2863

San Diego 92111 6841 Convoy Court Phone (714)292-7330, Telex 69-5025

San JoseSuite 1B, 280 Martin Avenue
Santa Clara 95050
Phone (408)296-3010, Telex 34-6439

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

COLORADO

*Denver 6801 So. Yosemite St. Englewood 80110 Phone (303)771-8012, Telex 4-5798

CONNECTICUT

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

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

FLORIDA

*Fort Lauderdale 33311 1871 West Oakland Park Blvd. Phone (305)731-1220, Telex 51-4474 Also serves Puerto Rico and U.S. Virgin Islands From Miami: 944-6948

*Orlando 32803 Suite 185, 1010 Executive Center Dr. Phone (305)894-3911, Telex 56-4465 From The Cape Kennedy Area: 636-0343

Pensacola 32503 Suite 130, 4900 Bayou Blvd. Phone (904)476-1897, Telex 70-2430

GEORGIA

*Atlanta 30329 Suite 106, 1680 Tullie Circle, N.E. Phone (404)633-0344, Telex 54-2233 (Info. Disp. Prod. (404)631-4191)

ILLINOIS

Chicago 1541 Elmhurst Rd. Elk Grove Village 60007 Phone (312)593-2830

Chicago Service Center Unit E 175 Randall Rd. Elk Grove Village 60007 Phone (312)956-1774

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

KANSAS

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

MARYLAND

*Rockville 20852 1500 East Jefferson Street Phone (301)881-6133, Telex 89-8349

MASSACHUSETTS

*Boston 244 Second Avenue Waltham 02154
Phone (617)890-4550, Telex 92-3446
From Providence: (401)739-4771
(Info. Disp. Prod. (617)890-5950)

MICHIGAN

*Detroit 22132 West Nine Mile Road Southfield 48075 Phone (313)358-3122, Telex 23-0692

MINNESOTA

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

MISSOURI

*St. Louis 11331 Natural Bridge Road Bridgeton 63044 Phone (314)731-4696, 7, Telex 44-851

NEW JERSEY

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

Morris Plains 07950 520 Speedwell Avenue Phone (201)540-0330, Telex 13-6479

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

NEW MEXICO

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

NEW YORK

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

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

*Endicott 2314 Watson Blvd. Endwell 13763 Phone (607)748-8291, Telex 932-421

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

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

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

NORTH CAROLINA

*Greensboro 27405 1011 Homeland Avenue P.O. Box 6526 Phone (919)274-4647, Telex 57-4416

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

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

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

OKLAHOMA

*Oklahoma City 73105 901 Office Park Plaza Phone (405)848-3361, Telex 74-7227

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

Factory Service Center Tektronix Industrial Park Beaverton 97005 Phone (503)644-0161, Telex 36-0485

PENNSYLVANIA

Ft. Washington 19034 165 Indiana Avenue Phone (215) 643-4935

†Philadelphia Service Center 1030 W. Germantown Pike Norristown 19401 Phone (215)539-5540, Telex 84-6482

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

Valley Forge 19481 Suite 108 Davis Road and Oakwood Road Phone (215) 783-7711

TEXAS

*Dallas 75240 Phone (214)233-7791, Telex 73-0570 From Austin Area: ENterprise 9915

*Houston 77027 Suite H, 3723 Westheimer Phone (713)622-8141, Telex 77-494 San Antonio 78209

8031 Broadway Phone (512)826-0686, Telex 76-7456

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

VIRGINIA

Alexandria 22304 Suite 11, 5249 Duke Street Phone (703)751-6096, Telex 8-9406 Hampton 23366

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

WASHINGTON

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

WISCONSIN

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

*Field Office/Service Center

+Service Center

BUSINESS INFORMATION

General Information—Customers Outside The United States



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

SERVICE

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

WARRANTY

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

PLEASE DO NOT RETURN INSTRUMENTS OR PARTS BEFORE RECEIVING DIRECTIONS.

WHO TO CONTACT FOR QUOTATIONS, ORDERING INFORMATION & TECHNICAL ASSISTANCE

COUNTRIES WITH TEKTRONIX FIELD OFFICES

AUSTRALIA BELGIUM DENMARK

SWEDEN SWITZERLAND

BELGIUM FRANCE CANADA JAPAN

THE NETHERLANDS

UNITED KINGDOM

COUNTRIES WITH TEKTRONIX DISTRIBUTORS

Contact the distributor in your country as listed on page 317 and 318.

Contact the nearest office listed on page 317.

COUNTRIES WITH NO TEKTRONIX DISTRIBUTOR OR TEKTRONIX FIELD ENGINEERING OFFICE

Please address your inquiries and orders to:

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

INFORMATION AND QUOTATIONS

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

METHOD OF PAYMENT

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

SHIPMENTS

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



INTERNATIONAL FIELD OFFICES

AUSTRALIA

Tektronix Australia Pty. Limited
80 Waterloo Road
North Ryde, N.S.W. 2113
Phone 888-7066, Telex AA 24269
Cable: TEKTRONIX Australia
128 Gilles Street
Adelaide, South Australia 5000
Phone 23-2811
Unit 10, Fyshwick Square
Kembla Street
Fyshwick, A.C.T. 2600
Phone 95-1761
25-27 Alma Road
St. Kilda, 3182
Phone 94-0229

BELGIUM

Tektronix s.a. Av. Jules Cesar 2 1150 Brussels Phone 719848, Telex 26713 Cable: TEKTROBEL

CANADA

Tektronix Canada Ltd.

Montreal 900 Selkirk Street Pointe Claire 730, Quebec Phone (514)697-9110, Telex 05821-570 Cable: TEKANADA 825 - 12th Avenue S.W. Calgary 3, Alberta Phone (403)269-7558, Telex 038-21730

Toronto 133 Wynford Drive Don Mills 403, Ontario Phone (416)445-8650 1792 Courtwood Crescent Ottawa, Ontario K2C 2B5 Phone (613)225-2850, Telex 01-3419

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

Halifax Burnside Commercial Centre 10 Akerley Blvd. Dartmouth, Nova Scotia Phone (902)469-9476, Telex 019-22656

DENMARK

Tektronix A/S

DK - 2880 Bagsvaerd **Krogshojvej** 29 Phone (01)98 77 11, Telex 16482

FRANCE

TEKTRONIX
Z. I. Courtaboeuf, B.P. 13
91 - Orsay
Phone 907 78 27
Telex TEKFRANS 69 332 F
Cable: TEKFRANS Orsay
Centre Regional de Lyon

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

Centre Regional de Nancy 16, rue de la Cote 54 - Nancy Phone (28)27.24.88 Telex TEKNANCY 86 802 F Centre Regional de Nice
16, avenue de la Mer
05 - Villeneuve-Loubet-Plage
Phone (93)31.29.84,
Telex TEKNICE 46 663 F
Centre Regional de Rennes
6 bis, avenue Louis Barthou
35 - Rennes
Phone (99)30.05.30,
Telex TEKTREN 74 829 F
Centre Regional de Toulouse
284, route Saint-Simon
31 - Toulouse
Phone (61)42.04.50,
Telex TEKTOULS 57 791 F

JAPAN

Sony/Tektronix Corporation
9-31, Kitashinagawa - 5, Shinagawa-Ku
Tokyo 141
(P.O. Box 14, Haneda Airport,
Tokyo 149)
Phone 445-0221 (Area 03/Tokyo)
Telex TK 2262, TK 2436, TK 4666
Cable: SONYTEK Tokyo
c/o Takahashi Building North No. 2
2-19 Isemachi Kita-ku
Osaka-shi
530
Phone 312-2751 (area 06/Osaka)
8 Hijie-cho-2 Nakamura-ku
Nagoya
Phone 581-3548 (area 052/Nagoya)

THE NETHERLANDS

Tektronix Holland N.V. Verkoopkantoor Voorschoten Leidseweg 16 (P.B. 39) Voorschoten Phone 01717-6946, Telex 31737

SWEDEN

Tektronix AB Fack 161 20 Bromma 20 Phone 08/98 13 40 Telex 178 31 Tekswed S Cable: TEKTROSWED Stockholm

SWITZERLAND

Tektronix International A.G. Gubelstrasse 11 (P.O Box 57) CH-6301 Zug Phone 042 21.91.92, Telex 78808 Cable: TEKINTAG

UNITED KINGDOM

Tektronix U.K. Limited
Beaverton House
36-38, Coldharbour Lane
(P.O. Box 69)
Harpenden, Herts
Phone Harpenden 61251, Telex 25559
Cable: TEKTRONIX Harpenden

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

7 Shiel House, Shiel Walk Livingston, West Lothian SCOTLAND Phone Livingston 32766/7

INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix, Inc., P.O. Box 500, Beaverton, Oregon, U.S.A. 97005 Telephone: (503) 644-0161 Telex: 36-0485 Cable: TEKTRONIX

ARGENTINA

Coasin S.A.
Virrey del Pino 4071
Buenos Aires
Phone 52-3185, 51-9363 & 52-4368,
Telex 012-2284
Cable: COASIN, Buenos Aires
Lamadrid 188
Cordoba
Phone 2 3707
Alberdi 939
Rosario
Phone 3 1348

BRAZIL

Importacao,

Ambriex S.A.
Rua Ceara, 104 2° e 3° ands.
ZC-29
Rio de Janeiro, GB
Phone: 264-7406
Cable: RAIOCARDIO Rio de Janeiro
Rua Tupi 535
Sao Paulo
Phone 52-7806 & 51-0912
Cable: RAIOCARDIO Sao Paulo
Rua Coronel Vicente, 421-1° andar
Porto Alegre-Est. Rio Grande do Sul
Phone 4-7411
Rua Contria, 578-6° and.
Belo Horizonte
Phone 35-4500

Industria E Comercio

CEYLON

Maurice Roche Limited P.O. Box 61 Colombo Cable: LAXAPANA Colombo

CHILE

Equipos Industriales S.A.C.I. Moneda 812 - Of. 912 (Casilla 13550) Santiago Phone 716 882 & 382 942

COLOMBIA

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

ECUADOR

Proteco Coasin Cia Ltda. Apartado 228A Quito Phone 52-6759

HONG KONG

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

INDIA

Hinditron Services Private Ltd.
Manesha
69/A Nepean Sea Road
Bombay 6
Phone 365344, Telex 2594
Cable: TEKHIND Bombay

KOREA

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

MALAYSIA

Mecomb Malaysia Sendirian Berhad

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

MEXICO

Tecnicos Argostal, S.A.
Av. Jalisco 180
Mexico 18, D.F.
Phone 5-15-85-80, Telex 017-74208
Av Universidad 3335 Norte
Monterrey, N.L.
Phone 51-13-60, Telex 038865
Calz. J. Gonzales Gallo 383
Guadalajara, Jal.
Phone 5-17-26-46 & 5-17-78-12
Telex 068710

NEW ZEALAND

W. & K. McLean, Ltd.
103-105 Felton Mathew Avenue
Glen Innes
(P.O. Box 3097)
Auckland
Phone 587-039 & 587-037
Cable: KOSFY Auckland
5th Floor, Westbrook House
181 Willis Street
(C.P.O. 496)
Wellington
Phone 555-869

PAKISTAN

Pak-Land Corporation
Central Commercial Area
Iqbal Road
P.E.C.H. Society
Karachi 29
Phone 417315 & 418094
Cable: PAKLAND Pakistan
20, Grand Hotel Bldg.
101, Bank Road
Rawalpindi
Phone 68348
Cable: NUCLEAR RAWALPINDI

PERU

Importaciones y
Representaciones
Electronicas, S.A.
Franklin D. Roosevelt 105
Lima
Phone 27-2076
Cable: IREING, Lima

PHILIPPINES

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

SINGAPORE

Mechanical & Combustion Engineering Co. Pte. Ltd. No. 12 Jalan Kilang Redhill Industrial Estate (P.O. Box 46, Alexandra Post Office) Singapore 3 Phone 642361-3 & 632611 Cable: MECOMB

TAIWAN

Heighten Trading Co. Ltd. (P.O. Box 1408) Taipei Republic of China Phone 518324, 518372, 517517 Cable: HEIGHTEN Taipei

THAILAND

G. Simon Radio Co. Ltd. 30, Patpong Avenue, Suriwong Bangkok Phone 30991-3 Cable: SIMONCO Bangkok

URUGUAY

Coasin Uruguaya S.A. Cerrito 617-4° Montevideo Phone 9-79-78 Cable: COAUR Montevideo

VENEZUELA

Coasin C.A. Edificio Eguski

Edificio Eguski Avenida Havana Y Val Paraiso Dos Caobos Apartado Postal 50939 Caracas 105 Phone 728662 Y 72311 Cable: INSTRUVEN, Caracas



INTERNATIONAL DISTRIBUTORS AND REPRESENTATIVES

Supplied and Supported by Tektronix Limited, P. O. Box 36, St. Peter Port, Guernsey, Channel Islands Telephone: Guernsey 23411/2/3/4/5, Telex: 41193

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

ANGOLA

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

AUSTRIA

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

EAST AFRICA (Kenya, Tanzania and Uganda)

Engineering & Sales Co., Ltd. Bankhouse, Government Road (P.O. Box 46658) Nairobi, Kenya Phone 26815

FEDERAL REPUBLIC OF GERMANY

Rohde & Schwarz Vertriebs GmbH 2 Hamburg 50 Grosse Bergstrasse 213-217 (P.O. Box 1226) Phone (1411) 38 14 66 Telex 0 213 749 Cable: ROHDESCHWARZ Hamburg

75 Karlsruhe Kriegsstrasse 39 (P.O. Box 5229) Phone (0721) 2 39 77 Telex 7 826 730 Cable: ROHDESCHWARZ Karlsruhe

5000 Koeln 1 Sedanstrasse 13-17 Phone (Koeln 0221) 77 22 1 Telex 888-5417 Cable: ROHDESCHWARZ Koeln

8 Muenchen 2 Dachauer Strasse 109
Phone (0811) 52 10 41
Telex 0 522 953
Cable: ROHDESCHWARZVERTRIEB Muenchen

WEST BERLIN

Rohde & Schwarz Handels-GmbH Berlin 1 1 Berlin 1 Ernst-Reuter-Platz, 10 Phone (0311) 34 14 03 6 Telex 0 181 636 Cable: ROHDESCHWARZ Berlin

FINLAND

Into O/Y 11, Meritullinkatu (P.O. Box 10153) Helsinki Phone 11123 Cable: INTO, Helsinki

GREECE

Marios Dalleggio Representations

2, Alopekis Street Athens 139 Phone 710.669, Telex 216435 Telex Answer Code: DALM GR Cable: DALMAR Athens

IRAN

Berkeh Company Ltd. 20 Salm Road Roosevelt Avenue Tehran Phone 828294 & 831564 Cable: BERKEHKAR, Tehran

ISRAEL

Eastronics Ltd. 75 Haifa Road (P.O. Box 21029) Tel Aviv Phone 440-466, Telex 033-638 Cable: EASTRONIX Tel Aviv

ITALY

Silverstar Ltd.

Via dei Gracchi No. 20 Milano 20146 Phone 49.96.551/ten lines Telex 32634 SILSTAR Milano Cable: SILVERSTAR Milano

Via Paisiello No. 30 Roma 00198 Phone 85.45.54/85.53.66/86.90.09/ 85.45.29/86.46.29/86.83.92 Telex 61511 SILSTAR Roma Cable: SILVERSTAR Roma Piazza Adriano, 9 Torino 10139 Phone 54.00.75 & 54.35.27 Cable: SILVERSTAR Torino

LEBANON

Projects (P.O. Box 5281) Beirut Phone 251680 Telex 20466LE Cable: PROJECTS Beirut

MOROCCO

F. Pignal, Materiel Radio En Gros 21/29 Boulevard Girardot (P.O. Box 86) Casablanca Phone 702-61 Cable: PIRADIO Casablanca

MOZAMBIQUE

Equipamentos Tecnicos (Mozambique) Lda.

Av. 24 de Julho, 1847 (P.O. Box 310) Lourenco Marques Phone 22601 Cable: EQUIPAL-Lourenco Marques

NORWAY

Morgenstierne & Co. A/S

Konghellegt.3. (P.O. Box 6688 Rodelokka, Oslo 5) Oslo Phone (02) 37 29 40, Telex 1719 Cable: MOROF Oslo

PORTUGAL

Equipamentos de Laboratorio Lda.

Estrada Lisboa - Sintra Amadora P.O. Box 1100 (Casal de Garoto) Lisbon Phone 97 02 51, Telex 1702 Cable: EQUILAB, Lisboa

REPUBLIC OF SOUTH AFRICA

Protea Physical & Nuclear Instrumentation (Pty) Ltd.

(P.O. Box 7793) Johannesburg Phone 838-8351, Telex J7337 Cable: MANLU

SPAIN

C.R. Mares, S.A.

Valencia 333 Barcelona (9) Phone 257.62.00, Telex 54676 Cable: SERAM Barcelona Gaztambide, 60-1° **Madrid** (15) Phone 449-33-00, Telex 27332 Cable: SERAM Madrid

TUNISIA

Selection Internationale 17, Rue Kamel Ataturk Tunis Phone 243.891 & 241.066 Cable: INTERSEL Tunis

TURKEY

M. Suheyl Erkman Necatibey Cad No. 207, Galata Istanbul Phone 441546 Cable: INGMESUER Istanbul

YUGOSLAVIA

Elektrotehna Titova 51 61000 **Ljubljana** Phone 311-233 & 320-241, Telex 31184

ZAMBIA

Baird and Tatlock (Zambia) Ltd. Chandwe Musonda Road (P.O. Box 1038) Lusaka Phone 75315/6, Telex 4277 Cable: PIPETTE, Lusaka Brunell Road (P.O. Box 1097) Ndola Ndola Phone 3522 & 2253/4/6, Telex 3441 Cable: PIPETTE, Ndola



Tektronix, Inc.'s prices are controlled by the Price Commission as a prenotification firm. We are required to justify price changes on the basis of allowable cost increases.

None of the prices quoted herein are in excess of base prices, therefore conspicuous identification of price is not required.

Information regarding the lawful base price or other queries concerning our prices and the Economic Stabilization Act will be furnished upon request. Please direct your inquiry as follows:

Tektronix, Inc. Attn: E. E. Swanson P.O. Box 500 Beaverton, Oregon 97005

and furnish us the following information:

Nature of your query:

TEKTRONIX item or part number

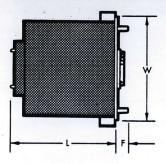
Located on catalog page:

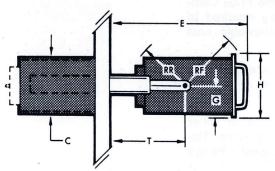
Your name and address:

Upon receipt of your written inquiry we shall furnish you a written reply within 48 hours, signed by an officer of the company.

Instrument Dimensions







RACK MOUNT INSTRUMENTS							
EXCLUSIVE OF PLUG-IN UNITS AND PROBES							
Symbol	Description	Definition					
Н	Height	Height of front panel.					
W*	Width	Width of front panel.					
L	Length	Rack front to rearmost permanent fixture excluding cables.					
F	Forward Clearance	Back of front panel to foremost protrusion.					
G	Vertical Axis	Bottom of front panel to horizontal plane of rotation.					
E sta	Extended Inst.	Maximum forward clearance with instrument out and horizontal.					
RF	Radius — front	Front radius of rotation.					
RR	Radius — rear	Rear radius of rotation.					
Т	Track	Rack front to pivot point.					
С	Cabinet	Cabinet height.					

^{*}Instruments mount to a standard 19-inch wide rack.

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

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

		Term		MOUNTING DIMENSIONS																
			н				F G E			В	RF RR		R		r		c			
PRODUCT			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
R116			5.3	13.3	17.0	44.6	1.6	4.1	1.8	4.5	25.8	65.4	11.6	29.4	8.3	21.0	14.6	37.2	5.1	12.8
R140, R141A, R142 R144, R146, R147, R148, R149			3.5	8.8	18.5	47.1	1.6	4.1	-		24.1	61.3	-	-	_	-	-	-	3.0	7.6
R230, R240, R241, R250, R287, R288			7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
R422			7.0	17.8	12.5	31.8	1.8	4.6	3.5	8.9	16.6	42.3	_	_	_	_	_	_	6.8	17.2
R432, R434			5.3	13.3	18.0	45.7	1.6	4.1	_	_	_	-	_	_	_	_	_		5.3	13.2
R453A, R454A,			7.0	17.8	17.4	44.2	1.8	4.6	3.5	8.9	20.7	52.6	11.6	29.5	7.9	20.0	9.3	23.7	6.8	17.2
R485			7.0	17.8	16.2	41.1	1.8	4.6	3.5	8.9	19.3	50.6	10.9	27.6	7.9	20.2	9.3	23.7	6.8	17.2
R491			7.0	17.8	17.4	44.2	2.1	5.2	3.5	8.9	21.1	53.5	11.9	30.4	8.5	21.6	9.3	23.7	6.8	17.3
R520A, R521A, R522A			7.0	17.8	18.0	45.8	2.0	5.1		. —	23.0	58.4		_	_	_	_	_	7.0	17.8
R556			14.0	35.6	22.8	57.9	1.8	4.5	8.1	20.7	30.3	77.0	13.1	33.3	14.3	36.2	18.5	57.0	13.9	35.2
R561B, R564B			7.0	17.8	18.6	47.3	1.8	4.5	2.4	6.1	24.3	60.8	13.8	34.9	7.9	20.0	11.0	27.9	6.8	17.2
R568			7.0	17.8	21.0	53.3	2.0	5.1	1.8	4.4	28.6	88.8	14.4	36.6	10.2	25.8	15.1	23.6	7.0	17.8
1140A, R1340		χ	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
R4501			5.3	13.3	20.3	51.5	1.9	4.8		_	26.3	67.1	_	_	_	_		_	5.3	13.3
R5103N		-	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
RM529	۴.,		5.3	13.3	18.3	46.4	1.8	4.5	2.4	6.1	21.3	54.1	12.1	30.8	8.4	21.5	9.4	23.8	5.1	13.1
RM565			12.3	31.1	22.2	56.4	1.8	4.6	2.4	6.1	30.5	77.4	15.2	30.8	13.1	33.2	16.6	42.2	12.2	31.0
S54AR			5.3	13.3	17.8	45.1	_	-	-	/	_		_	_	_	_	_	_	5.3	13.3
129			10.5	26.6	21.6	55.0	2.0	5.1	1.8	4.5	29.5	74.9	17.6	44.8	11.1	28.3	13.3	33.7	10.5	26.8
650 Series			10.5	26.7	12.2	31.0	1.7	4.9	4.9	12.7	21.5	54.7	_	_	_	_	_		10.5	26.7
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	Mary 1		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
473-0071-00			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



SHIPPING VOLUMES

741	Domestic Pack	Export Pack
Туре	ft³	ft ^a
C-5 C-10 C-12 C-27 C-30A	0.6 1.5 2.3 2.3 1.0	1.3 3.0 4.5 4.5 3.0
C-31 C-32 C-50 C-51 C-52	1.0 1.0 2.2 2.2 2.2	3.0 3.0 3.7 3.7 3.7
C-53 C-58 C-59 D51 D54	2.2 2.2 2.2 1.5 1.7	3.7
D54R DM501 D66 D67 D83	2.6 0.7 1.8 1.8 2.5	8
DC 501 DC 502 DC 503 DM64 Engine	0.7 0.7 0.7 2.1	
Ana. Acc. FG 501 J-16 PG 501 PS 501 PS 502	2.2 0.7 0.8 0.7 0.7	3.4
PS 503 RG 501 S-1 S-2 S-3A	0.7 0.7 0.1 0.1 0.7	1.3 1.3 1.6
S-4 S-5 S-6 S-50 S-51	0.1 0.1 0.1 0.1 0.1	1.3 1.3 1.3 1.3 1.3
S-52 S-53 S-54 S51B S54A	0.1 0.1 0.1 1.4 1.4	1.3 1.3 1.3
S54AR S54U SG 502 TM 501 TM 503	2.6 2.2 0.7 0.3 1.7	e positie
1A1 1A4 1A5 1A7A 1L5	0.8 1.1 0.8 0.8 1.1	1.3 2.1 1.3 1.3 1.3
1L20 2A63 2B67 3A3 3A6	1.1 1.1 1.1 1.1 1.1	1.3 1.6 1.6 1.6 1.6
3A7 3A8 3A9 3A10	1.1 1.1 1.1 1.1	1.6 1.6 1.6 1.6

	SHIPPI					
	Domestic Pack	Export Pack				
Туре	fts	ft ³				
3A72	1.1	1.6				
3A74	1.1	1.6				
3A75	1.1	1.6				
3B3	1.1	1.6				
3B4	1.1	1.6				
3L5	1.1	1.6				
3S2	1.6	3.0				
3S5	1.6	3.0				
3S6	1.6	3.0				
3S7	1.1	1.6				
3T2	1.1	1.6				
3T5	1.1	1.6				
3T6	1.1	1.6				
3T7	1.1	1.6				
5A13N	0.7	1.6				
5A14N	0.7	1.6				
5A15N	0.7	1.6				
5A18N 5A19N	0.7 0.7	1.6				
5A20N	0.7	1.6				
5A21N 5A22N	0.7 0.7	1.6				
5A23N	0.7	1.6				
5A24N	0.7	1.6				
5B10N	0.7	1.6				
5B12N	0.7	1.6				
5B13N	0.7	1.6				
5CT1N	0.7	1.6				
7A11	1.3	2.1				
7A12	1.3	2.1				
7A13	1.3	2.1				
7A14	1.3	2.1				
7A15A	1.3	2.1				
7A16A	1.3	2.1				
7A17	1.3	2.1				
7A18	1.3	2.1				
7A19	1.3	2.1				
7A21N	1.3	2.1				
7A22	1.3	2.1				
7B50	1.3	2.1				
7B51	1.3	2.1				
7B53A	1.3	2.1				
7B53AN	1.3	2.1				
7B70	1.3	2.1				
7B71	1.3	2.1				
7B92 7CT1N	1.3	2.1				
7D11	1.3	2.1				
7D13	1.3	2.1				
7D14 7D15	1.3	2.1 2.0				
7L12	1.3	2.1				
7M11	1.0	2.0				
7S11	1.3	2.1				
7S12 7T11	1.3 1.3	2.1				
26A1	1.3	2.1				
26A2	1.3	2.1				
26G1	1.3	2.1				
26G2	1.3	2.1				
26G3	1.3	2.1				
106	1.4	3.0				
109	0.8	1.3				
113	4.7	7.0				
114	1.4	3.0				

Туре	Domestic Pack ft ³	Export Pack ft ³
115	1.4	3.0
R116	5.2	9.2
130	1.1	2.1
172	2.0	3.0
176	2.0	3.0
191 200-1B 200-2 201-1 201-2	1.4 10.0 10.0 13.4 13.4	3.0
202-1 202-2 203-2 203-3 204-2	13.4 13.4 10.8 10.8 12.5	=
204-3 205-1 205-2 205-3 206-1	12.5 20.0 20.0 20.0 9.7	-
207-1 R250 284 285 286	4.3 0.6 5.2 0.4 5.2	1.3 9.2 1.3 9.2
R288	5.2	9.2
323	5.2	9.2
324	5.2	9.2
326	1.4	3.0
410	0.7	1.6
422	5.2	9.2
R422	1.5	3.0
324	1.5	3.0
326	2.0	3.9
410	2.0	3.7
422	3.9	5.3
R422	5.2	9.2
432	2.9	4.1
R432	5.2	9.2
434	2.9	4.1
R434	5.2	9.2
453A-1	3.9	5.9
R453A-1	5.2	9.2
453A-2	3.9	5.9
R453A-2	5.2	9.2
453A-3	3.9	5.9
R453A-3	5.2	9.2
453A-4	3.9	5.9
R453A-4	5.2	9.2
454A	3.9	5.9
R454A 465 475 485 R485	5.2 3.3 3.3 2.7 5.2	9.2
491	3.9	5.3
R491	5.2	9.2
556	10.7	11.2
R556	10.8	11.1
561B	4.0	5.2
R561B	5.2	9.2
564B	4.0	5.2
R564B	5.2	9.2
565	6.9	9.2
RM565	6.9	9.2

	Domestic Pack	Export Pack
Туре	ft³	ft³
568 R568	5.2 5.2	9,2 9,2
576	9.1	11.2
602 603	2.2 3.3	5.2
604	2.2	5.2
611 613	6.6 1.8	7.4
1140A R1340	5.2 5.2	9.2 9.2
1401A	1.3	3.0
1430 1501	0.9 1.2	
1781 1791	6.4 12.2	le le
2101	1.4	3.0
2601 R2601	5.1 5.0	9.2 9.2
2620	0.6	
2901 4010	1.4 11.3	3.0
4501 4551	5.2	9.2 3.0
4601	6.4	9.2
4602 4610	6.4	
4620	6.4 6.4	- 5
4701 5103N/	2.6	
D10	3.3	
5103N/ D11	3.3	n. da
5103N/ D12	3.3	
5103N/ D13	3.3	
5103N/	5.0	
D15 7313	3.3 4.4	
7313 R7313	6.3	
7403N	4.4	7.4
R7403N 7603	6.3 4.4	
R7603	6.3	
7603N opt. 11	4.4	
7603N		
opt. 11s 7613	4.4	
R7613 7623	6.3 4.4	me rie
R7623	6.3	190
7704A R7704	5.6 6.3	8.6
7904	5.8	
		thering
S#1017		ni kr

BUSINESS INFORMATION

Symbols And Abbreviations



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

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

Below are some of the symbols and abbreviations used in this catalog. Those symbols found in ANSI Y10.19-1969 are marked with an asterisk.

alternating current	AC	graticule	grat	*ohm	Ω
*ampere	A	gravity unit	g	operational amplifier	op amp
amplitude modulation	AM	greater than	>	oscilloscope s	cope or CRO
approximate	approx	greater than or equal to	5	oscilloscope s	cope of end
approximately equal to	\approx or \approx	ground	> > gnd		
attenuation	\sim 01 $-$	0	gna	pair	pr
audio frequency	AF	*henry	Н	parts per million	P/M
automatic		*hertz	Hz	peak to peak	P-P
automatic	auto	horsepower	hp	per	1
bandwidth	bw	*hour	h	phase alternate line	PAL
base	b	1 2000		*pico	
*bel	B	impedance	Z	The state of the s	p - A
beta	β	*inch	in	picoampere	pA
beld	ρ	inductance	L	*picofarad	рF
calibrate	cal	intermediate frequency	IF	picosecond	ps
candela	cd	5.6.	3	plus	. +
cathode-ray oscilloscope CRC	or scope	kilo	. k	plus and minus	+ and $-$
cathode-ray tube	CRT	*kilogram	kg	plus or minus	± ,
*centimeter	cm	*kilohertz	kHz	positive	pos
clockwise	cw	*kilohm	$k\Omega$	pulse per second	p/s
common-mode rejection	CMR	*kilometer	km	pulse-repetition rate	PRR
	CMRR	*kilovolt	kV	pulse width	PW or tp
common-mode rejection ratio		100		Chart 1	
continuous wave	CW	less than	< < ∠ LED		e RFI
counterclockwise	ccw	less than or equal to	\leq	radio-frequency interference	
current	1	light emittng diode		resistance	R
*decibel	dB	local oscillator	LO	resistance-capacitance	RC
decibel referred to one	uв	low frequency	LF	resistance-inductance	RL
milliwatt	dBm	lumen	lm	*revolution per minute	r/min
deflection factor	DF			risetime	t _r
	ο Ο Γ	maximum	max	root mean square	RMS
*degree (plane angle)	°C	*mega	M	~	
*degree Celsius (centigrade)		*megahertz	MHz	*	_
*degree Fahrenheit	°F	*megohm	$M\Omega$	*second (time)	S
*degree Kelvin	K	*meter	m	serial number	SN
delay	dly	*micro	μ	signal	sig
delay line	DL	*microsecond	μ s	signal-to-noise ratio	S/N
differential	diff	*microwatt	μW	standing-wave ratio	SWR
direct current	DC	*milli	m	storage time	ts
division	div	millicandela	mcd	sweep	swp
The speciment of the second	566	*millimeter	mm	synchronize	sync
electrocardiogram	ÉCG	*millisecond	ms	1.49	
electroencephalogram	EEG	*millivolt	mV	temperature	T
electromagnetic interference	EMI	minus	_	time domain reflectometry	TDR
*farad	F	Ana -	1 1	tolerance	tol
*foot	ft	*nano	n	transconductance	g _m
*footcandle	fc	*nanometer	nm	nansconducidnes	9m
*footlambert	fC fL	*nanosecond	ns	the state of the s	
		nano watt	nW	vertical interval test signal	VITS
frequency modulation	FM	National Television	NTSC	*volt	٧
giga	G	System Committee		TABS (5)	
*gigahertz	GHz	negative	neg	*watt	W
3.34	0112	U.A. CLEE	9		



CONCEPT BOOKS

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

CIRCUIT CONCEPTS

Digital Concepts	062-1030-00	\$ 2.50					
Horizontal Amplifier Circuits*	062-1144-00	2.50					
Oscilloscope Cathode-Ray Tubes*	062-0852-01	2.50					
Oscilloscope Probe Circuits*	062-1146-00	2.50					
Oscilloscope Trigger Circuits*	062-1056-00	2.50					
Power Supply Circuits*	062-0888-01	3.00					
Sampling Oscilloscope Circuits	062-1172-00	4.00					
Spectrum Analyzer Circuits	062-1055-00	3.50					
Storage Cathode-Ray Tubes and Circuits	062-0861-01	2.50					
Sweep Generator Circuits*	062-1098-01	2.50					
Television Waveform Processing Circuits	062-0955-00	3.50					
Vertical Amplifier Circuits*	062-1145-00	6.00					
*7-book set covering Real-time							
Oscilloscopes	062-1180-00	21.50					
MEACUDEMENT CONCEDTS							

MEASUREMENT CONCEPTS						
Automated Testing Systems	062-1106-01	4.00				
Biophysical Measurements	062-1247-00	6.50				
Engine Analysis	062-1074-00	2.50				
Information Display Concepts	062-1005-00	2.50				
Probe Measurements	062-1120-00	2.50				
Semiconductor Devices	062-1009-00	3.00				
Spectrum Analyzer Measurements,						
Theory and Practice	062-1334-00	4.50				
Television System Measurements	062-1064-00	2.50				
Time-Domain Reflectometry Measure-						
ments	062-1244-00	2.50				
Transducer Measurements	062-1246-01	4.00				

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 TEK-TRONIX products.

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.

POWER

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

Most TEKTRONIX instruments are designed for operation from a power source with its neutral at or near ground (earth) potential.







They are not intended for operation from two phases of a multiphase system, or across the legs of a single-phase three-wire system (220 V).

TEKTRONIX instruments are equipped with either a three-conductor attached power cord, or a three-terminal power cord receptacle. The third wire, or terminal, is connected directly to the instrument frame, and is intended to ground the instrument to protect operating personnel, as recommended by national and international safety codes. Color coding of the power cord conductors follows the National Electrical Code ANSI C1-1971: the line conductor is black; the neutral is white; the safety earth or ground is green with a yellow stripe.



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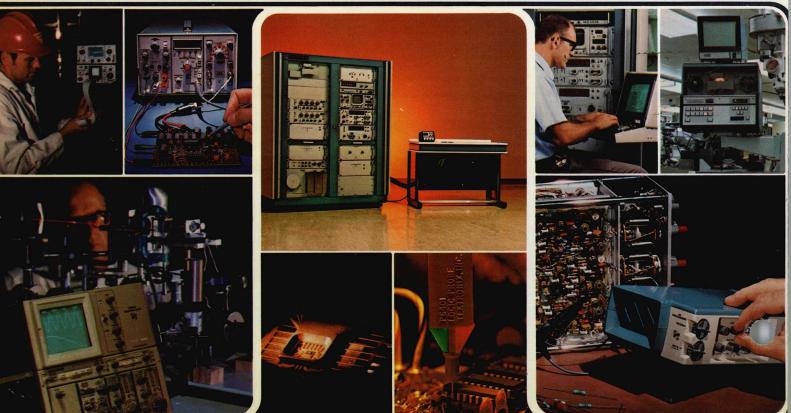
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